Eleonora Andrea Costa Santos

EXTERNALTIES FROM FOREIGN DIRECT INVESTMENT:

EVIDENCE FROM MANUFACTURING FIRMS IN PORTUGAL

Tese de doutoramento em Economia, orientada pelas Professoras Doutoras Maria Adelaide Pedrosa Silva Duarte e Marta Cristina Nunes Simões e apresentada à Faculdade de Economia da Universidade de Coimbra

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FEUC FACULDADE DE ECONOMIA
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Tese de doutoramento na área científica de Economia, apresentada à Faculdade de Economia da Universidade de Coimbra, para a obtenção de grau de Doutor. Orientada pelas Professoras Doutoras Maria Adelaide Pedrosa Silva Duarte e Marta Cristina Nunes Simões.

Coimbra, 2017

In memory of Professor Sanjaya Lall

(1940-2005)

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RESUMO

Muitos países se têm empenhado em atrair Investimento Direto Estrangeiro (IDE), liberalizando a sua legislação sobre investimento estrangeiro e concedendo incentivos aos projetos de investimento estrangeiro, incluindo benefícios fiscais.

A razão para essas políticas decorre da expectativa de ocorrência de externalidades de IDE, uma vez que as empresas estrangeiras possuem vantagens tecnológicas, como conhecimentos, capacidades de marketing e de gestão e experiência internacional, que podem ser transmitidas para as empresas nacionais, através de diferentes canais e podem estimular a mudança tecnológica no país hospedeiro.

Nós baseamo-nos em modelos macroeconómicos de difusão tecnológica para revelar os padrões empíricos de externalidades do IDE na indústria transformadora portuguesa, utilizando um novo conjunto de dados em painel balanceado, com um total de 5.045 empresas (nacionais e estrangeiras) para o período 1995-2007. Posteriormente, tentamos fazer recomendações de política tendentes ao aumento da produtividade e ao crescimento económico, através da análise da dinâmica de transição no processo de convergência real, em que o mecanismo de recuperação tecnológica permite relacionar o IDE com a produtividade, agrupada por grupos tecnológicos, de acordo com Pavitt (1984).

Em contraste com a literatura anterior para a indústria transformadora portuguesa que revela resultados controversos para o período 1996-2000, os nossos resultados parecem confirmar que a presença estrangeira está correlacionada positiva e significativamente com o crescimento da produtividade total dos fatores, mas apenas em certas indústrias e dependendo do tamanho das empresas nacionais. Com um desfasamento de um período, encontramos externalidades positivas em pequenas empresas nas indústrias escala-intensivas, através de ligações para trás (metais básicos e outro equipamento de transporte) e através de ligações para a frente (produtos metálicos).

A nossa pesquisa destaca o fato de que a natureza heterogénea das empresas da indústria transformadora, a distribuição desigual de externalidades entre indústrias, e o fato das externalidades requererem algum tempo para se materializarem, requer a utilização de modelos dinâmicos com dados em painel e uma análise desagregada por grupos tecnológicos e dimensão das empresas.

Visando a prossecução dos nossos objetivos de pesquisa, começamos por analisar os mecanismos de transmissão de externalidades do IDE para a produtividade das

empresas nacionais, com foco nas ligações com clientes (ligações para trás) e fornecedores estrangeiros (ligações para a frente). Nós concentramo-nos em cinco países da Europa Ocidental, com vista a fornecer uma imagem mais ampla dos fatores determinantes das externalidades do IDE em países desenvolvidos, através da sua classificação, de acordo com a Teoria das Empresas Heterogéneas. Tal permite uma melhor compreensão das variáveis relevantes a incluir nos estudos empíricos que se concentram nos países desenvolvidos, e que são: a *concentração*, as *despesas em I&D* (de empresas nacionais e estrangeiras), a *escala*, o *hiato tecnológico* e a *intensidade capitalística* das empresas.

Além disso, utilizando imputação múltipla no Stata 13.0, construímos uma base de dados que integra um número significativo de variáveis necessárias para investigar empiricamente a existência de externalidades de IDE na indústria transformadora Portuguesa. As variáveis, recolhidas das bases de dados AMADEUS, Quadros do Pessoal, EU Klems e OCDE, medem três dimensões: produtividade total dos fatores (PTF), presença estrangeira e variáveis que podem influenciar a produtividade das empresas nacionais, direta ou indiretamente, ou seja, afetando o impacto da presença estrangeira na PTF, tais como indicadores de eficiência da empresa e atividades de I&D.

Os nossos dados em painel fornecem um conjunto de 15 indicadores úteis para 4.685 empresas nacionais e 360 empresas com capital estrangeiro, na indústria transformadora. A análise empírica segue uma estratégia de duas etapas. Primeiro, utilizamos o estimador Wooldridge-Levinshon e Petrin, que é considerado um método robusto para estimar a PTF. Em seguida, regredimos a PTF em diversas variáveis explicativas usando o estimador SYS-GMM que é não-enviesado e consistente na presença de variáveis omitidas e variáveis explicativas endógenas. O nosso modelo dinâmico contempla desfasamentos temporais até dois períodos. A nossa análise ao nível agregado (i.e., para o conjunto dos ramos da indústria transformadora) permitiu encontrar resultados positivos e significativos, com um desfasamento temporal de um período, através de ligações para trás e de ligações para a frente. No entanto, encontramos externalidades horizontais negativas nos três períodos considerados, bem como externalidades verticais negativas, quer no período corrente, quer com um desfasamento de dois períodos. A análise empírica com desagregação por indústrias (classificadas por grupos tecnológicos), e controlando a dimensão das empresas, revelou que as empresas (pequenas e grandes) das indústrias escala-intensivas, e as pequenas empresas em indústrias baseadas na ciência, beneficiam de externalidades positivas significativas.

Finalmente, analisamos a relação entre os fluxos de entrada de IDE e um conjunto de indicadores de inovação (como as despesas de I&D em percentagem do PIB e o número de publicações científicas) e indicadores de capacidade de absorção (como o PIB per capita e o número de licenciados). O nosso objetivo é duplo. Primeiro avaliamos se os fluxos de entrada de IDE, nos últimos 30 anos de integração europeia, contribuíram para aumentar a produtividade. Em segundo lugar, avaliamos a eficácia das políticas de IDE para promover a inovação e a sua coordenação com medidas destinadas a promover a capacidade de absorção. Para promover a inovação, a agência de promoção de investimentos (AICEP) deverá continuar a encorajar os projetos de investimento estrangeiro nas indústrias tradicionais, porque estas parecem beneficiar mais de externalidades verticais do IDE, seguidas pelas indústrias onde Portugal possui uma vantagem comparativa. Em relação à capacidade de absorção, sugerimos novas estratégias, como a retoma do foco na produtividade e a articulação desse objetivo com a política de inovação para apoiar a investigação e a educação.

Como provamos que a convergência real não é um processo automático desencadeado pela presença estrangeira, sugerimos que o processo de convergência deve ser assistido por um reforço das medidas do lado da oferta, com uma política industrial integrada, favorecendo certos ramos da indústria transformadora onde há evidências de externalidades positivas do IDE. Isto é crucial porque, Portugal é uma pequena economia aberta que a torna vulnerável a fatores externos que impedem o crescimento económico. Desde o novo milénio, o país perdeu as vantagens de atraso de que tinha vindo a beneficiar desde a década de 1950. Além disso, a crise financeira global levou a uma queda na produção industrial, acompanhada por uma redução na atração de IDE. Neste contexto, a transferência de tecnologia que pode ocorrer devido à presença estrangeira pode contribuir para o aumento da PTF e promover o crescimento económico a longo prazo, em particular, na indústria transformadora, que é um setor motor de mudança tecnológica, na medida em que tem capacidade para gerar elevadas taxas de inovação e possui capacidade de arrasto para outros setores da economia.

As nossas recomendações de política quanto ao tipo de projetos de IDE que devem ser captados para a indústria transformadora constituem um importante contributo. Tanto quanto é do nosso conhecimento, não existem tentativas anteriores de realizar uma análise normativa da política de promoção de investimentos em Portugal, além daquelas inerentes à esfera de ação da AICEP, que não podem ser divulgadas para a comunidade académica.

ABSTRACT

Many countries strive to attract Foreign Direct Investment (FDI) by liberalizing their FDI regulations and providing investment incentives, including lower income taxes or income tax holidays, as well as import duty exemptions. The rationale for these policies stems from the expectation of externalities from FDI, since foreign firms possess technological advantages such as advanced know-how, marketing and managerial skills and international experience that can be transmitted to domestic firms through different channels, and may stimulate technological changes in the host country.

We draw on macroeconomic models of technology diffusion to uncover empirical patterns of externalities from FDI for the Portuguese manufacturing sector, using a new balanced panel dataset with a total of 5,045 manufacturing firms (domestic and foreign) for the period 1995-2007. Subsequently, we attempt to make policy recommendations to boost productivity and growth, through the analysis of the transitional dynamics under the real convergence process, in which the mechanism of technological catching-up allows to relate FDI with the manufacturing productivity, clustered by technological groups, following Pavitt (1984).

In contrast with earlier literature for the Portuguese manufacturing sector, that find controversial results for 1996-2000, our results seem to confirm that foreign presence is positively and significantly correlated with TFP growth, but only in certain industries and depending on the size of the domestic firms. In one-period lag, we find positive externalities in small firms in scale-intensive industries, through backward linkages, (basic metals and other transport equipment) and through forward linkages (metal products).

Our research highlights the fact that the heterogeneous nature of manufacturing firms and the uneven distribution of externalities across industries that entail time to occur, require the use of dynamic models with panel data disaggregated by technological groups and firm size.

To pursuit our research objectives, we start by analysing the transmission mechanisms of externalities from FDI to the productivity of domestic firms, focusing on linkages with foreign customers (backward) and suppliers (forward).

We focus on five Western European countries to provide a broader picture of the determinant factors of externalities from FDI in Developed Countries (DCs), through its classification, along the lines of the Theory of Heterogeneous Firms. This allows for a better understanding of the relevant variables to include in the empirical studies that focus on DCs, which are *concentration*, domestic and foreign *R&D expenditures*, *scale*, *technological gap*, and *capital intensity*.

In addition, applying multiple imputation in Stata 13.0, we construct a database that integrates a significant number of the variables necessary to empirically investigate the existence of externalities from FDI in the Portuguese manufacturing sector. The variables, collected from AMADEUS, *Quadros do Pessoal*, EU Klems and OCDE databases, measure three dimensions: Total Factor Productivity; foreign presence; and variables that may influence the productivity of domestic firms, either directly or indirectly, i.e., affecting the impact of foreign presence on the Total Factor Productivity, such as indicators of firm efficiency and R&D activities,

Our new panel data provides a set of useful 15 indicators for 4,685 domestic firms and 360 firms with foreign capital, in the manufacturing sector. The empirical analysis follows a two-stage strategy. First, we employ the Wooldridge-Levinshon and Petrin estimator, which is considered a robust method to estimate the TFP. Then, we regress the TFP on several explanatory variables using the system-GMM estimator that is unbiased and consistent in the presence of omitted variables and endogenous explanatory variables.

Our dynamic model consider time lags up to two periods. Our analysis at the aggregate level (i.e. for the whole manufacturing sector) shows positive and significant externalities via backward and forward linkages, in one-period lag, However, we found negative horizontal externalities in the three periods, as well as negative vertical externalities, both in the current period and with a two-period lag. The analysis with industry breakdown (classified by technological groups), and controlling for firm size, showed that firms (small and large) of scale-intensive industries, and small firms in science-based industries, benefit from positive externalities.

Finally, we analyse the relationship between FDI inward flows and a set of innovation (such as R&D expenditures as a percentage of GDP and the number of scientific publications) and absorptive capacity indicators (such as the GDP per capita and the number of graduates). The purpose is twofold. First, we assess whether FDI inflows, during the last 30 years of European integration, have contributed to increase the productivity, Secondly, we evaluate the efficacy of FDI policies to promote innovation and its coordination with measures aiming to promote the absorptive capacity. To promote innovation, the Investment promotion agency should continue to encourage foreign projects in traditional industries because they appear to benefit more from vertical externalities from FDI, followed by the industries where Portugal has a comparative advantage. Regarding absorptive capacity, we suggest new strategies, such as the resumption of focus on productivity and the articulation of this goal with the innovation policy to support research and education.

Since, as we have proved, that real convergence is not an automatic process triggered by foreign presence, we suggest that, it can be assisted by a reinforcement of supply-side measures, with an integrated industrial policy, favouring certain industries where there is evidence of positive externalities from FDI. This is crucial because, Portugal is a small open economy that makes it vulnerable to external factors that hinder the economic growth. Since the new millennium, the country lost the backwardness advantages from which it benefited since the 1950's. In addition, the global financial crisis led to a drop in industrial production accompanied by a reduction in FDI attraction. In this context, technology transfer, that can occur due to foreign presence, can increase the TFP and promote long-term growth, especially in the manufacturing sector, which is a driver of technological change, because it can generate high rates of innovation and drag capabilities to other sectors.

Our policy recommendations regarding the kind of FDI projects to attract to the manufacturing sector represent an important contribute since, to the best of our knowledge, there are no prior attempts to perform a normative analysis of the investment promotion policy in Portugal, other than those that are inherent to the sphere of action of AICEP, which cannot be disclosed to the academic community.

Keywords: firm-level data, productivity, FDI Externalities, Portugal

JEL classification: F15, F23, O1, O3, O4

LIST OF ABBREVIATIONS

2SLS-Two-Stage Least Squares

3SLS- Three-Stage Least Squares

ANBERD-Analytical Business Enterprise Research and Development

AR(1)- First Order Autoregressive Process

AR(2)- Second order Autoregressive Process

ARD- Annual Census of Production Respondents

AB-Arellano-Bond

BvD- Bureau van Dijk

CEEC- Central and Eastern European Country

CSF-Community Structural Funds

DV-Dependent Variable

DC-Developed Country

EFAP- Economic and Financial Assistance Programme

EU- European Union

EA-Euro Area

EC-European Commission

EEC-European Economic Community

FDI-Foreign Direct Investment

GDP-Gross Domestic Product

GMM- Generalized Method of Moments

GVA-Gross Value Added

ICT- Information and Communication Technology

INE- Instituto Nacional de Estatística

IES-Informação Empresarial Simplificada

IPR-Intellectual Property Rights

IPA-Investment Promotion Agency

LDC-Least Developed Country

LP-Levinsohn-Petrin

MA(1)- First Order Moving Average Process

MS-Member States

M&A- Mergers & Acquisitions

MNC-Multinational Corporation

NACE- European Classification of Economic Activities

OLS-Ordinary Least Squares

PR-Performance Requirements

IRC- Imposto sobre o Rendimento das Pessoas Coletivas

AICEP-Agência para o Investimento e Comércio Externo de Portugal

PPI-Producer Price Index

QP-Quadros do Pessoal

R&D -Research and Development

Rev.-Revision

SME- Small and Medium Enterprise

OECD- Organisation for Economic Cooperation and Development

TFP-Total Factor Productivity

UK- United Kingdom

UNCTAD- United Nations Conference on Trade and Development

WLP-Wooldridge, Levinsohn and Petrin

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INTRODUCTION

Background

There is a general consensus among scholars that Foreign Direct Investment (FDI) can stimulate technological changes through the adoption of foreign technology, know-how and externalities, therefore boosting technological catch-up and promoting economic growth in host countries. However, FDI may also generate crowding-out effects on domestic investment, detrimental competition of foreign affiliates with domestic firms, market-stealing effects and create a risk for external vulnerabilities.

Externalities from FDI may be horizontal or vertical. Horizontal externalities occur when the entry of the MNC generates positive externalities for local competitors. Vertical externalities arise from the linkages between MNCs and their local suppliers/customers (backward/forward linkages).

In this thesis, we set out to determine whether and under which conditions do domestic manufacturing firms benefit from externalities from FDI in Portugal. The issue of whether there are positive and significant externalities from FDI in the manufacturing sector is crucial since Portugal is a small open economy facing restrictions arising from an economic crisis that has hampered productivity growth. Nevertheless, most of the few existing firm-level panel data studies for Portugal (Farinha and Mata, 1996; Proença et al., 2002; Crespo et al., 2009, 2012) are focused only on horizontal externalities. This thesis, by contrast, investigates the occurrence of both horizontal and vertical externalities from FDI. Additionally, those studies are largely inconclusive as they use different data sources and methodologies; and they do not consider firm heterogeneity across industries nor the fact that externalities need time to occur.

Therefore, there is a need for further research that can provide a broader picture of externalities from FDI through the differentiation of these effects according to their diverse channels, the construction of a consistent data set; the inclusion in the analysis of vertical externalities and their dynamic effects, using up-to-date econometric techniques.

Research questions and objectives

Research Questions

This study will focus on externalities from FDI on the productivity of Portuguese domestic manufacturing firms. The prime research questions are as follows:

1) Are there positive and significant FDI externalities in the Portuguese manufacturing firms?

FDI may cause positive direct effects on host economies, such as capital formation, job creation, increased tax revenue and shifts in the production and exports of host countries; and, indirect effects, which involve the access to foreign technology, because MNCs' advanced technology (including marketing and knowledge management, etc) makes them more efficient than their domestic counterparts. Thus, the access to foreign technology by domestic firms may allow them to increase their productivity. However, FDI effects are not always positive and may depend on the level of development of the host countries. Nonetheless, studies investigating the effects of FDI in Developed Countries show mixed results.

2) What kind of externalities?

Externalities from FDI may be horizontal or vertical. Horizontal externalities refer to the effects on domestic competitors; while vertical externalities are caused by linkages between foreign firms and their domestic suppliers/customers. The empirical evidence on externalities from FDI suggests that vertical externalities are more likely to occur than horizontal externalities, for many reasons. First, it is easier to learn generic technologies than to absorb and adopt specific rivals' technologies; Second, horizontal externalities from FDI are more likely to generate losses of profits for MNCs than vertical externalities; third, if MNCs do not compete directly with domestic firms, then they will not have an incentive to prevent the spread of technology to domestic firms. However, in practice, the role of FDI as a catalyst for TFP growth is controversial. While studies in Developing or Transition Economies find that backward linkages are more likely to occur than forward linkages; research in small Developed Countries found that resource sharing via forward linkages may be more important, than via backward linkages, for instance regarding product innovation through collaboration with foreign suppliers.

3) In which industries do externalities from FDI occur?

This information is crucial to assist the government and the Investment Promotion Agency (AICEP) regarding the strategies to adopt, concerning the type of projects to promote; and articulate those strategies with the Industrial Policy, to maximize the benefits for the Portuguese economy.

4) What are the policy implications?

This is relevant to evaluate the effectiveness of public policies regarding the fulfilment of real convergence.

Objectives

Bearing in mind the research questions, the objectives of this thesis are defined as follows:

1) To investigate the existence of externalities from FDI in the Portuguese manufacturing sector, over the period 1995-2007, and discuss their nature, sign and magnitude; as well as their determinant factors.

2) To construct a consistent database for the empirical analysis of externalities from FDI in the Portuguese manufacturing sector.

3) To make policy recommendations regarding the type of foreign projects to attract and maintain; in order to maximize the benefits for the Portuguese economy, in terms of TFP increase.

Research Methodology and Methods

Our research is based, first, on the elaboration of a framework to conduct the empirical analysis, and on that basis, we researched and consulted an extensive theoretical and empirical bibliography, especially concerning externalities from FDI, with a focus on vertical externalities in the Western European Countries.

Moreover, the lack of a database that integrates a significant number of the variables necessary to empirically investigate the existence of externalities from FDI in Portugal represents an important limitation. Thus, we construct a new balanced panel dataset containing several variables taken from AMADEUS, *Quadros do Pessoal*, EU Klems and OCDE databases. The database includes three types of variables: those necessary to estimate the Total Factor Productivity; those related to foreign presence; and determinant factors of externalities from FDI, such as indicators of firm efficiency and R&D activities. This data set contains 5,045 manufacturing firms (domestic and foreign) for the period 1995-2007 and provides a group of 15 reliable indicators for the analysis of externalities from FDI, in 4,685 domestic manufacturing firms.

We chose 1995 as our starting year because the Foreign Investment Code, that liberalizes foreign investment and allows foreign investors to apply for state aid, came into force in that year. Because this law was created to promote foreign investment and, thus, to facilitate the occurrence of productivity externalities from FDI, the inclusion of prior years in our sample would not likely to conduct to positive externality effects. On the other hand, TFP can be expressed in terms of technological progress- that includes positive externalities, which are a driver of economic growth- and efficiency. Since Amador and Coimbra (2007) show that, in 1995-2005, the contribution of efficiency was negative due to investment in assets with low return, there is scope for research on the existence of positive productivity externalities in that period. Another reason for the choice of this period of 13 years is related to comparison purposes. Indeed, our dataset shares the period 1996-2000 with the studies of Proença et al. (2002) and Crespo et al. (2009, 2012), whose results are controversial. Nonetheless, we wanted to include more years in our sample, for which there are no empirical studies. Hence, we have extended the time from 2001 to 2007. We chose not to include the years after 2007, despite the inclusion of year dummies in all regressions, because there was the possibility that the size of the aggregate shocks during the global financial crisis of 2008, and in the previous recessions, was not comparable.

For the empirical analysis, we used a two-stage econometric methodology. Firstly, the estimation of the Total Factor Productivity (TFP) was performed using semi-parametric techniques, since the validity of results depends on the robustness of the estimation method for the TFP. Indeed, several methodological issues may arise when TFP is estimated using ordinary least squares (OLS) in a panel of firms. OLS estimation of firm-level production functions introduces a simultaneity or endogeneity problem because productivity and input choices are likely to be correlated. In response to these methodological issues, empirical literature has relied extensively on four estimation techniques; fixed effects, instrumental variables, generalized method of moments (GMM), and semi-parametric estimators. However, because of the poor performance of both GMM and fixed effects estimators, it appears that the semi-parametric estimators (Olley and Pakes, 1996 or Wooldridge-Levinsohn and Petrin) are to be preferred. Although the choice of the estimator depends on the data at hand and the underlying assumptions, currently the most widely used is the Wooldridge-Levinsohn and Petrin procedure. The reason is that their procedure is based on a control function approach that employs intermediate inputs as the proxy variable for unobserved productivity. Since intermediate inputs are always positive (at least in our database), this approach has the advantage of retaining a higher number of observations than the Olley and Pakes (1996) approach. Therefore, this estimator is likely to be more efficient and we use it to estimate the TFP as the residual of the production function. Secondly, we regressed the TFP in a series of explanatory variables including variables that reflect the foreign presence and the determinant factors of externalities from FDI. We estimated the externalities from FDI using the system-GMM (System Generalized Method of Moments) estimator and the econometric software Stata 13.0. Our data refers to the period 1995-2007.

Lastly, we use a normative approach, where we attempt to perform a *cæteris paribus* analysis of the transitional dynamics under the real convergence process, in which the mechanism of technological catching-up allows to relate FDI with the manufacturing productivity. Thus, we evaluate, under a policy perspective, the correlation between and the evolution of FDI inward flows and the changes on a set of innovation and absorptive capacity indicators. Based on the results of externalities obtained in chapter 3, we perform some recommendations on the design and implementation of FDI policies in articulation with industrial policy, i.e., according to the type of FDI externality, technological groups, and/or specific manufacturing industries. These recommendations consider a logical framework for intervention to ensure causal linkages between, on the one hand, the specific goals and constraints associated with strengthening the articulation between FDI and Industrial policies, and, on the other hand, between the proposed policy measures/instruments and the expected results.

Outline of the Thesis

The thesis is organised as follows: Chapter 1 provides a theoretical framework for the analysis of the relationship between FDI and the productivity of domestic firms in Developed Countries, to identify the transmission mechanisms of FDI regarding productivity externalities and to identify and classify the main determinants of the occurrence and magnitude of vertical externalities. After this classification, we review 20 empirical studies for five Western Europe countries (Spain, Ireland, Italy, Portugal, and the United Kingdom), aiming to systematize the main results regarding the nature of the externalites, signal and magnitude, and to discuss the possible causes for mixed results.

Chapter 2 describes the construction of the database developed to identify the externalities associated with FDI that are linked with higher productivity of domestic firms. Subsequently, we perform a descriptive statistical analysis of the variables as well as a preliminary analysis of the correlation between the variables of foreign presence and productivity.

Chapter 3 reviews the empirical studies for the Portuguese manufacturing sector with the purpose of analysing the state-of-art of methodology and the results; then it describes the characteristics of Portuguese manufacturing firms and analyses the evolution of FDI flows and stocks into that sector. Subsequently, it discusses the empirical strategy and analyses the existence of externalities from FDI in the Portuguese manufacturing sector, in 1995-2007. Results are discussed and policy implications are presented.

Considering the results of the previous chapter, the main purpose of chapter 4 is to evaluate whether the Investment Promotion policies during the last 30 years of European integration have contributed to convergence, through increased productivity in the Portuguese manufacturing sector. The analysis is performed comparing the evolution of FDI inward flows, the manufacturing performance and several indicators of technological change. This chapter also discusses the impact of FDI on the reduction of the technological gap and on the innovative and the absorptive capacity of domestic firms in the Portuguese Manufacturing sector.

Chapter 5 summarizes the thesis and discusses the main conclusions from the study. It emphasizes the contribution of this research to guide future Investment Promotion policies. The limitations of the study are also discussed and future research avenues are proposed.

Chapter 1

Externalities from FDI on domestic firms' Productivity:

A Literature Review for Developed Countries

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ABSTRACT

In this paper, we analyse the transmission mechanisms of externalities from FDI on the productivity of domestic firms, focusing on establishing the main linkages between them. Considering the complexity of the mechanisms involved, the analysis of the factors determining their effectiveness is far from being fully exploited. We expect to contribute to the existing literature by providing a broader picture of the determinant factors of externalities from FDI, through its classification, along the lines of the Theory of Heterogeneous Firms. This allows for a better understanding of the relevant variables to include in the empirical studies. Moreover, the transmission mechanisms of externalities from FDI are different according to the stage of development of the recipient countries. However, the existing literature reviews and meta-analysis include both Developed and Developing countries, hindering the learning process regarding the transmission mechanisms of externalities in the Developed Countries. We attempt to fill this gap by reviewing the empirical literature for five Western European countries and suggest some explanations for the mixed results.

Keywords: FDI, linkages, vertical externalities, Developed Countries.
JEL classification: F23

1. INTRODUCTION

Foreign Direct Investment (FDI) is generally considered by many international institutions, politicians and economists as a key generator of economic growth (Alfaro, 2017). This is due to the fact that FDI exerts direct and indirect effects on host economies. The first includes capital formation, job creation, increased tax revenue and shifts in the production and exports of host countries, while the latter mainly involves the access to Multinational Corporations' (MNCs) technology (Crespo and Fontoura, 2006; Cantwell, 2017).

The access to foreign technology is important because, according to the Theory of Industrial Organization, MNCs possess advanced technology (in the broad sense, i.e including marketing and knowledge management, etc) that makes them more efficient than their domestic counterparts (Dunning and Rugman, 1985). Moreover, empirical studies (e.g., Eaton and Kortum 1999, Keller, 2001) show that, in OECD countries, the main sources of technological changes leading to increases in the total factor productivity (TFP) come from abroad. The reason is that R&D is highly concentrated in a small number of Developed Countries (DCs) (Archibugia and Pietrobelli, 2003). As a result, the convergence of income between countries depends on the level of international technological diffusion (Keller, 2001). Indeed, technology can be transferred through voluntary agreements or through externalities from FDI. These consist of an increase in the productivity of domestic firms due to the presence of MNCs in the host economy (Lesher and Miroudot, 2008). Thus, one of the main motivations for policies that aim to attract FDI is the potential benefit of acquiring new technologies that may allow domestic firms to increase their productivity (Buckley et al., 2003).

Externalities from FDI may be horizontal or vertical. Horizontal externalities occur when the entry of the MNC generates positive externalities for local competitors. Vertical externalities arise from the linkages between MNCs and their local suppliers/customers (backward/forward linkages). The empirical evidence on externalities from FDI suggests that vertical externalities are more likely to occur than horizontal externalities. According to Kugler (2006) this happens for a number of reasons. First, it is easier to learn generic technologies than to absorb and adopt specific rivals' technologies; Second, horizontal externalities from FDI are more likely to generate losses of profits for MNCs than vertical externalities; third, if MNCs do not compete directly with domestic firms, then they will not have an incentive to prevent the spread of technology to domestic firms.

However, as de Mello (1997) points out, the role of FDI as a catalyst for output growth is a less controversial assumption in theory than in practice. Indeed, according to Hilvo and Scott-Kennel (2011), different contexts and approaches produce different results. For example, while studies in Developing or Transition Economies find that backward linkages are more likely to occur than forward linkages; research in small Developed Countries (Scott-Kennel & Enderwick, 2005) found that resource sharing via forward linkages may be more important, than via backward linkages, for instance, regarding product innovation through collaboration with foreign suppliers (Cuervo-Cazurra and Un, 2007). Consequently, our analysis focus on vertical externalities that might occur in DCs with an aim to ascertain whether there are positive and significant externalities from FDI on a small open economy that faces restrictions due to the economic crisis.

This paper reviews the literature on the impact of the FDI on the productivity of local manufacturing firms in DCs, in order to provide a description of what variables to include and the state of-art methodology to perform an empirical analysis for DCs. Bearing this in mind, this paper aims to accomplish three specific goals. Firstly, considering that the transmission mechanisms of externalities from FDI are complex, because the same mechanism may generate more than one type of externality; and the fact that empirical studies often fail to identify all possible benefits in one mechanism, we aim to describe the channels through which domestic firms can benefit from externalities from FDI. Secondly, as the analysis of the determinant factors of externalities from FDI has been relatively limited and *ad hoc,* we aim to identify the relevant determinant factors to include in empirical studies for DCs. In addition, empirical studies report a large amount of heterogeneity in the productivity of firms, within sectors. These results highlight the role of domestic firms' characteristics in the internalization of externalities from FDI. Thus, drawing upon the Theory of Heterogeneous Firms, we aim to classify the determinant factors of externalities from FDI into 'internal' and 'external' to the firms. Thirdly, considering that: a) the (macro) external conditions in the host economy are important for the generation of externalities and, thus, externality effects are different in Developed and Developing Countries; b) there is a lack of empirical research focusing on DCs; and c) empirical evidence finds mixed results and statistically insignificant externalities via forward linkages (Javorcik, 2004, Görg and Greenaway, 2004); we will analyse a set of 20 empirical studies with panel data at firm level for the manufacturing sector of five European economies, in order to draw some conclusions on the determinant factors of externalities and identify the key methodological issues.

We expect this article to contribute to the existing theoretical and empirical literature in two ways. Firstly, by drawing upon the theory of Heterogeneous Firms, we aim to provide a more complete picture of the determinant factors of vertical externalities by classifying them into internal and external and relating them. Secondly, with our review of empirical studies focused on DCs.

In what follows, Section 2 describes the transmission mechanisms of externalities from FDI, according to the Theory of Heterogeneous Firms; Section 3 classifies the determinant factors of externalities from FDI into internal and external to the firm, and analyses the relationship between them; Section 4 reviews a group of 20 empirical studies for DCS and, finally, section 5 concludes.

2. TECHNOLOGY TRANSFER, FDI AND PRODUCTIVITY EXTERNALITIES

In this section, we explain the role of FDI as a vehicle of technological diffusion and describe the mechanisms through which FDI exerts its impact on local firms' productivity. To this end, we start by arguing that FDI is the preferred channel of international dissemination of technology; then we describe the transmission mechanisms of externalities.

2.1. FDI AS CHANNEL OF INTERNATIONAL TECHNOLOGY DIFFUSION

The literature on International Technology Diffusion has emphasized three channels for technology transfer: international trade of intermediate goods, international dissemination of the results of research and development (R&D) and FDI (see e.g. Keller, 2004). However, international trade of intermediate goods is considered a weak source of international technological diffusion since the technology is not directly incorporated in the imported intermediate inputs (Keller, 2004). Thus, the larger the volume of tacit knowledge involved in the production of the intermediate goods, the greater the limitation because tacit knowledge is subjective and, thus, not measurable.[1] Moreover, according to Coe and Helpman (1995), the majority of high technological content goods are imported by the MNCs. Therefore, the empirical results about the importance of international trade on the technological diffusion can be misleading if there is no distinction between the effect of the activities of MNCs and International Trade. The second channel seems to be a stronger source of international technological diffusion. The reason is that the disclosure of R&D results suggests a complete domain of the technology as opposed to the ability to use only the incorporated technology. However, since in this second case, the technology is not tied to any particular form, externalities seem to be more difficult to measure. As a result, FDI is considered the main channel of

[1] According to Polanyi (1983), tacit knowledge (embodied and therefore requiring absorptive capacity) is easy to transfer but difficult to appropriate. However, while codified knowledge (formulas, blueprints, drawings, and patent applications) can be transferred, the process is slow.

international technological diffusion and contributes to the creation of new knowledge or the adaptation of foreign technology (Lim, 2001).

According to the literature, technology diffusion occurs in two stages. Firstly, MNCs transfer technology to their subsidiaries in the host country. In the next stage, technology diffusion to local firms may occur via externalities, through different channels. The occurrence of externalities depends on the assumptions of the early 1990's Endogenous Growth Theory (Aghion and Howitt 1992, Grossman and Helpman 1991 a,b, Romer 1990, Segerstrom et al., 1990). According to this theory, technology has, to some extent, the nature of a public non-rival good. A key assumption is that the production of knowledge does not take the form of a physical device, being instead usually incorporated (a patent, a software program, etc.). Therefore, the marginal cost of its exploitation by an additional agent is negligible and its returns cannot be fully appropriated by the owner and, thus, knowledge externalities arise.

However, because technology cannot be transferred at zero cost, the technological diffusion is likely to be incomplete and vary geographically. Indeed, the high cost of coding the technology motivates innovative firms to ensure that only its contours are encoded, leaving the rest as "tacit" (Polanyi, 1958). Part of that tacit knowledge is often transferred through contacts and personal instructions (David, 1992). Since FDI provides contacts between local and foreign individuals, then technology diffusion may inadvertently occur. In addition to this involuntary transmission of knowledge, recent literature has focused on the possible voluntary transmission of knowledge from MNCs to local customers and suppliers. In this case, the diffusion of knowledge may assume the form of acquisition of skills, training and the introduction of management practices that are likely to increase the TFP of local firms (Borensztein et al, 1998; Mastromarco and Ghosh, 2009).

2.2. TRANSMISSION MECHANISMS OF EXTERNALITIES

In this section, we describe the channels by which domestic firms can appropriate knowledge from foreign firms operating in the host economy. This appropriation may take the form of utilization of foreign knowledge or the recombination of foreign and internal knowledge into a new kind of knowledge. This process may require absorptive capacity, which according to Narula and Marin (2003) "includes the ability to internalize knowledge created by others and modifying it to fit their own specific applications, processes and routines" [Narula and Marin (2003), p 23].[2]

The theoretical literature on technology transfer (e.g., Görg and Greenaway, 2004) considers that technology diffusion from MNCs to local firms may occur at two levels: the horizontal technology transfer that occurs through contacts with local competitors (via demonstration/imitation, labour mobility, exports, competition, consulting and specialized services and coordination with local institutions); and the vertical technology transfer that occurs through linkages with local suppliers (backward linkages) or local customers (forward linkages).

Regarding the horizontal level, the entry of the MNCs may provide externalities to the local competitors through various channels. The demonstration / imitation (for local firms) is probably the most obvious channel (Das, 1987, Wang and Blomström, 1992).

Concerning demonstration, the introduction of a new technology in a given market may be costly and risky for local firms to perform due to the uncertainty of the results. However, if the technology is successfully used by a MNC, it encourages local firms to adopt it, if the goods produced are similar (Barrios and Ströbl, 2002).

Geographical proximity can lead to externalities through imitation or demonstration effects, especially in industrial clusters. Domestic firms may be able to learn and copy by simply observing, or through reverse engineering, personal contacts and industrial espionage. Additionally, when subsidiaries introduce innovations, they

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[2] One aspect that we do not discussed in this section, but that is implicit, is the geographical proximity between MNCs and local firms. Several authors argue that the transmission mechanisms of externalities from FDI are reinforced when a smaller geographical area is considered (Aitken and Harrison, 1999; Jordaan, 2008 a, b). See Crespo and Fontoura (2010) for a review. We will focus this issue on section 3 when we discuss the determinant factors of vertical externalities.

may be demonstrating to their competitors how to deal with the technology and thus the efficiency of the later may increase.

Labour mobility occurs if local firms hire former MNCs' employees and are able to learn from them in order to implement their technology, or if MNCs' former employees create their own firms and apply the acquired knowledge for their own benefit (Glass and Saggi 2002; and Pesola, 2006). However, the effects of labour mobility on the productivity of local firms are difficult to measure because it involves the monitoring of workers and estimating the impact on the productivity of other workers (Saggi, 2001).

Exports are viewed by some authors as another channel through which knowledge externalities to local firms can take place (Kokko et al, 2001; Greenaway et al, 2004). According to those authors, the export activity involves costs of studying foreign markets, establishing distribution networks and transport infrastructure. MNCs can meet these costs in a easier way due to their greater experience in foreign markets and financial capacity (Greenaway et al., 2004). Imitation or collaboration with MNCs in order to learn the export process allows local firms to reduce the costs of internationalization and have a positive impact on their productivity. However, in our opinion, this is a particular case of the imitation/demonstration channel.

The increased competition induced by the entry of MNCs is another channel of externalities from FDI (Wang and Blomström, 1992; Markusen and Venables, 1999). The higher competitive pressure, particularly in highly competitive sectors with low barriers to entry, induces technological change and learning. Indeed, competition may lead to the rationalization of resources, the adoption of new technologies and the introduction of new products by local firms to protect their market share (Blomstrom and Kokko, 1998).

However, at an early stage, the presence of the MNCs may imply significant losses of market shares for the local firms, forcing them to operate on a less efficient scale and, thus, increasing their average costs (Aitken and Harrison, 1991; Harrison, 1994). In the next stage, however, the entry of a MNC creates a selection effect, where the competitive pressure drives the least efficient firms out of the market, increasing the average productivity of the survival local firms.

The entry of the MNCs may also be accompanied by foreign consulting and specialized services (trade brokers, accounting firms and consulting, etc.) that may be available for local firms and hence may contribute to the increase of their performance.

Regarding the coordination with local institutions, the diffusion of knowledge is possible in two ways: partnerships between firms, universities and institutes, as well as the leakage of technological content from the original recipient to his local rivals.

Concerning vertical technology transfer, the use of more specialized inputs generates a positive social value in the form of increased productivity for the local firm, that is not appropriated by the MNCs. In certain circumstances (i.e, increased returns in the production of inputs, transportation costs and benefits of specialization), backward externalities occur when a MNC, by increasing its demand for inputs, leads to the introduction of new varieties of inputs. The introduction of these specialized inputs reduces the cost of production of the final goods, making the production more profitable. This mechanism is modelled, for example, in Rodriguez-Clare (1996), Markusen and Venables (1999) and Lin and Saggi (2005).

Relating to the backward linkages, the presence of the MNCs may benefit local suppliers if they are interested in guaranteeing a certain quality standard. In this context, MNCs can provide technical support to local suppliers in order to improve the quality of inputs or to assist their suppliers in the introduction of innovations, training, creation of productive infrastructure, procurement of raw materials, as well as the introduction of new management techniques, among others (Lall, 1980).

Several case studies (see Moran, 2001) show that MNCs often provide technical assistance to its suppliers in order to raise the quality of its products and facilitate innovation. As a result, FDI in downstream sectors induces greater competition, lower prices and increased production and value added in upstream sectors. Moreover, while the technological gap between local and foreign firms may limit the transfer of technology in the sector, MNCs probably purchase less sophisticated inputs in order to narrow the gap. The competition among local firms to supply MNCs is also likely to generate an increase in their efficiency.

Regarding forward linkages, externalities arise when MNCs provide higher quality and /or cheaper inputs to local producers of final goods (Markusen and Venables, 1999). Meyer (2004) argues that ‘FDI in infrastructure and business services directly influences productivity of its customers if services required by businesses improve, or are newly introduced.’ (Op cit., p. 11).

Downstream effects of FDI are generally more beneficial than the upstream effects (Blomström and Kokko, 1998). Indeed, local firms may be able to compete in world markets with technical expertise based on the industrial application of the MNCs' technology. This provides opportunities for countries to remain competitive in various "niches" of high technology (Blomström, 1991). However, there are few studies addressing the importance of forward linkages. Aitken and Harrison (1991) is one of these studies. Another example is Zysman et al. (1996). The authors find that, in the 1980s, US electronics firms gradually deepened the technological capacity and autonomy of their Asian subsidiaries, largely in response to the competitive challenge represented by their Japanese competitors. The transfer of higher value-added production from the U.S. to Asia allowed subsidiaries to produce more sophisticated electronic parts.

3. DETERMINANT FACTORS OF VERTICAL EXTERNALITIES

3. 1. INTRODUCTION

In section 2 we concluded that vertical externalities are more likely to occur than horizontal externalities. We identified (backward and forward) linkages as the main transmission mechanism of vertical externalities and we highlighted that forward linkages are especially relevant, not only to the increase of local firms' productivity but also to enhance countries' competitiveness. The implications for the economic growth are obvious.

While most Endogenous Growth Models focus on the role of R&D in the technological diffusion, in the early 2000s, a new approach, triggered by Bernard and Jensen (1995) has introduced firm heterogeneity in the analysis of how technology diffusion influences economic growth. Similarly, the more recent empirical studies take into account the heterogeneity of subsidiaries' performance, in addition to domestic firms' characteristics, in the analysis of the determinants of FDI. For example, Görg et al. (2009) conclude that the larger, more productive and more experienced firms are more likely to invest in the Czech Republic. Hence, in spite of sharing many characteristics of the monopolistic competition models from New Trade Theory, this approach assumes differences in firms' characteristics within a sector, especially with regard to productivity (Ciuriak et al, 2011).

This trend of incorporating heterogeneity into the analysis have also influenced the most recent theoretical models of technology transfer (Driffield and Love, 2007; Marin and Sasidharan, 2010). A key assumption of this new approach is that the decisions on where MNCs locate the production and the extent of control over these activities is part of their global sourcing strategies (Antràs and Helpman, 2008) and cannot be analysed in a framework of International Trade theories (Coase, 1937; Williamson, 1975; Grossman and Hart, 1986). Hence, the core model of Melitz (2003), based on Krugman (1980), is being developed in several ways. One dimension of this literature is using the interaction of sunk costs and heterogeneous firm level productivity to determine the reason why some firms invest abroad while others stay in the domestic market (Helpman et al., 2004). Other extensions include models of firm decision on: how many products to produce and in which international markets to sell (Bernard et al., 2010); imports of inputs (Kasahara and Lapham, 2013); and international outsourcing (Antrás and

Helpman, 2008; Caliendo and Rossi-Hansberg, 2012). Hence, along the lines of the Theory of Heterogeneous Firms, we identify and classify the determinant factors of vertical externalities.

3.2. DETERMINANT FACTORS

We focus on vertical externalities because empirical studies suggest they are more likely to occur than horizontal externalities. In particular, downstream effects of FDI provide opportunities for countries to remain competitive in various "niches" of high technology, as domestic firms may be able to compete in world markets with technical expertise based on the industrial application of the MNCs' technology (Blomström, 1991). Crespo and Fontoura (2007) remark that there has been an effort to research the factors that determine the existence, sign and magnitude of externalities from FDI. Yet, the literature does not present clear-cut evidence on which factors impact on their existence and/or magnitude. Thus, along the lines of the Theory of Heterogeneous Firms we suggest the following classification into 'internal' and 'external' factors in Table I.1.

[Insert Table I.1 here]

The 'internal' determinant factors are those related to firms' characteristics; whether they are domestic (size, financial capacity, age of firms and employees including managers, and the absorptive capacity) or foreign (home Country, value of the technology, intensive use of intermediate inputs, FDI motive; entry mode, and age, level of autonomy and size of the subsidiary); whereas the 'external' determinant factors are those that firms cannot control through their behaviour, and are specific of a certain industry (level of specialization, existence of agglomeration economies; export or domestic market-orientation, market concentration and capital intensity); or is an outcome of the interaction between domestic and foreign firms (symbiotic), such as the technological gap, the geographical proximity or cooperation between domestic and foreign firms.

We now describe the mechanism through which those determinants impact on the existence of linkages, and therefore, on the occurrence of vertical externalities.

Individual -Domestic Firms

The size of domestic firms is important for benefits associated with the presence of MNCs to occur, because small firms may not operate in an enough large scale to deal with some of the technologies introduced by the MNCs (Ngo and Conklin, 1996).

Similarly, the lack of financial capability makes it very hard to achieve a production scale enough to handle with some of the technologies introduced by the MNCs (Cline, 1987).

The age of the firms is likely to determine the occurrence of externalities from FDI to domestic firms (Suyanto and Salim, 2010). Older firms have served the market for longer time and may have a larger network of contacts and information on the markets. Therefore, the probability of vertical externalities to occur is higher.

Regarding the age of managers, in our opinion youth brings energy to innovate and to overcome the difficulties, but it may also mean less experience. Therefore, managers must not be too young to allow some market experience and the establishment of a network of contacts with suppliers and local clients for vertical externalities to occur.

Concerning the age of the employees, FDI flows are sensitive to the health of the workforce (Globerman and Shapiro, 2002), Since, *coeteris paribus*, younger workers are healthier than older workers, and firms with younger employees attract more foreign investors, then firms with younger employees are more likely to benefit from vertical externalities (Liu and Zou, 2008; Stancik, 2009).

The absorptive capacity is often proxied by the human capital which have an impact on FDI flows. Indeed, MNCs tend to acquire firms with a higher level of human capital (Teixeira and Tavares-Lemhann, 2007) and M&As are more likely to generate vertical externalities.

Individual- Foreign firms

The origin of the FDI is a determinant factor of externalities from FDI (Karpaty and Lundberg, 2004; Javorcik et al. 2004; Takii, 2011). In fact, the origin of the FDI may be expressed by many factors such as culture, language, the level of development of the country, among others. Foreign investors coming from countries with a culture characterized by multiculturalism, are more likely to mingle with the locals and make efforts to learn the local language, and thus, to establish contacts with local suppliers and customers. Moreover, if the language of investing and host countries is the same or similar, the probability of contacts between suppliers/customers may be higher. Also, the degree of development of the country of origin may influence the type of FDI and, therefore, it may influence the occurrence of vertical externalities.

The technological strategy of MNCs is also a determinant factor of vertical externalities. Indeed, the degree of technological expertise of the subsidiaries determines the existence of externalities from FDI (Marin and Sasidharan, 2010; Narula and Dunning, 2010). Subsidiaries that are an important source of technological knowledge and perform their own R&D and innovation are more prone to establish linkages with domestic firms (Jindra et al., 2009). If subsidiaries have superior technology comparing to their domestic counterparts, they will require more specialized and complex inputs and may not be able to get them in the host country. However, this problem can be solved by providing technical assistance to their potential suppliers. On the other hand, If MNCs have much more sophisticated technology than their domestic clients, and they are the leading suppliers of those domestic firms, then it is likely that forward linkages occur.

An additional determinant factor is the intensive use of intermediate inputs by MNCs. Local sourcing depends positively on the transport costs (and therefore on distance) between the MNCs home country and the host country (Rodriguez-Clare, 1996). If transport costs are high enough, the MNCs may have an incentive to buy inputs locally. Then, the occurrence of backward linkages is likely.

The motivation of FDI is another determinant factor of vertical externalities (Driffield and Love 2006). Local market-oriented MNCs, measured in terms of share of domestic sales in total sales, are likely to establish backward linkages (Jordaan, 2011 and Giroud et al., 2012). Indeed, In this case, MNCs will need to tailor products to local market specific needs. Engaging with domestic suppliers will facilitate the process of adapting the products to local taste and may provide MNCs with reliable information about domestic customer preferences. If MNCs are export-oriented and domestic firms produce for the domestic market, the potential for externalities increases if the requests imposed by the MNCs, by serving foreign markets, are largely dependent on local suppliers to make the necessary adjustments (Moran, 2001). If the FDI is motivated by the access to specific items which are not available in the country of origin and are not easy to transfer, the probability for backward externalities is high. If FDI is related to the existence of tariffs and other trade barriers that prevent MNCs to export to the host country, MNCs try to jump barriers by establishing a subsidiary in the host economy to gain access to the local market (Chryssochoidis et al., 1997). The local presence need only be enough to circumvent the trade barriers, since the MNC wants to keep the maximum added value in its domestic economy. Therefore, in this case, the probability of occurrence of backward linkages is low. The internationalization strategies allow MNCs to increase their potential for absorbing external knowledge; and influence their supply mode (Figueiredo, 2011). Externalities from FDI are expected to be higher when the FDI is technology sourcing because the entry of the MNCs can lead to the process of technological development and competition that can generate externalities for domestic firms (Driffield and Love 2003). In addition, scale economies and transaction costs of outsourcing seem to be forcing MNCs to consolidate their supply relationships with a smaller number of major suppliers, for example in the automotive and electronics industries (Ernst, 2002).

The entry mode also influences the existence of externalities (Javorcik, 2004 and Merlevede and Schoors, 2005; Jabbour and Mucchielli, 2007). Subsidiaries with higher degree of local participation (M&As) facilitate access to foreign technology by local firms and are expected to create more vertical linkages with the host economy (Crespo and Fontoura, 2007; Liu and Zou, 2008 and Stancik 2009). In contrast, wholly-owned foreign projects are unlikely to generate positive vertical externalities. Also, in greenfield projects, we expect that foreign wholly-owned subsidiaries rely more on imported inputs.

The age of subsidiaries also may influence the sourcing decisions (Zhang et al, 2010; Suyanto and Salim, 2010) as older subsidiaries are probably more independent from the headquarters and may take their own decisions about local sourcing.

Indeed, strategic decisions by MNCs in terms of supply and linkages are related to their degree of autonomy and have an impact on the existence of externalities from FDI (Jordaan, 2011). A subsidiary with a high degree of autonomy is more likely to supply locally; while less autonomy means that the subsidiary may rely more on imports (Holm and Pedersen, 2000).

The size of the subsidiaries determines the occurrence and magnitude of externalities from FDI. Smaller subsidiaries are probably more adaptable to the external environment than larger firms. Therefore, smaller subsidiaries are more likely to establish linkages with domestic firms (McCann, 1997). Furthermore, it is probable that smaller subsidiaries need more local support because of their organization fragilities (Chen and Chen, 1998). In contrast, larger subsidiaries are probably more able to find niches in the highly internationalized networks and therefore source on a global basis (Barkely and McNamara, 1994). In addition, smaller subsidiaries with little international experience will less likely choose Greenfield projects because of the lack of knowledge about the host market; and many smaller subsidiaries assign less weight to the disadvantages associated with any strategic incoherence resulting from the acquisition (Mendes, 2002), Thus, there is more likelihood of vertical externalities to occur.

External- Industry specific

Regarding specialization, an initially high level of expertise in certain activities may attract more investments and generate agglomeration economies (Barrell and Pain, 1999). Since physical proximity facilitates the flow of knowledge, agglomeration economies may facilitate the occurrence of vertical externalities. As a result, areas of high productivity tend to be geographically clustered, creating strong linkages (Anselin, 2001).

Firms in export-oriented industries are already accustomed to meet the superior quality required in export markets and adapt more easily to foreign firms demand in downstream sectors. This mechanism is especially effective when there is high sectoral competition. In fact, it is claimed that the industries that export a significant part of their production face greater competition than those market-oriented (Barrios and Strobl, 2002; Bekes et al., 2006), hence, it is more likely that vertical externalities occur.

In our view, firms in concentrated markets are likely to have market power that can facilitate linkages with foreign clients/suppliers, and thus vertical externalities may arise. For example, domestic firms with market power can beat their rivals (if there are any, since, in these markets, competition is low) more easily, when competing to become suppliers of a MNC. Moreover, stronger industry concentration generates larger profits that can be re-invested, for example, in new technologies or in the production of more sophisticated products that can be more appealing to foreign firms.

Capital intensity represents a firm’s commitment to modernization and upgrading of its productive capacity. In the long run, capital expenditures typically have a positive impact on firms’ performance (Lee & Blevins, 1990; Lee and Xiao, 2011). Thus, more productive firms can lower the price of the goods sold. If this is the case, then, it is our opinion that firms in capital intensive industries are more prone to establish linkages, for example, with foreign clients, and vertical externalities are more likely to arise.

External- Symbiotic

It is argued that there must be some difference between the technologies of the two types of firms (foreign and domestic) for externalities from FDI to occur. Hence, the higher the technological gap the greater the potential magnitude of vertical externalities. If the technology gap is large, it implies that MNCs have much more sophisticated technology than their domestic counterparts; and if they establish linkages with domestic firms, then its is likely that vertical externalities occur.

The geographical proximity facilitates relationships between foreign and domestic firms and the flow of knowledge from the first to the later. Therefore, it favors the occurrence of vertical externalities.

Finally, the propensity to establish technological cooperation is a key determinant of the existence of externalities from FDI (Dunning and Lundan, 2008; Narula and Dunning, 2010). This propensity for establishing technological cooperation will be greater if the FDI is technology sourcing since MNCs opt for less stringent appropriability strategies in order to facilitate the exchange of knowledge in the host country, demonstrating reciprocity (Faria and Sofka, 2008). The higher this propensity the greater the potential for the occurrence of vertical externalities.

Crespo and Fontoura (2007) remark that empirical studies do not specify the mechanisms by which the determinant factors of vertical externalities neither are effective nor distinguish between factors of occurrence and factors of magnitude. The first are factors that cause the externalities and the second are factors susceptible to intensify the extent of externalities. Hence, based on the several authors referred above in this section, Table I.2 shows the possible connections between the several determinant factors of occurrence.

[Insert Table I.2 here]

According to our analysis, factors of occurrence are classified into primary, secondary and tertiary, and emerge respectively in the first, second and third column. The primary factors are those that do not depend on other factors; the secondary factors depend, at least at some level, on the primary factors, and the tertiary factors depend on secondary and, ultimately, on the primary factors. In our opinion, because ‘FDI motive’ and ‘entry mode’ are related to both factors on the fourth column, the propensity to establish cooperation and the intensive use of local inputs, we label it ‘factors of liaison’.

The fourth column contains what we label ‘fuse factors’, i.e., factors that trigger externalities from FDI. In other words, ‘cooperation’ between domestic and foreign firms, and the ‘intensive use of local inputs’ by foreign firms most probably lead to external economies and, ultimately, vertical externalities arise.

We will now describe how primary, secondary, tertiary and liaison determinant factors are related and contribute to the occurrence of ‘fuse factors’.

Technological specialization promotes the learning effect between firms. Cantner and Graf (2004) provide empirical evidence concerning specialization and cooperation. The higher a region’s specialization, the more cooperatives are formed between partners outside that region. Taking cooperatives as a proxy for knowledge externalities, this result may show that the exchange of knowledge is highest in a specialized cluster (Dawid and Wersching, 2007). In addition, the geographical proximity may lead to agglomeration (industrial clusters) which is important for establishing contacts, cooperate and supply locally. As a result, cooperation between MNCs and local firms may occur when a high level of expertise (specialization) in some activities attract more investments to a certain location, creating geographical proximity between firms (Anselin, 2001).

The age of the managers can also influence the propensity to establish technological cooperation. In our opinion, the youth of managers may imply propensity to innovate, but it also means less experience. Therefore, linkages are more likely to occur if the managers are not too young, to allow for market experience and a network of contacts with foreign firms.

Foreign investors coming from multicultural countries probably are more prone to establish contacts with local suppliers and customers. Also, the degree of development of the country of origin may influence the type of FDI projects and, thus, have an influence on the occurrence of vertical externalities.

The propensity to establish technological cooperation is a key ingredient for the existence of linkages (Jindra, 2010) and depends on the origin of the FDI (Javorcik et al, 2004; Wei and Liu, 2004; Takii, 2011).

Both market concentration and capital intensity contribute to provide market power and resources to domestic firms and, thus, the probability of cooperation between these firms and foreign firms is higher, in our view.

Assuming that human capital (as proxy for the absorptive capacity) is important to attract FDI inflows (Teixeira and Tavares-Lemhann, 2007), then the greater the level of human capital, the greater the likelihood of MNCs chose Mergers and Acquisitions (M & As) and source locally.

The size of the subsidiary may also impact on local sourcing. Small firms with less experience of international markets are likely to enter the domestic market through M&As to minimize the risks associated with the lack of knowledge about local tastes and overcome the weaknesses of their organization (Chen and Chen, 1998). In our opinion, FDI projects via M&As are more likely to source locally than Greenfield projects because in the former type of firms the sourcing decisions may be attributed to nationals as they be included in the board of directors. In contrast, larger firms are probably more capable to find niches in the highly internationalized networks and therefore usually supply in the international markets (Barkely and McNamara, 1994).

Regarding the age of workers, because younger employees are probably healthier than the older ones, and MNCs are sensitive to the health of the workforce regarding their M&A projects (Globerman and Shapiro, 2002), the age of employees impacts on the entry mode. In addition, in foreign projects via M&As, the sourcing decisions are more likely to be established by the previous firm owners. In this case, the subsidiary management team is more likely to be an advocate of local sourcing (Tavares and Young, 2002)

The FDI motive may contribute to cooperation and to the intensive use of local inputs (Driffield and Love, 2006). According to Belderbos et al. (2001) if the subsidiaries are market driven, then they will adapt their products to local tastes, which may involve local supply and probably will cooperate with local firms. In addition, local sourcing of components and parts is a priority for international subcontractors that place great emphasis on flexibility (Chen et al, 2004).

On the other hand, high levels of investment on incorporated technology by the MNCs require more specialized and complex inputs that can be more expensive through imports. The solution would be to provide technical assistance to potential domestic suppliers (Driffield and Love, 2007; Marin and Sasidharan, 2010).

The sourcing decisions are also related to the level of autonomy of the subsidiary. The higher the autonomy, the more likely is local sourcing (Holm and Pedersen, 2000; Jordaan, 2011). For example, McAleese and McDonald (1978) have shown that purchases of local inputs tend to increase as the subsidiaries become more mature.

In this context, the age of subsidiaries also may have an impact on sourcing decisions (Zhang et al, 2010; Suyanto and Salim, 2010). In our opinion, older firms are likely to have gained more autonomy over time, and thus the likelihood of local sourcing is higher. On the other hand, we hypothesise that older domestic firms are more likely to be more integrated in the market and, thus, have more probabilities to have sourcing contracts with MNCs.

The intensive use of local inputs is related to FDI motive. If the MNC is motivated by the access to specific items that are either not available or not easy to transfer from the host country, the probability of local sourcing is higher. On contrary, if the FDI motive is to overcome tariffs or other trade barriers that prevent MNCs to export to the host country, the probability of local sourcing is low (Chryssochoidis et al., 1997). The entry mode also influences the local supply (Jabbour and Mucchielli, 2007). Greenfield projects are expected to rely more on imported inputs. However, when the FDI is via M&As, it is expected that domestic suppliers of the acquired firm will continue to supply the firm (Stancik 2009).

In our view, both determinant factors of occurrence and magnitude depend on firm behaviour (foreign and domestic). However, foreign firms' behaviour is crucial for vertical externalities to occur, in the sense that it is ultimately their choice whether to establish cooperation and/or source locally; that can cause vertical externalities. In other words, the determinant factors related to foreign firms are relatively more important for the occurrence of vertical externalities than those factors related to domestic firms' characteristics. In Table 2 we present 5 primary internal factors related to foreign firms (origin of FDI, size, politics on the value of the technology, level of autonomy and age of the subsidiary) and 2 factors of liaison (FDI motive and entry mode) also related to foreign firm's characteristics, while internal factors related to domestic firms are only 4 and all are primary (age of managers, absorptive capacity, age of workers and age of firms).

Conversely, the determinant factors related to domestic firms' characteristics are relatively more important for the magnitude of vertical externalities. In other words, depending on domestic firms' characteristics, the intensity of vertical externalities can be higher or lower. Table I.3 shows the determinant factors of magnitude of vertical externalities.

[Insert Table I.3 here]

Indeed, Table 3 shows 5 domestic firms characteristics as internal determinant factors of magnitude (absorptive capacity, age of workers, age of firms, firm size, and financial capacity) and just 2 related to foreign firm's characteristics (FDI motive and entry mode).

The joint analysis of tables 2 and 3 shows that the determinant factors of occurrence related to domestic firms' characteristics (absorptive capacity, age of workers and age of firms) are also determinant factors of magnitude. The magnitude of vertical externalities will be higher if the absorptive capacity is higher too. The same reasoning applies for the age of workers and the age and size of firms. Younger workers, in principle are more receptive to foreign ideas, older and larger firms are likely to possess more resources to implement foreign knowledge. In addition, small firms may not be able to operate on a scale large enough to handle some of the foreign technology (Ngo and Conklin, 1996). However, we do not find convincing evidence that support the idea that the remaining determinant factors, domestic firms' size and financial capacity, can generate vertical externalities. In our view, these characteristics can only impact on the intensity of vertical externalities, once they occur.

Regarding foreign firms' characteristics as determinant factors of magnitude, as Moran (2001) stresses, the magnitude of linkages increases if the MNCs are largely dependent on local suppliers and impose high quality inputs. On the other hand, the share of foreign capital can be regarded as a proxy of the entry mode, and several studies (Javorcik, and Spatareanu, 2003; Javorcik, 2004b; Merlevede and Schoors, 2005) report the influence of the share of foreign capital on externalities from FDI. Indeed, MNCs with higher local participation will not only facilitate access to foreign technology to local firms but also will probably create more linkages (Merlevede and Schoors, 2005). On the other hand, local producers of final products in export-oriented sectors usually face greater competition when compared to firms that supply the local market (Blomström and Sjöholm, 1999). Hence, these firms probably are familiar with the imposition of high quality to their products and were already forced to import inputs if the local inputs do not meet the quality requirements. Thus, these firms can at best benefit marginally from the improved quality of local inputs and therefore, the magnitude of vertical externalities will be lower. However, if these firms produce for the local market, then the magnitude of vertical externalities will be greater. Finally, we find that benefits arising from linkages will be greater if the technological gap is not too low, because in this case local firms will have (potentially) more to learn with the MNCs. However, if the technological gap is too high, local firms may not have the necessary absorptive capacity to implement foreign innovations.

4. EMPIRICAL STUDIES

4.1. INTRODUCTION

In Section 2, we discussed the transmission mechanisms of externalities from FDI on the productivity of domestic firms, to assist the analysis of empirical literature, regarding the type of estimating equations and variables aiming to capture the externality effects. Section 3 provided a set of determinant factors of vertical externalities that can be included in the empirical studies. However, researchers acknowledge that empirical studies should account for firm heterogeneity and, therefore, they must be carried out at firm level. Indeed, domestic firms' (heterogeneous) characteristics, influencing, for example, the absorptive capacity, are not only important to capture certain types of FDI projects that are likely to generate vertical externalities, but also may enhance the magnitude of the externalities from FDI.

We will now analyse a set of empirical studies for DCs regarding the type of the estimated equation, variables, proxies, determinant factors, and results, to draw some conclusions regarding the direction of future empirical research on externalities from FDI for DCs. The empirical literature review is motivated by two main reasons. First, there is a lack of empirical research that seeks to explain the impact and policy implications of externalities from FDI specifically in DCs; second, empirical evidence has shown mixed results for the same country and time period. Thus, this section addresses the former and tries to explain the later. We are the first to confine such analysis to the DCs, in particular to five Western European Countries. Previous literature reviews had focused only in the Least Developed Countries (LDCs); or in a mix of countries with different levels of development; or just in one country (DC or LDC). Although our analysis is not a meta-analysis, we expect that our group of studies is large enough to provide a more comprehensive explanation for the different results for the same country. In order to do so, we selected a group of five Developed western European countries.

The empirical literature on the impact of FDI on the productivity of local firms (e.g., Haddad and Harrison, 1993 and Harrison and Aitken, 1999) is mostly derived from association studies. According to Keller (2004): "This approach is based on economic theory in the following sense. Often, there are several models that have been proposed to explain, in this case, FDI spillovers, while model-specific evidence does often not yet exist. Association studies try to shed light on the most interesting models by proposing what might be the common reduced-form equation of all these FDI externality models. In order to accommodate several models, the framework cannot be very specific." (*Op cit*, p. 760).

The approach starts by a neoclassical production function[3]:

$$Y_{ijt} = A_{ijt} K_{ijt}^{\beta k} L_{ijt}^{\beta l} M_{ijt}^{\beta m} \quad (I.1)$$

where Y_{ijt} represents physical output of firm *i* in sector j and period *t*, K_{ijt}, L_{ijt} and M_{ijt} are the inputs (capital, labour and materials, respectively). A_{ijt} is the Hicksian neutral efficiency level (our concept of total factor productivity – TFP) of firm *i* in sector j and period *t*. For a given level of *A*, higher output levels demand higher levels of inputs (K, L and M).

Taking natural logs of (1) and since the firm-level productivity is $tfp_{ijt} = \beta_0 + \varepsilon_{ijt}$, we obtain a linear production function

$$y_{ijt} = \beta_0 + \beta_k k_{ijt} + \beta_l l_{ijt} + \beta_m m_{ijt} + \varepsilon_{ijt} \quad (I.2)$$

where lower cases refer to natural logarithms. Defining the value added as $va_{ijt}=y_{ijt}-\beta_m m_{ijt}$ and assuming that $L = L^P + L^{NP}$, where L^P stands for production worker (unskilled) labour and L^{NP} stands for non-production worker (skilled) labour.

Then, from equation (2), the productivity is estimated as a residual

$$\widehat{tfp}^{v}_{ijt} = va_{ijt} - (\hat{\varepsilon}^{v}_{jP}\, l^{P}_{ijt} + \hat{\varepsilon}^{v}_{jNP}\, l^{NP}_{ijt} + \hat{\varepsilon}^{v}_{jK}\, k_{ijt}) \quad (I.3)$$

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[3] The specification is slightly different from the Cobb Douglas used in the Solow model since in Solow model technology is labour augmenting and the equation assumes the form of $Y_{ijt} = f(K_{ijt}, A_{ijt}L_{ijt})$.
The use of a production function is along the lines of the New Growth Theory. This theory approaches knowledge externalities under the assumption of a spontaneous, automatic and free transmission mechanism (Romer, 1986, 1990 and 1994, Lucas, 2009). However, firms are mostly knowledge integrators, combining different sources of knowledge in order to generate new knowledge (Weitzman, 1996 and 1998). Hence, the production function is not the most adequate function to explain the generation of knowledge externalities. Instead, it is necessary to specify a knowledge generation function (Nelson and Winters, 1982 and Weitzman, 1996 and 1998) where internal and external knowledge are complementary inputs.

Following Haddad and Harrison (1993), equation (I.3) is expressed as a augmented-solow type of equation, in order that the productivity growth can be expressed as a function of externalities from FDI and other control variables [4]

$$dtfp_{ijt}^{v} / tfp_{ijt}^{v} = f(F_{jt}, X) \qquad \text{(I.4)}$$

where F_{jt} is the measure of foreign presence in a certain industry *j* and *X* is a set of control variables. In particular, our estimating model is

$$dtfp_{ijt}^{v} / tfp_{ijt}^{v} = \beta_0 + \beta_1 tfp_{ijt-1}^{v} + \beta_2 \sum_{t=2}^{0} f_{jt} + \beta_3 x_{ijt} + \gamma_t + \mu_{it} \qquad \text{(I.5)}$$

Where the growth of TFP depends on the previous level of TFP, the foreign presence and other control variables. We also include year dummies γ_t that account for possible changes in the growth of TFP due to stochastic shocks at firm or sectoral level over time and an error term μ_{it}.

However, early studies, including those reviewed here for Developed Countries, used labour productivity (*Y/L)* instead of the estimated TFP ($\widehat{tfp}^{v}_{ijt}$), due to data limitations and less sophisticated econometric methodologies.[5] Therefore, under the assumption of perfect competition, taking logs and computing total differentials, the augmented Cobb-Douglas type equation in those studies is

$$(y/l)_{ijt} = \beta_0 + \beta_1(f_{jt}) + \beta_2 x_{ijt} + \varepsilon_{ijt} \qquad \text{(I.6)}$$

where again lower-case letters refer to natural logarithms, the coefficients β are the factor elasticities of product and *f* represents the measures of foreign presence (at horizontal and/or vertical level), *x* is a set of control variables and ε_{it} is the error term.

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[4] Where the human capital is the L^{NP}, i.e, the non-production worker (skilled) labour.

[5] The labour productivity (Y/L), in spite of being often used in the literature (eg, Kokko, 1994, Barrios and Strobl, 2002), captures only one aspect of the productivity improvement.

The analysis of our group of econometric studies, in the next section, regarding the type of equation, variables and proxies to include in the estimating equations will help us to establish the best practices regarding the empirical research.

4.2. THE SELECTED STUDIES

We analyse 20 empirical studies that test the effects of FDI on the productivity of domestic manufacturing firms for 5 countries of Western Europe, with panel data at firm level.[6] The sample contains only DCs because the extent to which externalities occur is not the same for DCs and LDCs (Roording and Vaal, 2010). In fact, studies on DCs document positive productivity externalities even after controlling for industry and regional fixed effects (Hale and Long, 2006).[7] This occurs for several reasons. First, FDI projects in DCs are mainly market-driven (Roording and Vaal, 2010). Thus, according to what was said in section 3.2, market-oriented MNCs are likely to establish backward linkages; and the potential for vertical externalities is increased. Second, because labour market is more restrictive in LDCS, it does not work as well, and it is not as regulated as in DCs, the potential for vertical externalities is lower. Third, in countries with developed financial markets, the access to credit for investment is facilitated, favouring the occurrence of linkages (Alfaro et al. 2004).

However, while all our selected studies investigate the existence of horizontal externalities, only 35% investigate the existence of vertical externalities. The choice of the countries is related to the number of studies produced for comparison purposes.

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[6] The choice of studies for these 5 countries is related to many reasons. First, our purpose is to analyse the effects of FDI in a small developed and open economy (Portugal). Second, we want to analyse the impact of FDI in the manufacturing sector only. Third, Countries should be from Western Europe and we need at least 3 studies to compare results. Empirical research on externalities from FDI in Western Europe Countries had its apogee from the early 2000s to 2010, coinciding with the introduction of Input-Output tables in the analysis and the development of databases and estimation methods. Having exhausted the enthusiasm for these countries, researchers started to focus on transition economies and then in developing countries. The fact that FDI inflows into Western Europe have declined since the 2008 crisis may also, at least in part, explain the absence of more recent studies with the characteristics we want to analyse. One exception is the recent study Barge-Gil et al. (2017) for Spain but the authors include the services sector in their analysis, and not just the manufacturing sector. Other examples of more recent studies that do not comply entirely with our requirements are Barrios et al (2012) that focus on knowledge externalities for Ireland; Del Bo (2014) that analyses externalities from FDI on the productivity of electricity sector for EU countries; and Mariotti et al (2011, 2014) that focus on the productivity externalities from MNCs to Italian firms in the services sector.

[7] See for example, Girma, et al. (2001) and Haskel et al. (2007).

Nevertheless, despite the research on vertical externalities, the number of such studies for DCs is still scarce. Most of the studies (35%) are for the UK, 20% refer to Portugal and the other countries represent a share of 15 % each. As Figure I.1 shows, in all countries, except for Ireland, the growth rate of the manufacturing Gross Value Added has been relatively constant over the period 1995-2007.

[Insert Figure I.1 here]

According to Inklaar and Timmer (2008), these countries shared the average weight of manufacturing in the overall economy of approximately 22%, in 1997. We focus on the manufacturing sector because, being a major producer of tradables, it potentially generates high rates of innovation and drag capabilities to other sectors of the economy. In other words, the manufacturing sector is a driver of technological change (Andreoni and Gregory, 2013).

Estimated Equation, Variables and Proxies in selected studies

Table I.4 shows the empirical studies in our group of studies regarding the country, period, estimator, dependent variable, proxy for foreign presence and results.

[Insert Table I.4 here]

With reference to equation (6), two studies (Ruane and Uğur, 2005 and Albanese et al, 2008) use the functional form of the type,

$$\mathrm{dln(Y/L)}_{\mathrm{jt}} = \beta_0 + \beta_1 d\ln F_{ijt} + \beta_2 \ln X_{ijt} + \varepsilon_{ijt} \tag{I.7}$$

while 4 studies (Driffield, 2004; Haskel et al, 2007.; de Propis and Driffield, 2006 and Reganati and Sica, 2007) use an empirical model of the type:

$$\mathrm{dln(Y/L)}_{\mathrm{jt}} = \beta_0 + \beta_1 \ln F_{ijt} + \beta_2 \ln X_{ijt} + \varepsilon_{ijt} \tag{I.8}$$

and the remaining studies use an empirical model such as,

$$\ln(\mathrm{Y/L})_{ijt} = \beta_0 + \beta_1 \ln F_{ijt} + \beta_2 \ln X_{ijt} + \varepsilon_{ijt} \qquad (I.9)$$

Both specifications in (7) and (8) assume that FDI have a permanent effect on labour productivity; while specification (9) assumes that FDI only impacts on the level of the labour productivity.

The group of variables *X* include interaction variables that may be determinant factors of externalities from FDI. The most used variables in these studies are the absorptive capacity and the geographical proximity. Tables I.5 (*a* and *b*) show the proxies used for the dependent and independent variables and for the measures of foreign presence, respectively.

[Insert Table I.5 a and I.5.b here]

Sales are used in 85% of the studies; whether as a proxy of output, or entering the formula of labour productivity (output/labour) or value added (sales less the intermediate inputs); while the share of foreign employment is used in 50% of studies as proxy for foreign presence.

Only two studies refer the robustness check of measures for foreign presence. Indeed, Haskell et al (2007) use the employment and the capital of foreign firms as alternative measures; while Jabbour and Mucchielli (2007) test the magnitude of backward externalities by using the average foreign equity participation in manufacturing weighted by each firm's share in the total employment of the sector; and the the share of foreign firms in manufacturing. Both studies conclude that the results are similar regardless the proxy used for foreign presence.

Determinant Factors in selected studies

Considering our classification of the determinant factors in section 3, we now analyse how the authors of the selected studies have tested the determinant factors of externalities from FDI.

For the UK, while De Propis and Driffield (2006) and Driffield (2004) find negative horizontal externalities, due to agglomeration economies and government policies, Girma and Wakelin (2002) and Haskel et al. (2007) find positive horizontal externalities via competition and the level of development, respectively. The effect of the agglomeration economies on vertical externalities is indeterminate in Harris and Robinson (2004); whilst Haskel et al. (2007) and Girma et al. (2008) find that the level of development and the FDI motive give rise to positive externalities via backward linkages. In contrast, externalities via forward linkages are positively affected by the level of development; while the impact of the FDI motive is negative.

For Portugal, Farinha and Mata (1996) and Proença et al. (2002) find non-significant horizontal externalities, due to firm size and technological gap; while Crespo et al. (2009, 2012) find a negative effect on horizontal externalities. Crespo et al. (2012) find positive externalities via backward linkages and positive but non-significant externalities via forward linkages, due to geographic proximity.

For Ireland, Barrios et al. (2012) and Ruane and Uğur (2005) test the absorptive capacity and find non-significant and positive results, respectively. Barry et al (2005) find that firm size and the capitalistic intensity impact negatively on horizontal externalities.

For Italy, Imbriani & Reganati (1999) and Reganati and Sica (2007) test the impact of the geographical proximity and the absorptive capacity on horizontal externalities and find non-significant results; while Albanese et al (2008) find a positive influence of geographical proximity on horizontal externalities. Reganati and Sica (2007) also find a non-significant impact of the absorptive capacity on externalities via backward linkages, but positive for externalities via forward linkages.

Finally, for Spain, Jabbour and Mucchielli (2007) find that technological gap impact negatively on horizontal externalities and positively on vertical externalities. Barrios and Ströbl (2002) test the absorptive capacity and find a non-significant effect on horizontal externalities; whilst Alvarez and Molero (2005) conclude that the share of foreign capital has a positive effect on horizontal externalities.

Thus, while the absorptive capacity is tested in 24% of studies, the share of foreign capital and the geographical proximity are tested in 15% of studies, and the firm size and the FDI motive are tested only in 9% of the studies, followed by the agglomeration economies, export capacity and technological gap (6%). Finally, the level of development of the host country, the FDI policies adopted, the market size and the competition are analysed in 3 % of the studies.

The meta-analysis of Havranec and Irsova (2010) includes 4 of our 20 studies. However, our analysis provides different insights. We focus on findings for five developed Western European countries and we focus on the determinants factors of externalities from FDI, included in these studies. Comparing our analysis with the findings of Havranec and Irsova (2010) and the study of Javorcik (2002), we conclude the following. Our analysis of the determinant factors confirms to some extent the study of Havranec and Irsova (2010). The authors claim that the most used determinants of horizontal externalities are the technological gap, trade openness, IPR protection, human capital and FDI penetration (measured by the ratio of inward FDI stock to GDP). Moreover, our results confirm the findings of Javorcik (2002) that the determinants used to explain vertical externalities are mostly competition, FDI motive, the share of foreign capital and technological gap.

Results in selected studies

Table I.6 compares the results of Havranec and Irsova (2010) with the results of our selected studies. The sample of Havranec and Irsova (2010) contains 4 studies, 1 for each of the selected countries, except for Ireland. In what follows, our results are shown in parentheses. The results analysed by Havranec and Irsova (2010) include 75% (55%) of studies with positive horizontal externalities, 100% (100%) show positive externalities via backward linkages; and 33% (67%) show positive externalities via forward linkages.

[Insert Table I.6 here]

The results are mixed and sometimes indeterminate. In fact, the years of 1993-1996 showed controversial results for the UK and Ireland; as well as the years 1995 and 2000 for Portugal; and 1998 for Spain. In contrast, it seems consistent to assume that, according to the sample of studies, the results are positive for horizontal externalities in the UK for 1974-1988; and negative for 1997. However, for Portugal, horizontal externalities appear to be non-significant for 1989-1992; positive in 1999; and negative in 2001; while in Spain, horizontal externalities seem to be non-significant in 1991-1992; positive in 1999; and negative in 2000. Regarding Ireland, horizontal externalities appear to be non-significant in 1991 and 1998-199; while in Italy, horizontal externalities seem to be non-significant in 1994-1998; and positive in 2003-2005. Though mixed results may be a consequence of different data sources and methodologies, positive and negative results may also be affected by business cycles, and, the amount of inward FDI flows targeting the manufacturing sector in those periods.

Comparing the results for each country, considering the methodologies and variables used, we highlight the following aspects, drawn from Table I.4.

For Ireland, the 3 studies analyse the period 1991-1995, where both studies of Ruane and Ugur (2005) and Barry et al. (2005) use the same dependent variables and proxies for the foreign presence; and Barrios et al (2012) use the TFP as dependent variable, and the R&D stocks of foreign firms as a proxy for foreign presence. While Ruane and Ugur (2005) find positive but non-significant results for horizontal externalities, Barry et al. (2005) find negative results and Barrios et al (2012) find positive results. The explanation for different results, especially between the studies of Ruane and Ugur (2005) and Barry et al. (2005), since they have several common characteristics, may be attributed to different econometric techniques. Indeed, while the first use OLS, the second use fixed effects and Barrios et al. (2012) use 2SLS.

In the case of Italy, studies by Reganati and Sica (2007) and Albanese et al. (2008) analyse the common period of 1999-2002; and the studies of Imbriani and Reganati (2004) and Reganati and Sica (2007) use the same dependent variable and the same proxy for foreign presence. However, Imbriani and Reganati (2004) find negative but non-significant results and Reganati and Sica (2007) find positive but non-significant results. Albanese et al. (2008) share the same econometric technique with the other two studies, but the authors use the TFP as the dependent variable and the number of firms as proxy for foreign presence and find positive horizontal externalities.

Regarding Portugal, Farinha and Mata (1996) analyse the 1986-1992 period while Proenca et al. (2002) focus their analysis between 1996 and 1998 and Crespo et al. (2009, 2012) analyse the period 1996-2001.The common period is 1996-1998 for the last 3 studies. Except for Farinha and Mata (1996), that use a random effects model, all authors use the system GMM to estimate an equation where the dependent variable is the labour productivity which depends on variables of foreign presence in level (whose proxy is the employment in foreign firms, except Proença et al. that use the capital stock). Results for horizontal externalities are controversial. Indeed, while Crespo et al. (2009, 2012) find negative results; Farinha and Mata (1996) and Proença et al. (2002) find non-significant results. Regarding Vertical externalities, Crespo et al (2009, 2012) find positive and positive but non-significant results via backward and forward linkages, respectively. One possible cause for these controversial results may be the underestimation of the real externality effects due to econometric problems associated with traditional panel data estimation methods.

Concerning Spain, Barrios and Strobl (2002), Jabbour and Mucchielli (2007) and Alvarez and Molero (2005) analyse the common time span of 1991-1994 and the authors use the capital stock as a proxy for foreign presence. However, even though both Barrios and Strobl (2002) and Jabbour and Mucchielli (2007) use the output as the dependent variable; the first use fixed effects; while the second use OLS, and find non-significant and negative horizontal externalities, respectively. Alvarez and Molero (2005) find positive results by regressing the labour productivity using the GMM estimator.

In the case of the UK, studies that found positive results use the output or value added as the dependent variable; while studies with negative results use the capital stock as a proxy for foreign presence. It is interesting to note that the studies of Driffield (2004) and Harris and Robinson (2004) share the date of publication and the same period of analysis of 1983-1995. They also use the capital stock as a proxy for foreign presence and the output as the dependent variable and find opposite results (negative and positive, respectively) for horizontal externalities. In this case, we believe that the methodology and the fact that the data source is not the same may have influenced the results. Indeed, while Driffield (2004) apply the econometric approach of Griliches and Lichtenberg (1984) to ONS, ANBERD (Analytical Business Enterprise Research and Development) and STAN OECD data; Harris and Robinson (2004) use weighted panels with DPD algorithm in PcGive with data from ARD (Annual Census of Production Respondents). Regarding the results for vertical externalities, externalities via backward linkages are positive using output as dependent variable and Levhinson and Petrin (2003) econometric procedure; and are undetermined in the studies where the proxy of foreign presence is the capital stock and the methodology is the weighted panels in the DPD algorithm. We cannot arrive to a conclusion about the presence of forward externalities in the UK since the result is positive, undetermined or negative depending on the use of employment, capital stock or output as the proxy for foreign presence.

5. CONCLUSION

According to some authors, externalities are more likely to occur at vertical level (Kugler, 2006). Vertical externalities (especially via forward linkages) seem to exert a significant influence on the competitiveness of countries and stimulate economic growth via increased exports (Freund and Moran, 2017).

Overall, internal characteristics of firms (local and foreign) appear to be more important for the occurrence and magnitude of vertical externalities than external factors.

In this context, empirical studies at firm level report that firms are strongly heterogeneous in various performance measures, namely size and productivity (Melitz, 2003). Thus, domestic firms' characteristics that enhance the absorptive capacity (such as firm size) may be key contributors to the magnitude of externalities from FDI. Hence, there is scope for further analysis on the transmission mechanisms of externalities from FDI considering firms' heterogeneity.

Some conclusions can be drawn from the analysis of the empirical studies on Western European Countries. First, there is a lack of evidence of externalities via forward linkages when compared with those arising from backward linkages; second, researchers traditionally regress the output on foreign presence and control variables that are efficiency measures (capital intensity, economies of scale and sectoral concentration); third, the impact of the FDI motive has not been fully exploited in the empirical literature perhaps due to the difficulty to disentangle all possible effects; and finally, the share of statistically non-significant results is high.

Hence, up to now, the empirical literature has not contributed to an unambiguous explanation of the transmission mechanism of externalities from FDI, and, therefore, the link between theoretical and empirical literature is missing (Lautier and Moreau, 2012).

We expect to contribute for the existent literature in two ways. Firstly, we present a new classification on the determinant factors of vertical externalities; secondly, we are the first to review the literature focusing on a set of developed European countries. This is of crucial importance regarding the choice of variables to include in empirical models to evaluate the existence of externalities from FDI in Developed Countries.

Chapter 2

Assessing the Impact of Foreign Direct Investment on

Domestic Manufacturing Firms' Productivity: A Database for Portugal

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ABSTRACT

The lack of a database that integrates a significant number of the variables necessary to empirically investigate the existence of externalities from FDI in Portugal represents an important limitation in this area. This paper presents a new balanced panel dataset with a total of 5,045 manufacturing firms (domestic and foreign) for the period 1995-2007. We use multiple imputation in Stata 13.0 to construct a large dataset containing several indicators taken from AMADEUS, *Quadros do Pessoal*, EU Klems and OCDE databases, that allow us to congregate variables that measure three dimensions: total factor productivity; foreign presence and factors that may influence the productivity of domestic firms, such as indicators of firm efficiency and R&D activities. Our panel dataset provides a set of useful 15 indicators for the analysis of externalities from FDI in 4,685 domestic manufacturing firms. We perform correlation analysis by technological groups based on Pavitt's Taxonomy. Results indicate that the foreign presence is positively and significantly correlated with the TFP growth. Moreover, the sign and magnitude of the coefficients for the control variables indicate that concentration, the stock of foreign knowledge and the technological gap potentially assist the TFP growth of domestic firms, but only in some technological groups.

Keywords: firm-level data, productivity, FDI Externalities, Portugal
JEL classification: F2, O3

1. INTRODUCTION

Since the 1990's, globalisation has mainly taken place through trade in goods and capital flows, with special emphasis on foreign direct investment (FDI). The tremendous growth in FDI flows is one of the most powerful causes of globalization. In 1982, the total global FDI flows amounted to $57 billion and, in 2014, reached $1.2 trillion (UNCTAD, 2015). In 2016, global flows of FDI were $1.75 trillion and UNCTAD predicts a modest recover for 2017–2018 (UNCTAD, 2017).

FDI exercises direct and indirect effects on host economies. The indirect effects consist of externalities which are appropriated by domestic firms without payment to the MNC. Accordingly, in the last two decades there have been important developments in terms of the empirical and theoretical literature on the impact of externalities from FDI on the productivity of domestic firms. However, the empirical evidence for Portugal is scarce and characterized by the use of different databases/data sources, variables and methodologies.

Our database is intended to be used in panel studies at the firm-level. There are several reasons for using panel data with this level of disaggregation. Firm-level data make possible to understand, on one hand, how strategies, technological competences or entry modes of MNCs impact in host economies and, on the other hand, how domestic firms characteristics, namely through efficiency measures, permit them to cope with foreign knowledge and technology (Harris, 2009; Giroud, 2011). Panel data allows controlling for firm fixed effects and time effects.[8] Furthermore, our time span is thirteen years, allowing for the study of dynamic effects, which is crucial since externalities from FDI need time to materialize.

Panel studies performed at firm-level for Portugal include Proença et al. (2002, 2006) and Crespo et al. (2012). However, the authors attain different conclusions concerning the occurrence of horizontal externalities.[9] The first study does not find

[8] Firm fixed effects are used to ensure that MNCs' investment decisions are based on initial firm conditions that do not change over time. This approach helps to reduce the possibility of reverse causality, i.e, that the positive relationship between FDI and the productivity of domestic firms is because MNCs invest in the domestic firms with higher productivity. Moreover, year dummies prevent the situation where a positive relationship between foreign presence and the productivity of domestic firms is spurious, i.e, a mere consequence of business cycle forces.

[9] Horizontal externalities occur when the entry of the MNC generates positive externalities for local competitors.

significant externalities; while the second finds positive externalities and the last finds negative externalities. One of the reasons for these different results may be the fact that the authors use different databases. Indeed, Proença et al. (2002, 2006) used data from Dun & Bradstreet and Crespo et al. (2012) used both Dun & Bradstreet and *Quadros do Pessoal* databases. Furthermore, with the exception of Crespo et al. (2009, 2012), the authors do not investigate the existence of vertical externalities.[10] Nevertheless, Crespo et al. (2012) find that the occurrence of externalities via backward linkages is conditioned on the existence of geographical proximity between foreign and domestic firms; and the authors do not find any significant evidence supporting the existence of externalities via forward linkages. [11,12]

Hence, to this date, research findings are far from sound and consensual concerning the existence and magnitude of firm-level externalities from FDI in the Portuguese manufacturing sector. One of the reasons may be that all previous attempts relied on incomplete and inconsistent databases to estimate externalities from FDI. For example, *Quadros do Pessoal* does not possess financial variables such as tangible and intangible assets that we use to proxy for physical capital and R&D expenditures. Thus, the lack of harmonised and detailed data deprived these studies of a robust and appropriate tool to assess the benefits of FDI on the Portuguese economy. We fill this gap by providing a balanced panel database with a significant number of the variables that we believe are needed to more throroughly empirically analyze the existence of externalities from FDI that can have an impact on the productivity of Portuguese manufacturing firms.

Our main data source is the AMADEUS database. Data from AMADEUS is compiled by the Bureau van Dijk Electronic Publishing (BvD). The dataset has financial accounting information from detailed harmonized balance-sheets of firms and their investors. It also provides the amount of foreign investment. This dataset is different from other datasets used by Portuguese researchers. Fundamental advantages include the detailed ownership information provided and the financial information from balance-sheets.

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[10] Vertical externalities occur when the linkages between MNCs and their local suppliers/customers (backward/forward linkages) generate positive externalities.

[11] Contacts between domestic suppliers of intermediate inputs and their multinational clients in downstream sectors.

[12] Contacts between foreign suppliers of intermediate inputs and their domestic clients in upstream sectors.

This paper is organized as follows. Section 2 describes the empirical model to analyze the existence of externalities from FDI at the firm-level, in order to identify the variables needed in the database, their relationship and the expected sign. Section 3 describes the construction of our database. Section 4 analyzes the findings on the correlation between the variables by technological groups of industries and Section 5 concludes.

2. EMPIRICAL MODEL

In this section, we start by describing the steps necessary to quantify the dependent variable and then identify the independent variables, in particular those related to foreign presence.

Departing from a cobb-douglas type of equation:

$$Y_{ijt} = A_{ijt} K_{ijt}^{\beta k} L_{ijt}^{\beta l} M_{ijt}^{\beta m} \qquad (II.1)$$

where Y_{ijt} represents physical output of firm *i* in sector j and period *t*, K_{ijt}, L_{ijt} and M_{ijt} are the inputs of capital, labour and materials, respectively. A_{ijt} is the Hicksian neutral efficiency level (our concept of total factor productivity – TFP) of firm *i* in period *t*. For a given level of A, higher output levels demand higher inputs (K, L and M) levels.

We assume that $L = L^P + L^{NP}$, where where L^P stands for production workers (unskilled) labour and L^{NP} stands for non-production workers (skilled) labour. We proxy L^{NP} by the sectoral average of years of schooling since we do not possess information for individual firms.

Although we can observe Y_{ijt}, K_{ijt}, L_{ijt} and M_{ijt}, A_{ijt} is not observable and hence, needs to be estimated.

The estimation of A_{ijt}, depends on several different components such as skills, knowledge and firm-level capabilities, including managerial and organisational competences. We assume that A_{ijt} or TFP in logs is given by:

$$\ln (A_{ijt}) = \beta_0 + \varepsilon_{ijt} \qquad (II.2)$$

where β_0 measures the mean efficiency level across firms over time; ε_{ijt} is the time- and producer-specific deviation from that mean.

Taking natural logs of (II.1) and inserting equation (II.2) we obtain a linear production function

$$y_{ijt} = \beta_0 + \beta_k k_{ijt} + \beta_{lP} l^{P}_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt} + \varepsilon_{ijt} \qquad (II.3)$$

where lower cases refer to natural logarithms. The error term ε_{ijt} can be further decomposed into an observable (or at least predictable); and an unobservable i.i.d.

component, representing unexpected deviations from the mean due to measurement error, unexpected delays or other external circumstances, i.e, $\varepsilon_{ijt} = v_{ij} + u^q_{ijt}$. Hence, equation (3) becomes

$$y_{ijt} = \beta_0 + \beta_k k_{ijt} + \beta_{lP} l^P_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt} + v_{ijt} + u^q_{ijt} \qquad \text{(II.4)}$$

Since the firm-level productivity is $tfp_{ijt} = \beta_0 + v_{ijt}$ and rearranging the terms, we obtain[13]

$$tfp_{ijt} = y_{ijt} - (\beta_k k_{ijt} + \beta_{lP} l^P_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt}) - u^q_{ijt} \qquad \text{(II.5)}$$

And the estimated productivity is

$$\hat{tfp} = tfp_{ijt} + u^q_{ijt} \qquad \text{(II.6)}$$

This empirical model allows us to address the simultaneity bias that occurs in the estimation of TFP, when unobserved productivity or TFP shocks, *i*, *j* and *t*, are correlated to the choice of inputs. Since the Olley-Pakes (1996) and Levinsohn-Petrin (LP) (2003) techniques, while controlling for the simultaneity bias, suffer from collinearity problems, Ackerberg et al. (2007) and, later, Wooldridge (2009) suggested modifications to the original LP approach aiming to correct the collinearity issue.

Defining the value added as $va_{ijt}=y_{ijt}-\beta_m m_{ijt}$, then it can be estimated through equation (II.4) as a residual

$$\hat{tfp}_{ijt} = va_{ijt} - (\hat{\varepsilon}^v_{jP}\, l^P_{ijt} + \hat{\varepsilon}^v_{jNP}\, l^{NP}_{ijt} + \hat{\varepsilon}^v_{jK}\, k_{ijt}) \qquad \text{(II.7)}$$

As described in section 2 of chapter 1, the literature on International Technology Diffusion has emphasized three channels for technology transfer: international trade of intermediate goods, international dissemination of the results of research and development (R&D) and FDI (Keller, 2004). In this theoretical framework, externalities

[13] The productivity term is identified assuming that tfp_{ijt} is a state variable in the firm's decision problem (i.e. it is a determinant of both firm selection and input demand decisions), although u^q_{ijt} is either the measurement error or a non-predictable productivity shock (Olley and Pakes, 1996).

from FDI (regarded as a set of intangible assets, codified and tacit knowledge and technologies) may have an impact on long-term growth (Romer, 1986, Lucas, 1988, Grossman and Helpman, 1991). The size of the impact of FDI depends on the degree of which the technology transfer to domestic firms leads to increasing returns in domestic production, via TFP growth.

Accordingly, and following the studies reviewed in section 4.2 of chapter 1, where the estimating equation [see equation (I.8)] assumes that increases in levels of FDI can lead to long-term changes in the TFP, our model corresponds to a production function augmented by foreign presence and control variables, as well as interaction variables

$$\begin{aligned} d\hat{tfp}_{ijt} &= \beta_0 + \beta_1 \hat{tfp}_{ij(t-1)} + \beta_2 \sum_{m=0}^{2} f_{j(t-m)} + \beta_3 (f_{jt} * hfd_{ijt}) + \beta_4 (f_{jt} * rd_{ijt}) + \beta_5 (f_{jt} * mrdf_{jt}) + \\ &\beta_6 (f_{jt} * s_{ijt}) + \beta_7 (f_{jt} * kl_{ijt}) + \beta_8 (f_{jt} * tg_{ijt}) + \beta_9 hfd_{ijt} + \beta_{10} rd_{ijt} + \beta_{11} mrdf_{jt} + \beta_{12} ds_{ijt} + \\ &\beta_{13} tg_{ijt} + \beta_{14} kl_{ijt} + \gamma_t + \mu_{it} \end{aligned} \qquad \text{(II.8)}$$

Where the lowercases denote variables in logarithms and *f* is the measure of foreign presence (*hor, back* and *for*). We also include year dummies γ_t that account for possible changes in the growth of TFP due to stochastic shocks at firm or sectoral level over time and an error term μ_{it}. Our model (II.8) follows the models of technology diffusion.

The TFP growth is assumed to depend on three sets of variables; variables that measure the foreign presence; interaction terms; and control variables, within a fixed effects dynamic model, including a time trend. These sets of variables are described as follows.

Variables related to foreign presence

Externalities from FDI may be horizontal or vertical. Horizontal externalities occur when the entry of the MNC generates positive externalities for local competitors. Vertical externalities occur when the links between MNCs and their local suppliers/customers (backward/forward linkages) generate positive externalities. Hence, we measure the foreign presence through three variables *hor, back* and *for* defined at sectoral level. Horizontal technology transfer occurs through contacts with local competitors (via demonstration/imitation, labour mobility, exports, competition, consulting and specialized services and coordination with local institutions). *hor* is a sectoral externality variable that measures the share of output by foreign firms in the total output of the industry, i.e, measures the presence of FDI on a given industry and is calculated in the following way[14]

$$hor_{jt} = \sum_i foutput_{it} \Big/ \sum_{i \in j} output_{it} \qquad \text{(II.9)}$$

where $foutput_{it}$ is the output of firms with foreign capital operating in industry j at time t. Thus the value of the variable increases with the output of foreign firms.

Hirschman (1958) stated that lack of linkages in the developing economy leads to lack of industrial development. From a developmental perspective, it is generally assumed that linkages between MNCs and domestic firms are better than no linkages, and the more and deeper linkages are, the better it is for the host economy (Altenburg, 2001; Scott-Kennel and Enderwick, 2004).

MNCs in other industries appeared to foster broad linkages in the host economy by creating industries that supply the MNC and by inducing forward industries to use the multinational's output as inputs, the crowding-in effect of FDI (Wilkins, 1998).

The variable *hor* measures the presence of FDI in a given industry, then the higher its value the greater the increase in domestic firms' productivity. Thus, following (Barrios and Strobl, 2002) we expect a positive effect on domestic firm's TFP growth.

Vertical externalities occur when a MNC increases the demand for local inputs, leading to increased specialization in upstream sectors and, as a result, causing the reduction of costs in downstream sectors. If the MNCs are interested in maintaining the quality standards they are likely to provide technical support to local suppliers in order to improve the quality of inputs, or assist them in the introduction of innovations, training, creation of productive infrastructure, procurement of raw materials, as well as the introduction of new management techniques, among others (Lall, 1980).

[14] Aitken and Harrison (1999) suggest the inclusion of sectoral dummies to control for the possibility of selection bias. This bias arises from the fact that the positive effect of FDI in high tech firms do not necessarily indicate a spillover effect since MNCs typically locate in sectors with higher productivity.

Vertical technology transfer occurs through linkages with local suppliers (backward linkages) or local customers (forward linkages).

We define *back* as

$$back_{jt} = \sum_{k \neq j} \delta_{jk} * hor_{kt} \tag{II.10}$$

where δjk is the share of industry j's output supplied to industry with foreign presence *k*. The variable *back* is intended to capture the effect that multinational customers have on domestic suppliers. Both *j* and *k* are two-digit industries.

Forward linkages occur when the MNCs provide higher quality and/or cheaper inputs to their clients that produce final goods (Markusen and Venables, 1999). Better quality inputs supplied by foreign firms may increase the productivity of domestic firms in industry *j*.

Similarly, we define *for* as

$$for_{jt} = \sum_{k \neq j} \lambda_{kj} * hor_{kt} \tag{II.11}$$

where λ_{kj} is the share of inputs that industry *j* buys from industry k. The variable captures the contacts between domestic firms and their foreign suppliers.

Parameters δ and λ are obtained from the OECD Input-Output (IO) Tables.[15] We exclude the diagonal elements of the IO tables in the calculation of the weighted average, because intrasectoral effects are accounted for in the variable *hor*. Moreover, we focus on inputs for intermediate consumption; therefore we do not include the imports, exports or other components of final demand in the calculation of the IO coefficients.

As highlighted by Lin and Saggi (2007), the net effect of linkages can either be positive or negative when domestic suppliers serve the MNCs exclusively. Indeed, under these circumstances the technology transferred to domestic suppliers increases but the reduction of the rivalry among domestic suppliers tends to reduce the aggregate output level of the intermediate goods industry. In addition, Carluccio and Fally (2010) stress that a decrease in the cost of inputs compatible with the foreign technology, while

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[15] Another source for IO tables is World Input-Output Tables (www.wiod.org) but this source lacks data for one of the investor countries (Norway) which prevent us from using it for comparison.

benefiting foreign firms and the most productive downstream domestic firms adopting the foreign technology, it negatively affects firms using the domestic technology. However, we assume that the higher the value of *back* and *for,* the greater the magnitude of vertical externalities and thus the greater the effect on the TFP growth of domestic firms. The increase in demand of high quality inputs by MNCs or due to the purchase of better quality inputs provided by foreign firms (Lall, 1980; Markusen and Venables, 1999). Hence, following Markusen and Venables (1999) we expect a positive coefficient for variables *back* and *for*.

Control variables

We include six control variables; *hfd* is the Herfindhal index that measures market concentration, *rd* is the value of R&D expenses proxied by firms' intangible assets, *mrdf* is the average value of sectoral foreign R&D expenditure, *s* measures the scale of operations, *tg* is the technological gap, and *kl* measures the capital intensity.

Concentration

The Herfindhal index indicates the market concentration and is calculated as

$$H_{it} = \sum_{g \in J} \left(\frac{X_{gt}}{\sum_{g \in J} X_{gt}} \right)^2 *100 \tag{II.12}$$

where X represents the output of firm g (domestic or foreign) belonging to sector j, at time t. The output is proxied by firm turnover obtained from AMADEUS database, deflated by a Producer Price Index. The Herfindahl index also serve as a proxy of (the lack of) competition. Indeed, since this variable is calculated as a share (%), values close to 0 indicate markets under perfect competition, and a value of 100 denote the presence of monopoly rents.

If the impact of the variable *hfd* on the TFP growth is positive, it means that the market power can facilitate the access to the necessary resources for domestic firms to increase their productivity. Indeed, stronger industry concentration generates larger profits that can be re-invested, for example, in new technologies or in the production of more sophisticated products; however, if the sign is negative it implies that the monopolistic inefficiencies are causing a decrease in the rate of innovation (Sjöholm,

1999) and, thus, a loss of productivity. As a result, the expected sign of this variable is not predefined.

Domestic R&D expenditure

Endogenous growth theories predict R&D activities to be an important determinant of TFP growth since innovations can ultimately raise efficiency (Aghion & Howitt, 1998; Jones, 1995; Romer, 1990). The variable *rd* is included in our model to proxy the domestic firms' absorptive capacity. A certain level of absorptive capacity is required to absorb foreign technology (Liu and Buck, 2007). Domestic R&D expenditures influence domestic TFP in three ways. Firstly, R&D may be cost reducing, lowering the production costs. Secondly, firms may create and produce new products with R&D expenditures by using the same volume of factors. Finally, Kinoshita (2001) considers that R&D activities increase the capacity of domestic firms to imitate new technologies and uses it as a proxy for absorptive capacity (Cohen and Levinthal, 1989; Griffith et al, 2003). Thus, we expect positive sign for the coefficient of *rd*.

Average sectoral R&D expenditure of foreign firms

The variable *mrdf* is included in our model to proxy the average stock of foreign knowledge in each industry. Liu and Buck (2007) found evidence that foreign R&D activities had positive impacts on the innovation performance of domestic firms, if domestic firms possess the absorptive capacity to learn the foreign knowledge. Because innovations are a source of TFP growth, we expect a positive sign for the coefficient of *mrdf*.

Scale

Small firms have less capacity to benefit from foreign presence and are less capable to face competition (Aitken and Harrison, 1999). Yet, some studies [Dimeli and Louri (2001), Girma and Wakelin (2001) and Sinai and Meyer (2004)] find that only small domestic firms (and medium in the later case) benefit from positive externalities from FDI. Hence, the evidence on the impact of scale in firms' productivity appear to be inconclusive. Nonetheless, in the presence of increasing returns to scale, i.e., if there is a industry-specific optimal scale, then TFP increases with scale (Baldwin, 1996; Schoors and Van Der Tol, 2002) and we expect a positive coefficent for *s*.

Technological gap

The determinants of technology diffusion build on models by Nelson and Phelps (1966), Benhabib and Spiegel (2005), Romer (1990) and Aghion and Howitt (1992). Following Gerschenkron (1962) hypothesis, the technological progress is an increasing function of the technology gap (*tg*). We define a way to measure the speed of technology diffusion, i.e, to capture autonomous technological transfer from foreign firms to technologically laggard domestic firms (Griffith et al. 2004; Madsen et al. 2010). The indicator is a ratio of labour productivity between domestic firms and the presumptive foreign leader.[16] Therefore, the variable *tg* is constructed an inverse measure of the technological gap since values of this variable close to 1 mean a small gap and values close to 0 signify a large gap. Thus, and according to the catching-up hypothesis, if the value of *tg* is close to one, the gap is too small; which means that domestic and foreign firms possess similar levels of efficiency and, thus, the domestic firms are not prone to learn much from the MNCs. However, according to the technology-accumulation hypothesis, if the value of *tg* is close to zero, the gap is too large; which means that domestic firms do not possess the necessary "absorptive capacity" to incorporate the knowledge of foreign firms (Lapan and Bardhan, 1973; Wang and Blomstrom, 1992; Perez, 1997; Kinoshita, 2001). Thus, the expected coefficient of this variable is not predefined.

Capital intensity

Capital intensity represents a firm's commitment to modernization and upgrading of its productive capacity. In the long run, capital expenditures typically have a positive impact on firms' performance (Lee & Blevins, 1990; Lee and Xiao, 2011). The higher the capital intensity is, the higher the expected TFP (Buckley, Clegg, Zheng, Siler and Giorgioni, 2010). Hence, we expect a positive coefficent for *kl*.

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[16] There are two reasons for using labor productivity rather than TFP. First, because of correlation of tg calculated with TFP and the error term; second, for the sake of comparison with other empirical studies for Portugal that use the labour productivity

Interaction variables

These variables are included in our model to test the impact of foreign presence in the TFP growth of Portuguese manufacturing firms, given the values of concentration, absorptive capacity, sectoral average of foreign knowledge, scale, technological gap and capital intensity. Thus, we include the interaction variables labelled *F*hfd, F*rd, F*mrdf, F*s, F*tg* and *F*kl,* respectively. Wheren F stands for the measure of foreign presence in the same industry (*hor),* in downstream (*back)* or upstream industries *(for).*

FDI and concentration

If the impact of the variable *F*hfd* is positive, it means that the impact of foreign presence in the TFP growth of Portuguese manufacturing firms is positive, given the values of market concentration. In other words, the influence of concentration on the referred impact is positive because the benefits of having market power ouweight the potential disadvantage of inneficiences from monopoly rents; and otherwise if the value of *F*hfd* is negative. Hence, the sign of *F*hfd* is not predefined.

FDI and absorptive capacity

From what was said above about the domestic firms absorptive capacity, we assume that the impact of foreign presence in the TFP growth of Portuguese manufacturing firms, given a certain level of absorptive capacity, is positive, i.e, that the coefficient of the variable *F*rd* is positive.

FDI and the average stock of foreign knowledge in the industry

Empirical literature provide evidence of positive impacts of foreign R&D activities on the innovation performance of domestic firms, as described above. Hence, we assume a positive impact of foreign presence in the TFP growth of Portuguese manufacturing firms, given a certain level of foreign R&D activities. The expected sign for the variable *F*mrdf* is positive.

FDI and scale

We assume a positive impact of foreign presence in the TFP growth of the Portuguese manufacturing firms, given a certain level of scale, because the adoption of an efficient scale of operations is important to increase the TFP. Consequently, we expect a positive sign for the variable *F*s*.

FDI and technological gap

For the Portuguese economy, Flôres et al. (2002) suggest that the externality effects are maximized when the technological gap is between 50%-80% while Proença et al. (2002) find that *tg* must be around 60%-95% in order to maximize the externalities.[17] Thus, the expected sign of *F*tg* is not predefined.

FDI and capital intensity

Foreign firms usually use more capital-intensive technologies (Lall, 1978; Ferragina, 2013). The extent to which local firms benefit from this superior technology depends largely on their own technological capabilities as defined by capital intensity (Globerman, 1979; Liu et al., 2000). Therefore, we assume a positive impact of foreign presence in the TFP growth of Portuguese manufacturing firms, given a certain level of capital intensity, and expect a positive sign of *F*kl*.

[17] The difference in results may be due to the different proxies used for the variable *tg*.

3. CONSTRUCTION OF THE DATABASE

3.1.AMADEUS DATABASE

We construct a database to assess the existence and magnitude of externalities from FDI in Portugal. The previous section provided information on the variables to include. We now describe the sources and data collection and discuss the choice of proxies.

AMADEUS provides financial data on 250,000 firms in about 40 European countries including standardised annual accounts, financial ratios, sectoral activities and ownership. It provides comparable financial information for public and private firms across Europe with a focus on private firm information.

A major aspect in the construction of a database is data integrity. In other words, it is necessary to ensure that the database is in accordance with the rules and measures of statistical quality (Dyer, 1992). According to Fox et al. (1994), the four key factors that guarantee a database of high-quality are accuracy, timeliness, completeness and consistency. Hence, we gather evidence indicating the integrity of AMADEUS database. Bureau van Dijk (BvD) collects and harmonises the data from the mandated firm reports. In particular, in the Portuguese case, financial data come from *Informação Empresarial Simplificada* (IES).[18] This information is collected in a massive way by Coface, BvD's partner for Portugal, that send it to BvD for subsequent upload in SABI and AMADEUS databases.

The IES was approved by Order No 208/2007, of February 16, as amended by Ordinances No. 8/2008, of January 3, 64-A/2011, of 3 February and 26/2012 of 27 January. Before 2007, firms were required to provide the same information on their annual accounts to various public entities, through different means: deposit of annual accounts and the corresponding registration in the commercial register offices; delivery of annual statement of accounting and tax information to the Ministry of Finance (Autoridade Tributária e Aduaneira); and delivery of annual accounting information to INE and Banco de Portugal), for statistical purposes.[19, 20]

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[18] Simplified Business Information
[19]Taxes and Customs Authority.
[20] Bank of Portugal.

Thus, the fulfilment of each of these obligations entailed the need for firms to transmit substantially identical information on their annual accounts to four different entities through various means. With the creation of IES, all reporting obligations are transmitted electronically to a single entity in a single moment in time. Thus, we think the four parameters of quality are met. Indeed, the fact that Bureau van Dijk provides data for all European countries ensures the integrity regarding the coverage and consistency of the database and facilitates the comparison of the results between empirical studies for different European countries.

In addition, although the innovative density of services, i.e, the share of innovative firms in the total population of firms in the services sector in Portugal is higher than that of manufacturing, international comparisons of the results justify the analysis of this sector. Indeed, most authors focus on manufacturing, since, as Figure II.1 shows, "In nearly all participating countries (..) the share of innovative service-sector firms in the population of service sector firms (*i.e.* the innovative density of service-sector firms) was below that of manufacturing firms" **(**Tamura et al, 2005, pp. 135-136).

[Insert Figure II.1 here]

For example, in Germany and Spain, 65% and almost 40% of the manufacturing firms are innovative *vis-a-vis* 55% and 25% of service-sector firms, respectively. The largest gaps, of 20%, are found in Belgium, Denmark and the Netherlands.

3.2. OTHER SOURCES

The construction of a database to measure externalities from FDI on manufacturing firms' productivity requires a set of variables both at national (to measure the representativeness) and firm-level, such as gross output, the number of employees, intermediate inputs, price indices, turnover, tangible assets, among others. Hence, we need to include these variables in our database. Since data sets from International organizations include only some of the variables needed, they are not suitable for studying the effects of FDI on the productivity of Portuguese manufacturing firms. Indeed, while IMF and UNCTAD databases provide information on FDI flows that are not consistent with one another, OECD and Eurostat provide data that complement the previous two.

OECD provides data on flows and bilateral and sectoral positions while Eurostat provide FDI data by industry and by country of origin and destination.[21] However, even if we could match the information from these sources it still would not be enough for our purposes.

National sources, such as *Banco de Portugal*, *Ministério do Trabalho e Segurança Social*, *Instituto Nacional de Estatistica*, *Ministério da Economia* and Dun & Bradstreet provide more comprehensive databases. However, the definitions, data treatments and nomenclatures differ. Moreover, some of these databases possess low coverage and are incompatible with each other and lack important financial variables (from balance sheet and income statement) needed for our aim.

Therefore, we prefer to deal with information collected and processed by international institutions, such as Bureau van Dijck. The foremost advantage of BvD is to provide harmonised data concerning definition, nomenclature and data treatment that allow us to compare our results with other international studies. Still, the dataset from BvD (AMADEUS) needs some additional firm-level and aggregated variables. Indeed, besides the financial variables provided by AMADEUS we need information on Years of Schooling, Price Index, Intermediate Inputs, Gross Output and Gross Value Added.[22] Hence, we need to complement the information from AMADEUS with data from *Quadros do Pessoal* (QP) database and the EU Klems database in order to construct our database (See Table II.1 for detailed information on the sources for each variable).

[Insert Table II.1 here]

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[21] Moreover, OECD is deeply involved with the IMF in defining the methodology for FDI data collection (see for example the Survey of implementation of methodological standards for Direct Investment, SIMSDI [OECD/IMF, 1999]).

[22] Quadros do Pessoal database contains information on years of schooling of employees for each firm. We use the statistical mean of this variable for each industry. For Portugal, other authors (e.g, Crespo et al, 2008 and 2012; Proença et al., 2002 and 2006) proxy skilled labour by total earnings per worker hired by domestic firms. We think that 'years of schooling' is a more reliable proxy for absorptive capacity since higher salaries not always correspond to payment for skills. Blalock and Gertler (2008) use firm's investment in R&D as a proxy for absorptive capacity. However, Schmidt (2005) finds that the current level of R&D expenditure primarily endeavours to accumulate new knowledge and develop new products and processes. Over time, it also helps to develop the skills and knowledge necessary to source external knowledge but immediately it can, at best, contribute to explore absorptive capacities for specific types of knowledge. Khordagui and Saleh (2013) argue that, in line with the education economics literature, cognitive ability [proxied by the Trends in Mathematics and Science Scores from the World Bank] is a more reliable measure of the quality of human capital than that of years of schooling. However this data is not available at firm or sector level.

The EU Klems Growth and Productivity Accounts include measures of output and input growth, and derived variables such as multifactor productivity at the industry level. The input measures include various categories of capital, labour, energy, material and service inputs. The measures are developed for 25 individual EU member states, the US and Japan and cover the period from 1970 to 2005.

Quadros do Pessoal (QP) correspond to our benchmark for the values of variables at sectoral level. Indeed, QP is a 25-year old administrative source of data with statistical purposes. The information comes from a questionnaire whose reply is mandatory, by Decree- Law No. 35/2004, for all entities with workers under legal labour contract. In 1995-2007 it covered a range of 192,000- 342,000 firms with 2.2- 2.9 million workers.

The information provided by QP includes, among others: Firm name (Name and Fiscal number); Location (Address, District, County and Town); Main Activity; Legal nature; Date of Establishment, Joint-Stock (private, public, foreign); Turnover and Number of Employees (in October of each year). It also includes data on employees: National Insurance Number; Professional Category and Occupation, Level of Qualification, Level of Education, Gender, Age, Nationality, Seniority in the Firm; Type of Contract (full time and part time); Wage; Extra benefits and Monthly hours paid (normal and overtime), among other information.

The advantage of using Quadros do Pessoal lies in its hitherto stability, reliability and annual updating, while the disadvantage may stem from changes in the legislation that exert an impact on the data source.

3.3. DATA

Every firm in AMADEUS is allocated to an industry at two-digit level because the input-output tables are in this format. The sectoral codes follow NACE Revision 2 (see Table II.2) that allow to compare our results with other international studies.

[Insert Table II.2 here]

Table II.3 contains the variables available at AMADEUS. We collect information for 5,045 firms, starting with the larger ones to ensure the representativeness of the dataset, over the period 1995-2007. Our data set is a balanced panel comprising 65,585 observations for 24 manufacturing industries (from 10 to 33).

[Insert Table II.3 here]

If some firms are active in more than one industry, we allocate the firm to the first industry. We assume that the second activity is a secondary source of revenue and as such represents a negligible share of turnover (less than 10%). Firms with three NACE-sectors are omitted since we assume that multi-industry firms do not accurately represent the typical sectoral behaviour of a firm.

We aim to test the influence of foreign presence on the TFP growth of domestic firms. However, since the FDI decisions are likely to depend on firms' characteristics and their performance, a common problem of empirical studies is the inherent selection bias. The problem of sample selection bias has been largely dealt with in the econometric literature (see, for example, Amemiya, 1984, and Wooldridge, 2002). This bias (also referred as selection effect) is an error in choosing the individuals or groups to take part in a study, caused by a sampling bias, i.e, a non-random sample of a population that causes an under representation of some members. Several studies report that MNCs tend to acquire shares in the largest and most successful domestic firms [Djankov and Hoekman (2000), Evenett and Voicu (2001), Damijan et al (2003a,b)]. Therefore, the choice of a sample consisting predominantly of large firms (measured by turnover) may result in a misrepresentation, where the participants are not equally balanced or objectively represented and lead to misleading results.[23] Thus, our sample contains firms of all sizes to ensure that the data are not biased towards large firms.

Table II.4 shows the most used dependent variables and proxies by previous studies.

[Insert Table II.4 here]

[23] If the productivity differences are greater when including the smaller firms, then there is a problem of a sample selection that arises from endogenous stratification. For example, Harris (2002) found that foreign-owned plants are more productive than the UK-owned plants. Thus it is important to calculate sample weights for each firm to ensure that they adequately reflect the underlying distribution in the population.

Not every authors use the TFP as a productivity measure. For example, Blomstrom (1986) and Kathuria (2000) use an efficiency index that measures the distance between the average value added per worker of the firm and its sectoral "efficient frontier". Aitken and Harrison (1999) use the logarithm of the output and Haddad and Harrison (1993) estimate the growth of total output assuming that it depends on labour and capital.

Regarding the impact on the results from using different measures for the dependent variable, in our view, since turnover in manufacturing sector consists mainly of sales, the use of sales or turnover leads to the same results, except for firms with a significant share of services in total turnover. However, we consider that the use of value added may produce different estimates, since the value added is calculated as the difference between the turnover (or sales) and the intermediate inputs. Thus, for the same amount of sales, the value added will be lower for less productive firms which makes TFP estimates, obtained by using the value added, an important indicator of firm performance. Nonetheless, the main advantage of using the real value added is that value added is directly comparable across industries, while real output (measured by turnover deflated by PPI) is not comparable because, conceptually, it is measured using different units in each industry. This is of particular relevance because our main focus is the productivity growth of domestic firms. Thus, in our view, the TFP shoul be estimated using the value added as in our equation (II.7); rather than using the real output.

Concerning the variables that measure foreign presence, *AMADEUS* contains information on ownership, including firm name and investor country. To find the firm's ultimate owners (UOs), BvD focuses on identifying the owners, if any, who exercise the greater degree of control over the firm.

We collected foreign firms with at least 10% of share of foreign capital. The threshold of 10% of foreign capital is the standard in the FDI literature. According to OECD (2008), the ownership of 10 per cent determines the existence of a direct investment relationship and implies that the direct investor is able to influence or participate in the management of the firm. Hence, we classify firms as foreign or domestic by including a dummy variable (*duf*) in our database that equals 1 if the firm is foreign (minimum of 10% of share of foreign capital) and 0 otherwise.

We gathered information on 18 investing countries (country codes are shown in Table D1 of Apendix D). Figures II.2 and II.3 shows the share of firms and number of industries, by investor Country. The mean of foreign capital for all manufacturing industries is 58%.

[Insert Figures II.2 and II.3 here]

Spanish and French firms represent roughly 49% of foreign firms in our sample. Spain and France invest respectively in 19 and 17 of all 24 manufacturing industries. Hence their investment is spread in 79% and 71% of all manufacturing industries in Portugal, respectively. By contrast, Norwegian firms correspond to 0.3% of foreign firms in our sample and their investment represent only 4% of all manufacturing industries.

Since several authors stress the need to choose appropriate measures of foreign presence in order to capture externalities from FDI (e.g., Liu and Nunnenkamp, 2009; Barrios et al., 2011), we test alternative measures of foreign presence. Table II.5 contains the most commonly used proxies for the variable *Ho*r.

[Insert Table II.5 here]

For example, Haddad and Harrison (1993), Chuang and Lin (1999) and Djankov and Hoekman (2000) calculate the variable *Hor* as the share of assets held by MNCs, Aitken and Harrison (1999) use the share of foreign capital, Kathuria (2000) uses the share of sales and Driffield (2001) uses the growth of foreign sales.

Relating to vertical externalities, because data on linkages between domestic and foreign firms are not available at firm-level, vertical linkages are usually calculated at sectoral level using the coefficients from input-output tables at two-digit level. The source of our IO tables is the OECD. IO tables describe the sales and purchases relationships between producers and consumers within an economy, i.e, the inter-industrial relationships. Following Barrios et al. (2011), we use the coefficients from the IO tables of home countries because the coefficients of IO tables for Portugal are not correlated with those for foreign countries (Appendix D describes the procedure to calculate the correlation between the IO tables of home and host countries).[24]

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[24] IO tables reflect the inter-industry transactions. Hence, researchers use the IO coefficients (i.e. each industrial sector's purchases, per unit of output, of intermediate and investment goods from other sectors) to calculate the flows of technology. Thus, purchased inputs (both intermediate and investment goods,

Following Haddad and Harrison (1993), Chuang and Lin (1999) and Djankov and Hoekman (2000) we include an alternative measure (*hoz*) by using the assets held by MNCs instead of output. The variables *b2* and *f2*, for backward and forward linkages respectively, are obtained by multiplying the coefficients δ_{jk} and λ_{kj} in equations (10) and (11) by *hoz.*

We also construct a second alternative measure of foreign presence using value added (*hoz1*). Alternative measures of backward and forward linkages are denoted by *bb* and *ff* and are obtained by multiplying the coefficients δ_{jk} and λ_{kj} in equations (10) and (11) by *hoz1.* See Appendix C for details on the construction of variables that measure the foreign presence and the alternative measures.

Table II.6 shows the control variables mostly used in emprical studies.

[Insert Table II.6 here]

Control variables include those variables that can influence domestic firms' efficiency. Among these, the following stand out: skilled labour, technological gap, capital intensity, concentration index, scale and R&D activities. The skilled labour is proxied by the total salaries and training costs; or the ratio of skilled workers on the number of unskilled workers; or the gross enrollment rate in higher education (or high school); the technological gap is proxied by the ratio of turnover (sales) of firm *i* on the turnover (sales) of the foreign firm that is regarded as a leader in the respective industry; the capital intensity is proxied by the ratio of fuel and electricity on total employment; the concentration index is proxied by the Herfindhal index; scale is proxied by the

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domestic as well as foreign) act as carriers of technology across industry and from one country to the other sectors (Papaconstantinou et al., 1996). The use of host country's IO coefficients imply that MNCs have the same production technology as domestic firms (Barrios et al, 2010). This challenges the assumption of externalities from FDI arising from contacts with MNCs that possess superior technology (eg, Markusen, 2004). Moreover, the International Business literature has provided evidence that the sourcing policy of a MNC depends largely on its nationality. For example, Japanese MNCs tend to purchase intermediate inputs from other Japanese MNCs which in turn influence the demand of their foreign affiliates for domestic inputs (Belderbos et al., 2001). In addition, Rodriguez-Clare (1996) shows that transport costs play an important role in the decision of sourcing domestically. According to Rodriguez-Clare (1996), MNCs from neighbouring countries are more likely to import inputs due to relatively low transport costs. To sum up, the evidence suggests that MNCs use similar production technology in the host country to that used at home; hence, it is likely that their supply strategies are also similar. Therefore, Barrios et al. (2010) suggest that before using host country IO coefficients, researchers should test their correlation with the IO coefficients of the investor country.

turnover on the average sales in the industry; and finally, the R&D activities are proxied by the R&D expenditures; or the R&D expenditures in the private sector as a % of GDP. Thus, Table II.6 provides measures that can be used in our applied analysis to the Portuguese manufacturing. Indeed, we use the same measures for concentration and scale; whereas we use alternative proxies for the rest of the variables due to data availability.

Table II.7 reports the summary statistics of all the variables used in this research, classified into four groups: variables to estimate the TFP, variables of foreign presence, interaction variables and control variables.

[Insert Table II.7 here]

The average means for each group of variables range from -3.63 (variables of foreign presence) to 8.01 (control variables). The mean standard deviation of four groups of variables ranges from 1.15 (control variables) and 2.88 (interaction variables). The lower average minimum is -13.37 (interaction variables) and the larger average maximum is 15.26 (variables to estimate the TFP). The standard deviation is lower than the mean for variables to estimate the TFP and control variables; it is larger than the mean for the variables related to foreign presence (which suggests that the mean values have a higher variance); and almost similar to the mean of interaction variables.

The analysis of data distribution reflects firm heterogeneity along the lines of Melitz (2008); and a check on values for skewness and Kurtosis, especially in the case of the variable l^{np} (non-prodction or skilled labour) necessary to estimate the level of TFP; and the alternative measures of foreign presence, indicates that data are not normally distributed. However, we do not need univariate normality of either the dependent or the independent variables, only the residuals need to have a normal distribution. The reason is that, even though the dependent variable is normally distributed, the residuals may fail the assumption of normality. Nonetheless, normality only assures that the p-values for the t-tests and f-test will be valid, but it is not required in order to obtain unbiased estimates of the regression coefficients. However, we need a robust procedure to estimate the level of the TFP, such as the semi-parametric methods [e.g, Olley and Pakes (1996) or Levinsohn and Petrin (2003)]; and a robust procedure to estimate the existence of externalities on the TFP growth of domestic firms, such as the General Method of Moments (GMM).[25]

In the next section we will analyze the relationship between the TFP growth and two sets of independent variables across technological groups according to Pavitt's taxonomy. This taxonomy shows how technological trajectories aiming to increase the competitiveness and the productivity of domestic firms shape their linkages with foreign firms. Indeed, as seen in section 2 of Chapter 1, the convergence of income between countries depends on the level of international technological diffusion, because the main sources of technological changes leading to increases in the TFP stem from the MNCs' advanced technology. In this context, the adoption of a new technology by the domestic firms is more likely to occur if MNCs demonstrate that the technology is successful and if the goods produced are similar (Barrios and Ströbl, 2002). Though intra-sector heterogeneity may be substantial, some industries share the technological opportunities, nature of knowledge, appropriability conditions and market structure. Pavitt taxonomy groups industries according to the nature and sources of technological change, of production systems and market structures. Thus, it is a robust conceptual and versatile tool to identify patterns of technological innovation and, therefore, to analyse the opportunities of technological catch-up caused by the foreign presence in the host economy.

[25] We consider that normal distributed data possess a kurtosis value of 3 and a skewness value of 0.

4. CORRELATIONS ACROSS TECHNOLOGICAL GROUPS

4.1. PAVITT'S TAXONOMY

Based on data relative to 2000 important innovations for the UK over the period 1945-1979, Pavitt (1984) ranked industries according to the production and use of innovation. The author assumes that the results reflect the behaviour of the manufacturing industries in most industrialized countries. The types of industries vary according to the production and use of innovation (where the producer of innovation may not coincide with its user), the main industry in which the firm innovates, the source of technology (internal or external to the firm), and the characteristics of the innovative firms (such as firm size and the diversification of innovation).

Thus, according to these features, Pavitt (1984) identifies three types of industries: production intensive, science-based and supplier-dominated industries. The first group is divided into scale-intensive and specialized suppliers industries.

Firms in scale-intensive industries (e.g. motor vehicles and other transport equipments) are characterized by their relative large size, producing a relatively large share of process innovations (compared to product innovations), and the main source of technology relies on production engineering of their suppliers and R & D. The major appropriation mechanisms are the trade secret, know-how and process patents. The consumers are price sensitive and the technological trajectories (process and product) aim at cost reduction.

In specialized suppliers industries, firms are relatively small and the consumers are sensitive to their performance (e.g. Machinery and Equipment). These firms innovate internally and through their consumers and produce a relatively large share of product innovations. The key mechanisms of appropriation are design, know-how, patent and the knowledge of customers.

Firms in science-based industries (such as electronics) are characterized by relative large size and produce roughly the same share of process and product innovations. The sources of process innovations are internal and external (from suppliers). The key mechanisms of appropriation are know-how, trade secret and patents. Hence, it is expected that firms in science-based and specialized suppliers industries are more technologically intensive than firms in the remaining industries.

In supplier-dominated industries, firms are characterized by a relative small size, limited resources regarding engineering and internal R & D and rely on suppliers to innovate. Since consumers are price sensitive, their technology is efficiency-seeking. This type of firms can be found in traditional industries (such as textiles, clothing and footwear).

Pavitt's taxonomy has evolved over time, since it was originally proposed. In this article we follow the adaptation of O'Mahony and Van Ark (2003) and Bogliacino and Pianta (2010) which is shown in Table II.8.

[Insert Table II.8 here]

According to the characteristics of each technological group, described in the beginning of this section, in the first column we include the scale intensive industries (NACE codes 10, 11, 12, 19, 22, 23, 24, 25, 29 and 30), that are characterized by low and medium low technology. In the second column we include the specialized suppliers industries (NACE codes 28, 32 and 33), that are characterized by medium low and medium high technology. In the third column we include the science based industries (NACE codes 20, 21, 26 and 27), that are characterized by medium high and high technology. Finally, in the fourth column, the supplier dominated industries (NACE codes 13, 14, 15, 16, 17, 18 and 31) that are characterized by low and medium low technology.

Figures II.4 to II.6 show the representativeness of our sample by technological group compared with total values from *Quadros do Pessoal*.

[Insert Figures II.4 to II.6 here]

Regarding turnover, the most representative technological group is the specialized suppliers with an average of 14%; while the groups of science-based and scale-intensive industries represent 3-4% on average, in 1995-2007. The supplier dominated industries represent 6% on average in the same period. Concerning the number of firms, scale-intensive and science-based industries represent on average 36-38%; while supplier dominated and specialized suppliers represent 10-21%, on average. Finally, as regards the employment (measured by the number of employees), the specialized suppliers represent 46% on average; followed by science-based and scale-intensive industries with 29-33% and the supplier dominated industries represent 14%.

In the last decade, empirical work inspired on Pavitt's taxonomy has been encouraged by the rapid diffusion of the Community Innovation Survey (CIS) in Europe which allowed expanding the set of factors used to describe the dominant technological trajectories followed by innovating firms in the economies. These works have focused on the distinction between product and process innovation, the relevance of organizational innovation, the composition of R&D expenditures and the patterns of interactions of innovative firms with other firms and institutions (e.g, Veugelers and Cassiman, 1999; Mairesse and Mohnen, 2002; Reichstein and Salter, 2006).

A key aspect of Pavitt's taxonomy is the focus on *vertical linkages* as a way of resource interchange that enhances the competitiveness of the economy. According to the Home Market Hypothesis, university-industry links are more important on science-based industries; upstream linkages in related production technologies are more important for scale intensive and supplier-dominated industries, while downstream linkages are more relevant to shape the competitive position of specialised suppliers (Laursen and Meliciani, 2000; Castellacci, 2007).[26] Since the nature of science-based firms requires more diversity of R&D activities than the strictly required for current output, these industries provide more technological opportunities for suppliers, rivals and customers (Pavitt et al., 1989).

Bearing this in mind, we now perform an analysis of the correlation between the dependent variable *TFP* and the independent variables of equation (II.8) by technological groups, with special emphasis on measures of foreign presence, in order to ascertain what groups of industries potentially benefit from externalities from FDI.

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[26] First proposed by Corden (1970) and developed by Krugman (1980), The Home Market Effect integrates the New Trade Theory and is derived from models with returns to scale and transportation costs. It mainly consists of a hypothesized concentration of certain industries in large markets.

4.2. CORRELATION BETWEEN VARIABLES

There may be important common features in each technological group that shape a positive (or negative) correlation between the TFP growth and the foreign presence and other control variables. Bearing this in mind, we perform an analysis of bilateral correlations in the context of Pavitt's taxonomy. However, because the correlation analysis is not multivariate, it is just illustrative, hold some limitations and does not imply causality.

For example, in scale-intensive and science-based industries, the main source of knowledge and innovation is internal R&D (Bratti and Leombruni, 2009; Pellegrino *et al*. 2012). Mohnen and Hall (2013) find substantial positive impacts of product innovation on productivity. Therefore, science based industries rely heavily on the R&D activities and have the highest rates of productivity growth when compared to suppliers dominated and specialised suppliers groups (Bogliacino and Pianta, 2009).

The exploitation of economies of scale and the higher exposure to better technologies can enhance productivity in the manufacturing sector (Isaksson, 2007). For that reason, during the 1960's, it was expected that scale intensive and science-based sectors were likely to facilitate the catching up (Gerschenkron, 1962). Accordingly, Silva and Teixeira (2011), supported by empirical results for 'relatively less developed' countries in 1979-2003, conclude that substantial benefits have accrued to countries that allocated resources to more technologically advanced industries.

One example of successful adaptation of foreign technology to build productive capacity and integrate into the global economy is Thailand. From the mid-1990s onwards, when the comparative advantage in cheap labour got eroded, the leading exports have changed to science-based and scale-intensive products such as computer and electronics and electrical appliances. As a result, Thai economy grew at an average rate of 7.3-7.8 per cent a year, during the last three decades.

According to Moreira (1997), in Portugal, a great share of FDI flows in the manufacturing had been directed to scale intensive (metals, food and beverages) and science-based industries (computer and electronics). Thus, we expect that scale intensive and science based industries show a greater positive association between domestic firms and foreign presence variables and the TFP growth.

Table II.9 compares the Pearson correlation coefficients between the TFP growth of the domestic firms with the control variables in our empirical model, for the manufacturing sector and by technological groups. This coefficient is a measure of the strength of the linear relationship between two variables.

[Insert Table II.9 here]

All coefficients are significant at 5% level, except for the concentration measure in the scale intensive industries.

The coefficients are negative for the relationship between the variable *hfd* (concentration) and the TFP growth for the manufacturing and for most of technological groups, except for the specialized supplier's industries, which is positive and significant (0.0715). As stated in section 2, the expected sign for the correlation between this variable and the TFP growth is not predefined, because the Herfindahl index measures firms in relation to their industry and it is also an indicator of the degree of competition between them. In the specialized suppliers industries, the sign of the impact of the variable *hfd* on the TFP growth is positive, implying that the market power can facilitate the access to the necessary resources for domestic firms to increase their productivity. For the remaining technological groups, it appears that the monopolistic inefficiencies are causing a decrease in the rate of innovation and, thus, a loss of productivity. Thus, the overall effect in the manufacturing sector is negative (-0.0562).

Contrary to what was expected, the coefficients are negative for the relationship between the variable *rd* (a proxy for the absorptive capacity of domestic firms) and the TFP growth for the manufacturing and for all the technological groups. This may point to the fact that much firms' performed R&D do not impact directly on their productivity growth.

We confirm the sign of correlation coefficients between the variable *mrdf* (a proxy for the average stock of foreign knowledge) and the TFP growth, except in the specialized suppliers industries which is negative (-0.0608). This seems to reveal that, in these industries, the average stock of foreign knowledge does not have influence on domestic firms' productivity growth.

Contrary to what is expected, the coefficients are negative for the relationship between the variable *s* (scale) and the TFP growth for the manufacturing and all the technological groups. This implies that small firms may benefit more from the foreign presence than large firms.

As stated in section 2, the expected sign for the correlation between the variable *tg* (technological gap) and the TFP growth is not predefined, because if the technological gap is too low, foreign firms will transmit few benefits to the domestic firms; but the gap cannot be too high, otherwise domestic firm would not be able to absorb the foreign knowledge. Because this measure is constructed as a ratio of labour productivity of domestic firms to the labour productivity of the presumptive foreign leader in each industry, the larger the variable tg the more technologically sophisticated is the domestic firm (the lower the distance to the technological leader). Thus, because all the coefficients are negative, it appears that if the technological gap is too low, foreign firms will transmit few benefits to the domestic firms.

Our expectations about the sign of correlation between the variable *kl* (capital intensity) and the TFP growth were not fulfilled. Indeed, all groups show negative coefficients which appears to imply that labour intensive domestic firms benefit more from TFP increases than the capital intensive firms.

Table II.10 reports the correlation coefficients between the TFP growth and the alternative measures of foreign presence (turnover, capital and value added, as explained in section 3.3) in the manufacturing sector, and by technological groups.

[Insert Table II.10 here]

As expected all coefficients are positive (except for vertical externalities in science based industries, using capital as the measure of foreign presence) and significant at 5% level (except for foreign presence in downstream industries in science based industries, using turnover and the value added as measures of foreign presence).

The negative results (-0.0884 and -0.2137, respectively for externalities via backward and forward linkages) for vertical externalities in science based industries (using capital as the measure of foreign presence) indicate that differences in technology between countries prevent domestic suppliers/clients to establish linkages with foreign firms in upstream and downstream sectors.

5. CONCLUSION

Externalities from FDI may have an impact on domestic firms' productivity. However, the correct evaluation of these effects requires an adequate database with relevant variables. Hitherto, there were no attempts to construct such a database for Portugal. Hence, the purpose of this article is to describe the construction of a database to estimate externalities from FDI at horizontal and vertical level in Portuguese manufacturing firms.

The *status quo* of databases used in the previous studies for Portugal is characterized by the fact that international sources do not possess the necessary variables, while national sources, although providing more comprehensive data, lack similar definitions, data treatment and nomenclatures. AMADEUS, on the other hand, has been widely employed by researchers to estimate externalities from FDI in European countries due to its integrity and broad geographic reach. Thus, based on AMADEUS, we propose the construction of a database for the Portuguese economy containing 5,045 firms over the 1995-2007 period. The database contains three original types of variables; those needed to calculate the TFP, another set of key variables related to foreign presence and, finally, the control variables. The sample of foreign firms contains firms with at least 10% (and a mean of 58%) of foreign capital. Nearly half of foreign firms are Spanish and French that invest in more than 70% of the manufacturing industries. We construct our variables for backward and forward externalities using the IO tables for home countries since the foreign technology expressed in the technical coefficients is different from the domestic.

Before performing the empirical analysis, we analysed the correlations between the TFP growth and the variables related to foreign presence and the control variables, for the manufacturing sector and by technological groups, based on Pavitt Taxonomy. This exercise aimed to provide some indications on what relationships to expect when we estimate the impact of foreign presence and other control variables on the TFP growth of domestic manufacturing firms. Bearing this in mind, we grouped the industries according to the nature and sources of technological change, in order to identify patterns of technological innovation and, therefore, to better gauge the opportunities of technological catch-up caused by the foreign presence in the host economy.

Correlation results indicate that the foreign presence is positively and significantly correlated with the TFP growth. Furthermore, the sign and magnitude of the coefficients for the control variables indicate that the concentration, the stock of foreign knowledge and the technological gap potentially assist the technical efficiency of domestic firms, but only in certain technological groups. Indeed, only concentraded industries in specialized suppliers seem to benefit from positive effects of market power; However, the specialized suppliers is the only technological group that experience a decrease in the TFP due to the stock of foreign knowledge.

Overall, it appears that monopolistic inefficiencies cause a decrease in the rate of innovation and, thus, a loss of productivity of domestic manufacturing firms; secondly, a substantial amount of the firms' R&D activities do not impact directly on their productivity growth; thirdly, small firms may benefit more from increases in their TFP than large firms; fourthly, if the technological gap is too low, foreign firms will transmit few benefits to the domestic firms; and finally, capital intensive firms seem to experience decreases in their TFP.

Regarding implications for the empirical research, the correlations results may point to the occurrence of positive and significant externalities from FDI (both horizontal and vertical) in the manufacturing industry, and a positive impact of concentration and the stock of foreign knowledge and a negative impact of the technological gap (constructed as an inverse measure) on the TFP growth of domestic manufacturing firms, i.e, preliminary analysis of data seem to support the catching-up hypothesis described in section 2, rather than the technology-accumulation hypothesis. The results suggest that technologically backward firms are able to exploit the technologies developed by foreign firms and experience higher TFP increases than the technological sophisticated ones. If this is the case, then there is some expectation on productivity convergence due to foreign presence in the Portuguese manufacturing sector.

Chapter 3

Are There Externalities From Fdi For Portuguese Manufacturing Firms?

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ABSTRACT

Being a small open economy located on the European periphery, Portugal is vulnerable to external factors that undermine economic growth.

The Endogenous Growth Theory suggests that technological progress is a key factor for economic growth. The technology transfer resulting from foreign presence in a host country may increase the total factor productivity (TFP) and promote long run growth. In this context, the manufacturing sector, being a major producer of tradables, is a driver of technological change since it potentially generates high rates of innovation and drag capabilities to other sectors of the economy.

This paper investigates the existence of Foreign Direct Investment externalities for the Portuguese manufacturing sector from 1995 to 2007, using panel data and an empirical specification that follows the models of technology diffusion. We apply a two-stage empirical strategy. First, we employ the Wooldridge-Levinshon and Petrin estimator, which is considered a robust method, to estimate the TFP. Then, we regress the TFP on several explanatory variables using the system-GMM estimator. Our results allow us to provide some explanation for the mixed results of previous studies. Indeed, at the aggregate level, with one-period lag, we find significant positive vertical externalities; while, in the current period and with a two-period lag, we find significant negative horizontal and vertical externalities. However, when the sample is broken by industries, controlling for firm size, we find that, in particular, small and large firms in scale intensive industries; and small firms in science based industries benefit from positive externalities from FDI. The uneven distribution of such externalities confirms the heterogeneous nature of manufacturing firms and, therefore, the need of a disaggregated analysis by industries and firm size, in order to understand how externalities affect each industry.

Keywords: FDI, Externalities, manufacturing firms, Portugal
JEL Classification: F23, O3

1. INTRODUCTION

FDI may impact domestic firms' efficiency through the transfer of technology, marketing and managerial skills. Thus, it can be an important vehicle for economic growth (OECD, 2002; Merlevede and Purice, 2014). Indeed, in 2007, FDI stocks in percentage of *GDP* were equivalent to 50% of world *GDP*. However, the role of FDI as a channel for growth is a less debatable assumption in theory than in practice (de Mello, 1997). In particular, the issue on whether FDI contributes to the increase of the Total Factor Productivity (TFP) in the manufacturing sector is of particular importance, since Portugal is a small open economy facing restrictions arising from the economic crisis that slowed down the productivity growth.[27]

Thus, we investigate the existence of externalities from FDI in the Portuguese manufacturing sector, aiming to assist industrial policy regarding the choice of the appropriate measures to create and boost externalities from FDI, either in the same industry (horizontal externalities) or in upstream/downstream industries (vertical externalities).

One of the major difficulties in this kind of studies stems from the fact that one cannot reject the possibility that externalities from FDI occur because the initially more productive domestic firms attract more foreign capital. Therefore, we employ panel data at firm-level from the AMADEUS database for firms of all sizes over the period 1995-2007 to ensure that firms with different levels of (TFP) are evenly distributed in the sample.[28]

Panel data at firm-level is essential for two reasons. Firstly, firm fixed effects can be employed in order that the effect of FDI presence is identified by within firm changes in productivity variables. Thus, MNCs' investment decisions are based on initial firm conditions that do not vary over time, which rules out the possibility of reverse causality or selection. Secondly, our time span is from 1995 to 2007 (13 years), allowing

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[27] Although the innovative density of services in Portugal is higher than that of manufacturing, in most countries it is below that of manufacturing firms (Tamura et al, 2005). Therefore, for the sake of comparing results with other international studies, we investigate the existence of externalities from FDI in the manufacturing sector.

[28] Amador (2011) in his analysis of the Portuguese manufacturing finds a high probability of larger firms (with higher turnover) being more productive.

for the study of dynamic effects, which is crucial since, according to empirical literature, externalities from FDI need around 2 years to materialize. [29, 30]

We use a two-stage empirical strategy. First, the validity of results depends on the robustness of the estimation method for the tfp. Indeed, several methodological issues may arise when TFP is estimated using ordinary least squares (OLS) in a panel of firms. OLS estimation of firm-level production functions introduces a simultaneity or endogeneity problem because productivity and input choices are likely to be correlated.

In response to these methodological issues, empirical literature has relied extensively on four estimation techniques; fixed effects, instrumental variables, generalized method of moments (GMM), and semi-parametric estimators. However, as a result of the poor performance of both GMM and fixed effects estimators, it appears that the semi-parametric estimators (Olley and Pakes, 1996 or Wooldridge-Levinsohn and Petrin) are to be preferred.

Although the choice of the estimator depends on the data at hand and the underlying assumptions, currently the most widely used is the Wooldridge-Levinsohn and Petrin procedure. The reason is that their procedure is based on a control function approach that employs intermediate inputs as the proxy variable for unobserved productivity. Since intermediate inputs are always positive (at least in our database), this approach has the advantage of retaining a higher number of observations than the Olley and Pakes (1996) approach. Therefore this estimator is likely to be more efficient and we use it to estimate TFP as the residual of the production function.

In the second stage, in a growth-accounting equation, we use the measure of TFP, obtained in the previous stage, to evaluate the impact of FDI on the growth of TFP, using the system GMM estimator proposed by Arellano and Bover (1995) and Blundel and Bond (1998).

The firm level panel data studies for Portugal (Farinha and Mata, 1996; Proença et al., 2002; Crespo et al., 2009, 2012) usually focus on horizontal externalities, with few exceptions. The results for the same period are different, most likely due to different

[29] Dynamic effects are analyzed through the inclusion of the *lagged dependent variables* on the *right* hand *side* of estimating equations.

[30] Haskel et al. (2007) and Sembenelli and Siotis (2005) report a period of around two years for FDI to be fully reflected in the productivity of domestic firms in the UK and Spain, respectively. Arnold and Javorcik (2005) and Keller and Yeaple (2009) find shorter lags of one year or less.

samples and methodologies. In addition, they do not explore, as we do in this paper, the fact that externalities are heterogeneous across industries. Hence, we try to reconcile some of these results by making use of the best available firm level data and state-of-the-art econometric methodology in order to distinguish in what industries externalities from FDI can be found. The results will enable policy makers to decide in what industries they need to attract FDI.

We disaggregate our analysis in three dimensions; by nature of externality, by industry and by firm size. First, we do not limit our analysis to horizontal externalities but also investigate the existence of vertical externalities. Since measures of horizontal and vertical foreign presence are highly correlated, we estimate separate regressions for horizontal and vertical externality effects to avoid multicollinearity. Second, we estimate horizontal and vertical externality effects for two-digit NACE (revision 2) industries to ascertain in which industries foreign presence exerts positive effects. Finally, we split the firms into large and small, since we assume that externalities from FDI are more likely to occur in larger firms, because small firms may not be able to operate on a scale large enough to handle some of the foreign technology (Ngo and Conklin, 1996).[31]

The results show that, while in the full sample we find evidence of negative horizontal and vertical externalities in the current period; when conducting the analysis across industries, there is evidence of both positive and negative horizontal and vertical externalities which may explain why results are different for the same period in the previous studies.

We cluster the industries by technological groups according to the adaptation of O'Mahony e Van Ark (2003) and Bogliacino and Pianta (2011) of Pavitt's taxonomy. Thus, firms in scale-intensive industries (NACE rev. 2 codes 10, 11, 12, 19, 22, 23, 24, 25, 29 and 30) are large and their main source of technology relies on production engineering of their suppliers and R&D; Firms in science based industries (NACE rev. 2 codes 20, 21, 26 and 27) are characterized by relative large size and produce roughly the same share of process and product innovations. The sources of process innovations are internal and external (from suppliers); In supplier-dominated industries (NACE rev. 2 codes 13, 14, 15, 16, 17, 18 and 31) firms are characterized by a relative small size, limited

[31] We use the number of employees as a criteria for size. Following the European Comission and the Portuguese Statistical Office (INE), we classify firms as small those who have less than 250 employees; and large firms otherwise.

resources regarding engineering and internal R&D and rely on suppliers to innovate; finally, in specialized suppliers industries (NACE rev. 2 codes 28, 32 and 33), firms are relatively small and the consumers are sensitive to their performance.

Overall, we find small but positive and significant externalities in scale intensive and science based industries. When the sample is broken by industries, controlling for firm size, we find that small and large firms in scale intensive industries and small firms in science based industries benefit more from foreign presence. These results confirm the heterogeneous nature of manufacturing firms and, thus, the need of an analysis at the disaggregated level.

We make several contributions to the literature on externalities from FDI. First, we use a large panel of manufacturing firms which allows us to control for firm fixed effects and year effects, ruling out main concerns related to endogeneity. Second, we are one of the few authors that investigate the existence of both horizontal and vertical externalities from FDI in Portugal. Third, we use lags of the measures of foreign presence in order to account for the time lapse required for externalities to materialize. Fourth, we break down the results across industries along their trajectories of technological change which allow us to uncover some interesting patterns. Indeed, the technological groups more affected by foreign presence are scale intensive and science based industries.

The paper is organized as follows. Section 2 reviews the empirical studies for the Portuguese manufacturing sector with the purpose of evaluating the state-of-art of results. Section 3 describes the characteristics of Portuguese manufacturing firms (such as location, labour productivity and firm size) and analyzes the FDI flows and stocks into that sector in order that we can formulate some hypotheses on which sectors are likely to benefit more from foreign presence; section 4 describes our data source and the variables, as well as our empirical approach. Section 5 reports and discusses the results and section 6 concludes.

2. PREVIOUS EMPIRICAL EVIDENCE FOR PORTUGAL

Recalling the literature review for Portugal of section 4.2 (chapter 1), panel studies, at firm level, include Farinha and Mata (1996), Proença et al. (2002) and Crespo et al. (2009, 2012). Farinha and Mata (1996) analyzed the 1986-1992 period while Proenca et al. (2002) focused their analysis between 1996 and 1998 and Crespo et al. (2009, 2012) analyzed the period 1996-2001.

With the exception of Farinha and Mata (1996), that use a random effects model, all authors use the system GMM to estimate an equation where the dependent variable is the labour productivity, which depends on variables of foreign presence in level (whose proxy is the employment in foreign firms, except Proença et al. that use the capital stock). Data sources are Dun & Bradstreet and Quadros de Pessoal, except Farinha and Mata (1996) that also use data from Banco de Portugal.[32]

The present study is the most comprehensive for Portugal, regarding time (1995-2007) and sample size (65,585 observations). In addition, until now, only Crespo et al. (2009, 2012) have investigated the existence of vertical spillovers for Portugal.

Moreover, there are no studies for 2001-2007 and the results for 1996-2000 are controversial. Indeed, as shown in Table I.4 (chapter 1), regarding horizontal externalities, while Crespo et al. (2012), with panel data find negative results, for 1996-2001; Proença et al. (2002, 2006) find no significant results for 1996-1998; and Crespo et al. (2009) find negative results for 1996-2000. Finally, Crespo et al. (2012) find evidence of positive vertical externalities (via backward linkages) for 1996-2001, but only at regional level.

One possible cause for these controversial results may be the underestimation of the externality effects due to econometric problems associated with traditional panel data estimation methods, as highlighted by Proença et al. (2006).[33]

In addition to different results for the same period, hitherto researchers tested the impact of few determinant factors of FDI externalities for the Portuguese case; the technological gap/absorptive capacity and the geographical proximity between MNCs and domestic firms.[34] Given the lack of consensus of these studies, we need to analyze

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[32] The Portuguese Central Bank.
[33] Proença et al. (2006) use system GMM with variables in first differences.
[34] ´For a discussion on the diferent approaches adopted by the empirical studies, see section 4.2 of chapter 1.

the existence of horizontal and vertical externalities from FDI for manufacturing firms in 1995-2007. The results will enable policy makers to identify the industries that benefit most from attracting foreign capital and to implement the relevant policies in order to leverage the positive externality effects.

In the next section we characterize the manufacturing sector as a possible recipient of externalities from FDI as well as the foreign affiliates operating in Portugal in order to setup the background for our empirical analysis.

3. FDI IN THE PORTUGUESE MANUFACTURING SECTOR

3.1. FEATURES OF THE PORTUGUESE MANUFACTURING SECTOR

Regarding the geographical location of industrial activities, the industries of beverage, textiles and clothing, leather, wood and furniture are usually located in the North; while the industries of food, printing, coke and refined petroleum products, pharmaceuticals, information technology, electronics and optical and electrical equipment tend to locate in the South. The remaining manufacturing industries are located mainly in the Center of Portugal.

The industrial clusters are strongly polarized around the Northern and Central Coast (plastics, automotive components and ICT) and around the Central and Southern Coast (food, motor vehicles and other transport equipment, plastics, building materials and ICT), with some incursions in the interior.

According to the national accounts from INE, the manufacturing sectors with higher labour productivity in 1995-2007 were coke and petroleum products, computer, electronic and optical products and chemicals.[35] In the services sector the corresponding activities were real estate, rental and leasing and financial services.

The majority of Portuguese manufacturing firms are small. The largest firms, measured in number of workers belong to coke and petroleum products (with an average number of employees of 2,648 in 1996-2004) and transport equipment (46 employees on average) while the smaller firms belong to fabricated metal and wood products (6-7 employees on average). In this period, the average weight of manufacturing on total employment was 17%, with a falling trend (see Figure III.1).

[Insert Figure III.1 here]

Figure III.2 shows that, in 1995-2007, the manufacturing contribution to Gross Value Added (GVA) recorded also a negative trend, after a slight increase in 1996-1997.

[Insert Figure III.2 here]

[35] The Portuguese Statistical Office.

This is a trend across European Developed Countries since, according to Eurostat, the Gross Value Added at basic prices in 2003 and 2013 (as a share of total gross value added) declined from 20.6% to 19.3% in the Euro area (EA-18).

The manufacturing industries with the largest contribution to GVA in this period were textiles and footwear (14.1%), non-metallic minerals (9.2%), wood and paper products (8.9%) and rubber and plastics (4.3%).

During the 1990s, industrial policy focused on attracting foreign capital, mostly through privatizations, but also by offering Governement and EU subsidies and assistance to investors.[36]

3.2. FDI INFLOWS

FDI inflows represented a maximum share of 5.7% of GDP (see Figure III.3) over the period under analysis. However, in 2007, the share of foreign capital stocks to GDP was nearly 50%.

[Insert Figure III.3 here]

Figure III.4 shows the trend in flows and Portugal's position in capturing global flows in 1995-2007. Although the Portuguese accession to the European Economic Community (EEC) in 1986 encouraged the increase of these flows; in the 1990s there was a sharp decline compared to the previous decade due to adverse factors, namely the instability of interest and exchange rates, the slowdown of the privatization program and the end of full exploitation of single market investment opportunities. The value of flows in 1995-1999 ranged from $660 million to $3,005 million.

[Insert Figure III.4 here]

In 2000-2007, there was a large fluctuation in the value of FDI flows. In 2000-2001, the merger and acquisition (M&A) trends caused a boom of FDI at a global level

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[36] According to the Ministry of Finance data, between 1985 and 1995 the Portuguese Governement raised five billion euros. In June 1999, the Portuguese Governement continued with the privatization of large firms such as Portugal Telecom, Brisa, EDP, TAP, Rede Eléctrica Nacional (REN) and Portucel as well as other public transport companies.

(UNCTAD, 2002) increasing the share of Portugal that attracted flows of over $6 billion. However, in the next year, the rise in oil prices retracted the international investment flows. Hence the flows attracted by Portugal decreased to $1,801 million. In 2003 there was an increase to $7,155 million and then a sharp decrease in the following years. The year of 2006 recorded the highest peak of $10,914 million. According to OECD (2014) this was in part due to the fact that the global economy grew faster during that year.

In 2007 this amount was reduced by more than half, standing at $ 3,063 million. In 2007, according to UNCTAD, Portugal occupied the 29th position worldwide in terms of FDI reception, which was above that of several Eastern European countries such as the Czech Republic and Hungary. This represents a major achievement given the peripheral location and the weaknesses that Portugal presents at the aggregate level, namely the low productivity, low educational level and low R&D expenditures that are prone to cause difficulties in competition with other low-cost labour alternative destinations. However, according to the OECD database, in 1995-2007, Portugal attracted, on average, only 0.7% of global FDI flows.

Regarding the manufacturing sector, Figure III.5 shows the trend in FDI flows in manufacturing, over the period 1995-2007. The importance of the manufacturing sector concerns mainly the potential technological transfer from MNCs to local firms since it is a sector with high innovation indices and there may be indirect and induced impacts on other sectors through "pull" and "push" effects.[37]

[Insert Figure III 5 here]

In 1995, manufacturing ranked first relative to other economic sectors capturing 40% of FDI flows. In the following years, due to the domestic economic crisis, its importance in attracting flows decreased, and there were disinvestments in 1998-1999, in 2001-2002, 2005 and 2007. This may be partly due to the worldwide reorganisation of labour-intensive manufacturing industries towards fragmented production systems taking advantage of cost differentials of Central and Eastern European countries (CEECs).

[37] A study from Mateus & Associados (2010) indicates that the manufacturing sector supplies around 7.7% of the inputs required in related activities and buys around 12% of the production of all other sectors.

However, in 2004, the flows to manufacturing grew exponentially compared to 2003, reaching a peak that represented nearly half of total FDI inflows to Portugal. In the years 1996-1998; 2002-2003 and 2005-2007, the industries preferred by foreign investors were chemicals and rubber and plastics. In 1999-2000, foreign firms preferred to invest in textiles, clothing and footwear. In 2001, the largest number of foreign firms concentrated in sectors like machinery and equipment; and in 2004, in electric and optical equipment. Textiles ranked second, in the years 1996-1998 and 2003 and machinery and equipment in the years of 2002 and 2005 to 2007. In 2004 the sectors of food, beverages and tobacco ranked second on foreign investors preference.

4. DATA AND EMPIRICAL APPROACH

4.1. DATA SOURCE AND STATISTICS

Our data for the Portuguese manufacturing firms come from the AMADEUS database and covers the period 1995-2007. This balanced panel data set includes 5,045 manufacturing firms of all sizes (4,685 domestic and 360 foreign) for the 13 years in a total of 65,585 observations. Our regression analysis, however, includes only 51,535 observations since the rest had to be dropped due to collinearity.

Tables III.1a and III.1b show some basic statistics of our sample of firms. The values of TFP shown in these tables are estimated according to the methodology explained in section 4.2.

[Insert tables III.1a and III.1b here]

Firms with foreign capital represent 7% of our sample with a mean share of foreign capital of 58%. There are 12 Greenfield projects in 9 industries. The rest of foreign firms correspond to Mergers & Acquisitions (M&A). Foreign firms possess more capital and are more productive than their domestic counterparts.[38] Hence, we will analyze if there are productivity externalities from foreign firms to domestic firms.

4.2 METHODOLOGY

In the first stage of our econometric strategy, we estimate the level of TFP, rather than the output per capita, using a augmented solow model type of equation.

According to Griliches and Mairesse (1995), estimating growth equations with firm level panel data can lead to specification problems as well as the invalidity of instruments for capital and employment at the firm level. A way to address the issue of endogeneity in capital, and the possibility of productivity shocks is to use a two-step

[38] The results of t tests show statistical significant differences for the variables TFP, capital and labour (in logs).

approach and estimate TFP using the Wooldridge (2009) modifications to the original Levinsohn-Petrin (LP) (2003) value added approach from the following equation[39]

$$Y_{ijt} = A_{ijt} K_{ijt}^{\beta k} L_{ijt}^{\beta l} M_{ijt}^{\beta m} \quad \text{(III.1)}$$

where Y_{ijt} represents physical output of firm *i* in sector j and period *t*, K_{ijt}, L_{ijt} and M_{ijt} are the inputs of capital, labour and materials, respectively. A_{ijt} is the Hicksian neutral efficiency level (our concept of total factor productivity – TFP) of firm *i* in period *t*. For a given level of A, higher output levels demand higher inputs (K, L and M) levels.

We assume that $L = L^P + L^{NP}$, where where L^P stands for production worker (unskilled) labour and L^{NP} stands for non-production worker (skilled) labour. We proxy L^{NP} by the sectoral average of years of schooling since we do not possess information for individual firms.

Although we can observe Y_{ijt}, K_{ijt}, L_{ijt} and M_{ijt}, A_{ijt} is not observable and hence, needs to be estimated.

The estimation of $A_{ijt,}$ depends on several different components such as skills, knowledge and firm-level capabilities, including managerial and organisational competences. We assume that A_{ijt} or TFP in logs is given by:

$$\ln(A_{ijt}) = \beta_0 + \varepsilon_{ijt} \quad \text{(III.2)}$$

where β_0 measures the mean efficiency level across firms over time; ε_{ijt} is the time- and producer-specific deviation from that mean.

Taking natural logs of (1) and inserting equation (2) we obtain a linear production function

$$y_{ijt} = \beta_0 + \beta_k k_{ijt} + \beta_{lP} l^P_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt} + \varepsilon_{ijt} \quad \text{(III.3)}$$

[39] In chapter 1 we have suggested the need to specify a knowledge generation function (Nelson and Winters, 1982 and Weitzman, 1996 and 1998) where internal and external knowledge are complementary inputs. However, it was not possible to use a function of this type due to data limitations. Furthermore, we have remarked that firms' (heterogeneous) characteristics may enhance the magnitude of externalities from FDI. In the impossibility to test all firms' characteristics, we spilt the sample by firm size (according to the number of employees being less than 250, or otherwise) and cluster firms according to their technological trajectories to ascertain the influence of these characteristics on the occurrence and magnitude of externalities from FDI.

where lower-cases refer to natural logarithms. The error term ε_{ijt} can be further decomposed into an observable (or at least predictable); and an unobservable i.i.d. component, representing unexpected deviations from the mean due to measurement error, unexpected delays or other external circumstances, i.e, $\varepsilon_{ijt} = v_{ij} + u^q_{ijt}$. Hence, equation (3) becomes

$$y_{ijt} = \beta_0 + \beta_k k_{ijt} + \beta_{lP} l^P_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt} + v_{ijt} + u^q_{ijt} \quad \text{(III.4)}$$

Since the firm-level productivity is $tfp_{ijt} = \beta_0 + v_{ijt}$; and rearranging the terms of (2) we obtain[40]

$$tfp_{ijt} = y_{ijt} - (\beta_k k_{ijt} + \beta_{lP} l^P_{ijt} + \beta_{lNP} l^{NP}_{ijt} + \beta_m m_{ijt}) - u^q_{ijt} \quad \text{(III.5)}$$

And the estimated productivity is

$$\hat{tfp} = tfp_{ijt} + u^q_{ijt} \quad \text{(III.6)}$$

This empirical model allows us to address the simultaneity bias in traditional OLS regression techniques to estimate the TFP when unobserved productivity or TFP shocks, *i*, *j* and *t*, are correlated to the choice of inputs. Since the Olley-Pakes (1996) and Levinsohn-Petrin (LP) (2003) techniques, while controlling for the simultaneity bias, suffer from collinearity problems (Ackerberg et al., 2007), and later, Wooldridge (2009) suggested modifications to the original LP approach aiming to correct the collinearity issue.

Defining the value added as $va_{ijt} = y_{ijt} - \beta_m m_{ijt}$, then it can be estimated through equation (4) as a residual

$$\hat{tfp}_{ijt} = va_{ijt} - (\hat{\varepsilon}^v_{jP}\, l^P_{ijt} + \hat{\varepsilon}^v_{jNP}\, l^{NP}_{ijt} + \hat{\varepsilon}^v_{jK}\, k_{ijt}) \quad \text{(III.7)}$$

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[40] The productivity term is identified assuming that tfp_{ijt} is a state variable in the firm's decision problem (i.e. it is a determinant of both firm selection and input demand decisions), although u^q_{ijt} is either the measurement error or a non-predictable productivity shock (Olley and Pakes, 1996).

The theory of endogenous growth suggests that technological progress is a key factor for economic growth (Romer, 1990, Grossman and Helpman, 1991, Aghion and Howitt, 1997). In this context, FDI is regarded as a set of intangible assets, codified and tacit knowledge and technologies that are likely to generate positive externalities for the host economy. Thus, externalities from FDI may have an impact on long-term growth (Romer, 1986, Lucas, 1988, Grossman and Helpman, 1991), since the technological progress provided by FDI has increasing returns on output through TFP growth.

Endogenous growth models assume that the diffusion of technology across domestic markets is not automatic and emphasize other channels, besides technological progress, such as R&D, human capital accumulation, and externalities from FDI that may promote long run economic growth (Romer, 1986; Lucas 1988; Grossman and Helpman, 1991; Barro and Sala-i-Martin, 1995 and Loungani and Razin, 2001).

Thus, in the second stage of our econometric strategy, the growth of the estimated TFP is regressed against a set of variables that measure the foreign presence, interaction terms and other explanatory variables, within a fixed effects dynamic model**,** including a time trend. The three sets of variables in our econometric model are described as follows.

Variables related to foreign presence

Externalities from FDI may be horizontal or vertical. Horizontal externalities occur when the entry of the MNC generates positive externalities for local competitors. Vertical externalities occur when the links between MNCs and their local suppliers/customers (backward/forward linkages) generate positive externalities. Hence, we measure the foreign presence through three variables *hor*, *b1* and *f1* defined at sectoral level.

We have tested three measures of foreign presence: turnover, capital and value added of foreign firms (i.e, firms with, at least, 10% of foreign capital).[41] The joint analysis through normality tests and visual inspection with the qnorm command in stata, as well as the fact that empirical evidence for developed countries shows that extenalities are usually positive when turnover is used, led us to chose the turnover as the preferred measure.[42]

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[41] For a discussion on the alternative measures of foreign presence, see section 3.3 of chapter 2.
[42] Robustness tests for other measures indicated different results.

Recalling the variables of our model (II.8) as described in section 2 of chapter 2, the econometric specification is

$$\hat{dtfp}_{ijt} = \beta_0 + \beta_1 \hat{tfp}_{ij(t-1)} + \beta_2 \sum_{m=0}^{2} f_{j(t-m)} + \beta_3 (f_{jt} * hfd_{ijt}) + \beta_4 (f_{jt} * rd_{ijt}) + \beta_5 (f_{jt} * mrdf_{jt}) + \beta_6 (f_{jt} * s_{ijt}) + \beta_7 (f_{jt} * kl_{ijt}) + \beta_8 (f_{jt} * tg_{ijt}) + \beta_9 hfd_{ijt} + \beta_{10} rd_{ijt} + \beta_{11} mrdf_{jt} + \beta_{12} ds_{ijt} + \beta_{13} tg_{ijt} + \beta_{14} kl_{ijt} + \gamma_t + \mu_{it} \quad \text{(III.8)}$$

Where the lowercases denote variables in logarithms and *f* is the measure of foreign presence (*hor, b1* and *f1*). We also include year dummies γ_t that account for possible changes in the growth of TFP due to stochastic shocks at firm or sectoral level over time and an error term μ_{it}.

If it is expected that the current level of the dependent variable (DV) is heavily determined by its past level, then we use a dynamic specification that includes a lagged dependent variable ($\hat{tfp}_{ijt-1}$). The inclusion of lagged DVs is necessary to avoid unreliable results due to an omitted variable bias and reduce the occurrence of autocorrelation arising from model misspecification.

We include two lags of the variables that represent the foreign presence, since empirical studies indicate a period of two years for domestic firms to absorb the foreign knowledge and externalities to materialize. For example, Merlevede et al.(2014) find evidence that "the first two years after entry, domestic firms that supply minority foreign entrants enjoy a substantial contribution to productivity growth" (*op cit.* p.22)

We use the Sys-GMM to estimate equation (III.8), which combines the equation in first differences with the equation in levels. Hence, we place the fixed effects only in the equation in levels.

In this dynamic model, the lagged dependent variable ($\hat{tfp}_{ijt-1}$) may be correlated with the error term (μ_{it}) and the endogenous variables, causing the OLS estimator to be inconsistent and biased (Hsiao, 1986).

Nickell (1981) demonstrated that the use of the within estimator (also known as fixed effects estimator) in first order autoregressive models with fixed effects lead to biased results for the estimated coefficient of the lagged dependent variable.

However, there is still the autocorrelation problem, since the term $\hat{tfp}_{ijt-1}$ is correlated with the term $\mu_{i,t-1}$ in $d\mu_{it} = \mu_{i,t} - \mu_{i,t-1}$.

The independent variables are endogenous (*kl, tg, f, f*hfd*); predetermined (*s*) and exogenous (*hfd, rd, mrdf, f*mrdf, f*s and f*tg)*. However, any not strictly exogenous predetermined variable becomes potentially endogenous since it can be also be correlated with the error term $\mu_{i,t-1}$ (Roodman, 2009b).[43] Arellano and Bond (1991) and Bond (2002) suggest the use of instrumental variables in equation (III.8) to deal with the autocorrelation and endogeneity issues. Considering equation (III.8), we use lags of the dependent variable in levels, lagged two or more periods, as valid instruments for periods t=3,…, T, as in Arellano and Bond (1991) and Bond (2002).

Regarding the explanatory variables, it is assumed that increases in capital intensity, technological sophistication, foreign presence, and the joint impact of foreign presence and market concentration are correlated with contemporaneous shocks in the TFP.

On the other hand, it is likely that contemporaneous innovations may have an impact in future increases in the scale.

Finally, increases in concentration, domestic and foreign R&D expenses, and the joint impacts of foreign presence and foreign R&D expenses, scale and technological gap are not correlated with contemporaneous innovations.

Thus, to overcome the autocorrelation and endogeneity issues, the endogenous variables (*kl, tg, f, f*hfd*) are dealt with in a similar way as the dependent variable ($\hat{tfp}_{ijt}$); the predetermined variable (*s*) use its lagged values for two or more periods for t=1,…(T-2) as instruments; and exogenous variables (*hfd, rd, mrdf, f*mrdf, f*s and f*tg)* are used as their own valid instruments.

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[43] These are the variables in our final models for the three types of externalities, after performing robustness tests. The selection of the instruments was based on the relevance of the model and statistical significance of the variables so that it can support the Hansen test. Takii and Narkojo (2012) assume scale as predetermined and Karpaty and Lundberg (2004) assume R&D as exogenous, while Griffith et. al (2006) take firm level variables as endogenous and industry level variables as exogenous.

Denoting by F the vector of variables related to foreign presence and X the other explanatory variables (except the lagged dependent variable), the moments conditions are given by:

$$E(\hat{tfp}_{ijt-s} d\mu_{it}) = 0 \quad \text{for s=2,…,(t-1) and t=3,…, T}$$

$$E(F_{ijt-s} d\mu_{it}) = 0 \quad \text{for s=2,…,(t-1) and t=3,…, T}$$

$$E(X_{ijt-s} d\mu_{it}) = 0 \quad \text{for s=2,…,(t-1) and t=3,…, T} \qquad \text{(III.9)}$$

The GMM estimator applied to these moments conditions is known as GMM in first differences (see Arellano and Bond, 1991). Blundell and Bond (1998) and Bond et al. (2001) have demonstrated that, with persistent data over time, the first-differenced GMM estimator can behave poorly, since lagged levels of the series provide only weak instruments for subsequent first-differences.

Blundell and Bond (1998) proposed the use of the system-GMM estimator, that combines a system of equations in differences and in levels as the best estimator to deal with endogeneity of the explanatory variables (including the lagged dependent variable) and firms' unobserved fixed effects.

Indeed, we prefer system GMM over difference GMM for two reasons. First, system-GMM generally produces more efficient and precise estimates by improving precision and reducing the finite sample bias (Baltagi, 2008); second, differencing variables within groups will remove any variable that is constant; which mean the loss of a number of observations.[44] All explanatory variables are instrumented with their lags, as discussed in Arellano and Bond (1988, 1991).

Regarding the levels equation, Arellano and Bover (1995) suggested the use of the lagged variable in first differences as a valid instrument, if the explanatory variable in levels is correlated with the fixed effect (η_i) but the first difference is not.

The moments conditions of the equation in levels are given by:

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[44] Indeed, a potential problem of the difference-GMM estimator is that, under certain conditions, the variance of the estimates may increase asymptotically and create considerable bias if: (i) the dependent variable follows a random walk, which makes the first lag a poor instrument for its difference, (ii) the explanatory variables are persistent over time, which makes the lagged levels weak instruments for their differences, (iii) the time dimension of the sample is small (Alonso-Borrego and Arellano, 1996 and Blundell and Bond, 1998).

$$E\left[\hat{dtfp}_{ijt-s}(\eta_i + \mu_{i,t})\right] = 0 \quad \text{for s=1,...,(t-2) and t=3,..., T}$$

$$E\left[dF_{ijt-s}(\eta_i + \mu_{i,t})\right] = 0 \quad \text{for s=1,...,(t-2) and t=3,..., T}$$

$$E\left[dX_{ijt-s}(\eta_i + \mu_{i,t})\right] = 0 \quad \text{for s=1,...,(t-2) and t=3,..., T} \qquad \text{(III.10)}$$

The System-GMM estimator combines the moments conditions of the equation in first differences (9) with the moments conditions of the equation in levels (10). According to Blundell and Bond (1998) and Bond et al. (2001), the system-GMM estimator is the most consistent estimator in the presence of persistence over time. Indeed, unobserved productivity is assumed to display persistence over time, leading to serial correlation in the unobservables.

Since the variables that proxy for foreign presence are highly correlated, we regress each type of externality for domestic firms in a separate equation.

We use the command *xtabond2* in software STATA 13.0 to implement the System GMM two-step estimator with the Windmeijer (2005) correction.[45] Industries of tobacco and petroleum (with codes 12 and 19 according to classification Nace Revision 2) were dropped dure to insufficient number of observations.

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[45] The calculation of the efficient two-step GMM estimator uses a weight matrix based on initial consistent parameter estimates. In small samples, this may cause a severe downward bias in the estimated asymptotic standard errors. Indeed, when the moment conditions used are linear in the parameters, there is a difference between the finite sample and the usual asymptotic variance of the estimator. Applying Monte Carlo technique to the data panel approach, Windmeijer (2005) estimates this difference and obtains a corrected variance estimate that is approximate to the finite sample variance.

5. RESULTS

The validity of the results with system-GMM depends on the statistical diagnostics. We started by testing for the presence of second-order autocorrelation in the error term. The presence of AR(1) poses no problem because the differenced residuals are expected to follow an MA(1) process, however, if there is AR(2) autocorrelation, then the GMM-estimator is inconsistent. The reason is that the Arellano-Bond (AB) orthogonality conditions are established under the assumption that the error term in the levels equation is not autocorrelated. If the error term in the levels equation is not autocorrelated, then the error term in the first-difference equation has negative first-order autocorrelation, and 0 second order autocorrelation. If one rejects the hypothesis that there is 0 second-order autocorrelation in the residuals of the first-difference equation, then one also rejects the hypothesis that the error term in the levels equation is not autocorrelated. This indicates that the AB orthogonality conditions are not valid, no matter which lags are used as instruments. Thus, we test for second-order serial correlation.

We also report the results of Hansen's J test of overidentifying restrictions but not the Sargan's statistic.[46] The reason is that Sargan's statistic is a special case of Hansen's J under the assumption of homoscedasticity. Therefore, for robust GMM, the Sargan test statistic is inconsistent. Moreover, Arellano and Bond (1991) found that the Sargan test was not as sensitive to autocorrelation as was their autocorrelation test. This implies that the two tests sometimes disagree, with the Sargan test being sensitive to other types of violations of assumptions, but also being less sensitive to particular violations associated with autocorrelation. A reasonable approach is to use robust standard error estimation to deal with heteroskedasticity (and thus rendering the Sargan test unjustified), and then test for the remaining autocorrelation using the autocorrelation test which is more sensitive to such problems than the Sargan test.

Following Roodman (2009b), we also report the number of instruments used in the dynamic panel, since this kind of models can generate an enormous number of potentially “weak” instruments that can cause biased estimates. There are no clear rules

[46] In addition, the difference-in-Hansen test of exogeneity of instruments do not reject the null hypothesis that the instrument subset for level equations are orthogonal to the error (p-values 0.150, 0.426 and 0.253, respecyively for horizontal externalities and externalities via backward and forward linkages). As a result, we cannot detect invalid instruments based on this test statistic.

concerning how many instruments is "too many" (Roodman, 2009b), but the number of instruments should not exceed the number of groups, which is the case. Second, the p-value should have a higher value than the conventional 0.05 or 0.10 levels.

We examined the sensitivity of system-GMM regression results to the number of lagged instruments and to alternative number of independent variables. However, in theses alternative specifications, Arellano-Bond [AR(2)] and Hansen tests rejected the null hypothesis and/or the coefficient of variables become non significant.

Tables III.2 to III.26 show that the results for AR(2) and Hansen's J test support the validity of the chosen model specification.

We start by the analysis at aggregate level, and then we analyse the results by industry and within each industry, we also report the significant results by size.Table III.2 shows the results for the manufacturing sector; the first three columns display the results of model 1, without interaction variables; columns 4 to 6 show the results for model 2, with interaction variables.

[Insert Table III.2 here]

In this analysis, we report only the significant results (p-values are listed in parenthesis, next to the coefficient values). We start to analyse model 1 that does not contain interaction variables. In model 1, we find a negative and significant impact of past values of TFP on the TFP growth, no matter the kind of foreign presence (i.e, in the same industry or in upstream or downstream industries). These results suggest that domestic firms with lower past levels of TFP may benefit more from increases in their TFP, than those firms with higher past levels of TFP.

Regarding externalities, we find positive and significant vertical externalities (0.0609 and 0.0320, $p<0.001$) in the current period; positive horizontal externalities (0.0847, $p<0.001$) and via backward linkages (0.0549, $p<0.001$) with one-period lag; and positive horizontal externalities (0.0304, $p<0.001$) and via forward linkages (0.0264, $p<0.001$) in two-period lag.

We also find a positive statistical significance of the impact of concentration and capital intensity in all levels of foreign presence (i.e, horizontal and vertical), except for concentration when estimating externalities via backward linkages. Indeed, the coefficient is negative and non-significant (-0.00859). The overall results for the control variables indicate that concentration, capital intensity and technological gap (constructed as an inverse measure, i.e, the higher the coefficient the more technologically sophisticated are domestic firms) have a positive impact on TFP growth of domestic manufacturing firms.

Year dummies capture the influence of aggregate (time) trends. If they are positive, it means that, being in a que certain year *n*, has a positive increase in TFP, compared to the previous year; and otherwise for a negative value. The change in the TFP of domestic firms in the same industry was positive for the years 2003 and 2004 (respectively, 0.0376, 0.0268, $p < 0.01$); and was negative in 2001-2002 and in 2005-2006 (-0.0294, $p<0.05$; -0.0372, -0.0407 and -0.0641, $p < 0.001$). This suggests that in 2001-2002 and in 2004-2005, economic recession exerted its impact on the TFP growth of domestic firms in the same industry.

The changes in the TFP of domestic firms in upstream industries had a negative influence from 1998 to 2006 (respectively, -0.118, $p<0.001$; -0.0612, -0.0269, $p<0.01$; -0.0639, -0.0910, -0.158, -0.154, -0.233 and -0.100, $p < 0.001$), implying that economic recession in all these years had negative effects on the TFP growth of domestic firms in upstream industries. The changes in the TFP of domestic firms in downstream industries had a positive influence in 2005 (0.0260, $p<0.01$); and a negative impact in 1998-1999, 2002 and 2006 (respectively, -0.0379, -0.0354, -0.0362 and -0.0371, $p < 0.001$) most likely due to the economic recession.

From the estimation, the constant term, otherwise known to the intercept, is significantly negative for vertical externalities. This implies that at the point where all the explanatory variables are zero, the TFP growth of domestic firms will be equal to -0.0639 and -5.271, respectively for backward and forward linkages ($p<0.001$). This implies that the occurrence of vertical externalities requires a certain (positive) amount of FDI, technological gap, concentration or capital intensity.

Tables III.3 to III.26 refer to model 2, which is our chosen model because it contains the interaction variables. Model 2 is disaggregated by manufacturing industries (and each industry is then allocated to one of the four technological groups described in chapter 2). Moreover, within each industry, we perform an analysis by firm size (small firms being those with less than 250 employees and large firms otherwise) to assess how size influences the sign of the impact of the independent variables on the TFP growth.

[Insert tables III.3to III.26 here]

Our aim with this disaggregation is to provide some insights on the impact of technological trajectories and firm size on the occurrence of externalities from FDI in the Portuguese manufacturing sector.

Effects of TFP with one-period lag

The past level of TFP has a negative effect (-0.368, p <0.001) on the TFP growth of domestic firms in the same industry; and in upstream and downstream industries (respectively, -1.463 and -1.259 for backward and forward linkages, p <0.001). These results may suggest that domestic firms with lower past levels of TFP may benefit more from increases in their TFP, than those firms that experienced higher levels of TFP in the past.

Externalities

There are negative horizontal externalities (-1.535, p<0.001) and negative externalities through backward linkages (-0.0609, p<0.001) in the current period; and negative externalities at horizontal level (-2.294, p<0.001) and vertical level (-0.0835 and -0777, respectively for backward and forward linkages, p <0.001) with a two-period lag. Negative horizontal externalities may occur if domestic firms do not have enough absorptive capacity to learn the foreign technology and foreign firms intensify market competition and force the domestic rivals to produce at a suboptimal scale; while negative vertical externalities may arise if differences in technology between countries prevent domestic suppliers/clients to establish linkages with foreign firms in upstream and downstream sectors. However, we find positive vertical externalities with one-period lag (0.0629 and 0.306 respectively for backward and forward linkages, p <0.001). These results suggest that it takes one year for domestic firms in upstream and downstream industries to absorb the knowledge transmitted by their foreign clients and suppliers.

Influence of concentration on the impact of FDI on the TFP growth

Concentration has a negative effect on the impact of FDI on the TFP growth of domestic firms in the same industry (-2,060, $p < 0.05$) and in upstream industries (-0.170, $p < 0.001$), which implies that the monopolistic inefficiencies are causing a decrease in the rate of innovation and, thus, a loss of productivity in domestic firms in the same industry and in upstream industries. However, this effect is positive on the TFP growth of domestic firms in downstream industries (0.228, $p < 0.001$). It could be the case that, in these industries, concentration allows for larger profits that can be re-invested, for example, in new technologies, or in the production of more sophisticated products, that allow to increase the TFP.

Influence of the technological gap on the impact of FDI on the TFP growth

The technological gap has a positive effect on the impact of FDI on the TFP growth of domestic firms in the same industry (1.834, $p < 0.05$). Because this measure is constructed as the ratio of labour productivity of domestic firms to the foreign leader; the higher the value, the more technological sophisticated is the domestic firm. Thus, the results at aggregate level confirm the technology-accumulation hypothesis according to which, domestic firms must possess a certain level of absorptive capacity to incorporate the knowledge of foreign firms.

Influence of scale on the impact of FDI on the TFP growth

The scale has a positive effect on the impact of FDI on the TFP growth of domestic firms in the same industry (0.147, $p < 0.05$) and in upstream industries (0.100, $p < 0.001$). This implies that the adoption of an efficient scale is important to increase the TFP of domestic firms in the same industry and in upstream industries.

However, this effect is negative on the TFP growth of the domestic firms in downstream industries (-0.195, $p < 0.001$), which may point towards decreases in the TFP of larger domestic firms in downstream industries.

Influence of R&D activities of foreign firms (average stock of foreign knowledge) on the impact of FDI on the TFP growth

The average stock of foreign knowledge has a positive effect on the TFP growth of domestic firms in upstream industries (0.0291, $p < 0.001$) and a negative effect on domestic firms in downstream industries (-0.0630, $p < 0.001$). These results suggest that domestic firms in upstream industries are able to increase their innovation performance due to the existant stock of foreign knowledge; but in downstream industries, domestic firms experience decreases in their TFP.

Effect of concentration on the TFP

Concentration has a positive effect on the TFP growth of domestic firms in upstream industries (1.078, $p < 0.001$) and negative on domestic firms in downstream industries (-0.757, $p < 0.01$).

Effect of the technological gap in the TFP

The technological gap has a positive effect on the TFP growth of domestic firms in the upstream industries (0.198, $p < 0.001$) which suggests the technology-accumulation hypothesis, i.e, if the gap is too large, domestic firms do not possess the necessary "absorptive capacity" to incorporate the knowledge of foreign firms.

Effect of capital intensity on the TFP

Capital intensity has a positive effect on the TFP growth of domestic firms in downstream industries (0.467, $p < 0.001$). These results seem to indicate that the technological capabilities of domestic firms are important in order to benefit from more capital-intensive technologies of foreign firms.

Year effects

Year dummies capture the influence of aggregate (time) trends. If they are positive, it means that, being in a certain year *n,* has a positive increase in TFP, compared to the previous year; and otherwise for a negative value. The change in the TFP of domestic firms in the same industry was positive for the years 1998, 2002 and 2003 (respectively, 0.197, 0.196 and 0.190, $p < 0.05$); and was negative in 2001 (-0.376, $p < 0.001$). This suggests that in 2001, economic recession exerted its impact on the TFP growth of domestic firms in the same industry. The changes in the TFP of domestic firms in upstream industries had a positive influence in the years 1998, and from 2000 to 2007 (respectively, 0.203, 0.181, 0.0382, 0.0379, 0.233, 0.189, 0.0803, p <0.001; and 0.0385, p <0.01). However, in 1999 this impact was negative (-0.0413, p <0.001). This suggests that in 1999, economic recession exerted its impact on the TFP growth of domestic firms in upstream industries. The changes in the TFP of domestic firms in downstream industries had a positive influence from the years 1998 to 2004 and 2007 (respectively, 0.279,0.235, 0.125, 0.107, 0.190, 0.293, 0.442 and 0.342, p <0.001).

Constant

From the estimation, the constant term, otherwise known as the intercept, is negative for vertical externalities. This implies that at the point where all the explanatory variables are zero, the TFP growth of domestic firms will be equal to - 0.0792 and -0.202, respectively for backward and forward linkages (p<0.001). In other words, the occurrence of vertical externalities requires a certain (positive) amount of FDI, technological gap, scale, concentration or capital intensity.

Industry Analysis

The analysis of Externalities by industry and by size uses the same econometric specification as in model 2 (see Table III.2). We then group the results according to our taxonomy of technological goups and by size.

SCALE INTENSIVE INDUSTRIES

Externalities

In the current period, we find positive externalities in the TFP growth of domestic firms in downstream industries (0.00871, $p<0.001$) of the other transport equipment industry. However, the effect of FDI is negative in the TFP growth of domestic firms in the upstream industries (-0.0567, $p<0.001$) of the motor vehicles industry.

In one lag period, we find positive externalities in the TFP growth of domestic firms in the same industry (0.000789, $p<0.05$) in rubber and plastics; and in downstream industries (0.000942, $p<0.01$) of other non-metallic minerals industry.

However, we find negative externalities in the TFP growth of domestic firms in the upstream industries (-0.189, $p<0.001$) of the beverages industry.

Influence of concentration on the impact of FDI on the TFP growth

Concentration has a negative effect on the impact of FDI on the TFP growth of domestic firms in the same industry (-0.0121, $p <0.001$) of rubber and plastics industry.

Influence of the technological gap on the impact of FDI on the TFP growth

The technological gap has a negative effect on the impact of FDI on the TFP growth of domestic firms in the same industry in non-metallic minerals, basic metals, metal products and motor vehicles industries (-0.00842, -0.00845,-0.00691 and -0.00900, $p <0.001$). It also has a negative effect on domestic firms in upstream industries of the food, basic metals and metal products industries (respectively, -0.00860,-0.00819 and -0.00846, $p <0.001$); and a negative effect on domestic firms in downstream industries of food, basic metals and other transport equipment industries (-0.00861,-0.00819 and -0.00878, $p <0.001$). However, the technological gap has a positive effect on the impact of FDI on the TFP growth of domestic firms in upstream (0.187, $p <0.001$) and downstream industries (0.331, $p <0.001$) of beverage industries.

Influence of scale on the impact of FDI on the TFP growth

The scale exerts a positive effect on the impact of FDI on the TFP growth of domestic firms in the same industry (0.0111, 0.0121, 0.00846 and 0.00906, $p < 0.01$) of beverages, rubber and plastics, basic metals and motor vehicles industries; in upstream industries (0.00850, 0.00690, 0.00820, 0.00847and 0.0562, $p < 0.001$) of food, beverages, basic metals, metal products and motor vehicles industries; as well as in downstream industries (0.00853, 0.00690, 0.00820 and 0.0562, $p < 0.001$) of food, beverages, basic metals and motor vehicles industries.

Influence of R&D activities of foreign firms (average stock of foreign knowledge) on the impact of FDI on the TFP growth

The stock of foreign knowledge has a positive effect on the impact of FDI on the TFP of domestic firms in the same industry (0.00689, $p<0.001$) of metal products.

Effect of the technological gap in the TFP

The technological gap has a negative effect (-0.00831, $p < 0.01$; and -0.0100, $p < 0.001$) on the TFP of the domestic firms of the same industry of beverages and rubber and plastics; in upstream industries (-0.193, -0.00850, -0.0565 and -0.00878, $p < 0.001$) of beverages, non-metallic minerals, motor vehicles and other transport equipment industries; and in downstream industries (-0.337, -0.00850, -0.00846 and -0.337, $p < 0.001$; and -0.0564, $p<0.01$) of food, rubber and plastics, basic metals, other transport equipment and metal products.

Size impact

In the horizontal externalities

The size influences the horizontal externalities in food, basic metals, and other transport industries. In fact, in food industries, there are positive horizontal externalities in the lagged periods (1 and 2) but only in large firms (0.000540 and 0.000686, $p<0.01$).

In the basic metals industry, there are positive horizontal externalities (0.00000793, $p<0.05$) in the current period and negative (lagged one period) only in small firms (-0.0000120, $p<0.01$). In the other transport equipment industry, there are positive horizontal externalities (0.0557 and 0.0713, $p<0.001$) in the lagged periods (1 and 2) but only in small firms.

In externalities via backward linkages

The size influences externalities via backward linkages in beverages industries, basic metals and other transport equipment. In fact, in the beverage industries, there are positive externalities (0.334, $p<0.001$) in the current period, but only in large firms; while in the basic metals industry, there are positive externalities (0.000987, $p<0.001$) with one-period lag; and negative (-0.000678, $p<0.001$) with a two-period lag, but only in small firms; in the other transport equipment industry there are positive externalities (0.0617 and 0.0198, $p<0.001$) in the lagged periods (1 and 2), but only in small firms.

In externalities via forward linkages

The size influences externalities via forward linkages in the beverages and metal products industries. In fact, in the beverages industry, there are positive externalities (0.249, $p<0.001$) in the current period in small firms; and positive externalities in two-period lag (0.103, $p<0.001$) in large firms. We also find positive externalities (0.00107, $p<0.001$) with one-period lag, and negative externalities (-0.000680, $p<0.001$) in two-period lag, in small firms producing metal products.

The influence of concentration on the impact of FDI on the TFP growth

The size has effects on horizontal externalities via concentration, in food, rubber and plastics, non-metallic minerals, metal products and motor vehicles industries.

In fact, there are positive horizontal externalities (0.00750, $p<0.001$) in food industries; and negative in rubber and plastics, non-metallic minerals, and motor vehicles industries (-0.00770, -0.00846, -0.00855, $p<0.001$), but only in large firms. In the metal products industry, the externalities are negative (-0.00868, $p<0.001$) in small firms and positive (0.00836, $p<0.001$) in large firms. The size influences externalities via backward linkages via concentration in beverages industries, non-metallic minerals and basic metals. In fact, there are positive externalities (0.00796 and 0.00814, $p<0.001$) in beverages and non-metallic minerals industries, but only in small firms; while there are positive externalities (0.00809, $p<0.001$) in the basic metals industry, but only in large firms. The size influences externalities via forward linkages via concentration in food, basic metals, metal products and other transport equipment industries. In fact, there are positive externalities (0.000580 and 0.00848), $p<0.001$) in metal products and other transport equipment industries, but only in small firms; and in basic metals (0.0809, p<0.001), only in large firms. There are also negative externalities (-0.0908 and -0.00846, p<0.001) in food and basic metals industries in small firms. However, the size has no effect on the motor vehicles industry, with positive externalities (2.225 and 2.190, p<0.001), both in small and large firms.

The influence of the technological gap on the impact of FDI on the TFP growth

The size influences horizontal externalities via technological gap in food, basic metals, metal products and other transport equipment.

In fact, there are positive horizontal externalities (0.291, p<0.001) in the other transport equipment industry, and negative (-0.00842, p<0.001) in the basic metals industry, but only in small firms. There are also negative horizontal externalities in food, metal products and other transport industries (-0.00736, -0.00841 and -0.00796, p<0.001), but only in large firms. However, the size has no effect in beverages industry, with positive externalities (0.00685 and 0.00840, p<0.001), both in small and large firms.

In the influence of the scale on the impact of FDI on the TFP growth

The size has effects on horizontal externalities via scale in rubber and plastics, basic metals, metal products and other transport equipment.

In fact, there are positive horizontal externalities (0.00842 and 0.00865, p<0.001) in basic metals and metal products industries; and negative (-0.412, p<0.001) in the other transport equipment industry, in small firms only. We also find positive horizontal externalities (0.00769 and 0.00795, p<0.001) in rubber and plastics and other transport equipment industries, in large firms. However, the size has no effect on the motor vehicles industry, with positive externalities (0.00832 and 0.00856, p<0.001), both in small and large firms. The size influences externalities via backward linkages through scale effects in food, beverages, non-metallic minerals, metal products and other transport equipment. In fact, there are positive externalities (0.000324, p<0.001) in the non-metallic minerals industry; and negative (-0.255, p<0.001) in the other transport equipment, in small firms. We also find positive externalities (0.00826, 0.00691, 0.00846, p<0.001) in food, beverages, and metal products industries, but only in large firms. However, the size has no effect in basic metals industry, with positive externalities (0.000513, p<0.001; and 0.000318, p<0.05), both in small and large firms. The size influences externalities via forward linkages through scale in non-metallic minerals, motor vehicles and other transport equipment industries. In fact, there are negative externalities (-2.203, $p<0.001$) in the motor vehicles industry, in small firms; while there are positive externalities (0.00841, $p<0.05$) in the other transport equipment, in large firms. However, the size has no effect in food, beverages and basic metals industries, since we find positive externalities (0.00845, $p<0.001$; 0.00707, $p<0.01$; 0.00830 and 0.00846, $p<0.001$; 0.00825 and 0.00689, $p<0.001$; 0.000318, $p<0.05$), both in small and large firms.

In the influence of R & D activities of foreign firms (stock of foreign knowledge) on the impact of FDI on the TFP growth

The size has effect on horizontal externalities via the stock of foreign knowledge in beverages, basic metals, motor vehicles and other transport equipment industries. In fact, there are negative horizontal externalities (-0.000186, -0.000000397, $p<0.05$; and -0.00837, $p<0.001$) in beverages, basic metals, and motor vehicles industries; and positive in the other transport equipment (0.0781, $p<0.001$), in small firms. However, the size has no effect on non-metallic minerals, with negative externalities (-0.000128 and -0.000145, $p<0.001$) occurring both in small and large firms. The size has effects on externalities via backward linkages through the average stock stock of foreign knowledge in basic metals and other transport equipment industries. In fact, there are positive externalities (0.0000765; $p<0.001$) in basic metals and negative (-0.0344, $p<0.001$) in other transport equipment, in small firms. The size influences externalities via forward linkages through the average stock stock of foreign knowledge in rubber and plastics, metal products and motor vehicles industries. In fact, there are positive externalities (0.615 and 0.0000813, $p<0.001$) in rubber and plastics and metal products industries, in small firms; as well as negative externalities (-2.466, $p<0.01$) in the motor vehicles industry, in large firms.

In the effect of the technological gap on the TFP growth

The size influences the impact of the technological gap in the TFP growth of domestic firms in the same industry, in firms that produce food, basic metals and metal products. We find negative effects (-0.00816 and -0.00842, $p<0.001$) in firms that produce food and metal products in small firms; and a negative effect (-0.00845, $p<0.001$) in large firms that produce basic metals. The size has no effect on the impact of the technological gap in the TFP of the domestic firms in the same industry in rubber and plastics and motor vehicles industries, since we find a negative effect

(-0.00859, -0.00850, -0.00765 and -0.00870, p<0.001) respectively for small and large firms. The size influences the impact of the technological gap on the TFP growth of domestic firms in upstream industries of firms producing beverages, rubbers and plastics, basic metals, and other transport equipment. We find negative effects (-0.00825, -0.00250 and -0.781, p<0.001) in small firms that produce rubber and plastics, basic metals and other transport equipment; and negative effects (-0.00693, p<0.001) in large firms producing beverages. The size influences the impact of the technological gap on the TFP growth of domestic firms in downstream industries of food, non-metallic minerals, and basic metals. We find negative effects (-0.0908 and -0.00847, p<0.001) in small firms of food and basic metals; and negative effects (-0.00849, p<0.001) in large firms producing non-metallic minerals. Size has no effect on the impact of the technological gap on the TFP growth of domestic firms in downstream industries of beverages and metal products, since we find a negative effect (-0.00712, -0.00215, -0.358 and -0.00846, p<0.001) respectively for small and large firms.

In the effect of capital intensity on the TFP growth

The size influences the impact of capital intensity on the TFP growth of domestic firms in downstream industries of rubber and plastics, metal products, motor vehicles and other transport equipment. We find a negative effect (-0.000718, p<0.05 and -0.000132, p<0.001) on motor vehicles and other transport equipment industries; and positive (0.188 and 0.00157, p<0.001) in rubber and plastics and metal products industries, in small firms. We also find a negative effect (-0.000140, p<0.001) for large firms in the metal products industry. Size has no effect on the impact of capital intensity on the TFP growth of domestic firms in downstream industries in beverages and basic metals industries, since we find a negative effect (-0.000119, p<0.05; -0.000135, -0.000198 and -0.000139, p<0.001) respectively for small and large firms.

SPECIALIZED SUPPLIERS INDUSTRIES

Influence of concentration on the impact of FDI on the TFP growth

Concentration has a positive effect on the impact of FDI on the TFP growth of domestic firms in the same industry (2.240, 0.00847 and 0.00665, $p < 0.001$) in machinery and equipment, other manufacturing and repair and installation of machinery and equipment; it has a positive impact (0.00843, $p<0.001$) in domestic firms in upstream industries of repair and installation of machinery and equipment industry; and a negative impact (-0.00825, $p<0.001$) in domestic firms in downstream industries of other manufacturing industry.

Influence of the technological gap on the impact of FDI on the TFP growth

The technological gap has a negative effect on the impact of FDI on the TFP growth of domestic firms in the same industry (-0.0393, -0.00855 and -0.00846, $p < 0.001$) in machinery and equipment, other manufacturing and repair and installation of machinery and equipment.

Influence of scale on the impact of FDI on the TFP growth

Scale influences positively the impact of FDI on the TFP growth of domestic firms in the same industry (0.0420 and 0.00184, $p < 0.01$) of machinery and equipment and repair and installation of machinery and equipment; and in downstream industries (0.00816 and 0.00786, $p < 0.001$) of the other manufacturing and repair and installation of machinery and equipment industries.

Influence of R&D activities of foreign firms (average stock of foreign knowledge) on the impact of FDI on the TFP growth

The stock of foreign knowledge has a negative effect on the impact of FDI on the TFP growth of domestic firms in the same industry of machinery and equipment (-2.243, $p < 0.001$).

Effect of the technological gap in the TFP

The technological gap has a negative effect on the TFP growth of domestic firms in the upstream and downstream industries (-0.00951 and -0.00632, $p < 0.001$) of other manufacturing industry.

Influence of capital intensity in TFP

The capital intensity has a negative effect ($p < 0.001$) on the TFP growth of domestic firms in downstream industries (-0.000137, $p<0.001$) of the repair and installation of machinery and equipment industry.

Size impact

On horizontal externalities

The size has effect on horizontal externalities in repair and installation of machinery and equipment, since we find positive externalities (0.00546, $p<0.001$) in a two-period lag, but only in small firms.

On externalities via backward linkages

The size influences the externalities via backward linkages in repair and installation of machinery and equipment. Indeed, there are positive externalities (0.00853, $p<0.001$) in the current period, but only in large firms.

In the influence of concentration on the impact of FDI on TFP growth

The size has a positive effect (0.00850, $p<0.001$) on horizontal externalities via concentration, in domestic firms in other manufacturing, but only in large firms. The size has no effect on horizontal externalities via concentration, in domestic firms in repair and installation of machinery and equipment, since we find negative externalities (-0.00825 and -0.00856, $p<0.001$) in small and large firms.

In the influence of the technological gap on the impact of FDI on TFP growth

The size has no effect on horizontal externalities via technological gap in other manufacturing and repair and installation of machinery and equipment industries, since we find, respectively, negative (-0.0650 and -0.00849, $p<0.001$) and positive effects (0.00289 and 0.00173, $p<0.001$) in small and large firms.

In the influence of scale on the impact of FDI on TFP growth

The size has positive effects on horizontal externalities via scale in the machinery and equipment, other manufacturing and repair and installation of machinery and equipment industries. Indeed, there are positive effects (0.00827, $p<0.001$; 0.0299, $p<0.05$ and 0.00682, $p<0.001$) in small firms of other manufacturing; and in large firms of machinery and equipment and repair and installation of machinery and equipment industries. The size influences positively the externalities via backward linkages through scale in the other manufacturing industry, since we find positive effects (0.00817, $p<0.001$) only in small firms. The size influences externalities via forward linkages through scale in machinery and equipment and repair and installation of machinery and equipment industries. We find positive effects (0.00818 and 0.00742, $p<0.001$) in small firms in repair and installation of machinery and equipment and in large firms of machinery and equipment.

In the influence of capital intensity in TFP growth

The size has no effect on the impact of capital intensity in TFP growth of domestic firms in downstream industries of repair and installation of machinery and equipment, since we find negative effects (-0.000154 and -0.000129, $p<0.001$) in small and large firms.

SCIENCE BASED INDUSTRIES

Influence of concentration on the impact of FDI on the TFP growth

Concentration has a negative effect on the impact of FDI on the TFP growth of domestic firms in the same industry (-0.00729, $p<0.001$) in chemicals; and a positive effect (0.00973, $p<0.001$) in pharmaceuticals. Concentration has a negative effect on the impact of FDI on the TFP growth of domestic firms in the upstream sectors (-0.00841 and -0.00889, $p<0.001$) of pharmaceuticals and computer and electronics industries, and a positive effect (0.00973, $p<0.001$) in domestic firms in the upstream industries of electrical equipment; we also find a negative effect (-0.00841, $p<0.001$) in domestic firms in downstream industries of the pharmaceuticals industry.

Influence of the technological gap on the impact of FDI on the TFP growth

The technological gap has a negative effect on the impact of FDI the TFP growth of domestic firms in pharmaceuticals and computer and electronics (-0.00935 and -0.00923, $p<0.001$).

Influence of scale on the impact of FDI on the TFP growth

The scale has a positive effect on the impact of FDI the TFP growth of domestic firms in the same industry of chemicals and computer and electronics (0.00729 and 0.00924, $p<0.001$); and also in upstream (0.00841 and 0.00109 $p<0.001$) and downstream industries (0.00631 and 0.00887, $p<0.001$) of pharmaceuticals and computer and electronics industries.

Effect of the technological gap on the TFP

The technological gap has a negative effect on the TFP growth of domestic firms in the same industry in chemicals (-0.00708, $p<0.001$); and a negative effect in upstream firms (-0.00844 and -0.00874 $p<0.001$) of pharmaceuticals and computer and electronics industries; and in downstream sectors (-0.00844, $p<0.001$) of pharmaceuticals industry.

Effect of capital intensity on the TFP

Capital intensity has a negative effect (-0.000141, $p<0.01$) on the TFP growth of domestic firms in downstream industries of the pharmaceuticals industries.

Size impact

In the horizontal externalities

Size influences horizontal externalities in the computer and electronics industries. In fact, in computer and electronics there are negative horizontal externalities (-0.339 and -0.0442, $p<0.001$) with one and two-period lags, but only in small firms.

In externalities via backward linkages

The size influences externalities via backward linkages in the computer and electronics industry, since there are positive externalities (0.0227, $p<0.001$) with a two-period lag, but only in small firms.

In externalities via forward linkages

The size influences externalities forward linkages in the industry of electrical equipment. In fact, there are negative externalities (-0.523, $p<0.001$) with one-period lag and positive (0.222, $p<0.001$) with a two-period lag, but only in small firms.

The influence of concentration on the impact FDI on the TFP growth

The size influences the occurrence of horizontal externalities via concentration effects in chemicals and electrical equipment industries. In fact, there are negative externalities (-0.00850 and -0.00826, $p<0.001$) in large firms. The size influences externalities via backward linkages through concentration in chemicals and pharmaceuticals industries. In fact, there are negative externalities (-0.00846, $p<0.001$) in small firms producing chemicals and negative externalities (-0.00850, $p<0.001$) in large firms producing pharmaceuticals. The size influences the externalities via forward linkages through concentration in the computer and electronics industry, with positive externalities (0.00838, $p<0.001$) in small firms; and negative (-0.00989, $p<0.001$) in large firms.

The influence of the technological gap on the impact of FDI on the TFP growth

The size influences horizontal externalities due to the technological gap in the pharmaceuticals industry, recording negative externalities (-0.00922, $p<0.001$) in large firms; and in the computer and electronics industry, where there is a negative effect (-0.258, $p<0.001$) in small firms.

In the influence of the scale on the impact of FDI on the TFP growth

The size influences horizontal externalities due to scale effects in chemicals, pharmaceuticals and electrical equipment industries, since there are positive externalities (0.00849, 0.00946 and 0.00809, p<0.001) in large firms. Size influences externalities via backward linkages by scale effects in chemicals and pharmaceuticals industries, with positive externalities being found in small chemical firms (0.00846, p<0.001) and large pharmaceuticals firms (0.00850, p<0.001). Size has no effect on externalities via backward linkages by scale effects in the computer and electronics industry, with positive externalities (0.0447 and 0.00990, p<0.001) in small and large firms. The size influences the externalities via forward linkages by scale effects in computer and electronics and electrical equipment industries, since there are positive externalities (0.0188 and 0.00989, p<0.001) in small firms producing electrical equipment and large firms in computer and electronics. The size has no effect on externalities via forward linkages by scale effects in the pharmaceuticals industry, with positive externalities (0.00841 and 0.00844, p<0.001) in small and large firms.

In the influence of R & D activities of foreign firms (stock of foreign knowledge) on the impact of FDI on the TFP growth

The size has effect on horizontal externalities via the stock of foreign knowledge in pharmaceuticals and computer and electronics industries. We find positive (0.0125, p<0.001) effects in small firms in computer and electronics; and negative effects (-0.0000525, p<0.001) in large firms of pharmaceuticals. The size influences externalities via backward linkages through the stock of foreign knowledge in computer and electronics, since there are positive effects (0.00533, p<0.001) in small firms. The size influences externalities via forward linkages through the stock of foreign knowledge in the electrical equipment industry, since we find negative effects (-0.0444, p<0.001), in small firms.

On the effect, the technological gap on the TFP growth

The size influences the impact of technological gap on the TFP growth of domestic firms in the same industry of chemicals and electrical equipment, as we find negative effects (-0.00845 and -0.00800, p<0.001) in large firms. The size influences the impact of technological gap on the TFP growth of domestic firms in the upstream industries, in chemicals and pharmaceuticals industries, since we find negative effects (-0.00848 and -0.00845, p<0.001) in small firms of chemicals and large firms of pharmaceuticals. The size influences the impact of technological gap on the TFP growth of domestic firms in downstream industries of the computer and electronics industry, since we find a negative effect (-0.00857, p<0.001) in large firms.

On the effect of capital intensity on the TFP growth

The size influences the impact of capital intensity on the TFP growth of domestic firms in the upstream industries of the electrical equipment industry, since we find negative effects (-0.0377, p<0.001) but only in small firms.

The size does not influence the impact of capital intensity on the TFP growth of domestic firms in the upstream industries of the pharmaceuticals industry, since we find negative effects (-0.000131 and -0.000220, p<0.001) both in small and large firms.

SUPPLIER DOMINATED INDUSTRIES

Externalities

We find negative horizontal externalities (-0.00285, p<0.05) with one-period lag in textiles; and positive horizontal externalities (0.00264, p<0.05) with a two-period lag in wearing apparel. We also find positive externalities (0.00824, p<0.001) via backward linkages in the wood industry, in the current period.

Influence of concentration on the impact of FDI on the TFP growth

The concentration has a positive effect (0.0120 and 0.00978, p<0.001) on the impact of FDI on the TFP growth of domestic firms in the same industry in leather and paper industries; and negative (-0.00809, p<0.001) in the printing industry. The concentration has a negative effect (-0.00867, p<0.001) on the impact of FDI on the TFP growth of domestic firms in the upstream industries of the printing industry. The concentration has a positive effect (0.0126, p<0.001) on the impact of FDI on the TFP growth of domestic firms in the downstream industries of the leather industry.

Influence of the technological gap on the impact of FDI on the TFP growth

The technological gap has a negative effect on the impact of FDI on the TFP growth of domestic firms in the same industry of firms producing wearing apparel, leather and paper (-0.0103, -0.0121 and -0.00972, p <0.001).

Influence of scale on the impact of FDI on the TFP growth

The scale has a positive effect (0.0105 and 0.00796, p<0.001) on the impact of FDI on the TFP growth of domestic firms in the same industry in wearing apparel and printing. The scale has a positive effect (0.0126 and 0.00867, p<0.001) on the impact of FDI on the TFP growth of domestic firms in the upstream industries of leather and printing industries.

Effect of technological gap in TFP growth

The technological gap has a negative effect (-0.00977, p <0.001) on the TFP growth of domestic firms in the same industry of printing; in upstream industries (-

0.0131, p<0.05; -0.00919 and -0.00865, p<0.001) of textiles, paper and printing; and in downstream industries (-0.0132 and -0.0102, p <0.05) of textiles and furniture industries.

Effect of capital intensity on the TFP growth

The capital intensity has a positive effect (0.000582, p <0.01) on the TFP growth of domestic firms in downstream industries of the leather industry; while the effect is negative (-0.000288, p <0.01) in downstream industries of the wood industry.

Size impact

In externalities via backward linkages

The size has effect on externalities via backward linkages in the wood industry since there are negative externalities (-0.00740, p<0.01) in the current period, only in large firms.

In externalities via forward linkages

The size has effect on externalities via forward linkages in the wood industry since there are negative externalities (-0.00746, p<0.01) in the current period, only in large firms.

In the influence of concentration on the impact of FDI on TFP growth

The size has effect on horizontal externalities via concentration in textiles, printing and furniture industries, since there are negative externalities (-3.766 and -0.00896, p<0.001) in small firms in textiles and printing industries; and negative externalities (-1.205, p<0.001) in large firms producing furniture.

The size has effect on externalities via backward linkages through concentration in the paper industry, since there are negative externalities (-0.00875, p<0.001) in small firms. The size has effect on externalities via forward linkages through concentration in the leather industry, since there are positive externalities (0.0116, p<0.001) in small firms.

In the influence of the technological gap on the impact of FDI on TFP growth

The size has effect on horizontal externalities via technological gap in the industries of leather, wood and printing, since there are negative externalities (-0.0122 and -0.00883, $p<0.001$) in small firms of leather and wood; and positive externalities (0.00870, $p<0.001$) in small firms; and negative externalities (-0.00877, $p<0.001$) in large firms of printing industry.

In the influence of scale on the impact of FDI on TFP growth

The size influences externalities via backward linkages through scale in wood and furniture industries, since there are positive externalities in large firms of wood and small firms producing furniture (0.00748, $p<0.01$; and 0.00799, $p<0.001$).

The size has no influence in externalities via backward linkages through scale in paper industry, since we find positive effects (0.00877 and 0.00850, $p<0.001$) for both small and large firms. The size influences externalities via forward linkages through scale in industries of textiles, leather, wood, paper and printing. In fact, there are positive externalities in small firms of textiles and printing (0.661 and 0.00874, $p<0.001$); and in large firms of leather, wood and paper (0.0100, $p<0.001$; 0.00747, $p<0.01$; and 0.00881, $p<0.001$).

In the influence of R & D activities of foreign firms (stock of foreign knowledge) on the impact of FDI on TFP growth

The size has a positive effect on horizontal externalities via the stock of foreign knowledge in the industries of textiles, wood and furniture, since we find positive externalities (3.768 and 0.00885, $p<0.001$) in small firms of textiles and wood; and positive externalities in large firms (2.365, $p<0.001$) producing furniture. The size influences externalities via forward linkages through the stock of foreign knowledge in the textiles industry, since we find negative effects (-0.521, $p<0.001$) in small firms.

On the effect, the technological gap in *TFP growth*

The size influences the impact of technological gap on the TFP growth of domestic firms in the same industry of paper, since we find negative effects (-0.00889, $p<0.001$) in small firms. The size influences the impact of technological gap on the TFP growth of domestic firms in upstream industries of textiles, wood, and paper industries.

We find negative effects (-0.00961 and -0.00863, $p<0.001$) in small firms producing textiles and paper; and in large firms producing wood (-0.00689, $p<0.001$). The size does not influence the impact of technological gap in TFP growth of domestic firms in upstream industries of the leather industry, since we find negative externalities (-0.00734, $p<0.05$; and -0.00989, $p<0.001$), both in small and large firms.

The size influences the impact of technological gap on the TFP growth of domestic firms in downstream industries of textiles, wearing apparel, wood and furniture industries. We find negative effects (-0.00822 and -0.00957, $p<0.001$) in small firms producing textiles and wearing apparel; and in large firms producing wood and furniture (-0.00688, $p<0.001$; and -0.00732, $p<0.05$).

On the effect of capital intensity in TFP growth

The size influences the impact of capital intensity on the TFP growth of domestic firms in downstream industries of leather and paper industries. We find a positive effect (0.000349, $p<0.05$) in small firms producing leather and a negative effect (-0.000147, $p<0.001$) in large firms producing paper.

6. CONCLUSION

The portuguese manufacturing sector is characterized by small firms and an innovation dynamics that relies greatly on the so-called traditional industries. These industries are characterized by small firms, typically producing low-value added products. This *status quo* potentially threatens the TFP growth. Moreover, the results of studies assessing the existence of externalities from FDI for Portugal lack consensus for the period of 1995-2000. Hence, our main research question is: are there externalities from FDI for Portuguese Manufacturing Firms? Bearing this in mind, we perform an analysis of the existence of externalities from FDI in the manufacturing sector for 1995-2007, by technological groups and controlling for firm size, using panel data and an empirical specification that follows the models of technology diffusion.

At the aggregate level, in the current period, we find negative horizontal externalities (-1.535, $p < 0.001$) and negative externalities via backward linkages (-0.0609, $p < 0.001$). Through the analysis by industry and size, we conclude that the latter arise from the negative effect in firms (motor vehicles) in scale intensive industries (-0.0567, $p < 0.001$) and in large firms (wood) in supplier dominated industries (-0.00740, $p < 0.01$). With one-period lag, we find positive externalities (0.0629, $p < 0.001$) via backward linkages, especially in small firms (basic metals and other transport equipment) in the scale intensive industries (0.000987 and 0.0617, $p < 0.001$). We also find positive externalities (0.306, $p < 0.001$) through forward linkages, arising from small firms (metal products) in the scale intensive industries (0.00107, $p < 0.001$). With a two-period lag, we find negative externalities (-0.0835, $p < 0.001$) via backward linkages due to the effects in small firms (basic metals) in scale intensive industries (-0.000678, $p < 0.001$).

The empirical results suggest that vertical externalities (via backward and forward linkages) require one year to occur. It appears that small firms in upstream industries of other transport equipment; and small firms in downstream industries of metal products industry, need one year to learn from their foreign clients/suppliers. However, both horizontal and vertical externalities are negative in the current period and in a two-period lag, which suggest that the initial shock resulting from market interaction between foreign and domestic firms causes a decrease in the TFP of domestic firms. Moreover, after two years, the effects on the TFP of domestic firms are negative, which can be attributed to the decrease in the TFP of small domestic firms in science based industries (computer and electronics); and small domestic firms in upstream and downstream industries of scale intensive industries (basic metals and metal products).

Regarding the influence of control variables on TFP growth (either directly or through its effect on foreign presence), we can conclude the following.

Concentration. In chapter 2, the correlation coefficient between concentration and the TFP growth was negative, and the results of the empirical analysis confirm the sign of this relationship for domestic rivals in scale intensive and science-based industries; and for domestic firms in upstream industries of supplier dominated industries. This suggests that in these domestic firms, the effect of the access to resources offset the potential monopoly inefficiencies. However, these inefficiencies may occur in domestic rivals in supplier dominated and specialized suppliers' industries; as well as in domestic firms in upstream industries of specialized suppliers' industries and in downstream industries of supplier dominated industries, since the relationship between concentration and the TFP growth is negative in these industries.

R & D activities of foreign firms. In chapter 2, the correlation coefficient between R&D activities of foreign firms and the TFP growth was positive. The empirical results confirm the sign of the relationship for domestic rivals in scale intensive industries. However, the sign is negative for domestic rivals in specialized suppliers' industries which implies that, in these industries, domestic firms experience decreases in their productivity, perhaps due to large differences in both technologies (domestic and foreign).

Scale. In chapter 2, the correlation coefficient between scale and the TFP growth was negative. This is not confirmed by empirical results. Overall, across all technological groups, scale appears to play a role in the TFP increase.

Technological gap. In chapter 2, the relationship between technological gap and TFP growth was negative, which is confirmed by empirical results in all technological groups. Thus, it appears that the catching-up hypothesis is confirmed, i.e. if the technological distance between domestic and foreign firms is small, then domestic firms benefit little from the foreign presence, in terms of TFP growth.

Capital intensity. In Chapter 2, the relationship between capital intensity and the TFP growth was negative, which is confirmed by empirical results in downstream domestic firms in all technological groups, except in small firms in leather, rubber and plastics and metal products industries, where we find a positive relationship between those variables, suggesting that the technological know-how in these domestic firms is important to increase their TFP.

To sum-up, the industries where we find significant positive externalities are, by order of absolute magnitude, beverages, electrical equipment, other transport equipment and computer and electronics. In the beverages industry, one percent increase in the turnover of foreign firms increases the TFP of large domestic firms in upstream and small domestic firms in downstream industries in 0.334 and 0.249 percentage points, in the current period; and of large domestic firms in downstream industries in 0.103 percentage points, with a two-period lag. In the electrical equipment industry, one percent increase in the turnover of foreign firms, increases the TFP of small domestic firms in downstream industries in 0.222 percentage points, with a two-period lag. In the other transport industry, one percent increase in the turnover of foreign firms, increases the TFP of small domestic firms in the same industry in 0.0713 percentage points, with a two-period lag; of small domestic firms in upstream industries in 0.0617 percentage points, with one-period lag; and of small domestic firms in the same industry in 0.0557 percentage points, with one-period lag. Finally, in the industry of computer and electronics, one percent increase in the turnover of foreign firms increases the TFP of small domestic firms in upstream industries in 0.0227 percentage points, with a two-period lag.

These results suggest that the Portuguese *Investment Promotion Agency* (AICEP) should endeavour to promote FDI specially in scale intensive and science based industries. This could be achieved, in the case of horizontal externalities, by providing incentives for R&D cooperation and supporting private sector training programmes. On the other hand, the government can contribute to the occurrence of vertical externalities from FDI by supporting partnerships with foreign firms. This can be attained by several ways: providing linkage information in seminars, exhibitions and missions; sponsoring fairs and conferences; organising meetings and visits to plants; promoting supplier associations; and providing advice on subcontracting deals.

Our results, compared with previous econometric studies analysing the consequences of FDI in Portugal, show that FDI has a wider range of consequences than previously assumed. It has been shown in this study that industries are affected by FDI in different ways. None of the previous studies has analysed all the consequences investigated in this study. First, our study is based on more recent and previously unexplored datasets and we use a large panel of manufacturing firms which allows us to control for firm fixed effects and year effects, ruling out main concerns related to endogeneity. Second, we are one of the few authors that investigate the existence of both horizontal and vertical externalities from FDI in Portugal. Third, we use lags of the measures of foreign presence in order to account for the time lapse required for externalities to materialize. Fourth, we break down the results across industries along their trajectories of technological change which allow us to uncover some interesting patterns. Indeed, the technological groups more positively affected by foreign presence are scale intensive and science based industries. Thus, an important contribution has been made by providing a more complete picture of the effects of FDI in Portugal. By and large, the fact that externalities from FDI are unevenly distributed across and within industries and take one year to occur, makes possible to understand the conflicting results of previous studies for Portugal. Therefore, our analysis provides enough reasons for further research, and we anticipate that it will encourage empirical work in this direction.

Chapter 4

FDI in the Portuguese manufacturing sector:

Policy recommendations to boost productivity and growth

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ABSTRACT

From 1950 until the end of the 1990s, Portugal could benefit from backwardness advantages and managed to converge vis-à-vis with the EU average. In particular, the dynamic effects of foreign direct investment (FDI) operated a structural shift in exports, towards technology-intensive activities. However, since the year 2000, several factors, largely triggered by the global financial crisis, led to a drop in industrial production accompanied by a reduction in FDI attraction. The main objective of this chapter is to assess whether FDI inflows, during the last 30 years of European integration, have contributed to increase aggregate productivity and growth. We analyse the relationship between the FDI inward flows and a set of innovation and absorptive capacity indicators to assess the efficacy of FDI policies to promote innovation and its coordination with measures aiming to promote the absorptive capacity. Since technological linkages stemming from manufacturing industries are the main vehicles of technological change, we perform a *cœteris paribus* analysis of the transitional dynamics under the real convergence process, in which the mechanism of technological catching-up allows to relate FDI with the manufacturing productivity. Finally we make some recommendations on the design and implementation of policies in order to boost productivity. Evidence from the manufacturing sector suggests that positive externalities are restricted to certain industries. Moreover, the indicators of technological change show that the gap between Portugal and the EU-28 average is far from being closed. Rather than being an automatic process triggered by foreign presence, we suggest that productivity convergence based on FDI can be assisted by a reinforcement of supply-side measures, with an integrated industrial policy, focusing on sectors where there is evidence of positive externalities from FDI. Thus, structural change in the Portuguese productive sector requires the coordination between industrial policy and the instruments of Investment Promotion policy in priority industries.

Keywords: Industrial Policy, FDI, Productivity, Convergence, Portugal

JEL Classification: F15, O1, O3, O4

1. INTRODUCTION

After World War II, the Portuguese economy started a process of industrialization, first based on an import substitution policy, which was followed in the 1960s by export promotion policies along with an increasing openness to international trade. Industrialization supported by public and private investments accelerated convergence to the technological frontier.

In the 1960-1990 period, the second most important source of growth was the 'catching-up effect' (1.4%), followed by investment in physical capital (2.1%) [Pessoa, 1998]. Indeed, the increasing openness of the economy contributed to an increase in the productivity of manufacturing industries through access to up-to-date technology, disembodied technology and non-technological innovation, alongside with the movement of workers from agriculture to manufacturing industries.

In this process of structural change in terms of production, employment and demand, many low-productivity activities were reduced or disappeared. In turn, the economies of scale, provided by output growth, encouraged technical progress. This effect, combined with an export-promotion policy allowed an average rate of growth of real GDP per capita of 4.31% over the period 1961-1989, the third highest recorded in OECD, after South Korea and Japan. However, its evolution was not constant over time. The economy grew more intensely in the 1960s (5.65%) than in the following decades (4.40% and 3.01%, respectively). In fact, as the country approached the technological frontier, because of economic integration in EFTA and the EEC, the relative contribution of the catching-up effect was diminishing. On average, the contribution of the TFP to the growth rate of GDP declined from 1.7% to 1.2% from the 1960's to the 1980's, dropped sharply to 0.2% in the 1990's; and turned negative after 2000 (-1.2% for the first 10 years and -1% afterwards until 2015). In the 1990's real GDP per capita grew on average at a lower rate of 3.19% (reporting a negative growth rate of -0.81 in 1993), and, after 2000, the scenario completely changed with average annual growth rates of 0.60% in 2000-2009 and -0.22% in 2010-2016.

Simultaneously, China's entry into the World Trade Organisation in 2001, the increased foreign competition arising from the EU enlargements and the international financial crisis, slowed the pace of annual growth of real GDP per capita to 0.71% in the first ten years of the new millennium. Thus, the European integration of Portugal was marked by a gradual erosion of competitiveness of the economy and a worsening of the external accounts, due to several factors, namely, the successive increase in the labour cost; the resurgence of competition in the international markets; the expansion of domestic demand and a financing structure that favoured the public sector over the private sector; the high imported components and the low technological content of exports. Indeed, in 2001-2016, high tech exports accounted, on average, for only 5% of total exports.

Being a moderately innovative economy (Innovation Union Scoreboard, 2011), without the location advantages of the CEECs, the potential of convergence of the Portuguese economy, since 2005, was largely threatened by an average growth rate of Total Factor Productivity (TFP) of only 0.28% in 2005-2010. Indeed, in 2005-2014, GDP slumped into an average negative growth rate (-0.3%), with TFP accounting for -1.1% of this decline.

Notwithstanding, historically the role of manufacturing labour productivity has been important. In 1986-2016, the productivity per worker is on average twice of that of services and three times higher than that in agriculture. In addition, in the last 30 years, Portugal has quadrupled the share of resource allocation to R&D activities, from 0.4% of GDP in 1986 to a maximum of 1.6%, in 2009. However, the effects of technological improvements on growth have not been translated into real convergence (measured by real GDP per capita) of Portugal towards the EU-28 level (Mateus, 2015). The difficulties in the convergence process were evident in the evolution of net revenues from Community Structural Funds (CSF), which increased from 1% of GDP in 2007 to over 2% in 2013, while the average net revenues in the four "cohesion countries" remained around 0.5% of GDP.

It has been argued that the cause for non-convergence was the investment and the allocation of resources (labour) towards non-tradable services to the detriment of the manufacturing sector where the innovation indices are higher; as well as the implementation of structural reforms (OECD, 2013). The attempts to increase competitiveness based on wage flexibility instead of investment in new products and production processes contributed to revoke the potential positive effects from the R&D efforts. In addition, being a small open economy located on the European periphery, Portugal is vulnerable to external factors that undermine economic growth.

Historically, FDI has contributed significantly to economic growth, by strengthening the export capacity of domestic manufacturing firms. The share of foreign firms in Portuguese exports represented on average nearly 33% of total exports of the manufacturing sector in 1986-2016. However, the financial crisis caused a drop, not only in FDI flows but also in manufacturing output and employment in Europe, due to several external factors, and the Government incentives for innovation activities have been narrowed in most cases.

Following the above summing-up about the main features of the Portuguese growth process under Euroepan integration, FDI inward flows seem to play an important role. Our main goal is to evaluate, under a policy perspective, whether FDI inward flows during the last 30 years of European integration have contributed to convergence through increased productivity in the Portuguese manufacturing sector. Accordingly, we analyse several innovation and absorptive capacity indicators, in order to evaluate the efficacy of FDI policies in promoting innovation and increasing the absorptive capacity.

In this framework, the European Commission (EC) plays an important role regarding the Government incentive system for innovation activities in Europe, with a view to improve the competitiveness of firms. The National Innovation System is the flow of technology and information among actors (people and institutions) that shape a Country’s innovative process. The linkages (i.e., the set of relationships between agents) can take the form of joint research, personnel exchanges, cross patenting, and purchase of equipment. Understanding these systems can assist policymakers developing approaches for enhancing innovative performance in the knowledge-based economies (OECD, 1997).

Furthermore, the EC considers the manufacturing sector as a driver of economic recovery since it potentially generates high rates of innovation and drags capabilities to other sectors of the economy. In this context, industrial policy plays an important role by contributing to the achievement of higher levels of competitiveness through the increase of manufacturing productivity.

Hence, the purpose of this chapter is to evaluate from a policy perspective, the impact of FDI inward flows on the TFP of the Portuguese manufacturing sector, through the encouragement of innovation and the increase of absorptive capacity; and thus, on the process of convergence vis-à-vis the EU-28 average.

The presence of the MNCs can provide, for example, technical support to local suppliers in order to improve the quality of inputs or to assist their suppliers in the introduction of innovations and new management techniques, among others (Lall, 1980). In other words, FDI can improve the innovative and the absorptive capacity of domestic manufacturing firms and, thus, it is a vehicle of technological change. Bearing this in mind, we analyse the evolution of FDI and several indicators related to the innovative capability and the absorptive capacity; and we perform an analysis of the performance of the Portuguese economy regarding the achievement of goals to reduce the gap (technological plan) and to increase the innovative capability and the absorptive capacity (Europe 2020 strategy). The objective of this exercise is to provide some policy recommendations to boost productivity and prompt economic growth.

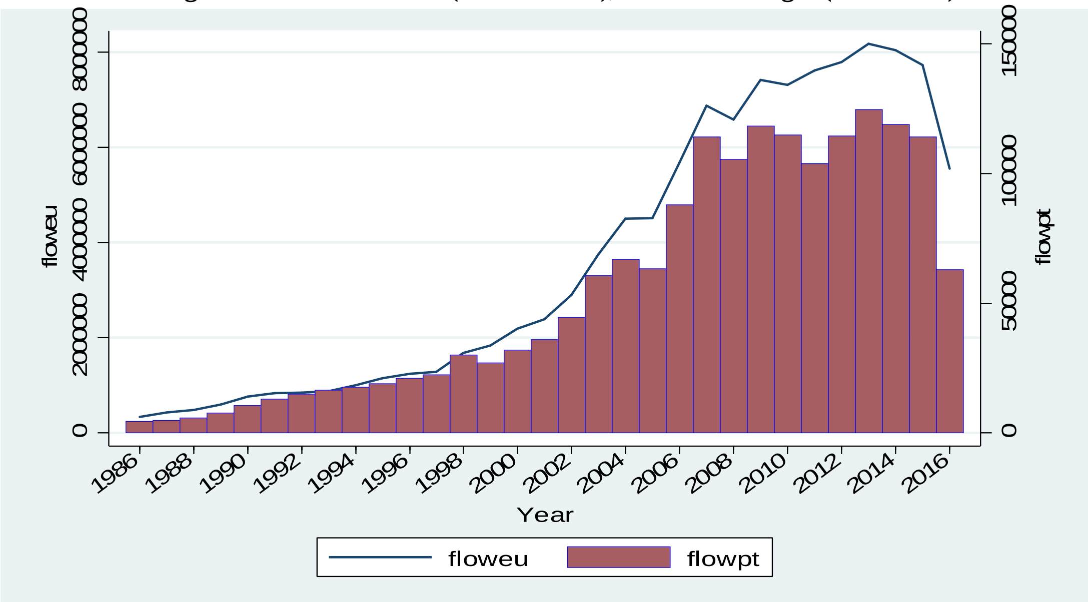
The chapter is organized as follows. Section 2 analyses trends in FDI flows and the European framework of Policies and instruments in the light of strategies for Industrial Policy and FDI promotion; Section 3 describes the legal framework and the Public Investment Policy related to FDI in Portugal; Section 4 analyses the evolution of FDI inward flows in Portugal and the Manufacturing performance, as well as a set of indicators of technological change in order to assess the efficacy of FDI policies to promote innovation and its coordination with measures aiming to promote the absorptive capacity; In Section 5 we make some recommendations on the design and implementation of FDI policies in the Industrial context; finally, Section 6 concludes.

2. EUROPEAN FRAMEWORK OF FDI POLICIES

2.1. FDI FLOWS IN EUROPE

In 1986-2016 the evolution of FDI flows to Portugal and those targeting the EU countries followed a similar rising pattern, until 2008 (see Figure IV.1).

Figure IV.1- FDI inflows (USD Million), EU and Portugal (1986-2016)



Notes- floweu denotes FDI flows to European Union Countries and flowpt denotes the FDI flows to Portugal. Source: UNCTAD, FDI/MNE database.

The evolution registered in the EU countries since the beginning of 2008, clearly reflects the financial crisis. In 2016, due to weak global economic growth and a dreary increase in the world trade, FDI dynamics in Europe was characterized by a significant fall of inflows (29%). In this scenario, several countries including Portugal experienced strong volatility in their inflows. As a result, the EU has changed from a position of net investor in relation to the non-EU countries, in 2009-2012, to a net receptor, since 2013 (see Table IV.1).

Table IV.1- FDI flows and stocks (EUR billion), EU-28, (2009–2014)

	2009	2010	2011	2012	2013 (1)	2014 (1)
Outflows to extra-EU	329.7	303.4	470.1	317.4	581.4	96.1
Inflows from extra-EU	274.6	224.5	424.7	309.8	620.5	118.9
Extra-EU outward stocks	3,736.5	4,219.4	4,883.2	5,112.0	5,344.4	5,748.6
Extra-EU inward stocks	2,784.8	3,145.1	3,720.3	3,905.9	4,179.7	4,582.5

Notes-(1) Based on international standards BPM6 and BD4. Source: Eurostat

Most of the decline in FDI flows in the EU is concentrated in the larger economies. France, Germany and the UK accounted for 50% of the decline while the share recorded by the 4 Cohesion Countries (Greece, Ireland, Portugal and Spain) was only 2%. The fall in FDI flows was motivated partially by the sale of Mergers and Acquisitions (M&As), especially in consumer products. In 2009-2014, for every euro invested in these products, about one and a half euros was sold. In the industries of paper and oil and gas, for every euro invested, 90% were divested (Gestrin, 2016).

Although FDI is sensitive to structural factors, the strong performance of the world-less-EU can be explained by the growing importance of emerging markets, especially China, whose share of FDI inflows increased from 14% to 22%. Comparing to total world, in the same period, the share of China increased from less than 10% to more than 18% and emerging economies are playing an increasingly large role as FDI partners.

However, according to Table IV.2, in 2011-2014, the top non-EU investors in the EU28 were the rest of European non-EU Countries (most likely due to geographical proximity) and the Central American Countries (especially Mexico, due to a solid economic performance and a pro-business climate, enhanced by political reforms and improved government stability) with 41% and 36% of total FDI inflows, respectively.[47]

[Insert Table IV.2 here]

Regarding the geographical distribution of FDI outflows, the top extra-EU receptors were Asian and South American countries with a share of 58.5% and 46.9% of total FDI outflows, respectively.

Table IV.3 shows that, while in 2014, the United States and Switzerland remained the main FDI partners in terms of stocks, the role of some emerging economies such as Brazil and China increased between 2011 and 2014.

[47] The list of European non.-EU Countries comprises: EFTA Countries (Switzerland, Norway, Iceland, Liechtenstein); Western European microstates (Andorra, Monaco, San Marino, Vatican City); Balkan Countries (Turkey, Serbia, Bosnia & Herzegovina, Former Yugoslav Republic of Macedonia, Albania, Kosovo, Montenegro); and Former Soviet Republics (Russia, Ukraine, Kazakhstan, Belarus, Moldova, and-although not technically European, considered as such politically- Azerbaijan, Georgia, and Armenia).

[Insert Table IV.3 here]

Concerning sectoral distribution of Extra EU-28 FDI stocks, Table IV.4 shows that services (especially financial and insurance activities) contributed with shares of 57% for outward stocks and 87% for inward stocks followed by the manufacturing sector, with shares of 28% for the former and 9% for the later.

Table IV.4- Extra EU-28 FDI stocks (EUR billion), by economic activity, EU-28 (end 2013)

	Outward	**Inward**
Total	5,344.4	4,179.7
Agriculture, hunting and fishing	2.8	2.0
Mining and quarrying	579.3	34.4
Manufacturing	1,495.2	394.4
Food products, beverages and tobacco products	237.3	92.4
Textiles and wood activities	50.7	9.7
Petroleum, chemical, pharmaceutical products	570.7	165.5
Metal and machinery products	394.1	58.5
Vehicles and other transport equipment	115.4	31.9
Electricity, gas, steam and air conditioning	58.9	11.3
Water supply; sewerage, waste management	4.3	3.1
Construction	43.3	14.3
Services	3,064.9	3,655.1
Trade; repairs of motor vehicles and motorcycles	239.0	154.2
Transportation and storage	54.6	28.7
Accommodation and food service activities	21.1	11.2
Information and communication	377.9	121.8
Financial and insurance activities	1,835.2	3,014.8
Real estate activities	36.2	55.5
Professional, scientific and technical activities	370.9	220.9
Other services (NACE Rev. 2 Sections N to U)	4.3	3.1
Other, including activities not allocated	95.7	65.1

Source: Eurostat

Within the manufacturing sector, the main activities regarding FDI outward stocks were Petroleum, chemicals and pharmaceutical products (38%) and metal and machinery products (26%). Regarding FDI inward stocks, the most important industries were Petroleum, chemicals and pharmaceutical products (42%) and, to a lesser extent, food, beverages and tobacco products (23%).

Since the EC acknowledges FDI as an important source of productivity gains (EC, 2010a), it designs and implements FDI promoting policies. The next section analyses the European International Investment Policy in the context of Industrial Policy.

2.2. EUROPEAN POLICIES AND INSTRUMENTS

FDI flows not only facilitate technology transfer and contribute to domestic firms' export performance but are also a crucial element to the consolidation of the Single Market.

Accordingly, incentives are often offered as a "package", a representative list of individual tax incentives that are being offered by some jurisdictions include: reduction of corporation tax (in the form of reduced rates or tax breaks), incentives for capital formation, through grants or investment tax credits. Tax incentives tend to be tied to specific activities that seem appropriate to encourage. Other incentives include credits on favourable terms or subsidies; land or buildings below market value; and participation in start-up costs, marketing and development costs or in operating costs.

In terms of attracting FDI, priority industries are divided into three groups: heavy industry, which relies on domestic sources of raw materials (iron, copper, lead and zinc); traditional industries such as textiles to develop international competitiveness; and industries where Portugal already has a comparative advantage (e.g., electric equipment, electronics and telecommunications equipment). Our results of chapter 3 support this course of action. Indeed, in heavy industry we find significant positive horizontal externalities (0.00000793) in the current period and we also find significant positive externalities via backward and forward linkages (0.000987 and 0.00107), with one-period lag. As far as the traditional industries are concerned, we find significant positive horizontal externalities (0.0557, 0.000789 and 0.000540) with one-period lag in other transport equipment, rubber and plastics and food industries. We also find positive and significant externalities, with a two-period lag (0.0713, 0.00264 and 0.000686) in other transport equipment, wearing apparel and food industries. In the current period, we find significant positive externalities via backward linkages (0.334 and 0.00824) in beverages and wood industries; and positive externalities (0.0617 and 0.0198) in other transport equipment, with lagged periods. In addition, we find significant positive externalities via forward linkages in the current period (0.249 and 0.00871) in beverages and other transport equipment industries; and also in beverages industries (0.103), with a two-period lag. In the industries where portugal has a comparative advantage, with a two-period lag, we find significant positive externalities (0.0227 and 0.222) from backward and forward linkages, respectively, in computer and electronics and in electrical equipment industries.

However, the fast rise of new global players as well as the Lisbon Treaty provisions is constraining the freedom of Member States (MS) in pursuing autonomous FDI policies. At the same time, the shift of investment policy from national to European level, as of December 2009, raises several challenges. Indeed, the process of designing and implementing an international investment regime has been arduous and the complex system of Treaties and Agreements is becoming less manageable.

The fact that manufacturing is organized along highly fragmented value chains, spread all over the world but concentrated in certain particularly attractive hubs, implies that industrial policies affect FDI (Lichtblau, et. al. 2013) and calls for the right policy mix that encompasses the right set of policies considering the country's environment and MNCs developmental strategies.

Industrial Policy

In 1957, the framework for sectoral policies was settled by the European Economic Community Treaty and the European Atomic Energy Community; while the industrial policy was left to the Member States. It was only in the 1970s that the principles of industrial policy were first described in the Colonna Report and, 22 years later, the Maastricht Treaty provided the first instruments of the EU's industrial policy.[48, 49]

The industrial policy focus on competitiveness was implicit and partially included in the Competition Policy and was coordinated with other policies (e.g. Regional Policy, Trade Policy and Science and Technology policies).[50]

However, the low productivity and stagnation of economic growth in the EU led to a ten-year period action and development plan adopted by the European Council in

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[48] EC (1970) Industrial Policy of the European Community (Colonna Memoradum).

[49] To increase the efficiency and the competitivity of the system, to encourage the essential process of restructuring industry and, regarding industrial jobs, to guarantee a sufficient number of' jobs as highly-paid as possible.

[50] In the sense of competition at product level, where the decisive factor was the price. However there are other forms of competition such as competition at the level of production factors, competition by innovation, and competition between firms.

march 2000, aiming to make Europe "the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion". The so-called ‘Lisbon Strategy’ relied heavily on innovation as the engine of economic change; the "learning economy" and the social and environmental renewal.

At the same time, the EU's inability to close the productivity gap with the United States and the increasing competition from the emerging economies led to a renewed interest in Industrial Policy. The EU enlargements compelled European authorities to deal with the ongoing structural change and to perform a reassessment of the industrial policy to turn it more explicit. As a result, in 2005 the European Commission (EC) published a Communication on industrial policy (EC, 2005) which indicates not only horizontal measures (addressed to all industries) but also the need to strengthen industry in Europe. The EC emphasized the fact that the manufacturing sector records 20% of output, employs 34 million people, accounts for more than 80% of private spending on R&D and ensures 75% of exports.

In the same course of action, in March 2010, the EU adopted a new economic strategy (Europe 2020) which replaced the Lisbon Strategy. This strategy integrates flag-initiatives, one of which refers to industry. The new Industrial approach consists of: (1) performing a better balance between horizontal and sectoral policies; (2) considering the entire value chain; (3) developing the monitoring of the industrial policy and competitiveness of MS by the EC. In this framework, the conditions for industrial development (better regulation, access to credit) and the strengthening of the internal market (intellectual property rights, Competition Policy, infrastructure and standards) are considered essential.

Industrial Policy in the EU is concentrated in six areas: advanced manufacturing and processing; nanotechnology, advanced materials and industrial biotechnology; micro-and nano-electronics; biotechnology and photonics; resource efficiency and raw materials; and Green Vehicles (EC, 2012a).

Hitherto, industrial dynamics in the EU have been determined by market pressures (with up to 500 million consumers in 2016) and by exposure to globalization, given the absence of barriers to FDI. Thus, it has focused on the determinants of competitiveness and developed a 'horizontal’ emphasis on research and innovation throughout industry.

One of main tasks of Industrial Policy is to provide support for the protection of intellectual property rights (IPR). While IPRs can influence innovation; the absence of such tool can have a detrimental effect on the economy and on its capacity to attract manufacturing activities and FDI (Dhéret et al., 2014). Hence, our primary question is then: is the EU's industrial policy and, FDI, helping to foster economic growth in catching-up members like Portugal?

The international financial crisis in 2008 brought about a 10% reduction in production and employment in European manufacturing sector and caused a drop on investment from 21.25% of GDP in 2007 to 18.6 percent in 2011. This underperformance created the need to measure consistently the competitiveness of high-income regions and poorer regions and called for a change of the concept of competitiveness, from a cost basis to productivity (Aiginger et al, 2013). The new concept allows for the evaluation of policy actions aimed at improving competitiveness vis-à-vis increased international competition and the rigidity of public budgets. These changes were accompanied by new strategies such as the resumption of the focus of industrial policy where the guidelines for the future go through a merger with innovation policy to support research and education (Aiginger, 2012). Indeed, in the framework of Europe 2020, which implies the re-industrialization aiming to create employment and achieve sustainable growth, the European Council adopted in 2010 an 'integrated industrial policy for the globalization era' (EC, 2010b). Focused on investment and innovation, this strategy mobilizes the single market and various policies (e.g. Competition Policy, Trade Policy, Research Policy, etc.). In this background, R&D and innovation are regarded as the main sources of economic growth and productivity in the medium-term, given that innovation facilitates structural changes towards economic activities with high value added (EC, 2012b). In fact, in 2005-2011, the average growth of output in high-tech industries was 3.3% in the EU-27; while the output of medium-high technology industries fell in Greece, Spain, France, Italy, Portugal, Sweden and the UK; and, on average, the output, in low and medium-low technology industries, decreased.

Thus, the EU's Innovation Policy is designed to support and enhance competitiveness through measures aimed at removing obstacles to innovation and shift the paradigm regarding the collaboration between the public and private sectors, including through partnerships between European institutions, National and Regional

Authorities and firms. In this context, clusters play a central role as a meeting site for firms and Research Institutions (EC, 2012a, b; OECD, 2012).

FDI is considered the main vehicle of technology transfer by many international institutions, politicians and scholars, since it represents the largest source of innovation, technology transfer and diffusion in the world economy (Iammarino and McCann, 2013) and the main instruments to promote the attraction of FDI are the structural funds.

Instruments

The presence (and magnitude) of externalities from FDI is crucial if FDI incentives should be economically justified, i.e., in order that benefits for the economy outweigh the costs of the incentives. However, evaluating the efficiency and effectiveness of FDI policies requires the design of policies that consider the attraction of FDI and the budgetary consequences in the host economy (OECD, 2003; Echandi et al., 2015).

The competent authorities must establish the objectives that FDI incentives are designed to achieve and evaluate the adequacy and effectiveness of FDI policies, since not all types of FDI incentives are suitable for the pursuit of the different categories of FDI attraction strategies. However, FDI incentives in many countries seem to overly rely on tax incentives.

The political practice to provide up-front incentives is often seen by investors as essential to offset the initial investment period or as an important signalling device through which the authorities make it clear that they commit to a long-term relationship.

According to OECD (2003), FDI incentives have a discriminatory nature and are defined as: "measures to influence the size, location or industry of a FDI project, by impacting its relative cost or changing the risks related to it, through incentives that are not available for domestic investors” (*op. cit., p.12*). They are comprised by two types of measures: rules-based approaches that depend on discrimination (according to nationality) of investors; and specific approaches that are incentives for individual foreign investors or investment size.

Rules-based approaches, in many cases represent a relatively simple selective application of investment subsidies. Specific approaches, on the other hand, produce a variety of different incentives, including exemptions, specially negotiated tax, subsidies and loans, free land, job training, employment subsidies and infrastructure, improvement of products, support for R&D activities and specific regulations and exceptions.

However, in practice, the dividing line between the two categories is often blurry. The authorities often offer incentives that are available to any firm not previously located in the host economy. In addition, specific approaches are sometimes applied to firms already located in the host economy, to encourage the expansion and to dissuade to ward off.

Incentive schemes are operated by national or regional jurisdictions and the purpose differs greatly between receptor sites, according to their economic development.

The authorities can develop two strategies: proactive policies to attract foreign investors in general. For example, making the relocation easier and less expensive, or covering the initial loss-making period of an investment.

Most FDI-attraction strategies through incentives are limited in scope, because they focus on specific aspects of the host economy: regionally oriented, usually economic depressed areas or in response to the closure of a factory; develop prioritized activities such as export processing zones; based on advantages to attract labour-intensive industries to countries abundant in labour; cultivating the selected sectors, for example in high technology industries.

FDI incentives can be financial or tax incentives. Financial incentives are usually motivated by the desire to develop a poor region and often include infrastructure grants and subsidies to training (particularly in activities that are new and investors face gap of labour skills). The most common incentives are tax incentives, although in the case of EU countries it takes the form of rules-based approaches, as changes in taxation in most cases require legislative action.

What distinguishes the European tax incentive system from the United States and some Asian countries, are the relatively few tax incentives available, since the EC considers that a "tax state aid" is harmful, and therefore prohibits it in most cases.

Moreover, the EC establishes a "maximum aid intensity" to the level of incentives that may be granted in the Member States (MS). Ceilings vary according to firm and project size and are based on average GDP for each region.

Although FDI incentives are designed to support convergence among European regions, MS do not share a mutual practice to combine the objectives of promoting FDI by Investment Promotion Agencies (IPA) with the economic policy.

Furthermore, the fact that value chains and local clusters are becoming important determinants of location for FDI projects has conditioned the action of IPAs in identifying unique business opportunities for target companies.

Despite of the EC restrictions, if they do not exceed the limits, countries are free to interpret the rules according to their self-interests. As a result, different countries and regions have their own programs, reflecting their own priorities for economic development.

Some of the incentive programs are based on the performance requirements (PRs) based on job creation and the amount of investment. There are two main categories of PRs: one category is associated with the capital structure and management of an investment, such as requirements regarding technology transfer, local equity, employment and the repatriation of funds and profits; the other focuses on trade and local production and includes requirements on local content, export performance, foreign exchange restrictions and regulations on imports and exports.

The most recurrent PRs are requirements on exports, local content and technology transfers. One important reason for imposing technology transfer requirements on foreign firms would be to induce them to transfer knowledge to local firms. However, the explicit requirements for technology transfer are relatively rare and some empirical evidence shows that the objectives may fail. For example, Blomström et al. (2000) showed that these technology transfers were negatively related to performance requirements in the case of United States affiliated technology imports to 33 host countries. Also, Urata and Kawai (2000) concluded that Japanese FDI in Asia provided less intra-firm technology transfers in the host countries that apply the technology transfer requirements as a condition for their establishment. As a result, there has been a low incidence of performance requirements in developed countries, but in some respects, the measures aim to achieve similar goals (e.g. anti-dumping, voluntary export restraints, strategic location incentives and rules of origin).

The current programming period (2014-2020) regarding the incentive system introduced several changes when compared to the previous one (2007- 2013). The summary of the main differences is presented in Table IV.5.

[Insert Table IV.5 here]

The most prominent changes occurred in objectives, which are now: investment for growth and employment and employment and territorial cooperation; new categories of regions: less developed, in transition and more developed regions; the eligible expenditure now varies between 85% and 60%, with less developed regions getting the maximum rate of funding; and the existence of *ex-ante* conditionalities.

Although a coherent sectoral strategy for state aid throughout Europe would be very promising, authorities should assess: 1) the convenience and opportunity of offering FDI incentives, 2) the structures for the design and implementation of policies; 3) The appropriateness of strategies and policy instruments; 4) the design and management of individual programs; 5) the transparency of procedures (evaluation, monitoring and follow-up); and 6) evaluation of extra-jurisdictional consequences of FDI incentive strategies [OED, 2003]. Dealing with coordination problems within the EU and high competition to attract valuable FDI, requires political fine tuning. Policies need to be tailor-made, adjusted to specific investors' requirements, and yet difficult to replicate elsewhere (Götz, 2006).

Investment protection and liberalisation are key components of a common international investment policy to be led by the European Commission. However, there is still scope for MS to follow complementing FDI policies.

The negotiation of incentives requires special skills and experience in the application of specific instruments. For example, FDI incentives may contain "claw-back" provisions to discourage investors from opting out, including the formal recovery and return procedures, however, these contractual commitments can be difficult to track unless they are carefully designed. Investors can, in most cases, allude to 'market conditions' before fulfilling their obligations under any incentive agreement. In addition, investors expect the authorities to speed decision-making beyond normal bureaucratic rules. Thus, the design of FDI incentives needs to be carefully considered, not only in terms of creating macroeconomic or sectoral subsidies but with an eye to concrete benefits for individual investors. For example, it is necessary to consider the tax laws of the country of origin and the agreements governing the taxation between the two countries, otherwise the incentives can be of little relevance or interest to investors. Given the Global Added Value chains, the rules on state aid need to adopt a sectoral and multisector approach rather than supporting a firm. While being evenly distributed within the sector, state aid may induce innovation and productivity growth as it encourages all firms operating in the same sector.

Considering the drawbacks of the European incentives-system described, we will now analyse the Portuguese FDI-attracting policies to ascertain their efficacy in increasing manufacturing TFP and foster convergence with the EU average.

3. FDI POLICIES IN PORTUGAL IN THE LAST THIRTY YEARS OF EUROPEAN INTEGRATION

The economic benefits from attracting FDI are generally positive externalities to the host economy. The channels through which externalities operate are 1) technology transfer and know-how; 2) firm development and restructuring (in relation with privatizations); 3) integration in international trade; 4) enhanced competition; and 5) support for training human capital in the host country (Mercinger, 2003). In developed countries, the first two channels are generally considered the most important ones (OECD, 2002). Policies to attract foreign investors include low tax corporate rates, reducing bureaucracy, preferential tariff arrangements, stepped-up investment in infrastructure and education measures. Many of the tariff arrangements, infrastructure and education measures have been directed to priority economic sectors and regions (in connection with “special economic zones”, “export processing zones”, etc.). Other measures were aimed at the general strengthening of social capital through subsidies to the final investment. But these strategies cannot be classified as FDI incentives because they encourage private Investment in general, whereas FDI incentives target or give preferential treatment to foreign investors.

Legal Framework

Portugal's accession to the EC was the engine of change in existent foreign investment legislation from 24 August 1977. Indeed, the new legal mechanism was necessary to liberalize the transfer of private capital (in the form of FDI) from the EC countries and non-EU countries. Under the new regime, enshrined in the diplomas of July and August 1986, all economic sectors are open to private investment, regardless of their origin.

The 1977 system, which followed the lengthy procedures, was replaced by a prior notification system based on the following characteristics. Before starting operations, the foreign investor should send the investment proposal to the competent national authority; within two months, the authority informs the applicant of its decision; failure to notify the applicant within that period gives the right to start operations immediately. This system was intended to create new jobs, attract foreign currency to reduce the Portuguese external indebtedness and to strengthen the regional development programs.

These objectives were reinforced with entry into force in 1995, of the Foreign Investment Code, under which non-resident firms can create and exercise any economic activity allowed to private sector.[51] It also ensured non-discrimination between domestic and foreign investors. Investors could request state aid for an investment project under a general incentive scheme or under a special contractual regime of foreign investment, in case of involving a certain amount of capital expenditures.

The Decree No. 2/96 of 16 May 1996, as amended by Decree No. 4/00 of 24 March 2000 establishes the procedures for submitting such a request; and Ordinance No. 865-A/ 2002 has established the minimum amount of capital associated with the eligible investment: EUR 25 million.

Investment projects under this scheme could benefit from financial incentives under operational programs and special tax incentives (in accordance with the Tax Benefits -Article 49a and Decree-Law No. 409/99 of 15 October 1999).

Law No. 44/2014, of 11 July, authorized the government to amend the Tax Benefits Statute and to adopt a new Tax Code of the investment that has adapted the European legislative framework for state aid for 2014-2020. This code aims to strengthen the tax-exempt investment schemes, about investments that aim to create or maintain jobs and which are in less-favoured regions. About the contractual tax benefits, the limit of corporate tax credit is extended as well as the credit increases for investments in regions with a per capita purchasing power significantly below the national average, which provide the creation or maintenance of employment or contribute to technological innovation or environmental protection.

In November 2014, the Council of Ministers reviewed the contractual arrangements for investment, special procurement system (RCI) incentives applicable to large classifiable investment projects within the jurisdiction of the Portuguese Agency for Investment and Foreign Trade (henceforth AICEP). The RCI allows a special negotiation treatment for these projects and the contracting of a set of incentives. The nature, amount and conditions of the incentives - financial incentives, tax benefits and specific compensatory measures to mitigate the costs - are determined considering the economic

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[51] Decree-Law No. 321/95 of 28 November 1995

impacts of the project, as well as the fulfilment of obligations by the sponsor and the contractually fixed economic targets, through a process led by AICEP mandated by the Government.

Public Investment Policy

According to Law 82-A/2014 which approved the major plan options for 2015, Portugal has implemented a program of structural reforms, aimed to reinforce the dynamism and flexibility of the economy, creating international competitive benefits and the sustainability of the public sector.

To attract foreign investment, the areas of public intervention are based on the transparency of public finances, the flexibility of labour market, the speed of court proceedings and liberalization in product markets. In addition, measures have been taken to simplify administrative requirements, to restructure operations and to promote business and to strengthen the management and rationalization skills of bank funds directed to small and medium enterprises (SMEs).

In October 2014, the EC approved the establishment of the Financial Development Institute which, as its counterparts in other European countries, channels the structural funds. This institution focus on three areas of intervention with the purpose of promoting economic growth and employment, supporting competitiveness and international presence; and contributing to sustainable development. In the field of innovation, measures were implemented to stimulate business innovation, strengthen the cooperation between firms and scientific and technological organizations and promote the inclusion of doctorates and masters in firms through financial incentives to SMEs. Aimed at creating a favourable environment for entrepreneurship, it was created the new special visa regime for knowledge intensive start-ups based in Portugal. Moreover, the incentives to promote business angels and venture capital have been strengthened, with financial support mechanisms and corporate tax incentives for start-ups.

The Industrial Development Strategy for Growth and Employment and The Competitiveness Agenda for Trade, Services and Restaurants 2014-2020 were designed to jointly cover all sectors, create employment and growth opportunities. In this context, fiscal policy is a key instrument in supporting investment, promoting sustainable growth, creating employment and strengthening the capital structure of firms.

In 2014, with the aim of turning competitive the country's tax system, the government reformed the corporate Tax (IRC), which included a reduction of tax rates, and approved the new Investment Tax Code. To fight fraud and tax evasion, it was designed the Cash Value Added Tax system that allows the adjustment of loans overdue in more than 24 months from the date of maturity without prior judicial decision. Attention was also paid to the conventions to avoid double taxation, with other European countries, and the negotiations take place with about 40 countries.

With the objective of creating a more favourable environment for investment, the government adopted a consolidation and revitalization of the business strategy based on: the simplification of administrative requirements for restructuring operations; development of business promotion actions; creation of business opportunity grants; mergers encouragement; enhance business management skills; and banking capitalization funds for SMEs.[52] At the same time, the creation of a multi-annual training program for new exporters led to the signing of international protocols for the release of intermediated credit lines and guarantees for the financing needed to support the internationalization of SMEs. In the context of this chapter, it is assumed that the policies and instruments described have been, to some extent, successful in attracting FDI and, indirectly, increase the TFP of domestic manufacturing firms.[53] Furthermore, international empirical studies provide evidence that FDI can improve the innovative capacity of the domestic firms. Though, the magnitude of the effect of FDI on innovation capacity may depend on the absorptive capacity of domestic firms (Fu, 2008). In the next section, we perform a benchmarking analysis on the relationship between FDI inflows and a set of innovative capability and absorptive capacity indicators, in order to assess the efficacy of FDI policies to promote innovation and its coordination with measures aiming to promote the absorptive capacity.

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[52] Government provided funds aimed at the fulfillment of capital ratios by banks at a certain level of interest rate and with the guarantee that banks will lend at least part of these funds to SMEs.

[53] Tavares-Lehman (2007) remarks that, although in recent years, Portuguese policy rearding FDI has evolved towards a more proactive and selective stance, the institutional agenda is not prone to maximize the potential benefits of existing investments and macro policies lack consistency. Also, Vinhas de Souza (1996) tested the effects of the regulatory structure upon the amount of the FDI flows to Portugal but the coefficients were not significant and the author could not find a clear sign of granger-causality between legal liberalization and tax policy and the size of the inflows, for 1985-1994. As a result, as Silva (1990) - notes, with the exception of some years in the 1980s, Portugal has never attracted a large amount of FDI flows. However, in chapter 3 we provide evidence of the positive impact of FDI on domestic manufacturing firms in Portugal.

4. FDI FLOWS TO MANUFACTURING,TECHNOLOGICAL CHANGE AND CONVERGENCE

For the follower economy, the process of catching-up with high-income economies consists in eliminating the productivity gap. Since the convergence process is partly driven by the convergence of TFP with the technological leader economy, identifying the drivers of productivity growth is crucial to understand the sources of the productivity gap.

FDI is believed to generate positive externalities in the form of knowledge spillovers to the domestic economy through, for instance, linkages with local suppliers and clients (backward and forward linkages), learning from nearby foreign firms and employee training programmes. In this context, the manufacturing sector, being a major producer of tradables, is the main engine of economic growth due to its higher productivity and innovation indices (Andreoni and Gregory, 2013). Furthermore, technological linkages stemming from manufacturing industries are main vehicles of technological change (Jones and Olken, 2005; Rodrik, 2007 and Su and Yao, 2016).

An increased foreign presence within an industry is correlated with the TFP growth of domestic firms through increased speed of technology transfer. Table IV.6 shows some quantitative results regarding the effect of FDI in the TFP of the manufacturing firms in the host economy.

For example, Keller and Yeaple (2009) estimate that, in 1987-1996, a 1% increase in the share of foreign-affiliates' employment in total employment, increases TFP of manufacturing plants in the U.S. by 1.1%.

For a panel of OECD Countries, including Portugal, Pessoa (2005) estimates that 1 % increase in FDI have an impact on the TFP of manufacturing firms of about 0.019% – 0.023% in 1985-2002. Using plant level panel data for the UK, Haskel et al. (2007) find that a 1% increase in the share of MNCs in total employment raised the TFP of that industry by 0.05% in 1973-1992.

Another study using panel data at firm-level (Fons-Rosen et al., 2013) analyses the impact of FDI in the TFP of manufacturing firms for a set of developed countries, including Portugal, and concludes that the impact is 0.007% in the 1999-2008 period.

Table IV.6- Impact of FDI on the TFP of manufacturing firms

FDI Measure		TFP increase (%)
Keller and Yeaple, 2009	Share of foreign-affiliates' employment	1.100
Pessoa, 2005*	Net annual inflows	0.019 -0.023
Haskel et al., 2007	Share of foreign-affiliates' employment	0.050
Fons Rosen et al., 2013*	Share of foreign capital of firms	0.008
Crespo et al., 2009[a]	Employment	129.96[b]
Crespo et al., 2012[a]	Employment	94.96[b]
Our results (chapter 3)	Turnover	0.629 / 0.306 [b]

Notes- *Cross-section studies, including Portugal; [a] Studies for Portugal using Labour Productivity as the dependent variable; [b] significant positive results via backward linkages at regional level. Source- Own elaboration

Crespo et al. (2009, 2012) have investigated the existence of vertical spillovers for Portugal using panel data at firm level from Dun & Bradstreet and Quadros do Pessoal, for 1996-2001. The authors investigate the impact of geographical proximity between MNCs and domestic firms on externalities from FDI. They find positive effects via backward linkages at regional level, in the presence of geographical proximity (see chapter 3, section 2).

Finally, our empirical results for 1995-2007, presented in chapter 3, are the following. At aggregate level, with one-period lag, we find significant positive externalities (0.0629 and 0.306) via backward and forward linkages, especially in scale intensive industries and science based industries. In other words, one percent increase in the turnover of foreign firms increases the TFP of domestic firms in upstream and downstream industries, respectively, in 0.0629 and 0.306 percentage points. The analysis by industries allow to uncover the patterns of these externalities. Indeed, with one-period lag, we find positive externalities from backward linkages in other transport equipment and basic metals; and positive externalities from forward linkages in metal products and non-metallic minerals. Thus, we conclude that scale intensive industries were responsible for the positive vertical externalities.

FDI is one of the main potential sources of externalities to Portugal (EC, 2016). For example, in the period 1985-1995 there was a stronger contribution of TFP to economic growth, in part associated with FDI inflows financed by EU Structural Funds

(Amador and Coimbra, 2007).[54] Indeed, after 1988 there was a burst in FDI flows which increased the capital stock of about 4.2%, adding about 0.31% to GDP growth, per year (Mateus, 2006). Freitas and Mamede (2008) found that the share of foreign firms in 2005 was higher than average for products with "High" and "Very High" income content (56% and 43%, respectively); while Gonçalves and Martins (2016), using panel data for Portuguese manufacturing firms, for 2010-2014, found that exports prompted the TFP growth. Hence, the sustained growth of the economy will depend largely on the ability of economic agents to diversify financing sources, including by attracting FDI (Júlio et al., 2013). Hence, we assume that FDI inflows may be a channel of technological catching-up, and perform an analysis of correlation between changes in FDI inward flows and in the manufacturing performance and in the aggregate productivity in order to provide a hint on the impact of FDI on the productivity and economic growth.[55]

Bearing this in mind, we start by analysing the evolution of FDI inflows and the manufacturing performance. Subsequently we analyse the evolution of a set of indicators related to the innovation system in the Portuguese economy. Finally we scrutinize the sources of the technological gap and the goals of the Technological Plan, which aim to narrow the gap.

Our analysis on the dynamics of Portuguese innovation systems draw from Schumpeterian literature on innovation and economic growth. The importance of innovation capability for the economic growth arise from the idea-based new growth models (Romer, 1990; Furman, Porter and Stern, 2002); whereas the role of absorptive capacity for imitation-based catching-up is highlighted in the technology-gap models (Abramovitz, 1986; Verspagen, 1991; Godinho et al., 2006; Fagerberg and Srholec, 2008). This exercise aims to gauge whether convergence is being triggered.

FDI inward flows

Portugal's accession to the EEC has indirectly contributed to the boost of inflows of foreign capital, which in 1986 accounted for 15% of GDP and 3.3% of total world FDI. Nevertheless, in 1986, FDI inflows represented only 4% of GDP (see Table IV.7) and 0.5% of global FDI; whereas in 2016 it represented only 1% of GDP.

[Insert Table IV.7 here]

[54] For a literature review on the topic see Chapter 1.

[55] Our analysis does not take into account technical transfer via FDI that occurs in Services sector.

After 2008, FDI flows have stabilized around 1% of GDP. However, in the period 2011-2015 FDI flows increased to 2% of GDP, due to privatizations carried out in the context of the Economic and Financial Assistance Programme (EFAP).

As for the evolution of FDI stocks, it confirms the increasingly importance of foreign subsidiaries in Portugal. In 2016, FDI stocks represented 28% of GDP, 3.5 times more than in 1986.

Table IV.8 shows FDI inflows by EU Country. In 1993, Portugal was in the ninth position. However, the Country dropped to 15th position in 2013, being surpassed by Poland, Czech Republic and Hungary.

[Insert Table IV.8 here]

Indeed, with the acceleration of globalization that started in the new millennium, FDI flows targeting the Portuguese manufacturing sector became more volatile (see Figure IV.2).

[Insert Figure IV.2 here]

Bearing this in mind, we analyse the joint evolution of FDI flows to the manufacturing sector and the factor contribution (%) to GVA increase in the manufacturing sector from 1986 to 2016, in search for a hint regarding the role of FDI to TFP increase in the manufacturing sector.

Foreign presence and Manufacturing performance

In what follows we analyse, on the one hand, the evolution of net FDI flows targeting the manufacturing sector in 1986-2016, and its performance regarding output, value added and productivity; and, on the other hand, the contribution of the subsidiaries in the manufacturing sector in Portugal, by technological groups, concerning high technology exports and growth accounting, in the same period.

Through the joint analysis of Figures IV.2 and IV.3 on the evolution of net FDI flows targeting the manufacturing sector and the performance of this sector, we can observe a tendency in which the peaks of 1994, 2004, 2006 and 2012 correspond to years in which the contribution of manufacturing to employment was higher than the contributions to output, value added and productivity (or equal to the contribution to GDP in the years of 1994 and 2012).

In the evolution of manufacturing sector from 1986 to 2016, we distinguish two phases. The first, from 1986 to 2004, is characterized by a decline in the share of output, TFP and GVA. After 2004, the 3 aggregates seem to have stabilized below 30%. In 2016, it is observed a small decline.

[Insert Figure IV.3 here]

In 1990 and 2013, the net flows to manufacturing were negative (i.e., foreign divestitures were higher than investments) yet we found that the contribution of manufacturing to the output was higher than the contribution to employment.

This evolution cannot be dissociated from further European integration, especially with the adhesion to the euro and the privatization process. The appreciation of the national currency (escudo) before the *adhesion* and the setting of an excessively high irrevocable conversion rate between the escudo and the euro had a strong punitive effect, in a context where Portugal could no longer offset the losses in competitiveness via the devaluation of its currency (Mateus, 2015). Moreover, privatization heightened the deindustrialisation, as shown, for example, with the liquidation of heavy metallomechanics. These difficulties, combined with a sharp drop in interest rates tended to guide investment to the so-called non-tradable goods, housing, public works and consumption (Marques and Lynce, 2011).

Through the analysis of Figures IV.2 to IV.4, we investigated the correlation between FDI flows targeting the manufacturing sector, and the manufacturing performance regarding output, employment, and labour productivity, as well as convergence (using the gap in labour productivity and the TFP vis-à-vis the EU-28 average), respectively. Regarding the manufacturing output, there is a positive but weak correlation in the current period. This correlation is negative but weak for the manufacturing output with one and two period lags.

Regarding employment, there is a positive but weak correlation in the current and lagged period, although the value of correlation is higher for employment with two-year lag. This may imply that it takes two years before the foreign projects begin to exert positive benefits regarding employment in the manufacturing sector.

Concerning labour productivity, there is a negative and strong correlation in the current period. This negative correlation is weak regarding labour productivity in lagged periods.

As for convergence of productivity with the EU-28 average, there is a positive but weak correlation with the gap of labour productivity. Because the gap is constructed as the ratio between labour productivity of EU28 countries and labour productivity in Portugal, a positive correlation implies that the larger the flows the larger the gap regarding labour productivity. Hence, in spite of FDI flows have a positive relation with employment in manufacturing, on the whole economy it appears that foreign firms contribute to deteriorate the labour productivity of domestic firms. One explanation is that may be the case that FDI causes a loss of market share to the domestic firms, via competition and these firms are forced to operate in an sub-optimum scale. As a result the labour productivity of domestic firms may decrease. However, there is a negative but weak correlation between FDI flows targeting the manufacturing sector and the gap of TFP (current period). In the same line of reasoning, because correlation is negative, it appears that FDI flows to manufacturing industries might help to close the gap regarding TFP.

The EU countries have been experiencing a relative under-performance regarding productivity, when compared to the US. It has been highlighted that the causes were the slower adoption of new technologies compared to the US (Jorgenson and Stiroh 2000; O'Mahony and Vecchi 2005; Venturini 2009), and the insufficient level of skills and organizational changes. Indeed, investments in these two later assets may affect countries' absorptive capacity, i.e. their ability to take advantage of the international diffusion of technology (Foster-McGregor et al., 2013). Since the bulk of technological innovations is concentrated in few countries, the economies that are far from the technological frontier need to improve the absorptive capacity of their industries as a mean to enhance productivity growth. The evolution of labour productivity in the Portuguese manufacturing sector, measured by GVA per hour worked shows that the Portuguese manufacturing sector follows the trend of the EU-28 average, especially since the financial crisis in 2008. Over the period, the values are near zero.

Table IV.9 shows the Growth Accounting analysis (GVA growth and contributions in volume). The contributions for GVA derive from labour (low, medium and high-skilled labour); capital (ICT and non-ICT) and the TFP.[56] The values for 1996-2005 are obtained from EUKlems database (version of 2009 for Portugal) and the values for the remaing years were obtained by multiple imputation in Stata 13.0. Examining Table IV.9 and Figure IV.2, we find that, in the years that recorded peaks of net flows, capital contributions to manufacturing GVA were positive and in 2004, where there is an absolute maximum in regarding net flows, the contribution of TFP was also positive (0.1).[57] It should be noted that in the cited years of maximum and minimum flows, the contribution of labour to the manufacturing GVA was negative.

[Insert Figure IV.4 and Table IV.9 here]

Concerning the closing of the technological gap in the last 30 years, in 1994, the TFP in Portugal was higher than that of the EU-28 average, but in the remaining years, when there was a maximum in net FDI flows, the TFP level was equal to the UE-28 average.

As for the labour productivity gap, it curiously narrowed both in 1990 and 2013 when net FDI flows were negative. This may imply that competition from foreign firms in the host economy caused a loss of domestic firms' market shares. As they are compelled to operate in an sub-optimum scale there is a subsequent fall in their labour productivity.

Turning now to a more detailed analysis of the contribution of foreign firms in the Portuguese manufacturing sector, through Tables IV.10 and IV.11 we conclude that, on average, in the last 30 years of European integration, the subsidiaries represented only 0.3% of the firms but contributed to 15% of value added and 33% of exports, of which (at least) 14% concerns high-tech products (see Table IV.12). Therefore, in general, FDI in Portugal has contributed significantly to the structural change of exports, towards technology-intensive activities. Thus, the loss of FDI attractiveness seem to have a negative impact on the export performance of the country.

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[56] This distintion in capital aims to better gauge the impact of information and communication technologies (ICT) on growth.
[57] The contribution is the factor share times the factor growth rate.

[Insert Tables IV.10 to IV.12 here]

Along the lines of the lower dynamism in promoting FDI, Portugal is the MS where foreign subsidiaries have less weight in employment and wealth creation. Tables IV.13a and IV.13b show the foreign firms' performance regarding gross operating surplus and employment.

[Insert Tables IV.13a and IV.13b here]

Regarding gross operating surplus, the importance of subsidiaries in 1986-2016 was greater in the motor vehicles industry, food products, rubber and plastics and chemicals, i.e., in scale intensive and science based industries.

The role of subsidiaries in creating employment was more relevant in the motor vehicles industry, food products and electrical equipment, rubber and plastics and other non-metallic minerals, again in scale intensive and science based industries.

Scale intensive industries are major contributors to the number of firms and employment, with science-based industries being the group with fewer firms and the specialized suppliers contributing less to employment (see Figure IV.5)

[Insert Figure IV.5 here]

The presence of foreign firms can trigger knowledge externalities to the manufacturing domestic firms, which are main vehicles of technological change due to their upstream and downstream linkages. Identifying the drivers of productive efficiency is crucial to understand the sources of the productivity gap. Thus, we will examine whether there was technological change in the Portuguese economy to assess the efficacy of public policies and instruments (financial incentives provided by the Structural Funds) in Portugal.

Technological Change

In this section we analyse a dataset of indicators of technological change, in order to establish the correlation between its changes and the evolution of FDI inward flows. If the correlation is positive, it may indicate a positive impact of FDI on innovation and/or the absorptive capacity in the Portuguese economy.

The construction of the dataset employs the method of multiple imputation.[58] Specifically, we construct a dataset that contains no missing values. The dataset comprises 8 indicators measuring two important country-specific dimensions: innovation and technological capabilities, and absorptive capacity (see Table F1 in appendix F). The dataset that is obtained by estimating the missing values in the original data sources (Pordata and Ministry of Science) provides comprehensive statistical information for the period 1986-2016 (for a total of 31 observations). Our empirical analysis of this dataset shows its reliability and points out its usefulness for future time series studies of the Portuguese national innovation system.

Historically, the first generation of innovation indicators focus on inputs such as R&D investment, education expenditure, capital expenditure, research personnel, university graduates, technological intensity, and the like. The second generation added input indicators by accounting for the intermediate outputs such as patents, scientific publications and new products and processes. The third generation draw attention to indicators and indexes based on surveys. Altough some of the information collected is now qualitative, there is no question that a fourth generation of innovation indicators is required for sound policy implementation. Such indicators would account for Knowledge, Networks and Conditions for innovation. A multi-layered concept like *knowledge,* however, can only be captured by composite indicators that may include composite knowledge investment and performance indicators; *networks* should include contractual agreements (partnerships, intellectual property licensing) and informal collaboration and knowledge exchange (working relationships of individuals across organizations); finally, *Conditions for innovation* refers to systemic innovation measures that capture the context in which organizations form and match expectations and capabilities to innovate. Yet, so far, these 4th generation indicators remain ad hoc and are of limited analytical value. They can be improved only through a coordinated and internationally effort.

Table IV.14 shows the most used innovation and absorptive capacity indicators

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[58] Multiple imputation is an iterative method to address missing data and fittingly reproduce the variance/covariance matrix one would have observed. In this process, the distribution of the observed data is used to estimate multiple values that reflect the uncertainty around the true value. These values are then used in a OLS model, and the results combined.

[Insert Table IV.14 here]

A major criticism of most absorptive capacity measures is that they were developed for large firms and are therefore totally inadequate for small firms. Since small firms do not always have a specific R&D department, it can be difficult to measure the resources allocated to research activities. Furthermore, as many small firms consider the patent process to be too expensive and time-consuming, the indicator of *Patent registrations* is also frequently inapplicable. Thus, the absence of a R&D department or a patent registration policy does not mean that a firm does not acquire knowledge. Hence, the suitability and validity of proxy measures for absorptive capacity are highly empirically questionable.

After Castellacci and Natera (2013) we measure the dimension of the process of technological change, i.e. the dynamics of the Portuguese innovation system, through a set of indicators of innovative capability and absorptive capacity.

Regarding innovative capability, the more domestic firms acquire and absorb new knowledge, the more innovation and competitive advantages they will obtain (Kim, 1998). Since absorptive capacity is a by-product of R&D (Cohen and Levinthal, 1990), *innovative input* is used as a measure of innovative capability, proxied by R&D expenditures as a percentage of GDP. The assimilation of new knowledge, that may lead to the development of new products and processes; and/or the ability to reform the organizational routines, to apply knowledge, can be measured by *technological and scientific output*, respectively proxied by the number of patent applications by residents and the number of scientific publications.

As far as absorptive capacity is concerned, GDP per capita controls for the purchasing power of the domestic market. The *income* and the *development level* are likely to hustle output growth (Balasubramanyam et al., 1999) and are measured by GDP per capita, purchasing power parity.

Indeed, assuming that the higher the GDP per capita, the greater the level of development, and the more education infrastructures. Cœteris paribus, the existence of universities and other educational institutions increases the absorptive capacity. Moreover, many empirical studies analyse the relationship between absorptive capacity and international technology transfer. These studies use *international trade*, as a measure of foreign technology, that can be proxied by Imports+ Exports as a percentage of GDP.

Higher education increases the ability to utilize new knowledge. Thus, higher absorptive capacity will lead to high performance (Conlin, 2006). Accordingly, we use an indicator of *human capital* measured as the total number of graduates. Furthermore, the World bank (World Development Indicators Database) uses *infrastructures* as an indicator of penetration of older technologies. First rate infrastructures devoid of a sufficiently qualified labour force will be useless and vice versa (Abramovitz, 1989). Infraestructures can be measured by the electric power consumption.[59]

Because the acess to education requires income, income inequality reveals primarily as a social problem of unequal access to education, arising from inadequate access to resources (Ball 2004; Teese and Polesel, 2003). The income distribution can be associated with social cohesion and economic inequality (Alonso and Garcimartín 2011) and can be measured by the Gini Index.

Starting with innovation, we analyse the R&D expenditure as a percentage of GDP in 1996-2016 (Figure IV.6).

[Insert Figure IV.6 here]

After joining the EEC, the weight of R&D in GDP, in Portugal, increased from 0.4% in 1986 to 0.8% in 2005. In 2009, this indicator rose to 1.6%, but became stable around 1.4% in 2012. This evolution allowed Portugal to converge with the EU. In fact, if in 1995 this indicator represented about a third of that for the EU average; in 2009, it reached the maximum of 82% of the EU average. However, after 2009, the economic conjuncture threatened the objective in line with the strategy Europe 2020 of increasing R&D spending to 2.7% of GDP.

Currently, Portugal is one of the most lagging MS regarding innovation capability, especially concerning patent applications (Mateus, 2015). From 1986 to 2012, on average the number of registered triadic patents in Portugal represented only 1.3% of the EU-28 average.

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[59] Archibugi and Coco (2004) suggest another two indicators: internet and telephone penetration. According to the authors, Internet is a key infrastructure for business and as a mean of access to knowledge; while telephone mainlines connect customers' equipment to the public switched telephone network allowing communications and exchange of knowledge. However we could not get values for internet prior to 2001. As regards telephone subscribers, we obtained data from world bank development indicators but it was not clear how many countries were included in the data, since the period 1986-2016 includes several EU enlargments. Hence we could not calculate the average value.

[Insert Figure IV.7 here]

Figure IV.8 shows the number of scientific publications in Web of Knowledge, concerning the EU-28 and Portugal over the period 1986-2016.[60] The number of Portuguese scientific publications represented on average nearly 55% of that of EU-28 per year. The number of publications in Portugal was much more volatile in the period, with an average of 678 publications per year, than that of EU-28, with an average of 1195 publications/year.

[Insert Figure IV.8 here]

According to the European Commission (2013), R & D intensity in 2000 to 2011 was on average of -0.16% in Portugal, compared to 0.8% of the EU average. On the contrary, in terms of Excellence in S & T, in 2005-2010, Portugal had a better performance than the EU average (4.23% and 3.09%, respectively).

Regarding Innovation and structural change, in 2010-2011, Portugal represented only 62% of the EU average, concerning the Index of economic impact of innovation (0.38% and 0.61%, respectively). Yet, in 2000-2010, the Portuguese performance regarding knowledge-intensity was well above that of the EU average (3.18% and 0.93%, respectively).

Regarding the absorptive capacity indicators, we start with the Income and Development Level. The GDP per capita in Portugal represented 76% of the EU average both in 1986 and 2016. On average, the GDP per capita expressed in PPPs in Portugal was 79% of the EU28 average over the period 1986- 2016 (see Figure IV.9).

[Insert Figure IV.9 here]

However, regarding this indicator, the distance between the EU-28 average and Portugal has increased when compared with the situation in late 1980s and early 1990's, soon after the EEC accession.

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[60] It is an integrated Web platform that provides information for research.

Turning to international trade, Figure IV.10 shows fluctuations in 1986-2016, with peaks in every 7-10 years' periods, i.e. in 1990, 2000, 2008 and 2015.

[Insert Figure IV.10 here]

We can split the period under analysis in two subperiods: the first starting in 1986 until 2000, when the Portuguese economy showed a greater dynamic concerning international trade, as a share of GDP, than that of the EU-28 average; and after the year 2000, when the situation was reversed and Portugal became less dynamic regarding trade openness.

The analysis of Figure IV.11 shows that the number of total graduates (male and female) from 1986 to 2004 has been increasing in Portugal. However, the distance from the EU-28 average remained stable. After 2004 the distance widened and, after 2013, we can observe a tendency of decrease regarding the number of graduates both in Portugal and the EU.

[Insert Figure IV.11 here]

The electricity consumption in Figure IV.12 shows an increase over the period, similar to the evolution in the remaining EU countries. However, the rate of growth has been higher in Portugal and, as a result, the distance has narrowed about one half, compared with the consumption in 1986.

[Insert Figure IV.12 here]

Finally, the Gini coefficient (Figure IV.13) measures income inequality ranging from zero for countries with no income inequality and one for countries with the greatest possible income inequality.

[Insert Figure IV.13 here]

According to the OECD database, in 2011-2012, Portugal improved its position from 0.343 to 0.338. During this period, Portugal was the ninth most unequal country among the 34 OECD countries, with a rate above the average rate of 0.315. 10% of the richest Portuguese population concentrated 25.9% of the income, while 10% of the poorest population concentrated only 2.6% of the income. The bulk of the income (63%) was concentrated on 40% of the population. These high levels of inequality may have a negative effect on the productivity gap.

In the period described, income inequality decreased only 4%. According to ISCTE data from the inequalities observatory, Lithuania recorded the greater income inequality in 2009, with a Gini coefficient of 37%, closely followed by Latvia with 36%. Portugal, along with Spain, recorded the third highest indicator of 34%.

In a nutshell, from the analysis of the indicators in the previous section, although Portugal has managed to improve its innovation gap, it seems it has failed to convert this into real economic convergence. In this context, the R&D intensity and the level of qualifications are regarded as major difficulties that prevent the increase of competitiveness of the Portuguese economy, affecting the potential growth of output. On the other hand, the improvement in innovation has occurred mostly in the public sector, while scoring on business innovation performance remains low (Veuglers and Mrak, 2009). Still, in recent years, the restrictions in the public finances motivated by the external debt, had interrupted the growth path of R & D investment financed by public funds, while the adverse economic context due to the financial crisis had a negative impact on firm innovation, including business cooperation with the R&D institutions. Moreover, innovation alone is not enough to increase productivity. Laggard economies must possess the ability to absorb, internalize and utilize the knowledge potentially made available to them. In other words, the absorptive capacity allows them to be able to generate new technologies and use resources efficiently, to increase productivity (Narula, 2004).

The indicators of absorptive capacity reflect in general an improvement in absolute terms. However, the distance between Portugal and the EU-28 average has widened, except in those indicators concerning infrastructures and inequality.

In order to get some insights on the role of FDI flows to innovation and absorption capacity in Portugal and to the convergence of gross value added between Portugal and the European Union countries, we conducted a correlation test to verify the relationship degree between FDI inward flows and the Innovation system indicators as well as with the gap between the Portuguese gross value added towards European Union countries.[61] The correlation coeficients are shown in Table IV.15.

[Insert Table IV.15 here]

The correlations between FDI inflows to Portugal and the innovation indicators are strong (coefficient>0.5), positive and significant (at 5% level), except for scientific publications.

Regarding the absorptive capacity, all indicators are positively and strongly correlated with FDI inflows, except for Gini index, which shows a negative, strong a significant correlation (-0.5664).

Since the higher the Gini index, the larger the inequality, it may be the case that FDI inflows have been contributing to reduce economic and social inequality in Portugal.

Finally, the gap between Portugal and the European Union Countries is positively and significantly correlated with FDI inflows, GDP per capita, the number of graduates and the electric power consumption. Since the higher the value of the GAP indicator, the greater the convergence with the European Union Countries, the sign of correlations may indicate that FDI flows have been contributing to reduce the gap. Moreover the increasing number of graduates, increases the absortive capacity of the Portuguese populations and this may have an impact on convergence of GVA towards the European Union Countries. Since the value of the coefficient is strong for the GDP per capita and the electric power consumption it may imply that those indicators may have a strong impact on reducing the gap. The statistical significance of correlation coeficients specify that all chosen indicators are valid for the analysis of the contribution of FDI inflows to innovation and absorptive capacity, except for scientif publications.

Tables IV.16 and IV.17 show the goals of Technological plan and Portugal 2020, aiming to converge with the EU-28 average.

[Insert Tables IV.16 and IV.17 here]

[61] Data on Gross value added (current basic prices in millions of Euros) for Portugal and the aggregate European Union Countries comes from EUKlems database- November 2009 release, March 2011 update.

It has been argued that the difficulties in the convergence process are not related to factor intensity or technological progress but with the contribution of efficiency to TFP. Indeed, from 1986 to 1998, structural change was characterized by a transfer of labour from agriculture to services; while the weight of the manufacturing employment has remained broadly stable and output has declined (Figure IV.3).

TFP can be expressed in terms of technology growth and efficiency. The former includes the effect of positive externalities which is a driver of economic growth. Amador and Coimbra (2007) show that, in 1995-2005, the contribution of efficiency was negative due to investment in real assets with low return, such as housing.

Since many services are non-tradable, this resulted in lower productivity gains and lower the average contribution of TFP to economic growth to merely 0.2% in 1990-2000. Hence, the inclusion of both tradable and non-tradable sectors can hinder the analysis of structural change, as measured by the TFP performance.

According to predictions of the EC (2016): "As economic conditions are expected to improve and investment to pick up, capital accumulation would eventually raise the growth potential. Prospects for labour force development are less optimistic." *(op. cit*, p.8)

On contrast, the TFP of the Portuguese economy is expected to improve slightly in the medium term. Nevertheless, the low average skill level of the labour force, although improving, and the low level of innovation may deter the growth of the TFP.

Being a small open economy located on the outskirts of Europe, Portugal is vulnerable to external factors that hamper economic growth. The competitiveness problems of the Portuguese economy were also reflected in the decrease of FDI flows.

Yet, sectoral empirical studies exist that, by estimating externalities from FDI via backward and forward linkages for the Portuguese manufacturing industry, allow to design FDI policies aimed at this specific industry. In this context, FDI policies may put forward suitable incentives to reach the FDI sectoral composition that enhances greater TFP growth for domestic firms, through externalities from FDI via backward and forward linkages. Bearing this in mind, and accounting for our empirical results on externalities from FDI in 1995-2007 (see Chapter 3), in the next section we make some policy recommendations.

5. POLICY RECOMMENDATIONS TO BOOST PRODUCTIVITY AND GROWTH

Based on sections 2.2, 3 and 4; and the results of externalities from FDI, we perform some recommendations on the design and implementation of FDI policies in articulation with industrial policy, i.e., according to the type of FDI externality, technological groups and/or specific manufacturing industries.[62] One should notice that, a more comprehensive ex-ante evaluation of FDI policy would also apply to other sectors. In such scenario, we would most probably be led to a choice of a mix of FDI in manufacturing and services. However, this is beyond the scope of our research.

These recommendations consider a logical framework for intervention to ensure causal linkages between, on the one hand, the specific goals and constraints associated with strengthening the articulation between FDI and Industrial policies, and, on the other hand, between the proposed policy measures/instruments and the expected results. Accordingly, in Table IV.18, the first policy component *goals*, determines the rest: constraints, policy measures/instruments, expected results and recommendations.

[Insert Table IV.18 here]

The Policy goals are the increase of manufacturing competitiveness, the reduction of the technological gap, the convergence of productivity, the attraction of FDI and the promotion of economic growth and employment.

Regarding the manufacturing competitiveness, the main barriers to this goal are deindustrialization, international competition, and the highly fragmented value chains. Hence, measures targeting all industries should be taken, such as the promotion of entrepreneurship; access to credit and the strengthen of the intellectual property rights and the competition policy. Moreover, according to our empirical results for 1995-2007, summarized in section 4, although Industrial policy should focus all industries, it must be able to attract FDI projects in industries that lead to positive externalities (especially in scale intensive and science based industries); and FDI Policies need to tailor to the specific requirements of investors. If this is accomplished, it is expected that foreign

[62] See Chapter 3.

firms, especially in scale-intensive industries in Portugal contribute to increase the turnover, employment, value added and gross operating surplus.

As far as the reduction of the technological gap is concerned, our results for 1995-2007, at aggregate level, provide support of the technology-accumulation hypothesis, i.e, if the gap is too large, domestic firms do not possess the necessary "absorptive capacity" to incorporate the knowledge of foreign firms. Indeed, the coefficient results are significant positive (see Table III.3 of chapter 3), whether through the direct impact of technological gap on the TFP growth (variable *tg*), when estimating externalities via backward linkages; or indirectly via the effects of foreign presence in the TFP growth of domestic firms (variable *f*tg*), given a certain level og technological gap, when estimating horizontal externalities. Thus, policy recommendations include the promotion of structural change towards economic activities with high added value via technological change. However, the major obstacles regarding the reduction of technological gap are the lack of fluidity in the technology transfer from universities to firms, low level of innovation capabilities and the reduction of public incentives for innovation, since R&D activities are expensive and small firms may be discouraged to pursue innovation in the absence of some public funding. To accomplish this goal, measures should be taken to stimulate innovation and cooperation between firms and scientific organizations.

Concerning the barriers to the convergence of productivity, the main are the erosion of competitiveness, the allocation of resources to non-tradables, the specialization in sectors of low technological intensity and the low average of labour skills. Hence the focus on the manufacturing as a driver of economic recovery aims to reduce the disparity in labour productivity towards the EU-28 average. In order to close the gap, the convergence process must be assisted by a reinforcement of supply-side measures and simultaneously it must favour certain industries where there is evidence of positive externalities from FDI.

Finally, barriers to attracting FDI and promote economic growth and employment are the fact that the Investment promoting policy is moving to European level and thus leaving the government with no autonomy to pursue such a FDI promoting policy prone to maximize externalities from FDI; the public budget constraints, the FDI strategies with narrow scope, and the difficulty of IPAs to identify business opportunities. Measures include Structural Funds, the special visa regime, the definition of priority industries and the improvement of the institutional environment. If authorities are successful in attracting the right kind of FDI projects, it is expected at the aggregate level, that an increase of one percent in turnover of foreign firms in downstream and upstream industries may contribute to an increase of domestic firms' TFP of 0.0629 and 0.306 percentage points.

This analysis seeks to contribute to the drawing up of a well-defined strategy. Thus, it is possible to state that the general objectives set out are in line with the major constraints posed by policies analysed here and thus constitute an appropriate starting point for further strategic specification. In this respect, the low levels of qualification of the population, the maladjustment of the articulation with the labour market; and the persistence of areas of inefficiency and the lack of innovation conform the main constraints. Finally, the system of goals and measures/instruments is articulated with the indicators of innovation and absorptive capacity. There are explicit synergies between specific objectives and measures/instruments. In this context, the selected indicators are generally relevant and their formulation clearly expresses the associated measurability dimension. The indicators use appropriate calculation methods and present realistic values against the objectives and resources.

To conclude, some remarks on Investment priorities. AICEP aims to attract foreign Investment focusing into three groups of priority industries: heavy industry, which relies on domestic sources of raw materials (iron, copper, lead and zinc); traditional industries such as textiles to develop competitiveness; and industries in which Portugal already has a comparative advantage (e.g. electrical equipment, electronic equipment and telecommunications). Table IV.19 combines our empirical positive and significant results by industry and by size for 1995-2007, distributed by the these three groups of priority industries.

[Insert Table IV.19 here]

Comparing the magnitude of the 3 types of externalities, periods and priority industries, several conclusions arise from this table. First, traditional industries appear to benefit more from foreign presence in upstream and downstream industries, followed by the industries where Portugal has a comparative advantage, in downstream industries. The analysis by size of chapter 3 indicates that these results for traditional industries are mainly due to the performance of beverages industry, where we find significant positive externalities via backward and forward linkages, specially in large firms. Second, these externalities occur mainly in the current period, in the case of traditional industries; and with a two-period lag, in the case of industries where Portugal has a comparative advantage. This is not surprisingly since while Portugal had a vast experience in traditional industries, by their nature, and thus domestic firms do not need much time to benefit from FDI presence; in the case of foreign firms producing electrical equipment and computer and electronics in science based industries, it is necessary two years for domestic suppliers and customers to benefit from the foreign superior knowledge, in terms of TFP increases. Third, heavy industries benefit less from foreign presence, when compared to the other two types of priority industries. Thus, our results, for 1995-2007, confirm the choice of AICEP regarding the priority industries where to attract foreign investment projects.

Main Recommendations

It will be useful to highlight that the proposed intervention strategy concentrates preferentially its attention on the effort to achieve higher levels of competitiveness through increased industrial productivity. Attention has been drawn to strengthening structural change towards economic activities with high added value, since technological change appears to be the only route available to achieve economic growth. Thus, the design of public policies analysed here has a strong affiliation to the set of policy instruments established in the context of the Structural Funds. Therefore, FDI Policies need to be tailored to the specific requirements of investors (for example, in compliance with the tax laws of investor's countries and the tax agreements between the two countries). Also, these policies should be difficult to replicate by other governments, in order that the host country will able to attract the desirable FDI projects. Examples of such measures are the creation of hubs of firms with high-skilled workforce and/or management expertise.

Regarding the Industrial Policy, in addition to the horizontal focus that support the whole manufacturing sector; it must also target the specific industries (vertical focus) where FDI generates positive externalities. Indeed, the quality and effectiveness of public policies analysed here, requires the assistance of supply-side measures with an integrated industrial policy, favouring scale intensive sectors, where there is evidence of positive externalities from FDI. Hence, FDI incentives should target that technological group instead of individual firms, after performing a balance between the benefits and costs (public budget) and aligning investors’ motivations with the country's development strategy.

6. CONCLUSION

Being a small and moderately innovative economy, without the locational advantages of the CEECs, the potential convergence of the Portuguese economy is threatened due to several factors that caused a fall not only in FDI flows, but also in production and employment, which were not fully compensated by government incentives for innovation activities, which in most cases were limited.

Based on the analysis of the Innovation System indicators, although Portugal has managed to improve its innovation activities, the distance between Portugal and the EU-28 average has increased, except for the indicators related to infrastructures and inequality, and the economy has not been able to converge with that average.

According to the OECD Reports (Portugal), several weaknesses persist such as the scarcity of human capital and the difficulties to adopt more modern production techniques, organizational practices and new products. Thus, the main challenge for Portugal is to increase productivity on a sustained basis. The path of sustainable growth goes through a process of structural transformation via technological change. In this context, the manufacturing sector, being one of the main producers of tradable goods and higher rates of productivity and innovation is considered the main engine of economic growth. In addition, the numerous technological linkages within the manufacturing industries enable the technological change. In this context, FDI is considered the main vehicle of technology transfer, since it represents the greatest source of innovation, (Lim, 2001). A greater foreign presence within an industry is correlated with the growth of TFP of domestic firms by increasing the speed of technology transfer. Historically, FDI has contributed to the structural change of Portuguese exports to technology-intensive industrial activities. Literature and our empirical results allow us to assume that FDI flows to Portugal can be a channel of technological catching-up.

AICEP aims to attract foreign Investment focusing into three groups of priority industries: heavy industry, which relies on domestic sources of raw materials (iron, copper, lead and zinc); traditional industries such as textiles to develop competitiveness; and industries in which Portugal already has a comparative advantage (e.g. electrical equipment, electronic equipment and telecommunications). Our results, for 1995-2007, confirm the choice of these priority industries regarding the attraction of FDI projects, since we find positive and significant externalities from FDI.

Indeed, regarding the first group, we find significant positive horizontal externalities (0.00000793) in the current period. With one-period lag, we find significant positive externalities via backward linkages (0.000987) in basic metals, and via forward linkages (0.00107) in metal products. Concerning the second group, with one-period lag, we find significant positive horizontal externalities (0.0557, 0.000789 and 0.000540) in other transport equipment, rubber and plastics and food industries. We also find positive and significant externalities with a two-period lag (0.0713, 0.00264 and 0.000686) in other transport equipment, wearing apparel and food industries. In the current period, we find significant positive externalities (0.334 and 0.00824) via backward linkages in beverages and wood industries; and positive externalities (0.0617 and 0.0198) in other transport equipment with one-period and two-period lags. We also find significant positive externalities via forward linkages in the current period (0.249 and 0.00871) in beverages and other transport equipment industries; and with two-period lag (0.103) in beverages. In the third group, we find significant positive externalities from backward and forward linkages (0.0227 and 0.222) in computer and electronics and electrical equipment industries, with a two-period lag.

Overall, combining the results by each group of priority industries for the 3 periods of time, we conclude that, in 1995-2007, one percent increase in turnover of foreign firms, raised the TFP of domestic firms in 0.002 percentage points in heavy industries, 0.931 percentage points in traditional industries and 0.245 percentage points in industries where Portugal has a comparative advantage.

The changes that recently occurred in industrial policy were accompanied by new strategies, such as the resumption of focus on productivity and merging with innovation policy to support research and education. In this context, the European Commission (EC) plays an important role about the Government incentive system for innovation activities in Europe, with a view to improving the competitiveness of firms. Thus, the objective of this chapter is to evaluate the impact of FDI inflows to manufacturing TFP in Portugal and, therefore, on the process of convergence with the EU-28 average. This exercise can provide policy recommendations to boost productivity and stimulate growth.

Though, with the acceleration of globalization that began in the new millennium, FDI inflows to the Portuguese manufacturing sector have become more volatile. Thus, we analysed the joint evolution of FDI inflows to the manufacturing sector and the factor contribution to the GVA increase in the manufacturing for 1986-2016, in search of a hint on the FDI impact on the manufacturing TFP. Our analysis has shown that FDI flows targeting this sector potentially help to narrow the gap with the TFP.

However, in order to grow and converge, Portugal need a well-defined FDI policy that aligns investors' motives with the national development strategy; that uses the funds according to the objectives; that performs a continuous assessment to ensure its effectiveness; and makes the necessary corrections. On the other hand, the industrial policy must reconcile the horizontal focus that support the development of industry in general, with a vertical focus, i.e, on specific sectors. This is critical for attracting FDI projects that generate positive externalities for domestic firms. In this respect, the importance of subsidiaries in job creation in 1986-2016 was greater in scale-intensive industries and in science-based industries (e.g, automotive, food, rubber and plastics and chemicals).

In order to boost productivity, an integrated industrial policy must be established, favouring scale-intensive sectors where there is evidence of positive externalities from FDI. In the past, economies of scale have encouraged technical progress in Portugal. Therefore, FDI incentives should be used to attract this technological group of industries, aligning investors' motives with the country's development strategy. In addition, the proposed intervention strategy should aim at reinforcing structural change towards high value-added economic activities (for example by attracting FDI in science-based industries), as technological change seems to be the only way available to achieve economic growth. In this context, clusters play an important role in improving the attractiveness of a region to FDI, providing local capacities that influence the location of economic activities.

In our view, it is only under these conditions that Portugal can resume the path of convergence with the European Union countries.

CONCLUSION

CONCLUSION

In this thesis, we have studied the impact of the foreign presence on the productivity growth of domestic firms with the aim of clarifying if there are externalities from FDI for the Portuguese manufacturing sector.

We have approached this subject in four different chapters: in chapter 1, we reviewed the literature, theoretical and empirical, focusing on the relationship between FDI and the productivity of domestic firms in developed countries; In chapter 2, we conducted a descriptive analysis of the construction of the database developed to identify the externalities associated with FDI that are linked to higher productivity of national companies; In chapter 3, our focus was the empirical study of the effects FDI in the growth of the TFP in the manufacturing industry in Portugal over the period 1995-2007; and in chapter 4, we try to assess whether foreign direct investment policies in the last 30 years of European integration have contributed to convergence with other EU Countries, by increasing productivity in the Portuguese manufacturing sector.

Below, we present a summary of the discussions and main conclusions of the different chapters, the policy recommendations, and strategies to be adopted and, finally, the limitations of the study and suggestions for future research.

Summary and conclusions

The first chapter of this thesis reviews the empirical literature on the effects of foreign presence in the manufacturing sector on the productivity growth of domestic firms in five Western European Developed Countries, considering the relevant transmission mechanisms of externalities from FDI. This review enables us to define the empirical strategy to follow in chapter 3.

Moreover, we provide a broader picture of the determinant factors of occurrence and magnitude of externalities from FDI through its classification. This allows for a better understanding of the relevant variables to include in the empirical studies. Thus, drawing upon the Theory of Heterogeneous Firms, we classify the determinant factors of externalities from FDI into ‘internal’ and ‘external’ to the firms. Overall, internal characteristics of firms (local and foreign) are more important for the occurrence and magnitude of vertical externalities than external factors. However, while the determinant factors related to foreign firms are relatively more important for the *occurrence* of vertical externalities; in contrast, the determinant factors related to domestic firms' characteristics are relatively more important for the *magnitude* of vertical externalities. Determinant factors related to MNCs characteristics such as FDI motive and the entry mode and, especially, local firms' characteristics that enhance the absorptive capacity (like the age and size of firms) may be key contributors to the magnitude of externalities from FDI. Therefore, these determinant factors need to be analysed in more detail to understand empirically how the transmission mechanism works and to test their effectiveness in enhancing the magnitude of vertical externalities.

Empirical studies of Western European Countries include independent variables that represent firms' characteristics, such as the absorptive capacity, and efficiency measures (e.g., capital intensity, economies of scale and sectoral concentration). We have confirmed, however, that the analysis of the factors determining the effectiveness of transmission mechanisms, in these studies, is far from being fully exploited. This is because these mechanisms are complex. For example, it is difficult to disentangle all possible effects of FDI motive on the TFP growth of domestic firms. Furthermore, most researchers do not include the relevant control variables related to the specific mechanism of vertical externalities they want to test. Hence, so far, the literature has not provided an unambiguous and complete explanation of the transmission mechanism of externalities from FDI.

Empirical studies lack the adequate measures (e.g., variables and proxies) to adequately reproduce the specific transmission mechanism of externalities from FDI they want to test and, therefore, the link between theoretical and empirical literature is missing. As a result, we have found that empirical studies are far from finding a consensus on the sign and magnitude of FDI effects on the TFP growth of domestic manufacturing firms in developed Countries. These studies include Ruane and Ugur (2005), Barry et al. (2005) and Barrios et al. (2012), for Ireland; Imbriani and Reganati (2004), Reganati and Sica (2007) and Albanese et al. (2008), for Italy; Farinha and Mata (1996), Proença et al. (2002), Crespo et al. (2009 and 2012), for Portugal; Barrios and Strobl (2002), Alvarez and Molero (2005) and Jabbour and Mucchielli (2007), for Spain; and Girma and Wakelin (2002), Driffield (2004), Harris and Robinson (2004), Girma (2005), De Propis and Driffield (2006), Haskel et al. (2007) and Girma et al. (2008), for the UK.

In our view, this lack of consensus can be explained by different data sources, periods, econometric methods, variables, proxies, and transmission mechanisms used in the estimating equations. Additionally, the fact that the existing literature reviews and meta-analysis include both developed and developing countries hinders the learning process of the transmission mechanisms of externalities in Developed Countries.

In chapter 2, we have focused on the description of the database that integrates a significant number of the variables necessary to empirically investigate the existence of externalities from FDI in Portugal. The correct quantification of the impact of foreign firms on domestic firms' TFP growth requires an adequate database with relevant variables. However, databases used in the previous studies for Portugal lack the necessary variables, similar definitions, data treatment and nomenclatures. AMADEUS, on the other hand, has been widely employed by researchers to estimate externalities from FDI in European countries, due to its integrity and broad geographic reach. Hitherto, there were no attempts to construct an adequate database for the Portuguese manufacturing sector. Thus, we present a new balanced panel dataset with a set of useful 15 indicators, in a total of 5,045 manufacturing firms (domestic and foreign) for the period 1995-2007. Additionally, since some industries share technological opportunities, the nature of knowledge, the appropriability conditions and the market structure, despite of intra-sector heterogeneity, we cluster the industries into scale-intensive, specialized suppliers, science-based and supplier-dominated industries, following Pavitt (1984) classification. Because the adoption of a new technology by the domestic firms is more likely to occur if MNCs demonstrate that the technology is successful, and if the goods produced are similar (Barrios and Ströbl, 2002), Pavitt taxonomy is an adequate and robust tool to identify the patterns of technological innovation and, hence, to analyse the opportunities of technological catch-up caused by the foreign presence in the host economy.

In chapter 3, we have investigated the existence of externalities from FDI for the Portuguese manufacturing sector from 1995 to 2007. Using panel data, we have applied a two-stage empirical strategy. First, we employed the Wooldridge-Levinshon and Petrin estimator, which is considered a robust method, to estimate the TFP. Then, we regressed the TFP on several explanatory variables using the system-GMM estimator. The choice of the estimator considered the fact that, with persistent data over time, the first-differenced GMM estimator can behave poorly, since lagged levels of the series provide only weak instruments for subsequent first-differences (Blundell and Bond, 1998 and

Bond et al., 2001). Blundell and Bond (1998) proposed the use of the system-GMM estimator, that combines a system of equations in differences and in levels as the best estimator to deal with endogeneity of the explanatory variables (including the lagged dependent variable) and firms' unobserved fixed effects. Thus, we prefer the system GMM over difference GMM for two reasons. First, system-GMM generally produces more efficient and precise estimates, by improving precision and reducing the finite sample bias (Baltagi, 2008); second, differencing variables within groups will remove any variable that is constant; which mean the loss of many observations.

Our results allow us to provide some explanation for the mixed results of empirical studies reviewed in chapter 1. At the aggregate level, in the current period, we find negative horizontal externalities and negative externalities via backward linkages. The latter arise from the negative effect in large (automotive) firms in scale intensive industries and in large firms (wood) in supplier dominated industries. Considering a one-period lag, we find positive externalities via backward linkages, especially in small firms (basic metals and other transport equipment) in the scale intensive industries. We also find positive externalities through forward linkages, arising from small firms (metal products) in the intensive scale industries. These results confirm that externalities are more likely to occur at the vertical level. Considering a two-period lag, we find negative externalities via backward linkages due to the impact on small firms (basic metals) in scale intensive industries. The empirical results suggest that small firms in upstream industries of other transport equipment and computer and electronics industries; and small firms in downstream industries of metal products industry, need one year to learn from their foreign clients/suppliers.

Moreover, the initial shock resulting from market interaction between foreign and domestic firms causes a decrease in the TFP of domestic firms. Furthermore, after two years, the effects on the TFP of domestic firms are negative again which can be attributed to the decrease in the TFP of small domestic firms in science based industries (computer and electronics); and small domestic firms in upstream and downstream industries of scale intensive industries (basic metals and metal products).

Regarding the influence of control variables on TFP growth (either directly or through its effect on foreign presence), we can conclude the following. Concerning concentration, in domestic rivals in scale intensive and science-based industries and in domestic firms in upstream industries of supplier dominated industries, the effect of the access to resources offset the potential monopoly inefficiencies.

However, these inefficiencies may occur in domestic rivals in supplier dominated and specialized suppliers' industries; as well as in domestic firms in upstream industries of specialized suppliers' industries and in downstream industries of supplier dominated industries, since the relationship between concentration and TFP growth is negative. As far as R & D activities of foreign firms are concerned, they have a positive impact on the TFP growth of domestic rivals in scale intensive industries.

Nevertheless, domestic rivals in specialized suppliers' industries experience decreases in their productivity, perhaps due to large differences in both technologies (domestic and foreign). Concerning scale, it appears to impact positively on TFP growth, across all technological groups. Moreover, it appears that the catching-up hypothesis is confirmed, i.e. if the technological distance between domestic and foreign firms is small, then domestic firms benefit little from the foreign presence, in terms of TFP growth. Finally, the impact of capital intensity on the TFP growth is negative in downstream domestic firms in all technological groups, except in the leather industry, where the technological know-how seems to be important to increase their TFP.

To sum-up, the industries where we find significant positive externalities are, by order of absolute magnitude, beverages, electrical equipment, other transport equipment and computer and electronics. In the beverages industry, one percent increase in the turnover of foreign firms increases the TFP of large domestic firms in upstream and small domestic firms in downstream industries in 0.334 and 0.249 percentage points, in the current period; and of large domestic firms in downstream industries in 0.103 percentage points, with a two-period lag. In the electrical equipment industry, one percent increase in the turnover of foreign firms, increases the TFP of small domestic firms in downstream industries in 0.222 percentage points, with a two-period lag. In the other transport industry, one percent increase in the turnover of foreign firms, increases the TFP of small domestic firms in the same industry in 0.0713 percentage points, with a two-period lag; of small domestic firms in upstream industries in 0.0617 percentage points, with one-period lag; and of small domestic firms in the same industry in 0.0557 percentage points, with one-period lag. Finally, in the industry of computer and electronics, one percent increase in the turnover of foreign firms increases the TFP of small domestic firms in upstream industries in 0.0227 percentage points, with a two-period lag.

The uneven distribution of such externalities confirms the need of a disaggregated analysis by industries and firm size and using lags of the variables that represent the foreign presence to understand how and when externalities affect each industry. Thus, our results allow us to reconcile the mixed results from previous studies for the Portuguese manufacturing sector.

In chapter 4, we attempted to evaluate whether FDI policies in the last 30 years of European integration have contributed to convergence by increasing productivity in the Portuguese manufacturing sector. To this aim, we have analysed the evolution of FDI inward flows and several indicators of manufacturing performance and technological change. We also performed an analysis of the performance of the Portuguese economy regarding the achievement of goals to reduce the technological gap and to increase the innovative capability and the absorptive capacity. The evidence for the Portuguese manufacturing industry suggested that the positive externalities of FDI were limited to certain industries; and the analysis of indicators of technological change shows that the gap between Portugal and the EU-28 average is far from being closed. Thus, the structural change in the Portuguese manufacturing sector requires the coordination between the industrial policy and the instruments of attraction of FDI in priority sectors.

Policy recommendations and strategies

We now present some suggestions on future empirical studies and policy recommendations concerning the kind of foreign projects to attract to the Portuguese manufacturing industry, to maximize externalities from FDI and thus increase the TFP of domestic firms.

First, the uneven distribution of externalities from FDI indicates the need of a disaggregated analysis by industries and firm size and the use of lagged variables that represent foreign presence, to understand how and when externalities affect each industry.

Second, since the new millennium, the potential of convergence of the Portuguese economy was disrupted due to a drop, not only in FDI flows but also in manufacturing output and employment, not fully compensated by Government incentives for innovation activities. Therefore, a promising way that Portugal has to return to a path of sustainable growth is undergoing a structural transformation process via technological change. FDI is considered the main vehicle of technology transfer and, historically, it has contributed significantly to the structural change of Portuguese exports towards technology-intensive industrial activities. Accordingly, measures were implemented to stimulate innovation, strengthen the cooperation in R&D activities and employ high skilled employees (doctorates and masters) in firms through financial incentives to SMEs. However, since Portugal is still well below the EU-28 average regarding innovation, FDI inward flows can be a channel of technological catching-up, especially in scale-intensive industries where it was demonstrated that MNCs have specially contributed to output, turnover, value added and gross operating surplus over the period 1996-2014. Thus, policy decision makers should implement a well-designed industrial policy that addresses systemic and network failures and reconciles horizontal policies with vertical policies for specific sectors that lead to positive externalities from FDI. In this context, the Portuguese Investment Promotion Agency (AICEP) should continue to promote FDI in scale intensive and science based industries. This could be achieved, in the case of horizontal externalities, by providing incentives for R&D cooperation and supporting private sector training programmes. On the other hand, the government can contribute to the occurrence of vertical externalities from FDI by supporting partnerships with foreign firms. This can be attained by several ways: providing linkage information in seminars, exhibitions, and missions; sponsoring fairs and conferences; organising meetings and visits to plants; promoting supplier associations; and providing advice on subcontracting deals.

Contributions of this study

Chapter 1 contributes to the existing literature by providing a broader picture of the determinant factors of externalities from FDI through its classification, along the lines of the Theory of Heterogeneous Firms.

This allows for a better understanding of the relevant variables to include in the empirical studies. Furthermore, the existing meta-analyses include both developed and developing countries, hindering the learning process of the transmission mechanisms of externalities in the developed countries. We attempt to fill this gap by reviewing the empirical literature for five Western European countries and suggest some explanations for the mixed results. This is of crucial importance regarding the choice of estimating equations and independent variables to include in empirical models to evaluate the existence of externalities from FDI in Developed Countries.

Chapter 2 contributes to the empirical literature through the construction of a consistent database of the manufacturing firms in Portugal over the period 1995-2007. In our view, a major limitation of the empirical studies that investigate the existence of externalities from FDI in Portugal is the lack of a database that integrates a significant number of the variables. Instead researchers have been relying in many data sources. In contrast, we use a large panel of manufacturing firms which allows us to control for firm fixed effects and year effects, ruling out main concerns related to endogeneity.

Chapter 3 presents a broader analysis of the effects of FDI on the TFP growth of manufacturing industries, clustered by technological content, controlling for firm size and using lagged variables of foreign presence. Our empirical results, compared with previous studies, show that FDI has a wider range of consequences than previously assumed regarding the occurrence and magnitude of externalities from FDI in the manufacturing sector.

Finally, chapter 4 attempts to perform a policy evaluation regarding convergence, during the last 30 years of European integration, by scrutinizing the impact of FDI inward flows on the fulfilment of the Government goals concerning the technological catching-up. To the best of our knowledge there are no prior attempts to perform normative analysis of the investment promotion policy in Portugal, other than those that are inherent to the sphere of action of the Portuguese Investment Promotion Agency (AICEP), which cannot be disclosed to the academic community.

Limitations of this study and future research

Inevitably, this study had some difficulties and limitations. A major difficulty resided in the reconciliation of different data sources, regarding the classifications of economic activities and units of measurement; The main limitations are related to data availability, sometimes due to confidentiality issues. For example, the lack of variables at firm level that represent R&D activities (domestic and foreign) prevented the use of a knowledge production function to estimate FDI horizontal externalities. Also, in chapter

4, it was not possible to obtain information from AICEP regarding funded projects and the goals for ongoing foreign investment projects, because they are confidential. Hence, there is scope for future analysis on the occurrence of externalities from FDI in the Portuguese manufacturing sector. In our view, the prospects for future research focus on three main directions. First, to test other determinant factors of externalities from FDI, presented in Chapter 1, namely FDI motive and the country of origin of the foreign investors. Second, extend the dataset to include variables such as FDI motive and R&D activities (domestic and foreign), and, thus, estimate the effects of FDI motive and using a Knowledge Generation function; third, to extend our analysis to services sector, since, as shown in Figure II.1, in Portugal, the innovative performance in this sector is higher than in the manufacturing sector.

Overall, externalities from FDI are unevenly distributed across and within industries and take one year to occur. This provides a conceivable explanation of conflicting results from previous studies for Portugal. Consequently, our analysis provides enough reasons for further research in the future.

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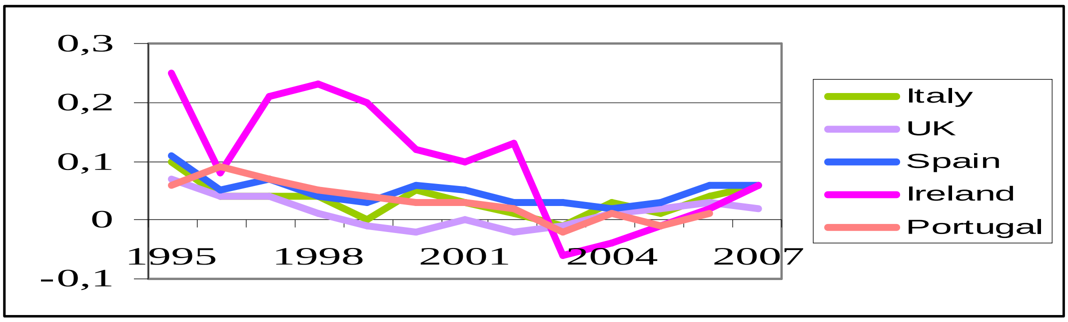
APPENDIX A

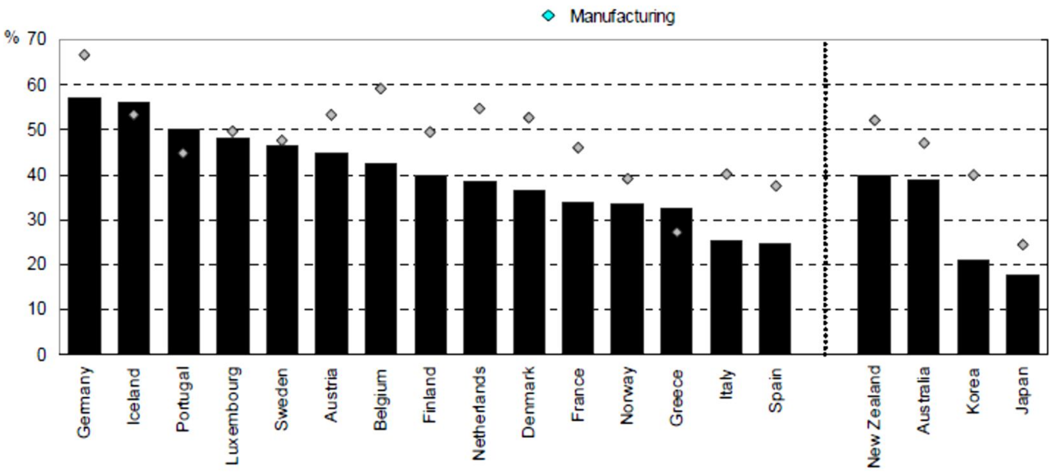
Figures

Figure I.1- Growth Rate of Manufacturing Gross Value Added (%)



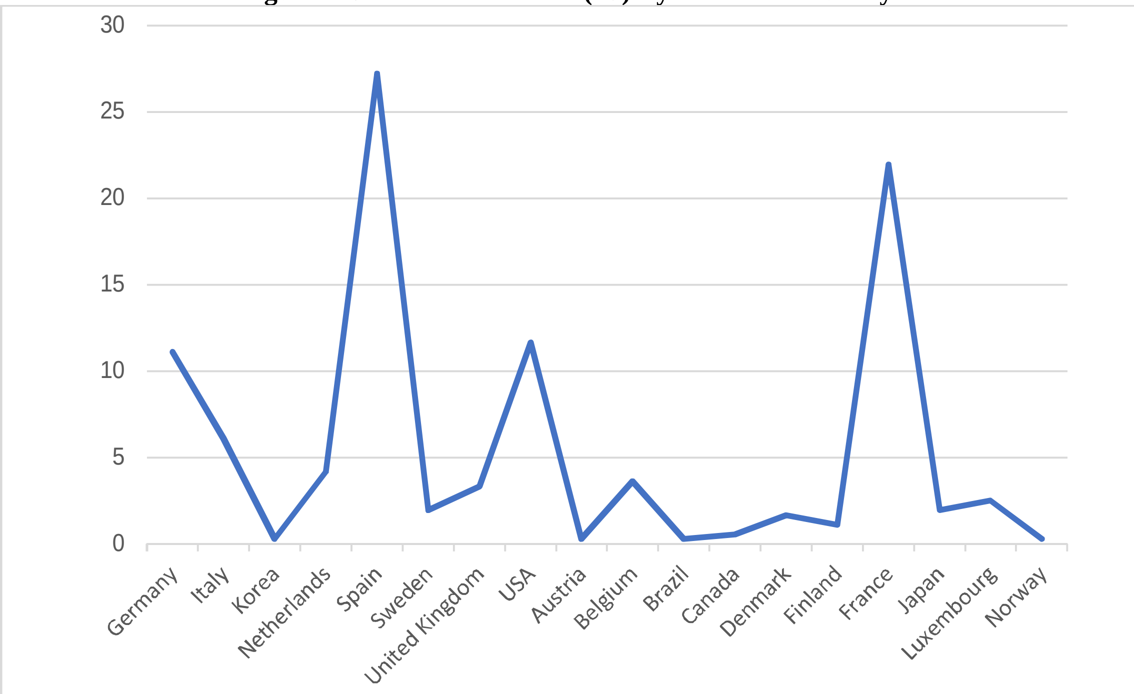
Source: author's calculations based on EUKlems database

Figure II.1- Innovative density in the Manufacturing and Services (%)



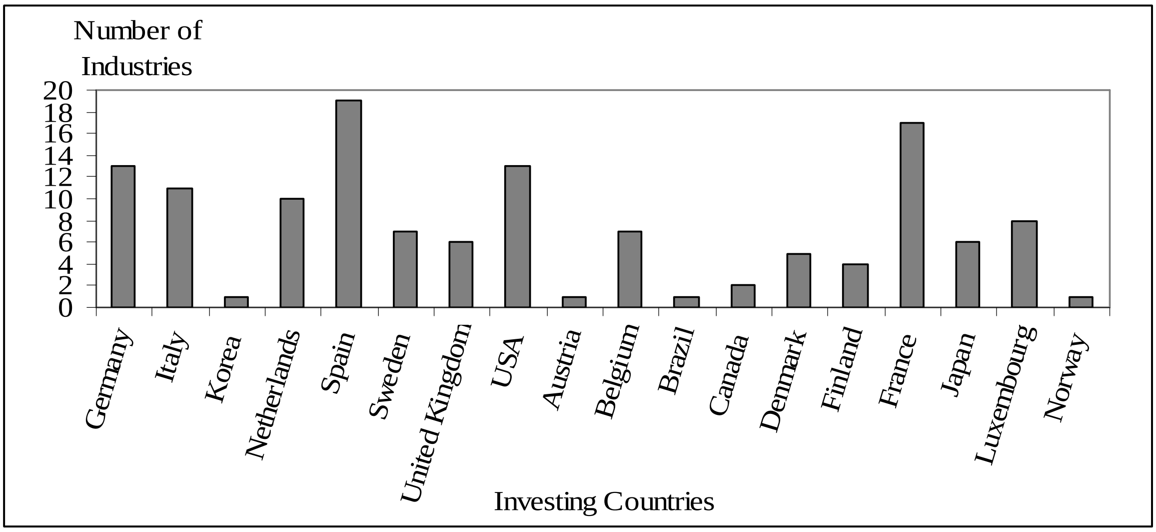
Note: The Innovative density is calculated as the share of innovative firms in each sector as a % of firms in each sector. Source: OECD based on data from Eurostat, CIS3 survey, 2004 and innovation survey of Australia, Japan, Korea and New Zealand, in Tamura et al. (2005)

Figure II.2- Share of firms (%) by investor Country



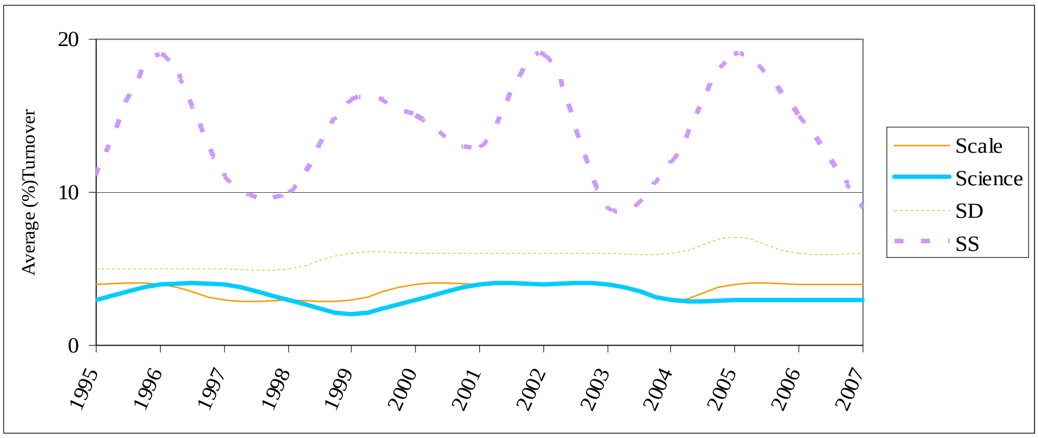
Source: author's calculations

Figure II.3- Number of industries with foreign presence, by investor country



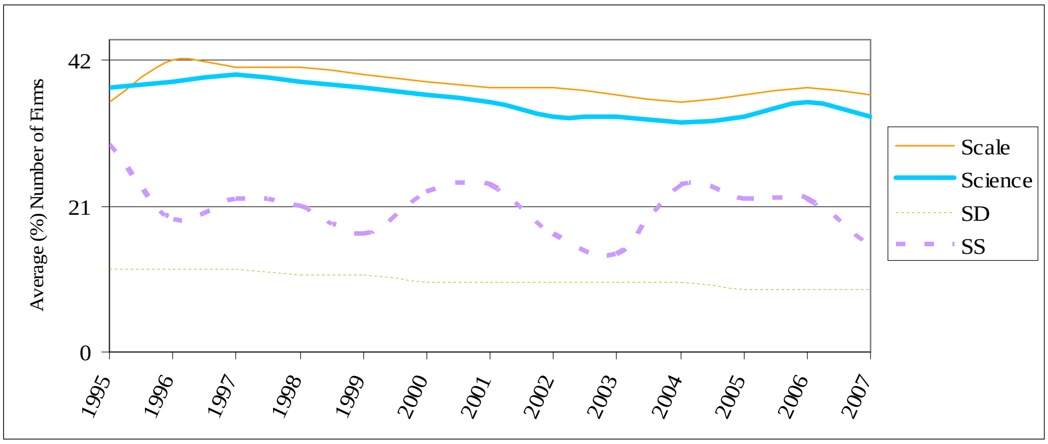
Source: author's calculations

Figure II.4-Representativeness of our database (Turnover %), by Technological groups



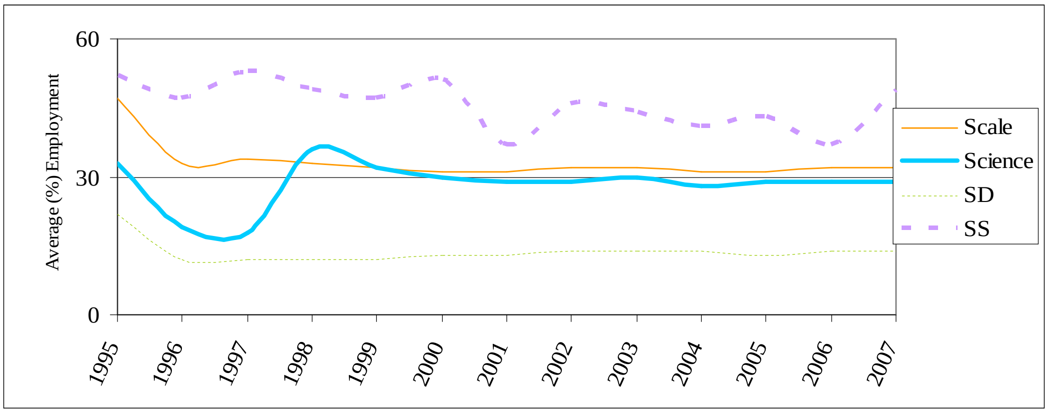
Source: author's calculations

Figure II.5-Representativeness of our database (Number of firms %), by Technological groups



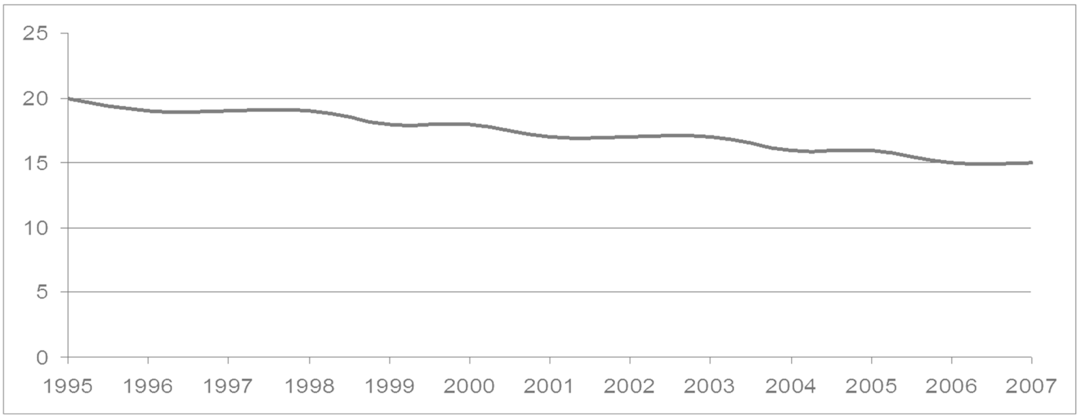
Source: author's calculations

Figure II.6-Representativeness of our database (Employment %), by Technological groups



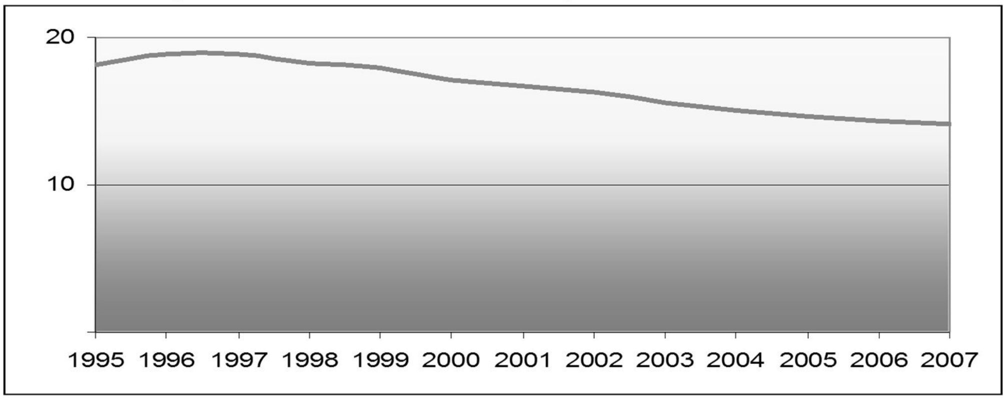
Source: author's calculations

Figure III.1- Share of Manufacturing in Total Employment (%)



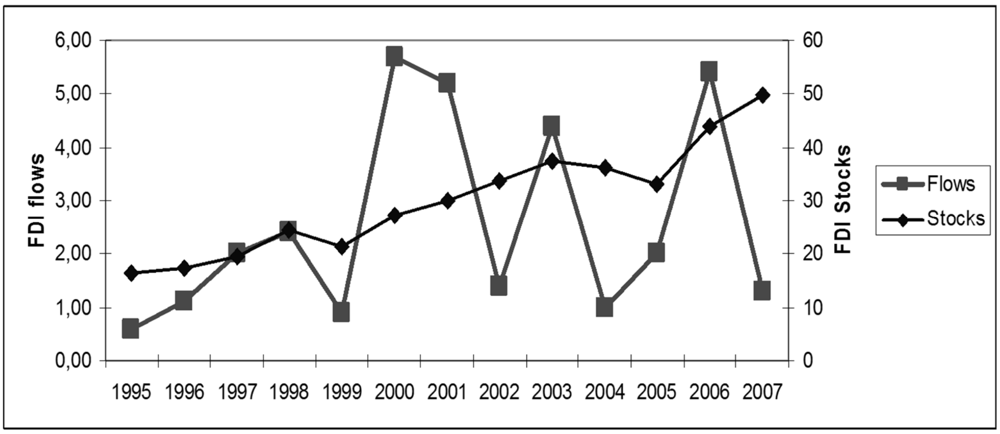
Source: National Accounts 1995-2007, INE

Figure III.2- Share of Manufacturing in Total Value Added (%)



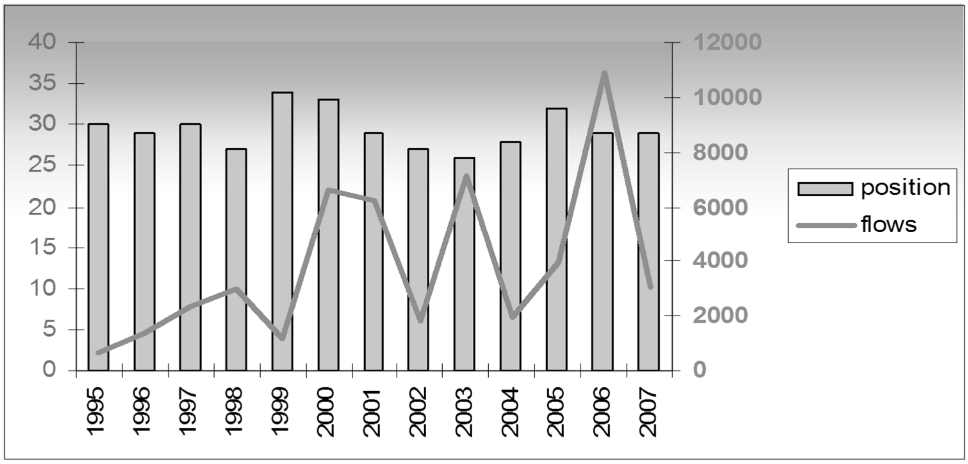
Source: National Accounts 1995-2007, INE

Figure III.3- FDI inward flows and stocks to Portugal, as a share of GDP (%)



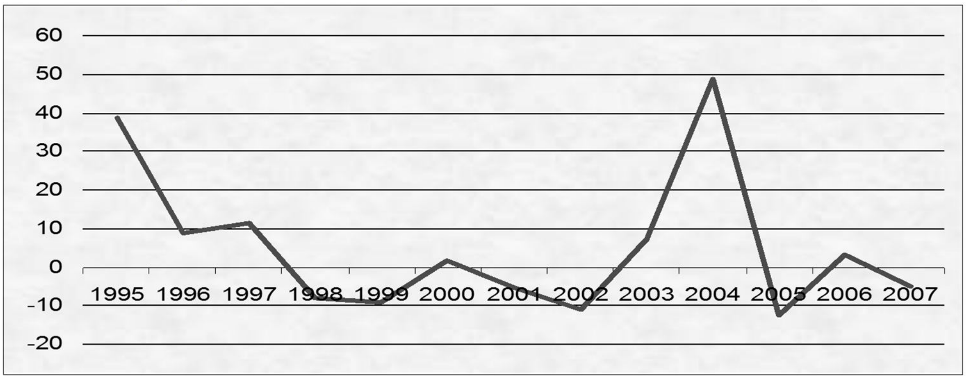
Source: OECD

Figure III.4- Inward FDI flows and Portugal's position, million dollars



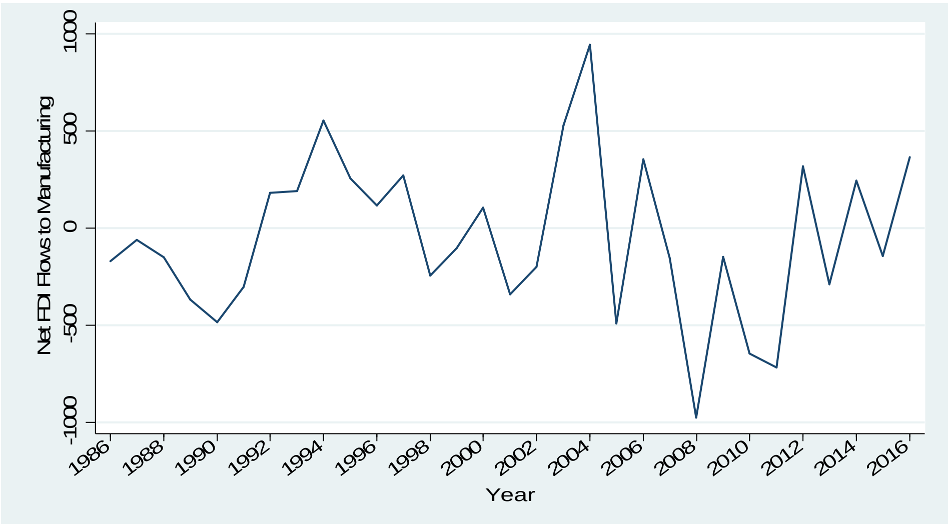
Source: UNCTAD and OECD

Figure III.5- Share of Net Inward Flows in Manufacturing (%)



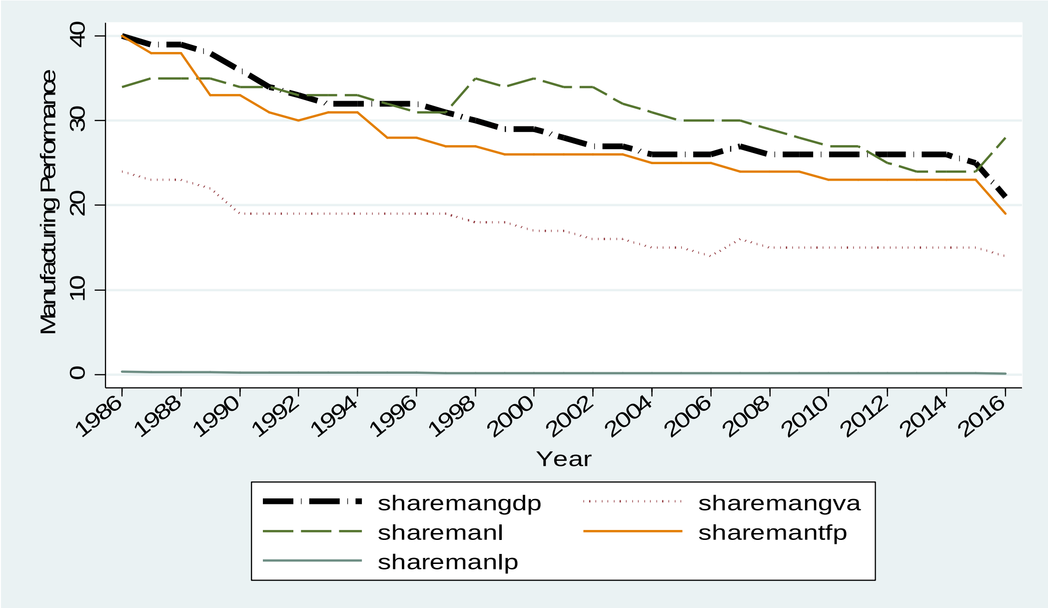
Source: OECD

Figure IV.2- Net FDI flows to Manufacturing (USD million), Portugal (1986-2016)



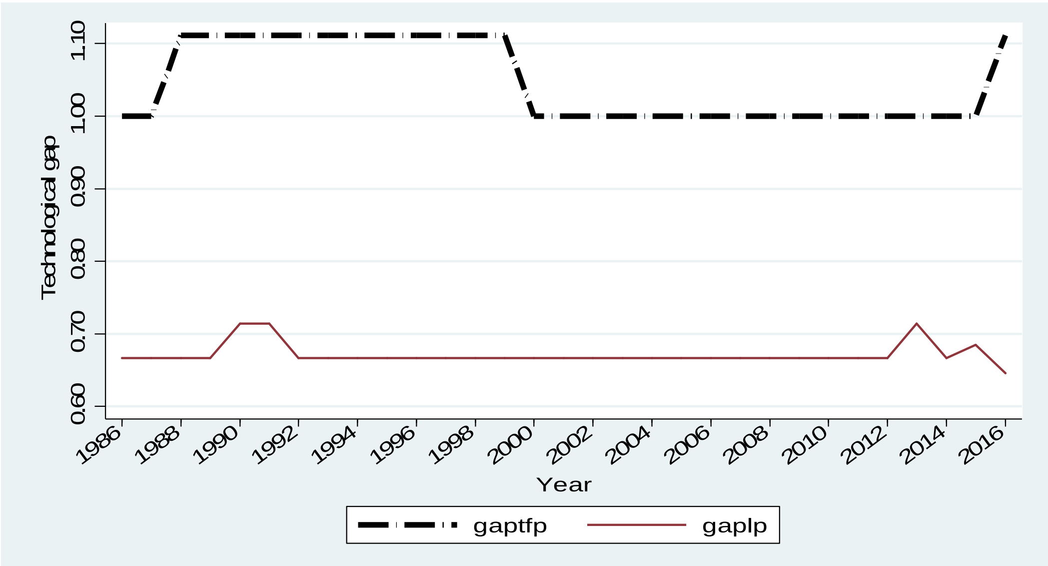
Source: Author's calculations based in OECD Stat.

Figure IV.3- Manufacturing Performance (%), Portugal (1986-2016)



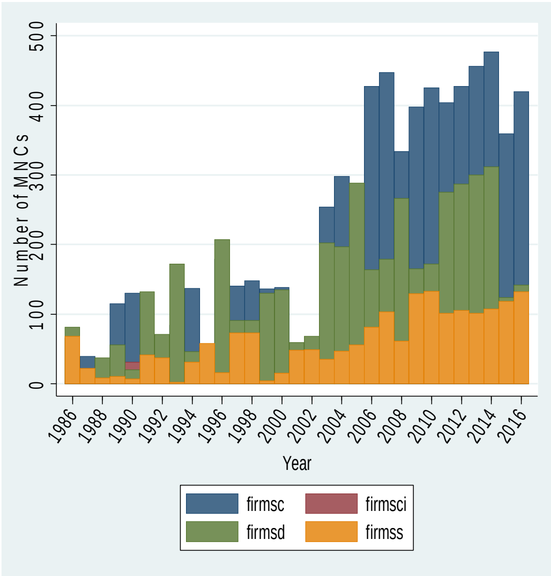
Notes: Labour productivity is the real GVA per hour worked Shareman denotes the share of manufacturing sector, gdp is gross domestic product, l is labour, lp is labour productivity, gva is gross value added and tfp is total factor productivity. Source: Total Economy Database. Groningen Growth and Development Centre.

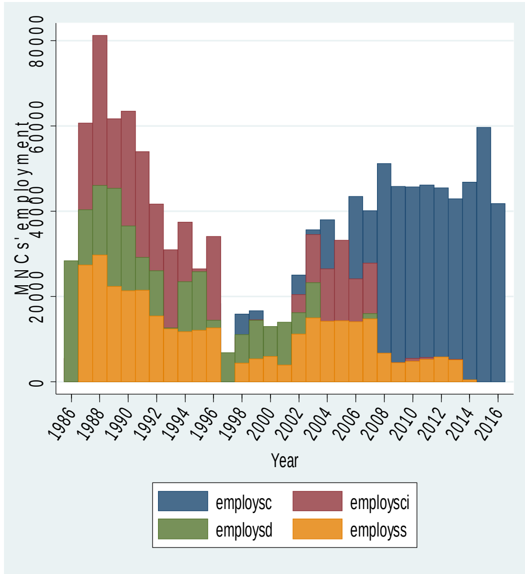
Figure IV.4- Productivity gap between the average EU-28 Countries and Portugal (1986-2016)



Notes: Lp is calculated as GDP per hour worked, USD, constant prices, 2010 PPPs and TFP is TFP level at current PPPs (USA=1). Source: Author's calculations based on OECD.Stat and Penn World Table, version 9.0

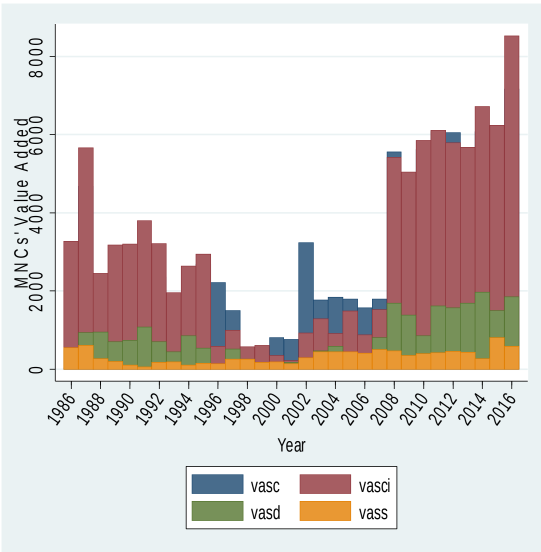
Figure IV.5 -MNCs by technological groups, Portugal (1986-2016)

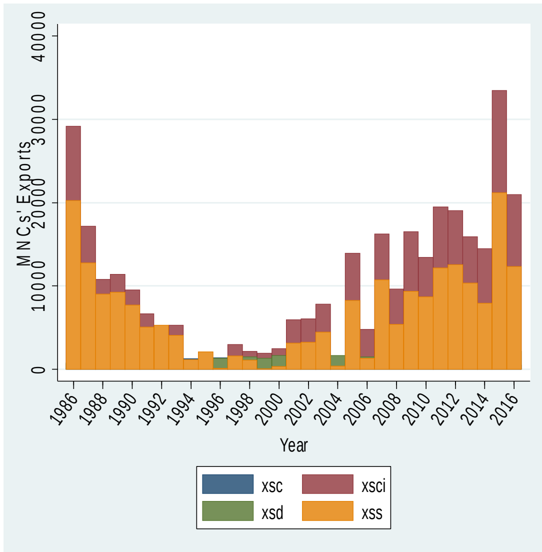




a

b



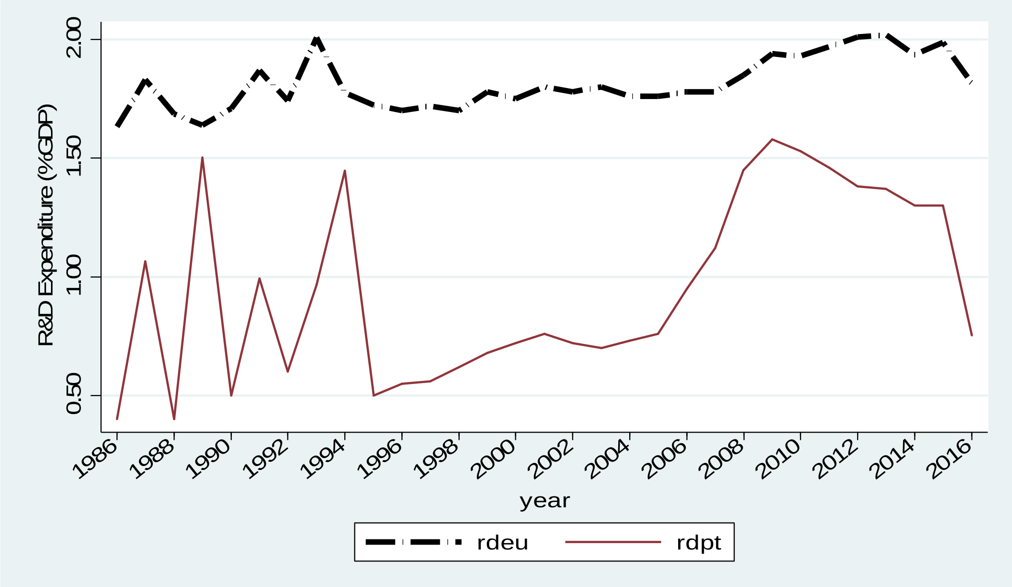


c

d

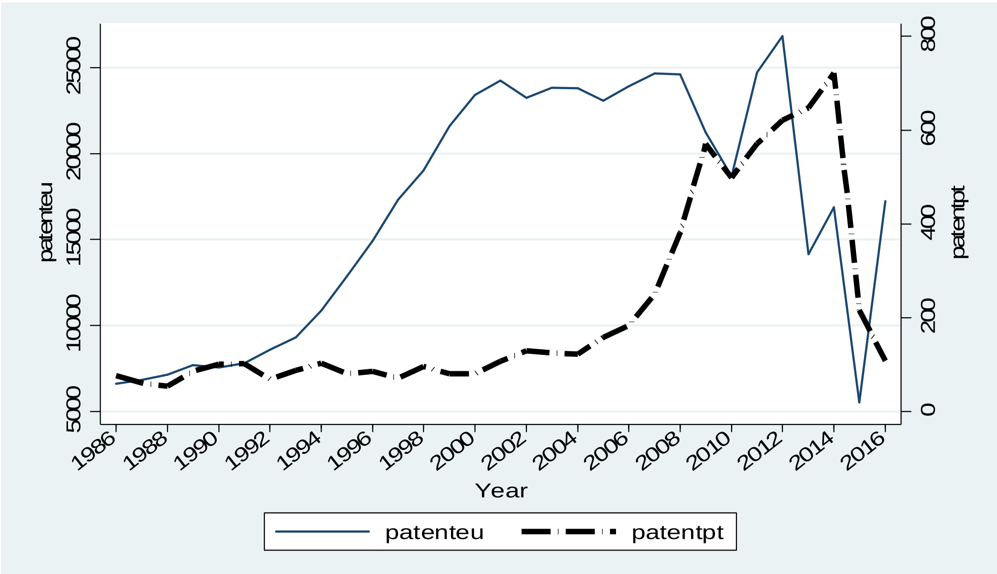
Notes: Panel a- Number of firms (*firm*), panel b-Number of employees (*employ*), panel c- Value Added (*va*) and panel d- Exports (*x*). Sc denotes scale intensive industries; sci denotes science based industries; sd denotes supplier dominated industries and ss denotes specialized suppliers industries. Nominal values are in EUR Million. Source: Author's calculations based in EUROSTAT- Foreign control of enterprises by economic activity (Portugal).

Figure IV.6-R&D Expenditure (% GDP), average EU-28 and Portugal (1986-2016)



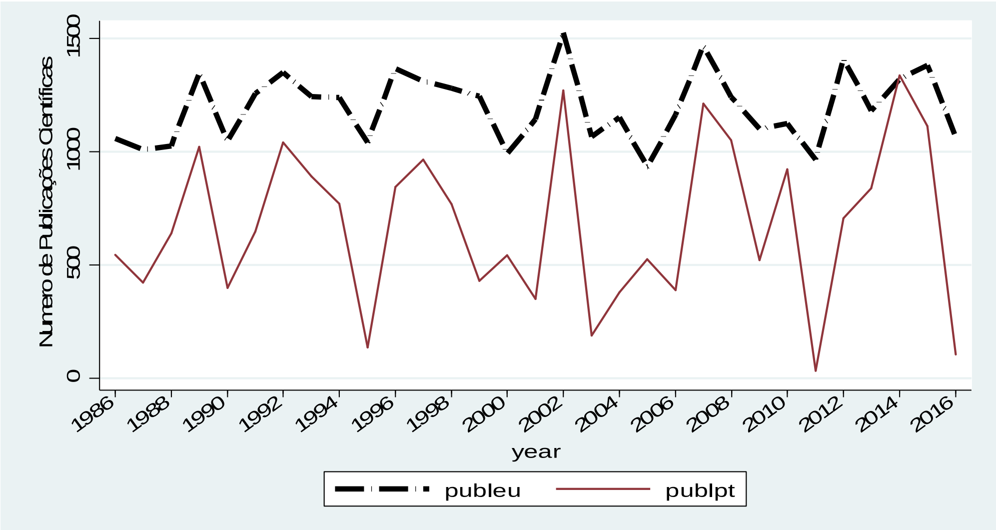
Notes: rd denotes Research & Development expenditure; eu denotes European Union and pt denotes Portugal. Source: Worldbank database (World Development Indicators).

Figure IV.7- Number of patents, average EU-28 and Portugal (1986-2016)



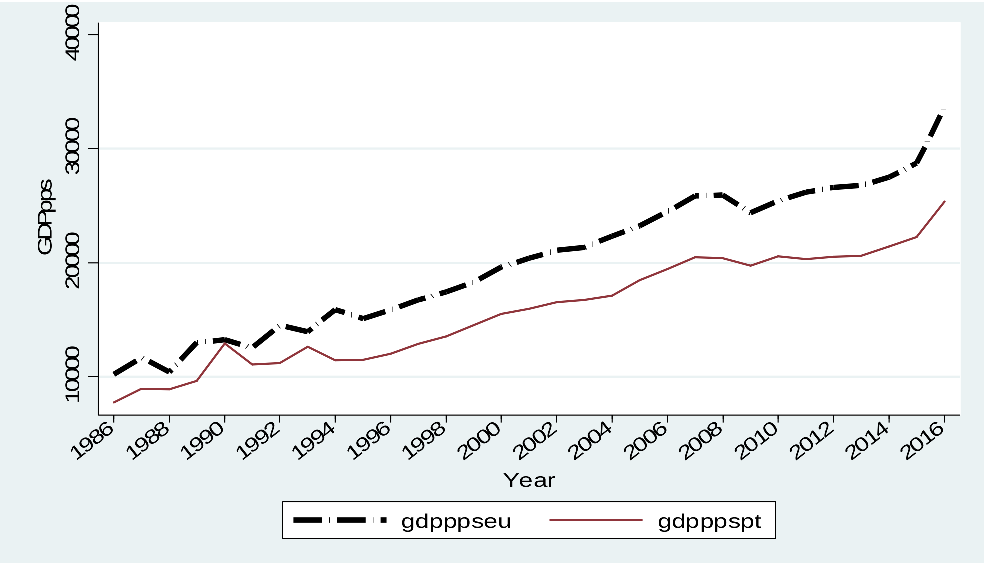
Notes: patenteu denotes patents in the European Union and patentpt denotes patents in Portugal. Source: PORDATA

Figure IV.8-Number of Publications (ISI -Web of Knowledge), average EU-28 and Portugal (1986-2016)



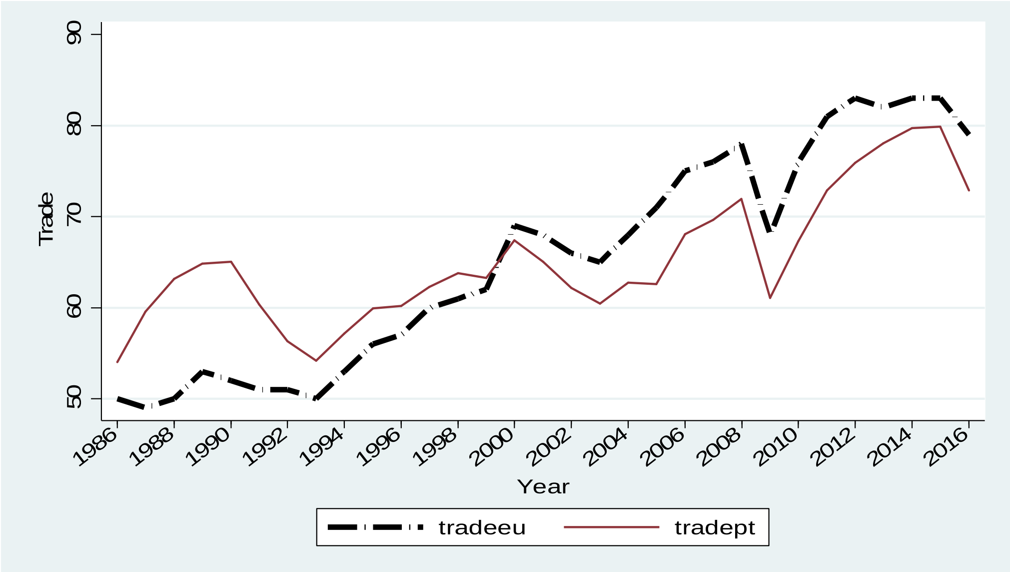
Source: OCEC, Ministry of Science and Higher Education

Figure IV.9- GDP per capita in pps, average EU-28 and Portugal (1986-2016)



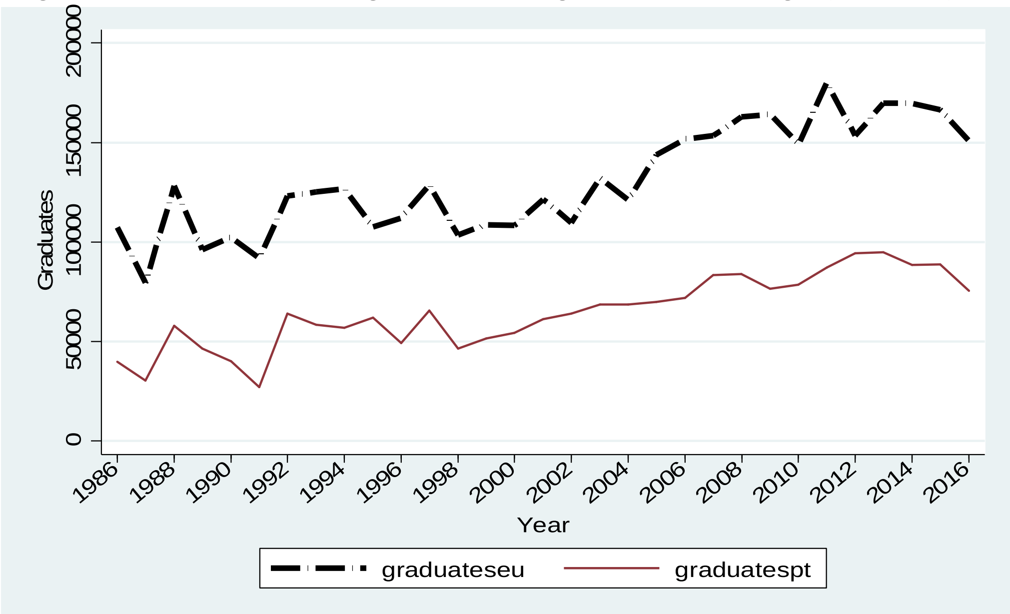
Notes: eu denotes European Union and pt denotes Portugal. Source: PORDATA

Figure IV.10- Trade (% of GDP), average EU-28 and Portugal (1986-2016)



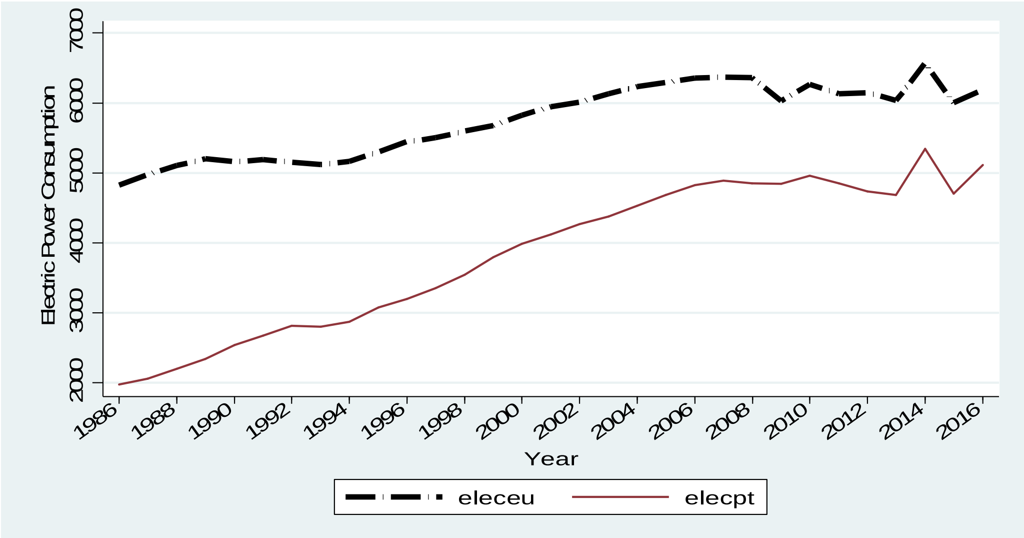
Notes: eu denotes European Union and pt denotes Portugal. Source: Worldbank database (World Development Indicators).

Figure IV.11- Total number of graduates, average EU-28 and Portugal (1986-2016)



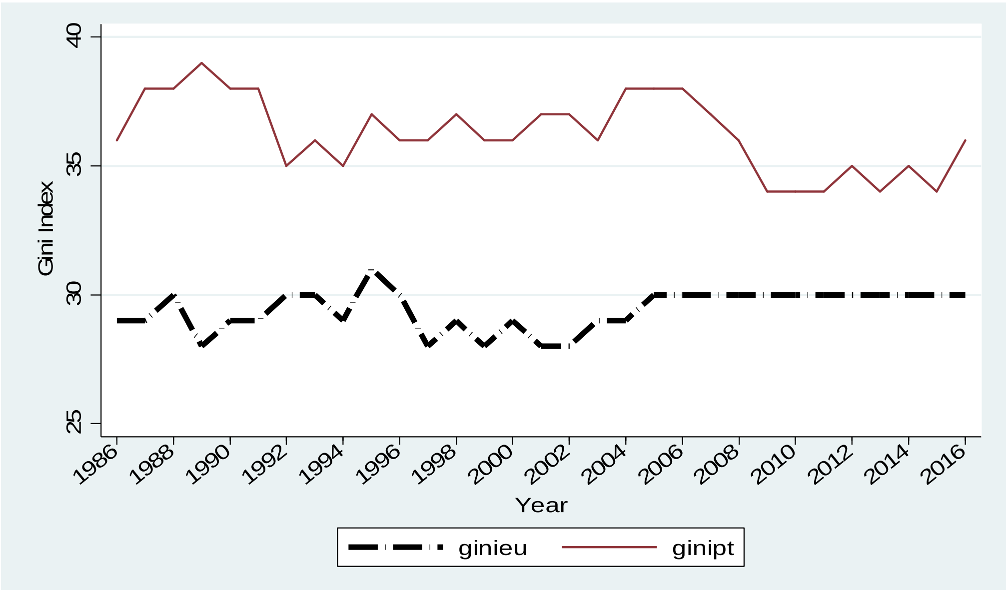
Notes: eu denotes European Union and pt denotes Portugal. Source: PORDATA

Figure IV.12-Electric Power Consumption (kWwh per capita), average EU-28 and Portugal (1986-2016)



Notes: eu denotes European Union and pt denotes Portugal. Source: Worldbank database (World Development Indicators).

Figure IV.13-Gini Index (%), average EU-28 and Portugal (1986-2016)



Notes- eu denotes European Union and pt denotes Portugal.Source: Pordata

APPENDIX B
Tables

Table I.1-Determinant factors of externalities from FDI

<table>
<tr><td rowspan="14">Internal</td><td rowspan="6">Domestic Firms</td><td>Firm size</td></tr>
<tr><td>Financial capacity</td></tr>
<tr><td>Age of firms</td></tr>
<tr><td>Age of managers</td></tr>
<tr><td>Age of workers</td></tr>
<tr><td>absorptive capacity</td></tr>
<tr><td rowspan="8">Foreign Firms</td><td>Origin of FDI</td></tr>
<tr><td>Politics on the value of the technology</td></tr>
<tr><td>Intensive use of intermediate inputs</td></tr>
<tr><td>FDI motive</td></tr>
<tr><td>Entry mode (Greenfield/ M&As)</td></tr>
<tr><td>Age of the subsidiary</td></tr>
<tr><td>Level of autonomy of the subsidiary</td></tr>
<tr><td>Size of the subsidiary</td></tr>
<tr><td rowspan="6">External</td><td rowspan="3">Industry Specific</td><td>Specialization</td></tr>
<tr><td>Agglomeration economies</td></tr>
<tr><td>Characteristics of the industry (export-oriented/ local market-oriented, market concentration, capital intensity)</td></tr>
<tr><td rowspan="3">Symbiotic</td><td>Technological Gap</td></tr>
<tr><td>Geographical proximity</td></tr>
<tr><td>Cooperation</td></tr>
</table>

Source: own analysis

Table I.2- Factors of occurrence of externalities from FDI

<table>
<tr><th>Primary</th><th>Secondary</th><th>Tertiary</th><th>Fuse</th></tr>
<tr><td>Specialization</td><td>Geographical Proximity</td><td>Agglomeration</td><td rowspan="5">Cooperation</td></tr>
<tr><td colspan="3">Age of Managers</td></tr>
<tr><td colspan="3">Origin of FDI</td></tr>
<tr><td colspan="3">Market concentration</td></tr>
<tr><td colspan="3">Capital intensity</td></tr>
<tr><td>Absorptive capacity</td><td colspan="2" rowspan="3">FDI motive/ Entry Mode</td><td rowspan="7">Intensive Use of Inputs</td></tr>
<tr><td>Size of the subsidiary</td></tr>
<tr><td>Age of Workers</td></tr>
<tr><td colspan="3">Politics on Technology</td></tr>
<tr><td colspan="3">Level of autonomy of the Subsidiary</td></tr>
<tr><td colspan="3">Age of the Subsidiary</td></tr>
<tr><td colspan="3">Age of firms</td></tr>
</table>

Source: own analysis

Table I.3- Factors of magnitude of externalities from FDI

		Vertical externalities
FDI motive		depend
Entry Mode		**-**
Absorptive capacity		+
Age of Workers		**-**
Age of firms	Financial Capacity	+
Firm size		+
Characteristics of the sector (Export-oriented/domestic market)		**(-/+)**
Technological Gap		depend

Notes: +Positive; - Negative. Source: own analysis

Table I.4-Empirical studies on FDI Externalities

Study	Pubdate	Country	Period	Methodology	Dependent Variable	Proxy for FDI	Horizontal	Backward	Forward
Ruane and Ugur	2005	Ireland	1991-1998	OLS	Labour Productivity	Employment	Ns +		
Barry et al	2005	Ireland	1990-1998	Fixed Effects	Labour Productivity	Employment	-		
Barrios et al.	2012	Ireland	1990-1995	2SLS	TFP	R&D	+		
Imbriani and Reganati	2004	Italy	1994-1996	Fixed Effects	Value Added	Employment	Ns -		
Reganati and Sica	2007	Italy	1997-2002	Fixed Effects	Value Added	Employment	Ns +	+	+
Albanese et al	2008	Italy	1999-2005	Fixed Effects	TFP	No. of Firms	+		
Farinha and Mata	1996	Portugal	1986-1992	Random effects	Labour Productivity	Employment	Ns		
Proenca et al.	2002	Portugal	1996-1998	GMM	Labour Productivity	Capital Stock	Ns		
Crespo et al.[a]	2009	Portugal	1996-2000	GMM	Labour Productivity	Employment	-	+	Ns +
Crespo et al.[a]	2012	Portugal	1996-2001	GMM	Labour Productivity	Employment	Ns-	+	Ns +
Barrios and Ströbl	2002	Spain	1990-1994	Fixed Effects	Output	Capital Stock	Ns		
Alvarez and Molero	2005	Spain	1991-1999	GMM	Growth of Productivity	Capital Stock	+		
Jabbour and Mucchielli	2007	Spain	1990-2000	OLS	Output	Capital Stock	-	+	+
Girma	2005	U.K.	1989-1999	GLS	TFP	Employment	Ns +		
Girma and Wakelin	2002	U.K.	1988-1996	GMM	Output	Employment	+		
Driffield	2004	U.K.	1983-1997	GMM	Value Added	Capital Stock	-		
Harris and Robinson	2004	U.K.	1974-1995	GMM	Value Added	Capital Stock	+	Und.	Und.
De Propis and Driffield	2006	U.K.	1993-1998	3SLS	Value Added	Capital Stock	-		
Haskel et al.	2007	U.K.	1973-1992	OLS	Output	Employment	+	+	+
Girma et al.	2008	U.K.	1992-1999	OLS	Output	Output	+	+	-

Notes: [a] Results at regional level. Pubdate- Date of Publication, +Positive; - Negative; Ns- Non Significant, Und- Undetermined. OLS- Ordinary Least Squares; 2SLS- Two-stage Least Squares; 3SLS- Three-stage Least Squares; GMM-Generalized Method of Moments. Source- Own Analysis.

Table I.5a-Variables and Proxies used in empirical studies of externalities from FDI

Variable		Proxies
Dependent	Output	Value of sales less the change in inventories, deflated
		Nominal value of production output
		Real gross output deflated by annual output price deflators
		Sales for changes in inventories of finished goods deflated by Producer Price Index
	Labour Productivity	Ratio of output to labour
	Value Added	Difference between the value of output and the intermediate inputs
Independent	Capitalistic Intensity	Total fixed assets divided by the number of workers
		Total value added divided by the number of workers
	Concentration	Total number of employees i to total employment in the sector
		Concentration is the sectoral Herfindahl concentration index.
	Human Capital	Ratio of white collar to blue collar employees
		Wage bill by the minimum wage
		Human resources devoted to science and technology activities
		Share of management personnel in total firm's employment
		Electricity consumption per employee
		Percentage of population in the region with at least secondary
	Scale	Average output of domestic firms to the average output of firms
		Establishment nominal gross output as a share of industry nominal gross output.
	Tg	Ratio of domestic firms to foreign firms' productivity
		Ratio of value added by all foreign firms to total value added

Note-TG is the technological gap. Source-Own analysis

Table I.5b-Measures of foreign presence

Variable	Proxies
Foreign presence	Change in employment in a foreign-owned plant as a share of total employment Dummy equals 1 if foreign ownership is higher than 50%. Dummy equals 1 if foreign ownership is between 10% and 50%. Foreign equity participation averaged over all firms in the sector, weighted by each firm's share in sectoral output. Ratio of turnover of foreign-owned firms to total turnover in the sector. Sectoral FDI flows Share of all foreign firms in the total output of sector Share of employment in sector accounted for by foreign-owned plants. Foreign equity participation of foreign firms Share of total employment in region accounted for by foreign-owned plants. Value of sectoral FDI flows Ratio of value added by all foreign firms to total value added in the sector

Source-Own analysis

Table I.6- Results of empirical Studies of externalities from FDI

	Havranec and Irsova (2010)			Our group of studies		
	sample =4			sample =20		
	Positive	**Negative**	**N.S.**	**Positive**	**Negative**	**N.S.**
Horizontal	3	1		11	6	3
Backward	4			6		
Forward	1	2		4	2	

Notes- N.S. is non-significant. Source: own elaboration based on Table A1 from Havranec e Irsova (2010)

Table II.1-Variables of our database

Variable	Source	Description	Units
plantid		Identification of firm	1-5045
year			1995-2007
nace		Industry codes	10-33
duf	AMADEUS	Dummy variable for nationality of capital, takes value 1 for foreign and 0 otherwise	0-1
sharefor	AMADEUS	Share of foreign capital	10-100
codec	AMADEUS	Investor Country Code	1-19
		Variables to calculate the TFP	
va	AMADEUS	Value added	Euros
l^p	AMADEUS	Production workers (unskilled) labour proxied by the Number of employees	Units
k	AMADEUS	Capital proxied by tangible assets-depreciation	Euros
mat	AMADEUS	Purchases of materials	Euros
l^{np}	QP	Non-production workers (skilled) labour proxied by average years of schooling by industry/year	*84-565*
		Variables that measure foreign presence	
horiz [a)]	Constructed	Horizontal externality measure = Total turnover of foreign firms / sectoral turnover	Units
back [a)]	Constructed	Measure of externality via backward linkages $back_{jt} = \sum_{k \neq j} \delta_{jk} * hor_{kt}$, where the Input-Otput (IO) coefficient δ_{jk} was calculated using the IO tables from OECD	Units
for [a)]	Constructed	Measure of externality via forward linkages $for_{jt} = \sum_{k \neq j} \lambda_{kj} * hor_{kt}$, where the Input-Otput (IO) coefficient λ_{kj} was calculated using the IO tables from OECD	Units
		Variables that influence the impact of FDI on the TFP of domestic firms	
hfd	Constructed	Herfindhal index indicates market concentration $H_{it} = \sum_{g \in J} \left(\frac{X_{gt}}{\sum_{g \in J} X_{gt}} \right)^2 * 100$, where g is an index for the firms (domestic or foreign) belonging to sector J to which domestic firm i belongs. X represents the output of firm g, at time t.	
rd	AMADEUS	Net Intangible assets	
mrdf	Constructed	Average net Intangible assets for foreign firms by industry/year	
s	Constructed	Measure of scale = turnover / average turnover	
kl	Constructed	Capital intensity =capital / labour	
tg	Constructed	Measure of technological gap = prod/prod for sectoral foreign leader	
prod	Constructed	Labour productivity = turnover/ number of employees	

Notes- All nominal variables are deflated by the PPI index. QP stands for Quadros do Pessoal. a) The variable *horiz* can be *hor, hoz* and *hoz1* according to the measure using turnover, tangible assets or the value added; the variable *back* is can be *b1, b2* and *bb* and the variable *for can be f1, f2* and *ff* , respectively.

Table II.2 - NACE Revision 2, Level 2 Classification

10 Manufacture of food products	22 Manufacture of rubber and plastic products
11 Manufacture of beverages	23 Manufacture of other non-metallic mineral products
12 Manufacture of tobacco products	24 Manufacture of basic metals
13 Manufacture of textiles	25 Manufacture of fabricated metal products, except machinery and equipment
14 Manufacture of wearing apparel	26 Manufacture of computer, electronic and optical products
15 Manufacture of leather and related products	27 Manufacture of electrical equipment
16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	28 Manufacture of machinery and equipment n.e.c. 29 Manufacture of motor vehicles, trailers and semi-trailers
17 Manufacture of paper and paper products	30 Manufacture of other transport equipment
18 Printing and reproduction of recorded media	31 Manufacture of furniture
19 Manufacture of coke and refined petroleum products	32 Other manufacturing
20 Manufacture of chemicals and chemical products	33 Repair and installation of machinery and equipment
21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	

Source-EUROSTAT

Table II.3- Variables of AMADEUS database

Value added	Extr. And other revenue	Other fixed assets
Adress	Financial expenses	Other non-current liabilities
Auditors	Financial P/L	Other operating expenses
Aver. Cost of empl./year (Ths.)	Financial revenue	Other shareholders funds
Board members & officers	Fixed assets	P/L for period:
CAE Rev. 3 code(s)	Gearing (%)	P/L after tax
Capital	Gross Margin (%)	P/L before tax
Cash & cash equivalent	Gross profit	P/L for period
Cash flow	Industry/activities	Per employee ratios
Cash flow/turnover (%)	Intangible fixed assets	Profit (loss) before tax
Collection period (days)	Interest cover (x)	Profit margin (%)
Costs of employees	Interest paid	Profit per employee (Ths.)
Costs of employees/oper. Rev.(%)	Legal form:	Profitability ratios
Costs of goods sold	Liquidity ratio (x)	Return on capital employed (%)
Credit period (days)	Loans	Return on shareholders funds (%)
Creditors	Long term debt	Return on total assets (%)
Current assets	Material costs	Sales
Current liabilities	Mergers and acquisitions	Secondary code(s):
Date of incorporation:	NACE code(s)	Share funds per employee (Ths.)
Debtors	Net assets turnover (x)	Shareholders funds
Depreciation	Net current assets	Shareholders liquidity ratio (x)
Ebit	Non current liabilities	Solvency ratio (%)
Ebit margin (%)	Number of employees	Stock turnover (x)
Ebitda	Operat. Rev. Per employee (ths.)	Stocks
Ebitda margin (%)	Operating revenue/turnover:	Tangible fixed assets
Employees	Operating P/L	Taxation
Export turnover	Operating revenue / turnover	Total assets
Export turnover/Total turnover (%)	Operational ratios	Total assets per employee (Ths.)
Extr. and other expenses	Other current assets	Total shareh. funds & liab.
Extr. and other P/L	Other current liabilities	Work. capital per employee(Ths.)

Source-AMADEUS

Table II.4- Most used dependent variables and proxies in the literature

Dependent Variable	Proxies
Gross output (level, growth)	Turnover or sales deflated by the index of output prices
Value added	Difference between the value of output and intermediate material inputs
TFP or labour productivity	TFP; Turnover or sales (deflated by the index of output prices) divided by the number of employees; Difference between the value of output and intermediate material inputs divided by the number of employees

Source-own analysis

Table II.5– Most used proxies for the variable hor in the literature

	Proxies
Foreign presence (Horizontal externality)	The share of assets owned by MNCs The share of foreign capital in firms' capital The share of foreign employment in the sector The share of MNCs sales in the sector The MNCs Value added

Source-own analysis

Table II.6- Most used control variables and proxies in the literature

Variables	Proxies
Skilled labour	Total salaries and training costs; ratio of skilled workers on the number of unskilled workers; gross enrollment rate in higher education (or high school)
Technological gap	Ratio of turnover (sales) of firm i on the turnover (sales) of the foreign firm regarded as a leader in the respective industry
Capital intensity	Ratio of fuel and electricity on total employment
Concentration index	Herfindhal
Scale	Turnover on the average sales in the industry
R&D activities	R & D expenditures;R & D expenditures in the private sector as a % of GDP

Source-own analysis

Table II.7- Basic statistics

(obs=65585)

	Mean	Std.Dev.	Min	Max	Skewness	Kurtosis
			Variables to estimate the TFP			
va	10.98	1.49	6.86	19.59	0.33	2.42
l^p	2.56	1.36	0.00	8.20	0.34	2.24
k	1.24	1.92	6.90	20.90	0.64	3.27
mat	12.71	1.54	7.29	21.63	0.29	2.53
l^{np}	5.95	0.21	4.00	6.00	-4.39	20.46
			Variables of foreign presence			
hor	-3.63	1.80	-7.44	-0.04	-0.71	2.74
b1	-7.86	2.88	-14.23	-0.26	-0.34	3.26
f1	-8.19	2.98	-14.27	-0.40	-0.32	3.01
hoz	-3.61	2.39	-9.34	-0.10	-1.23	3.55
b2	-7.84	3.28	-16.03	-0.49	-0.96	4.08
f2	-8.17	3.55	-15.97	-0.51	-0.83	3.31
hoz1	-3.69	1.82	-7.38	-0.06	-0.65	2.60
bb	-7.92	2.80	-14.11	-0.30	-0.35	3.40
ff	-8.26	3.00	-14.11	-0.38	-0.33	2.95
			Interaction Variables			
hor*hfd	-8.09	2.29	-13.37	-2.94	-1.09	3.39
hor*rd	3.20	2.30	-3.08	11.23	0.26	2.46
hor*mrdf	3.52	2.36	-1.13	9.93	0.07	2.01
hor*s	-5.37	2.13	-12.27	3.92	0.04	2.56
hor*kl	6.45	1.74	-1.81	13.44	0.11	2.90
hor*tg	-4.50	1.77	-8.88	-0.04	-0.70	2.78
b1*hfd	-12.32	3.23	-20.03	-4.24	-0.74	3.86
b1*rd	-1.03	3.10	-9.91	11.08	0.24	2.79
b1*mrdf	-0.71	3.21	-7.32	9.77	-0.05	2.71
b1*s	-9.60	3.03	-18.99	0.63	0.13	2.81
b1*kl	2.22	2.79	-8.45	12.57	0.25	3.36
b1*tg	-8.73	2.82	-15.67	-0.26	-0.32	3.32
f1*hfd	-12.66	3.45	-20.09	-4.13	-0.67	3.30
f1*rd	-1.37	3.03	-9.84	11.00	0.24	2.84
f1*mrdf	-1.04	3.29	-7.35	9.70	0.01	2.62
f1*s	-9.94	2.94	-18.93	0.72	0.09	2.76
f1*kl	1.88	2.72	-8.44	12.12	0.17	3.37
f1*tg	-9.06	2.94	-15.73	-0.49	-0.32	3.08
hoz*hfd	-8.08	2.98	-15.27	-2.48	-1.33	3.71
hoz*rd	3.21	2.59	-4.82	11.54	0.04	2.61
hoz*mrdf	3.54	2.79	-2.44	10.23	-0.42	2.46
hoz*s	-5.35	2.48	-13.94	4.38	-0.30	2.77
hoz*kl	6.46	2.13	-3.71	14.32	-0.66	3.46
hoz*tg	-4.48	2.38	-10.64	-0.21	-1.18	3.50

Notes-va is value added, lp and lnp are labour; k is capital and m are materials; hor, hoz and hoz1 are measures of horizontal externalities; and b1, b2 and bb, and f1, f2 and ff are measures of vertical externalities; hfd is concentration, rd and mrdf are R&D expenses of domestic and foreign firms, respectively; s is scale, kl is capital intensity and tg is the technological gap. Lower cases denote variables in logs. Source: own calculations in Stata 13.0.

Table II.7- Basic statistics (cont.)

	Mean	Std.Dev.	Min	Max	Skewnes	Kurtosis
			Interaction Variables			
b2*hfd	-12.31	3.75	-21.91	-4.00	-1.17	4.39
b2*rd	-1.02	3.32	-11.72	11.38	-0.16	3.15
b2*mrdf	-0.69	3.54	-9.13	10.08	-0.56	3.37
b2*s	-9.58	3.28	-20.78	0.96	-0.38	3.23
b2*kl	2.23	3.05	-10.36	12.91	-0.45	3.96
b2*tg	-8.71	3.24	-17.42	-0.49	-0.92	4.09
f2*hfd	-12.64	4.10	-21.90	-4.02	-1.04	3.50
f2*mrdf	-1.02	3.79	-9.07	10.00	-0.48	2.88
f2*s	-9.92	3.40	-20.70	1.05	-0.31	2.97
f2*kl	1.90	3.19	-10.34	12.78	-0.42	3.54
f2*tg	-9.04	3.53	-17.49	-0.64	-0.82	3.34
hoz1*hfd	-8.16	2.32	-13.29	-3.27	-1.02	3.21
hoz1*rd	3.13	2.32	-3.00	11.20	0.28	2.47
hoz1*mrdf	3.46	2.38	-0.88	9.89	0.10	1.98
hoz1*s	-5.44	2.09	-12.12	3.99	0.07	2.59
hoz1*kl	6.38	1.74	-1.72	13.43	0.14	2.88
hoz1*tg	-4.56	1.80	-8.87	-0.06	-0.64	2.63
bb*hfd	-12.39	3.17	-19.96	-4.10	-0.71	3.93
bb*rd	-1.10	3.03	-9.79	11.04	0.20	2.85
bb*mrdf	-0.77	3.14	-7.25	9.73	-0.04	2.84
bb*s	-9.67	2.91	-18.93	0.65	0.07	2.75
bb*kl	2.15	2.70	-8.45	12.40	0.20	3.43
bb*tg	-8.79	2.75	-15.68	-0.30	-0.32	3.45
ff*hfd	-12.72	3.48	-19.95	-3.99	-0.68	3.23
ff*rd	-1.43	3.06	-9.72	10.97	0.23	2.81
ff*mrdf	-1.11	3.32	-7.23	9.66	-0.01	2.59
ff*s	-10.00	2.93	-18.92	0.74	0.12	2.74
ff*kl	1.82	2.74	-8.37	12.08	0.15	3.33
ff*tg	-9.13	2.97	-15.76	-0.51	-0.34	3.02
f2*hfd	-12.64	4.10	-21.90	-4.02	-1.04	3.50
			Control variables			
hfd	-4.47	0.76	-6.57	-0.06	-0.46	3.61
rd	6.82	1.75	2.57	13.15	0	2.21
mrdf	7.15	1.00	5.26	10.88	0	2.64
s	-1.74	1.81	-8.48	7.40	0	2.90
tg	-0.87	0.45	-4.20	0	7	-0.89
kl	10.07	1.11	5.59	17.30	1	5.17

Table II.8- Classification of industries by technological groups, Portugal

Scale intensive	Specialized suppliers	Science based	Supplier dominated
NACE codes- 10,11,12,19,22,23,24,25,29 and 30	NACE codes-28,32 and 33	NACE codes-20,21,26 and 27	NACE codes-13,14,15,16,17,18 and 31
Food, Beverages and Tobacco, Coke And Refined Petroleum, Rubber and Plastics, Other Non-Metallic Minerals, Basic Metals, Fabricated Metal Products, Motor Vehicles and Other Transport Equipment	Machinery and Equipment, Other Manufacturing and Repair and Installation of Machinery and Equipment	Chemicals, Pharmaceuticals, Computer and Electronics and Electrical Equipment	Textiles, Wearing Apparel, Leather, Wood, Paper, Printing and Reproduction of Recorded Media and Furniture

Source: own analysis based on Pavitt (1984), O'Mahony and Van Ark (2003); and Bogliacino and Pianta (2010)

Table II.9- Correlation coefficients between the control variables and the productivity growth, for the manufacturing sector and by technological groups

	hfd	rd	mrdf	s	tg	kl
Manufacturing sector	-0.0562*	-0.0987*	0.0488*	-0.1250*	-0.4021*	-0.1942*
Scale intensive	-0.0137	-0.0530*	0.0860*	-0.0761*	-0.3336*	-0.1895*
Specialized suppliers	0.0715*	-0.2686*	-0.0608*	-0.2989*	-0.6536*	-0.3247*
Science based	-0.0390*	-0.2396*	0.0766*	-0.1167*	-0.3297*	-0.6765*
Supplier dominated	-0.1469*	-0.1066*	0.0778*	-0.1836*	-0.3513*	-0.3105*

Note-variables are in logs. * denotes significance level of 0.05. Correlation only for domestic firms. Source: Own calculations in Stata 13.0

Table II.10- Correlation coefficients between measures of foreign presence and the productivity growth, for the manufacturing sector and by technological groups

	Measure of foreign presence	horiz	back	for
Manufacturing sector	Turnover	0.1451*	0.0891*	0.0805*
	Capital	0.0583*	0.0413*	0.0334*
	Value Added	0.1280*	0.0820*	0.0705*
Scale intensive	Turnover	0.2226*	0.2567*	0.2605*
	Capital	0.2127*	0.2619*	0.2659*
	Value Added	0.1975*	0.2483*	0.2522*
Specialized suppliers	Turnover	0.2776*	0.1388*	0.2428*
	Capital	0.1510*	0.0868*	0.1506*
	Value Added	0.2603*	0.1373*	0.2246*
Science based	Turnover	0.3164*	0.0056	-0.0368*
	Capital	0.3398*	-0.0884*	-0.2137*
	Value Added	0.3065*	0.0008	-0.0431*
Supplier dominated	Turnover	0.2313*	0.1052*	0.1123*
	Capital	0.2223*	0.1088*	0.1168*
	Value Added	0.2198*	0.0980*	0.1050*

Note-variables are in logs. * denotes significance level of 0.05. Correlation only for domestic firms. Source: Own calculations in Stata 13.0

Table III.1a- Minimum and maximum shares of foreign capital by industry

Industry	Mean	St.Dev	Min.	Max.	Industry	Mean	St.Dev	Min.	Max.
10	53	20.99	12	87	**22**	61	20.79	32	93
11	47	24.86	10	86	**23**	61	25.11	22	100
12	46	6.24	39	54	**24**	50	24.09	14	94
13	52	28.09	20	100	**25**	57	23.89	18	100
14	73	19.64	41	99	**26**	55	20.74	37	95
15	41	26.57	15	100	**27**	48	19.29	20	100
16	31	20.50	10	59	**28**	67	22.36	19	94
17	66	23.21	28	99	**29**	51	24.55	16	100
18	55	25.80	22	100	**30**	46	0.00	46	46
19	23	0.00	23	23	**31**	57	31.87	23	99
20	69	23.36	24	100	**32**	57	10.48	41	75
21	66	22.03	24	100	**33**	52	22.00	30	85

Source: own calculations on Stata 13.0.

Table III.1b- Summary statistics for foreign and domestic firms

Total number of firms	5045
Fully domestic firms	4685
percent of total	93%
Firms with foreign share	360
percent of total	7%
Means for domestic firms	
TFP	5,152
Capital	2,657,802
Labour	34
Means for foreign firms	
TFP	7,691
Capital	1,162,430
Labour	24

Source: own calculations on Stata 13.0

Table III.2- Effect of FDI on the TFP growth of domestic manufacturing firms (aggregate level)

	(1)			(2)		
	hor	**b1**	**f1**	**hor**	**b1**	**f1**
tfp_{t-1}	-0.184***	-0.238***	-0.096***	-0.368***	-0.463***	-0.259***
	(-12.69)	(-15.82)	(-20.40)	(-20.74)	(-20.98)	(-21.86)
f_t	0.00699	0.0609***	0.0320**	-1.535***	-0.0609***	-0.0113
	(0.40)	(6.37)	(2.85)	(-9.97)	(-13.59)	(-0.68)
f_{t-1}	0.0847***	0.0549***	-0.00617	-0.0800	0.0629***	0.306***
	(4.11)	(5.30)	(-0.46)	(-0.66)	(11.32)	(4.89)
f_{t-2}	0.0304***	0.00706	0.0264**	-2.294***	-0.0835***	-0.777***
	(3.48)	(1.00)	(3.22)	(-3.61)	(-3.35)	(-4.90)
f*hfd				-2.060*	-0.170***	0.228***
				(-2.34)	(-13.99)	(3.69)
f*tg				1.834*	-0.138	0.00299
				(2.03)	(-3.69)	(0.13)
f*s				0.147*	0.100***	-0.195***
				(1.99)	(9.86)	(-4.10)
f*mrdf				0.0484	0.0291***	-0.0630***
				(0.99)	(5.57)	(-3.82)
hfd	0.203***	-0.00859	0.123***		1.078***	-0.757**
	(4.38)	(-0.16)	(3.34)		(14.76)	(-2.87)
kl	0.692***	0.428***	0.528***			0.467***
	(10.56)	(7.18)	(13.45)			(4.61)
tg	0.251***	0.630***	0.403***	-1.369	0.198***	0.180
	(4.18)	(9.98)	(9.37)	(-1.74)	(14.72)	(1.86)
1998	0.0492	-0.118***	-0.0379***	0.197*	0.203***	0.279***
	(1.72)	(-5.92)	(-3.41)	(2.30)	(13.68)	(7.54)
1999	0.0177	-0.0612**	-0.0354**	-0.0676	-0.0413***	0.235***
	(1.19)	(-3.19)	(-2.61)	(-0.72)	(-3.75)	(5.11)
2000	-0.00573	-0.0269**	0.00715	-0.0610	0.181***	0.125***
	(-0.13)	(-2.68)	(0.73)	(-1.04)	(16.61)	(5.02)
2001	-0.0294*	-0.0639***	0.00454	-0.376***	0.0382***	0.107***
	(-2.11)	(-6.94)	(0.37)	(-3.75)	(3.85)	(5.73)
2002	-0.0372***	-0.0910***	-0.0362***	0.196*	0.0379**	0.190***
	(-3.96)	(-4.78)	(-3.79)	(2.01)	(3.17)	(6.34)
2003	0.0376**	-0.158***	0.00611	0.190*	0.233***	0.293***
	(3.04)	(-4.39)	(0.49)	(2.48)	(15.80)	(7.29)
2004	0.0268**	-0.154***	0.0229	0.226	0.189***	0.442***
	(2.69)	(-5.13)	(1.58)	(1.62)	(9.45)	(5.84)
2005	-0.0407***	-0.233***	0.0260**	0.0666	0.0803***	-0.0181
	(-3.56)	(-6.98)	(2.60)	(0.98)	(7.56)	(-0.60)
2006	-0.0641***	-0.100***	-0.0371***	-0.128	0.0385**	0.342***
	(-4.88)	(-5.50)	(-3.40)	(-1.28)	(2.66)	(5.27)
cons	0.00511	-0.0639***	-5.271***	-0.0143	-0.0792***	-0.202***
	(1.74)	(-6.34)	(16.28)	(-0.22)	(-7.41)	(-6.46)
N	46850	46850	46850	46850	46850	46850
AR(2)	0.881	0.138	0.184	0.123	0.486	0.561
Hansen	0.067	0.399	0.370	0.653	0.257	0.196
Instruments	26	26	26	25	25	25
Wald	2567.54	4099.73	3635.39	725.57	7524.37	4971.31

Notes- hor is the measure of horizontal externalities and b1 and f1 are measures of vertical externalities; hfd is concentration, mrdf is the R&D expenses of foreign firms; s is scale, kl is capital intensity and tg is the technological gap. cons is the constant. Lower cases denote variables in logs. t-1 is one-period lag and t-2 is two-period lag. Missing values were omitted due to collinearity. Models 1 and 2 (without and with interaction variables) use measure 1 of foreign presence (turnover). z statistics in parentheses * $p<0.05$, ** $p<0.01$, *** $p<0.001$. Source: own calculations in Stata 13.0.

Table III.3- Horizontal Externalities by Technological groups (scale intensive industries)

Industry	Food	Beverages	Rubber and Plastics	Non-metallic Minerals	Basic Metals	Metal Products	Motor Vehicles	Other Transport Equipment
tfp_{t-1}	-0.910*	-0.721***	-0.325*	-0.0218	-0.00186	0.0799	-0.0650	-0.0368
	(-2.05)	(-2.39)	(-2.51)	(-0.48)	(-0.05)	(0.18)	(-1.39)	(-0.07)
hor_t					-0.00000687			
					(-0.12)			
hor_{t-1}	-0.00068		0.000789*	-0.0000132	-0.00000344	-0.00236	0.0000351	0.000011
	(-0.82)		(2.03)	(-0.28)	(-0.04)	(-0.37)	(-0.15)	(-0.02)
hor_{t-2}	-0.000806		0.000351	-0.00000361	-0.00000292	-0.00198	-0.000259	-0.000439
	(-1.03)		(0.65)	(-0.09)	(-0.04)	(-0.67)	(-1.15)	(-0.68)
hor*hfd			-0.0121***	0.00700				-0.0114
			(-6.53)	(0.18)				(-1.92)
hor*tg	-0.0000568			-0.00842***	-0.00845***	-0.00691***	-0.00900***	
	(-0.24)			(-3.84)	(-9.31)	(-4.92)	(-10.90)	
hor*s		0.0111***	0.0121***	0.00143	0.00846***		0.00906***	0.0115
		(-2.92)	(-6.54)	(-0.04)	(8.86)		(-11.26)	(1.90)
hor*mrdf	0.000105	-0.0000304	-0.0000368	-0.0000119	-0.000000246	0.00689***	-0.0000545	
	(-0.42)	(-0.22)	(-0.75)	(-0.28)	(-0.05)	(-4.91)	(-1.24)	
tg	0.00326	-0.00831**	-0.0100***				0.000175	-0.0100
	(-0.46)	(-3.87)	(-6.45)				(-0.67)	(-0.45)
Year	yes	yes	yes	yes	yes	yes	yes	yes
cons	-0.0289***	0.444***	0.323***	-0.000773	0.00714	-0.0358	-0.270***	0.375***
	(-4.23)	(2.43)	(4.78)	(-0.82)	(-1.58)	(0.59)	(-4.70)	(-5.97)
N	3 470	1 050	300	1 690	2 080	520	1 630	780
AR(2)	0.333	0.291	0.835	0.699	0.962	0.329	0.125	0.953
Hansen	0.290	0.512	0.142	0.310	0.629	0.739	0.490	0.251
instruments	28	25	28	27	28	28	28	28
Wald	1.12e+09	6.64e+07	8.34e+08	1.91e+06	2.73e+08	3.15e+09	1.67e+09	3.77e+07

Notes- hor is the measure of horizontal externalities and b1 and f1 are measures of vertical externalities; hfd is concentration, mrdf is the R&D expenses of foreign firms; s is scale, kl is capital intensity and tg is the technological gap, cons is the constant. Lower cases denote variables in logs; t-1 refers to one-period lag, and t-2 refers to two-period lag. Missing values were omitted due to collinearity. Omitted industries failed to satisfy AR(2) and/or Hansen tests; z statistics in parentheses * p<0.05, ** p<0.01, *** p<0.001. Source: own calculations in Stata 13.0.

Table III.4- Externalities via Backward Linkages by Technological groups (scale intensive industries)

Industry	Food	Beverages	Rubber and Plastics	Non-metallic Minerals	Basic Metals	Metal Products	Motor Vehicles	Other Transport Equipment
tfp_{t-1}	0.0251	-0.0157	0.306	-0.0337	-0.0463	-0.00499*	-2.005	-0.0754
	(-0.88)	(-1.13)	(-0.64)	(-0.17)	(-0.50)	(-2.24)	(-0.07)	(-0.28)
$b1_t$				-0.00171			-0.0567***	
				(-0.01)			(-4.62)	
$b1_{t-1}$	0.0000533	-0.189***	0.000885	0.000939	-0.0000293	-0.0000103	0.00594	-0.000662
	(-1.68)	(-5.08)	(-0.03)	(-0.51)	(-0.52)	(-0.70)	(-0.87)	(-0.59)
$b1_{t-2}$	0.0000657		-0.00146	-0.0000232	-0.0000455	-0.000000309	-0.00116	-0.000405
	(-1.27)		(-0.04)	(-0.09)	(-0.40)	(-0.05)	(-0.29)	(-0.41)
b1t*hfd	0.0000822		0.0101					
	(-0.76)		(-0.62)					
b1t*tg	-0.00860***	0.187***	-0.00967		-0.00819***	-0.00846***		
	(-8.41)	(6.84)	(-0.71)		(-6.47)	(-5.20)		
b1t*s	0.00850***	0.00690***		-0.00140	0.00820***	0.00847***	0.0562***	-0.114
	(-4.65)	(-8.9)		(-0.67)	(-6.73)	(-8.21)	(-4.69)	(-0.13)
b1t*mrdf	0.0000197			0.00313	-0.00000908	-0.0000108		0.113
	(-0.97)			(-0.01)	(-0.17)	(-0.74)		(-0.98)
tg		-0.193***		-0.00850***			-0.0565***	-0.00878***
		(-5.83)		(-4.19)			(-4.59)	(-7.59)
Year	yes	yes	yes	yes	yes	yes	yes	yes
cons	-0.607***	-0.170***	-0.303	0.271**	-0.00838***	0.000280***	-0.0339	-0.265*
	(-3.65)	(-61.0)	(-0.24)	(3.02)	(-8.69)	(-8.18)	(-0.04)	(-1.98)
N	3 470	1 050	300	1 690	2 080	520	1 630	780
AR(2)	0.150	0.485	0.125	0.359	0.164	0.290	0.625	0.843
Hansen	0.360	0.950	0.956	0.547	0.292	0.166	0.184	0.925
instrument	26	23	26	25	25	26	26	26
Wald	1.40e+10	6.84e+07	1.76e+09	2.58e+08	400912.46	1.72e+08	4.11e+07	2.94e+08

Table III.5- Externalities via Forward Linkages by Technological groups (scale intensive industries)

Industry	Food	Beverages	Rubber and Plastics	Non-metallic Minerals	Basic Metals	Metal Products	Motor Vehicles	Other Transport Equipment
tfp_{t-1}	0.0289	-0.0157	0.258	-0.0341	-0.0463	-0.00498*	-2.015	-0.0773
	(-0.92)	(-1.13)	(-0.05)	(-0.19)	(-0.50)	(-2.24)	(-0.61)	(-0.17)
$f1_t$				-0.00202			0.0226	0.00871***
				(-0.01)			(0.01)	(4.01)
$f1_{t-1}$	0.0000578		0.000677	0.000942**	-0.0000293	-0.0000103	0.00591	-0.000673
	(-1.36)		(-0.04)	(-2.85)	(-0.52)	(-1.17)	(-0.99)	(-1.06)
$f1_{t-2}$	0.0000667		-0.00126	-0.0000239	-0.0000455	-0.000000307	-0.00114	-0.000412
	(-1.28)		(-0.03)	(-0.15)	(-0.40)	(-0.05)	(-0.45)	(-1.12)
f1t*hfd	0.0000699		0.07					
	(-0.64)		(-0.15)					
f1t*tg	-0.00861**	0.331***	-0.0695		-0.00819***			-0.00878***
	(-8.78)	(2.55)	(-0.15)		(-6.47)			(-2.29)
f1t*s	0.00853**	0.00690***		0.00204	0.00820***	0.000000534	0.0562***	
	(-6.07)	(-8.00)		(-0.01)	(-6.73)	(-0.78)	(-3.43)	
f1t*mrdf	0.0000189	0.000116		-0.0000281	-0.00000908	-0.00000101	-0.0794	0.0000429
	(-0.85)	(-1.71)		(-0.68)	(-0.17)	(-0.90)	(-0.05)	(-0.23)
kl	-0.0000058	-0.000307**	0.000211	-0.000640	-0.000119	-0.000146***	0.00240	-0.000108*
	(-0.55)	(-3.41)	(-0.06)	(-1.58)	(-1.40)	(17.86)	(0.82)	(-2.14)
tg	-0.337***	0.0599	-0.00850***		-0.00846***	-0.0564**		-0.337***
	(-4.99)	(-0.13)	(-7.38)		(-5.23)	(-3.20)		(-4.99)
Year effects	yes	yes	yes	yes	yes	yes	yes	yes
cons	-0.0199**	-0.194***	1.158	0.270**	-0.00838***	0.00253***	-0.330***	0.478***
	(-12.59)	(-7.03)	(1.72)	(-3.25)	(-8.64)	(9.39)	(-6.68)	(-9.85)
N	3 470	1 050	300	1 690	2 080	520	1 630	780
AR(2)	0.500	0.450	0.964	0.161	0.674	0.558	0.213	0.621
Hansen	0.350	0.320	0.292	0.456	0.476	0.985	0.967	0.390
instruments	26	23	26	25	25	26	26	26
Wald	1.44e+10	6.84e+07	7.23e+08	9.68e+08	400906.34	1.71e+08	3.75e+07	1.05e+09

Table III. 6-Horizontal Externalities by Technological groups and size (scale intensive industries)

	Small firms							
Industry	**Food**	**Beverages**	**Rubber and Plastics**	**Non-metallic Minerals**	**Basic Metals**	**Metal Products**	**Motor Vehicles**	**Other Transport Equipment**
tfp_{t-1}	-0.521***	-0.233***	-0.0441*	0.000762		0.111		
	(-4.24)	(-9.17)	(-2.18)	(-0.03)		(0.76)		
hor_t				0.00000146	0.00000793*			
				(0.11)	(2.06)			
hor_{t-1}	-0.0000695		0.000117	0.00000274	-0.0000120**	0.000206	-0.0000636	0.0557***
	(-0.97)		(1.32)	(-0.21)	(-2.85)	(0.49)	(-1.02)	(-15.14)
hor_{t-2}	-0.000104		0.000176	-0.00177		0.000475	-0.000116	0.0713***
	(-0.35)		(0.86)	(-0.05)		(1.04)	(-1.00)	(-90.65)
hor*hfd						-0.00868***		
						(-15.15)		
hor*tg		0.00685***	0.0000153	0.00101	-0.00842***			0.291***
		(-5.74)	(-0.76)	(-0.06)	(-3.69)			(-9.69)
hor*s	0.00000448	0.0000295		-0.00000349	0.00842***	0.00865***	0.00832***	-0.412***
	(-0.51)	(-0.62)		(-0.54)	(-91.00)	(-15.2)	(-11.21)	(-4.53)
hor*mrdf		-0.000186*	-0.00000628	-0.000128***	-0.000000397*	0.000000155	-0.00837***	0.0781***
		(-2.39)	(-0.26)	(-6.03)	(-2.30)	(-0.07)	(-6.61)	(8.15)
tg	-0.00816***		-0.00859***	-0.0019		-0.00842***	-0.00850***	
	(-9.98)		(-4.35)	(-0.08)		(-6.04)	(-9.98)	
Year	yes	yes	yes	yes	yes	yes	yes	yes
cons	-0.308***		0.273***		0.00253***	0.0117	-0.173***	-0.117***
	(-3.11)		(8.08)		(6.35)	(0.82)	(-9.97)	(-2.59)
N	2 060	335	990	1 174	144	4 752	229	130
AR(2)	0.746	0.681	0.448	0.626	0.119	0.298	0.086	0.993
Hansen	0.350	0.580	0.753	0.109	0.805	0.400	0.155	0.612
instrument	29	27	29	28	29	29	29	29
Wald	3.40e+10	7.83e+08	5.80e+09	3.47e+06	9.38e+09	3.62e+10	1.32e+09	3.42e+07

Table III. 6-Horizontal Externalities by Technological groups and size (scale intensive industries) (cont.)

	Large firms							
Industry	**Food**	**Beverages**	**Rubber and Plastics**	**Non-metallic Minerals**	**Basic Metals**	**Metal Products**	**Motor Vehicles**	**Other Transport Equipment**
tfp_{t-1}	-0.490***	-0.500***	-0.00573		0.0000233	0.0227	-0.148	-0.257
	(-6.14)		(-0.27)		(-0.06)	(-0.45)	(-1.09)	(-1.07)
hor_t				0.000000127				
				(0.08)				
hor_{t-1}	0.000540**		0.00000468	0.0000266	-0.000000572	-0.000776	0.00019	0.000156
	(-3.21)		(-0.05)	(-0.25)	(-0.01)	(-0.72)	(-0.93)	(-0.49)
hor_{t-2}	0.000686**		-0.0000198	0.00756	-0.000000383	-0.000195	0.000119	0.000227
	(-2.89)		(-0.49)	(-0.51)	(-0.01)	(-0.31)	(-1.06)	(-0.40)
hor*hfd	0.00750***		-0.00770***	-0.00846***		0.00836***	-0.00855***	
	(-4.75)		(-10.10)	(-8.19)		(-9.90)	(-24.14)	
hor*tg	-0.00736***	0.00840***		0.000934		-0.00841***		-0.00796***
	(-4.69)	(10.33)		(-0.06		(-20.92)		(-8.66)
hor*s		0.00000446	0.00769***	-0.0000351	0.000000114		0.00856***	0.00795***
		(-0.06)	(-9.99)	(-0.22)	(-0.01)		(-8.93)	(-5.81)
hor*mrdf	-0.0000258	-0.000148	0.00000399	-0.000145***	8.08e-08	-0.0000181	-0.0000336	-0.0000141
	(-0.21)	(-0.55)	(-0.27)	(-10.33)	(-0.09)	(-0.23)	(-0.41)	(-0.22)
tg			-0.00765***		-0.00845***		-0.00870***	-0.000814
			(-10.19)		(-9.18)		(-9.33)	(-0.31)
Year effects	yes	yes	yes	yes	yes	yes	yes	yes
cons	-0.289***		0.468***		0.00253***	-0.0298***	-0.313***	0.401***
	(-10.75)		(8.61)		3.52	(-9.91)	(-9.84)	(12.58)
N	1 410	715	700	906	376	1 068	551	250
AR(2)	0.705	0.894	0.757	0.817	0.984	0.605	0.524	0.904
Hansen	0.262	0.806	0.453	0.263	0.869	0.140	0.265	0.817
instruments	29	27	29	28	29	29	29	29
Wald	1.21e+09	5.51e+08	4.20e+09	243867.10	1.61e+08	1.81e+09	3.55e+09	3.89e+08

Table III. 7-Externalities via Backward Linkages by Technological groups and size (scale intensive industries)

	Small firms							
Industry	**Food**	**Beverages**	**Rubber and Plastics**	**Non-metallic Minerals**	**Basic Metals**	**Metal Products**	**Motor Vehicles**	**Other Transport Equipment**
tfp_{t-1}	0.0171	-0.602***	-0.0236	-0.0387		0.0665	0.0179	
	-0.01	(-7.20)	(-0.35)	(-0.70)		(-0.75)	(0,01)	
$b1_t$			-0.0000163				-0.00000350	
			(-0.64)				(-0.02)	
$b1_{t-1}$		-0.000110	0.000249	0.00000465	0.000987***	-0.000314	0.0000184	0.0617***
		(-1.13)	(-0.85)	(-0.35)	(-9.01)	(-1.58)	(0,09)	(-8.12)
$b1_{t-2}$		0.0000500	0.0000320	-0.00000130	-0.000678***	-0.0000867	-0.0000263	0.0198***
		(-0.38)	(-0.42)	(-0.10)	(-9.43)	(-0.25)	(-0.09)	(-20.94)
b1t*hfd	-0.0669	0.00796***		0.00814***		0.00903		
	(-0.34)	(5.69)		(-19.52)		(-0.41)		
b1t*s	0.007			0.000324***	0.000513***	-0.000656	0.00841	-0.255***
	(-1.48)			(-6.41)	(-33.06)	(-0.04)	(-0.26)	(-2.87)
b1t*mrdf	0.0000155	0.000000470		0.000000948	0.0000765***	-0.00000138	0.00000134	-0.0344***
	(-0.01)	(-0.04)		(-0.19)	(-5.88)	(-0.01)	(0,08)	(-20.10)
tg			-0.00825***		-0.00250***			-0.781***
			(-3.97)		(-8.19)			(-3.46)
Year	yes	yes	yes	yes	yes	yes	yes	yes
cons	0.0635	-0.459***	0.281***	0.000479***	-0.00181***	-0.0262***	0.494	-0.242***
	(-0.38)	(-6.19)	(-8.69)	(-6.16)	(-8.93)	(-7.35)	(-0.71)	(-11.79)
N	335	1 286	99	1 174	144	4 752	229	130
AR(2)	0.860	0.171	0.884	0.620	0.320	0.491	0.977	0.420
Hansen	0.957	0.720	0.291	0.383	0.061	0.115	0.560	0.975
instrumen	24	27	26	26	27	27	27	27
Wald	9.70e+06	1.25e+10	3.16e+09	8.50e+06	1.84e+10	3.43e+10	6.39e+08	3.63e+07

Table III. 7-Externalities via Backward Linkages by Technological groups and size (scale intensive industries) (cont.)

	Large firms							
Industry	**Food**	**Beverages**	**Rubber and Plastics**	**Non-metallic Minerals**	**Basic Metals**	**Metal Products**	**Motor Vehicles**	**Other Transport Equipment**
tfp_{t-1}	-0.00572	-0.00724		-0.105	-0.0152	-0.000691	0.594	-0.0567
	(-0.03)	(-0.51)		(-0.69)	(-0.34)	(-1.25)	(-0.25)	(-0.19)
$b1_t$		0.334***					0.00305	
		(-6.59)					(-0.95)	
$b1_{t-1}$	0.0000323		0.0194	-0.000344	-0.00000258	-0.0000000997	0.00461	-0.0000375
	(-0.24)		(0.08)	(-0.93)	(-0.11)	(-0.12)	(-0.87)	(-0.02)
$b1_{t-2}$	-0.0000285		0.000527	-0.0000194	0.00000133	0.0000000387	-0.00116	0.000269
	(-0.23)		(-0.90)	(-0.08)	(-0.03)	(0.04)	(-0.41)	(-0.37)
b1t*hfd	0.0000874		-0.00277		0.00809***			
	(-0.23)		(-0.80)		(-40.27)			
b1t*s	0.00826***	0.00691***	0.0106	0.00481	0.000318*	0.00846***	0.0396	
	(-4.88)	(-8.91)	(-0.02)	(-0.03)	(-2.33)	(-5.17)	(-1.93)	
b1t*mrdf	-0.0000186	0.0000459	-0.0000432	-0.0000393	-0.0000339	0.000000111		0.0887
	(-0.16)	(0.98)	(-0.07)	(-0.82)	(-0.28)	(-0.81)		(-0.12)
tg		-0.00693***		-0.00373		-0.000000453		0.0802
		(-0.28)		(-0.02)		(-0.18)		(-0.11)
Year	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**	**yes**
cons	-0.589***	-0.180***	-0.222	-0.297***	0.000450***	0.00337***	-0.352***	-0.274
	(-5.53)	(-8.42)	(-0.05)	(-4.20)	(-6.97)	(-0.07)	(-6.32)	(-0.86)
N	1 410,00	715	218	700	906	376	868	551
AR(2)	0.411	0.471	0.987	0.769	0.793	0.536	0.466	0.697
Hansen	0.265	0.374	0,356	0.827	0.139	0.383	0.385	0.835
instrumen	27	24	27	25	26	27	27	27
Wald	8.26e+09	1.21e+08	7.31e+08	3.67e+08	469389.24	1.12e+09	4.21e+07	1.97e+09

Table III.8-Externalities via Forward Linkages by Technological groups and size (scale intensive industries)

				Small firms				
Industry	**Food**	**Beverages**	**Rubber and Plastics**	**Non-metallic Minerals**	**Basic Metals**	**Metal Products**	**Motor Vehicles**	**Other Transport Equipment**
tfp_{t-1}		0.0492		-0.0241	-0.0387		-0.296	
		(-0.33)		(-0.60)	(-0.08)		(-1.15)	
$f1_t$		0.249***		-0.00134				
		(-10.25)		(-0.04)				
$f1_{t-1}$	0.00000338			0.000247	0.00000465	0.00107***	0.000628	0.0000543
	(-0.03)			(-1.21)	(-0.35)	(-6.57)	(-1.77)	(-0.23)
$f1_{t-2}$	0.0000544			0.0000323	-0.0000013	-0.000680***	-0.00539	-0.0000228
	(-0.02)			(-0.56)	(-0.10)	(-4.17)	(-1.09)	(-0.12)
df1*hfd	-0.0908***				-0.00846***	0.000580***	2.225***	0.00848***
	(-5.95)				(-9.13)	(9.62)	(-9.55)	(-6.09)
df1*s	0.00845***	0.00707***		0.00830***	0.00846***		-2.203***	
	(-35.91)	(-9.89)		(-17.79)	(-8.75)		(-9.57)	
df1*mrdf		0.00000559	0.615***	-0.0000307	0.000000949	0.0000813***	-0.000129	0.00000309
		(-0.05)	(-7.59)	(-0.63)	(-0.15)	(-7.18)	(-0.08)	(-0.15)
kl	-0.000124	-0.000119*	0.188***	0.0000399	-0.000135***	0.00157***	-0.000718*	-0.000132***
	(-0.61)	(-2.25)	(13.08)	(-0.25)	(-5.90)	(0.83)	(-0.50)	(-7.11)
tg	-0.0908***	-0.00712***		-0.00131	-0.00847***	-0.00215***		
	(-5.99)	(-1.12)		(-0.04)	(-1.38)	(-5.36)		
Year effects	yes	yes	yes	yes	yes	yes	yes	yes
cons	-0.629***	-0.281***	0.0509***	0.281***	-0.0101***	0.00114***	-0.318***	0.152***
	(-1.91)	(-10.25)	(13.83)	(-14.75)	(-10.44)	(6.57)	(-9.81)	(8.57)
N	2 060	335	82	990	1 174	144	762	229
AR(2)	0.936	0.219	0.841	0.879	0.620	0.336	0.281	0.774
Hansen	0.210	0.945	0.268	0.150	0.340	0.288	0.120	0.480
instruments	27	24	27	26	26	27	26	27
Wald	3.77e+10	2.55e+08	1.57e+09	2.67e+09	8.50e+06	2.14e+10	9.91e+08	5.26e+10

Table III.8-Externalities via Forward Linkages by Technological groups and size (scale intensive industries) (cont.)

	Large firms							
Industry	**Food**	**Beverages**	**Rubber and Plastics**	**Non-metallic Minerals**	**Basic Metals**	**Metal Products**	**Motor Vehicles**	**Other Transport Equipment**
tfp_{t-1}	-0.0154	-0.00260	-0.194	-0.105	-0.0152	-0.000692	0.537	-0.0537
	(-0.10)	(-0.17)	(-0.02)	(-0.74)	(-0.34)	(-1.25)	(-0.23)	(-1.20)
$f1_t$							0.279	
							(0.32)	
$f1_{t-1}$	0.0000365		0.0119	-0.000344	-0.00000258	-0.0000000921	0.00448	-0.0000527
	(-0.44)		(-0.01)	(-0.97)	(-0.11)	(-0.11)	(-0.88)	(-0.19)
$f1_{t-2}$	-0.0000343	0.103***	-0.00283	-0.0000193	0.00000134	3.90e-08	-0.00111	0.000275
	(-0.33)	(10.98)	(-0.03)	(-0.11)	(-0.03)	(-0.04)	(-0.38)	(-0.73)
df1*hfd	0.0000996		-0.00113	-0.00556	0.00809***		2.190***	
	(-0.26)		(-0.01)	(-0.03)	(-40.32)		(-9.76)	
df1*s	0.00825***	0.00689***	0.00980	0.00559	0.000318*		0.0394	0.00841***
	(-6.02)	(-1.82)	(-0.06)	(-0.03)	(-2.36)		(-0.96)	(-4.21)
df1*mrdf	-0.0000205	0.0000472	-0.0000336	-0.0000391	-0.0000339	0.000000113	-2.466**	0.0000245
	(-0.19)	(1.02)	(-0.01)	(-0.74)	(-0.28)	(-0.85)	(-2.81)	(-0.40)
kl	-0.0000546	-0.000198***	-0.000284	0.000626	-0.000139***	-0.000140***	0.00117	-0.0000648
	(-0.22)	(-0.83)	(-0.02)	(-0.71)	(-7.44)	(-7.92)	(-0.64)	(-0.90)
tg		-0.358***		-0.00849***		-0.00846***		
		(-0.35)		(-8.16)		(-7.29)		
Year effects	yes	yes	yes	yes	yes	yes	yes	yes
cons	-0.583***	-0.157***	0.149	0.247***	0.000449***	0.00337***	-0.350***	0.135***
	(-6.42)	(-7.76)	(-0.26)	(-3.60)	(-7.81)	(7.38)	(6.53)	(-9.99)
N	1 410.00	715	218	700	906	376	868	551
AR(2)	0.365	0.186	0.996	0.726	0.793	0.536	0.472	0.409
Hansen	0.257	0.654	0.749	0.988	0.172	0.168	0.952	0.318
instruments	27	24	27	25	26	27	27	27
Wald	1.50e+10	1.20e+08	467045.39	3.75e+08	469368.56	1.12e+09	4.23e+07	1.87e+09

Table III.9-Horizontal Externalities by Technological groups (Specialized Suppliers industries)

Industry	Machinery&Equip	O.Manufacturing	Repair & Install.
tfp_{t-1}	-0.291	-0.00925	0.0166
	(-1.72)	(-1.85)	(1.83)
hor_{t-1}	0.00203	-0.000139	-0.0000360
	(0.69)	(-1.23)	(-0.49)
hor_{t-2}	0.00170	-0.000139	0.0000840
	(0.75)	(-0.36)	(0.75)
hor*hfd	2.240***	0.00847***	0.00665***
	(9.04)	(8.28)	(3.99)
hor*tg	-0.0393***	-0.00855***	-0.00846***
	(-11.63)	(-6.12)	(-12.74)
hor*s	0.0420***		0.00184***
	(13.02)		(9.94)
hor*mrdf	-2.243***	0.0000768	-0.0000201
	(-9.05)	(1.23)	(-0.62)
Year effect	yes	yes	yes
cons	-0.272	0.0149***	-0.000183
	(-0.99)	(6.90)	(-0.50)
N	1630	1160	8360
AR(2)	0.937	0.476	0.147
Hansen	0.130	0.294	0.300
Instrum	28	28	27
Wald Chi2	4.76e+08	9.45e+08	5.26e+07

Table III.10-Externalities via Backward Linkages, by Technological groups (Specialized Suppliers industries)

Industry	Machinery&Equip.	O.Manufacturing	Repair&Install
tfp_{t-1}	0.136	-0.0198	-0.00298
	(0.04)	(-0.36)	(-1.07)
$b1_{t-1}$	0.0000216	-0.000199	-0.0000805
	(0.01)	(-0.71)	(-0.93)
$b1_{t-2}$	-0.000158	-0.000603	-0.000264
	(-0.01)	(-1.26)	(-0.69)
b1t*hfd	0.0550	-0.000531	0.00843***
	(0.07)	(-0.00)	(12.61)
b1t*s		0.000443	
		(0.08)	
b1t*mrdf	-0.0479	0.0000790	0.0000370
	(-0.06)	(1.43)	(0.82)
tg		-0.00951***	
		(-5.29)	
Year effects	yes	yes	yes
cons	1.980***	0.0546	-0.420***
	(11.93)	(0.33)	(-5.02)
N	1090	2890	1160
AR(2)	0.922	0.540	0.800
Hansen	0.238	0.153	0.391
Instrum	26	25	26
Wald Chi2	7.36e+08	4.06e+08	7.77e+08

Table III.11- Externalities via Forward Linkages by Technological groups (Specialized Suppliers industries)

Industry	Machinery&Equip.	O.Manufacturing	Repair&Install.
tfp_{t-1}	0.137	-0.0197	-0.00293
	(0.02)	(-0.36)	(-0.96)
$f1_t$	-0.240		
	(-0.05)		
$f1_{t-1}$	0.0000209	-0.000200	-0.0000756
	(0.01)	(-0.71)	(-0.91)
$f1_{t-2}$	-0.000162	-0.000603	-0.000243
	(-0.08)	(-1.28)	(-0.66)
f1t*hfd	0.246	-0.00825***	0.000568
	(0.05)	(-10.99)	(0.56)
f1t*s		0.00816***	0.00786***
		(10.74)	(7.39)
f1t*mrdf	0.0000380	0.0000790	0.0000382
	(0.03)	(1.43)	(0.85)
kl	-0.000641	0.00131	-0.000137***
	(-0.01)	(1.01)	(-8.66)
tg		-0.00632***	
		(-5.25)	
Year effects	yes	yes	yes
cons	-4.003	0.829***	0.348***
	(-1.91)	(8.75)	(6.08)
N	1090	2890	1160
AR(2)	0.585	0.620	0.123
Hansen	0.621	0.165	0.385
Instrum	26	25	26
Wald Chi2	3.17e+07	4.05e+08	1.47e+09

Table III.12- Horizontal Externalities by Technological groups and size (Specialized Suppliers industries)

	Small firms			Large firms		
Industry	**Machinery&Equip.**	**O.Manufacturing**	**Repair&Install.**	**Machinery&Equip.**	**O.Manufacturing**	**Repair&Install.**
tfp_{t-1}	-0.637	0.00190		0.362	-0.000341	
	(-0.75)	(1.53)		(0.32)	(-0.37)	
hor_t			-0.0000252			-0.0000278
			(-0.32)			(-0.38)
hor_{t-1}	0.000510	0.0000666	0.0000727	0.00443	0.00000802	-0.0000306
	(0.19)	(1.34)	(0.85)	(0.54)	(0.19)	(-0.31)
hor_{t-2}	0.000144	0.0000102	0.00546***	0.00269	-0.0000318	
	(0.10)	(0.17)	(10.52)	(0.56)	(-0.39)	
hor*hfd		0.000193	-0.00825***		0.00850***	-0.00856***
		(0.58)	(-6.94)		(9.91)	(-8.71)
hor*tg	-0.00601	-0.0650***	0.00289***	-0.0293	-0.00849***	0.00173***
	(-0.01)	(-6.22)	(6.46)	(-1.58)	(-7.42)	(6.64)
hor*s		0.00827***	-0.0000823	0.0299*		0.00682***
		(6.11)	(-0.94)	(2.07)		(5.96)
hor*mrdf	0.00603	0.0000111	-0.000332	-0.000508	-0.00000471	-0.000438
	(0.01)	(0.29)	(-1.18)	(-0.06)	(-0.17)	(-1.78)
tg	-0.0145					
	(-0.03)					
Year	yes	yes	yes	yes	yes	yes
cons	-0.0134	0.433***		-0.741	0.348***	
	(-0.19)	(7.30)		(-0.28)	(4.54)	
N	762	559	2045	868	601	6315
AR(2)	0.659	0.316	0.043	0.621	0.272	0.572
Hansen	0.419	0.933	0.216	0.42	0.152	0.82
Instrum	29	29	28	29	29	28
Wald	2.63e+07	8.15e+09	9.02e+06	1.38e+08	4.93e+09	3.59e+07

Table III. 13- Externalities via Backward Linkages by Technological groups and size (Specialized Suppliers industries)

	Small firms			Large firms		
Industry	**Machinery&Equip.**	**O.Manufacturing**	**Repair&Install.**	**Machinery&Equip.**	**O.Manufacturing**	**Repair&Install.**
tfp_{t-1}	-0.698	0.0000823	0.0760	0.0846	-0.0723	-0.00251
	(-0.03)	(0.03)	(1.96)	(0.04)	(-0.43)	(-0.10)
$b1_t$					-0.000661	0.00853***
					(-0.00)	(11.15)
$b1_{t-1}$	0.000628	-0.0000263	-0.0000199	-0.000433	-0.0000546	-0.000000417
	(0.01)	(-0.74)	(-0.18)	(-0.02)	(-0.15)	(-0.00)
$b1_{t-2}$	-0.00539	-0.000152	-0.0000272	0.000568	-0.000401	0.0000108
	(-0.01)	(-1.09)	(-0.27)	(0.07)	(-0.44)	(0.02)
b1t*hfd	-0.0494	0.000212	-0.000629	0.528*		
	(-0.01)	(0.48)	(-0.00)	(2.01)		
b1t*s	0.0199	0.00817***	-0.0000690	-0.521		
	(0.07)	(7.48)	(-0.00)	(-1.95)		
b1t*mrdf	-0.000131	0.0000673	0.0000209	0.0000606	0.00699	0.00000265
	(-0.01)	(1.43)	(0.00)	(0.05)	(0.02)	(0.00)
b1t*kl	-0.0482		-0.00870		-0.00217	
	(-0.01)		(-0.01)		(-0.00)	
b1t*tg	-0.0494	0.000212	-0.000629	0.528*		
	(-0.01)	(0.48)	(-0.00)	(2.01)		
Year effects	yes	yes	yes	yes	yes	yes
cons	0.0218	0.348***	0.00147	2.175***	-0.692***	-0.0508
	(0.01)	(4.63)	(0.01)	(9.57)	(-4.89)	(-0.29)
N	762	559	2045	639	906	601
AR(2)	0.400	0.774	0.284	0.994	0.548	0.613
Hansen	0.986	0.222	0.361	0.772	0.620	0.376
Instrum	26	26	26	27	26	27
Wald Chi2	9.13e+06	7.81e+07	2.29e+07	1.56e+09	1.14e+08	1.20e+08

Table III.14- Externalities via Forward Linkages by Technological groups and size (Specialized Suppliers industries)

	Small firms			Large firms		
Industry	**Machinery&Equip.**	**O.Manufacturing**	**Repair&Install.**	**Machinery&Equip.**	**O.Manufacturing**	**Repair&Install.**
tfp_{t-1}	0.0105	0.0306	0.000152	0.0775	-0.0723	-0.00248*
	(0.00)	(0.77)	(0.05)	(0.39)	(-0.42)	(-2.03)
$f1_t$					-0.00178	
					(-0.00)	
$f1_{t-1}$	0.0000665	0.00000310	-0.0000280	-0.000419	-0.0000545	0.00000151
	(0.00)	(0.02)	(-0.78)	(-0.53)	(-0.15)	(0.10)
$f1_{t-2}$	-0.0000660	-0.000146	-0.000160	0.000581	-0.000401	0.00000958
	(-0.00)	(-0.74)	(-1.15)	(0.84)	(-0.43)	(0.33)
f1t*hfd		0.0321	0.000274	-0.000346		0.000433
		(0.15)	(0.60)	(-1.21)		(0.03)
f1t*s	0.00858		0.00818***	0.00742***	0.00233	
	(0.33)		(7.33)	(6.97)	(0.01)	
f1t*mrdf		-0.0247		0.0000593	0.0000720	0.00000118
		(-0.12)		(0.79)	(0.59)	(0.05)
f1t*kl)	-0.000121	-0.000820	-0.000154***	-0.000386	0.000591	-0.000129***
	(-0.01)	(-1.01)	(-11.62)	(-1.56)	(1.34)	(-12.00)
f1t*tg					-0.00787	-0.00809
					(-0.01)	(-0.64)
Year	yes	yes	yes	yes	yes	yes
cons	2.085***	0.836***	-0.250***	-0.0369***	0.0502***	-0.249***
	(7.13)	(5.99)	(-5.43)	(-5.11)	(9.80)	(-11.33)
N	451	1984	559	639	906	601
AR(2)	0.987	0.244	0.818	0.164	0.547	0.223
Hansen	0.285	0.201	0.360	0.386	0.621	0.426
Instrum	26	26	26	27	26	27
Wald Chi2	2.33e+09	2.02e+09	4.63e+09	6.64e+10	1.14e+08	9.01e+09

Table III.15-Horizontal Externalities by Technological groups (science based industries)

Industry	Chemicals	Pharmaceuticals	Computer and Electronics	Electrical Equipment
tfp_{t-1}	0.0806	0.149	-0.280	-0.560
	(1.33)	(0.55)	(-1.49)	(-0.49)
hor_{t-1}	-0.0000563	0.00132	-0.000282	-0.00101
	(-0.61)	(0.37)	(-0.42)	(-0.04)
hor_{t-2}	-0.000192	-0.00123	-0.0000774	0.000457
	(-1.61)	(-0.83)	(-0.33)	(0.06)
hor*hfd	-0.00729***	0.00973***		
	(-9.05)	(5.94)		
hor*tg		-0.00935***	-0.00923***	-0.215
		(-7.49)	(-10.28)	(-0.42)
hor*s	0.00729***		0.00924***	0.215
	(9.14)		(10.27)	(0.42)
hor*mrdf	-0.00000389	-0.0000423	-0.00000494	-0.0000403
	(-0.17)	(-0.35)	(-0.24)	(-0.04)
tg	-0.00708***		0.0000463	0.209
	(-7.94)		(0.13)	(0.41)
Year effects	yes	yes	yes	yes
cons	0.0251***	-0.265***	-0.0347	0.217
	(10.62)	(-4.16)	(-0.21)	(1.27)
N	750	300	600	1090
AR(2)	0.345	0.503	0.890	0.862
Hansen	0.510	0.521	0.093	0.672
instruments	27	28	28	28
Wald	1.99e+09	2.01e+09	3.04e+09	4.00e+09

Table III.16-Externalities via Backward Linkages by Technological groups (science based industries)

Industry	Pharmaceuticals	Computer and Electronics	Electrical Equipment
tfp_{t-1}	-0.0285	0.0139	-0.215***
	(-1.67)	(0.11)	(-6.46)
$b1_{t-1}$	-0.0000816	-0.00174	0.0000516
	(-1.23)	(-0.78)	(0.06)
$b1_{t-2}$	-0.0000975	-0.00146	0.000160
	(-1.56)	(-1.46)	(0.27)
b1t*hfd	-0.00841***	-0.00889***	0.00973***
	(-12.18)	(-7.32)	(3.83)
b1t*s	0.00631***	0.00109***	
	(12.43)	(7.36)	
b1t*mrdf	-0.00000770	-0.00000884	-0.00000948
	(-0.87)	(-0.51)	(-0.43)
tg	-0.00844***	-0.00874***	
	(-9.38)	(-6.03)	
Year effects	yes	yes	yes
cons	0.193***	0.0116	-0.0943***
	(4.72)	(0.09)	(-5.57)
N	750	600	1090
AR(2)	0.149	0.070	0.775
Hansen	0.560	0.597	0.810
instruments	25	26	26
Wald	2.23e+09	3.34e+09	2.76e+09

Table III.17-Externalities via Forward Linkages by Technological groups (science based industries)

Industry	**Pharmaceuticals**	**Computer and Electronics**	**Electrical Equipment**
tfp_{t-1}	-0.0285	0.0143	-0.182
	(-1.50)	(0.18)	(-0.01)
$f1_{t-1}$	-0.0000816	-0.00178	0.0000708
	(-1.09)	(-0.65)	(0.01)
$f1_{t-2}$	-0.0000975	-0.00150	0.000166
	(-1.41)	(-0.69)	(0.03)
df1*hfd	-0.00841***	-0.000146	0.00971
	(-7.99)	(-0.13)	(0.15)
df1*s	0.00841***	0.00887***	
	(10.18)	(7.00)	
df1*mrdf	-0.00000770	-0.00000905	-0.00000895
	(-0.90)	(-0.52)	(-0.02)
kl	-0.000141**	-0.000122	-0.000121
	(-3.10)	(-0.42)	(-0.00)
tg	-0.00844***		
	(-5.35)		
Year effects	yes	yes	yes
_cons	0.0458***	0.0464	-0.123
	(5.45)	(0.45)	(-0.01)
N	300	600	1090
AR(2)	0.079	0.561	0.987
Hansen	0.966	0.497	0.170
instruments	25	26	26
Wald	2.16e+09	3.60e+09	5.25e+07

Table III.18- Horizontal Externalities by Technological groups and size (science based industries)

	Small firms			Large firms			
Industry	**Chemicals**	**Computer and Electronics**	**Electrical Equipment**	**Chemicals**	**Pharmaceuticals**	**Computer and Electronics**	**Electrical Equipment**
tfp_{t-1}	-0.0140	-0.634***	0.159	0.0212		0.191	-0.207
	(-0.00)	(-9.46)	(0.12)	(1.37)		(0.02)	(-0.59)
hor_t	0.000719					-0.000303	
	(0.00)					(-0.06)	
hor_{t-1}	0.0000236	-0.339***	-0.000590	0.0000193	-0.00193	0.000468	0.00103
	(0.00)	(-8.72)	(-0.03)	(0.38)	(-0.45)	(0.05)	(0.34)
hor_{t-2}	0.0000268	-0.0442***	-0.000723	-0.0000583	-0.000207	-0.0000458	0.00136
	(0.00)	(-10.91)	(-0.03)	(-1.49)	(-0.40)	(-0.02)	(0.77)
hor*hfd				-0.00850***			-0.00826***
				(-5.26)			(-6.56)
hor*tg	-0.00852	-0.258***	-0.00808		-0.00922***	-0.00675	
	(-0.08)	(-4.54)	(-0.40)		(-8.37)	(-0.18)	
hor*s	0.00783		0.00810	0.00849***	0.00946***	0.00708	0.00809***
	(0.00)		(0.40)	(5.30)	(5.76)	(0.23)	(8.11)
hor*mrdf	0.000000886	0.0125***	0.0000162	0.00000251	-0.0000525***	-0.0000209	
	(0.00)	(7.29)	(0.01)	(0.30)	(-3.31)	(-0.08)	
tg				-0.00845***			-0.00800***
				(-9.28)			(-8.59)
Year effects	yes	yes	yes	yes	yes	yes	yes
_cons	-0.122	-0.104***	-0.0362	0.00952***	-0.0648***	-0.439	2.075***
	(-0.24)	(-7.47)	(-1.23)	(9.33)	(-9.16)	(-0.06)	(9.90)
N	349	121	451	401	218	479	639
AR(2)	0.700	0.084	0.984	0.830	0.637	0.388	0.944
Hansen	0.873	0.350	0.904	0.19	0.691	0.963	0.380
instruments	29	29	29	29	29	29	29
Wald	5.51e+06	4.56e+10	2.49e+10	4.86e+09	893284.10	8.81e+07	5.05e+10

Table III.19- Externalities via Backward Linkages by Technological groups and size (science based industries)

	Small firms			Large firms		
Industry	**Chemicals**	**Computer and Electronics**	**Electrical Equipment**	**Pharmaceuticals**	**Computer and Electronics**	**Electrical Equipment**
tfp_{t-1}	-0.00669	-0.812***	0.0554	-0.00999	0.00851	-0.634
	(-0.43)	(-8.63)	(0.00)	(-1.33)	(0.48)	(-0.03)
$b1_{t-1}$	0.0000289		-0.0000461	-0.0000246	-0.000122	0.000831
	(1.21)		(-0.00)	(-1.17)	(-0.34)	(0.01)
$b1_{t-2}$	0.00000997	0.0227***	-0.0000767	0.000000716	-0.0000567	0.000156
	(0.45)	(7.02)	(-0.00)	(0.04)	(-0.45)	(0.01)
b1t*hfd	-0.00846***			-0.00850***	-0.00132	
	(-4.02)			(-9.76)	(-0.99)	
b1t*s	0.00846***	0.447***	0.0000240	0.00850***	0.00990***	0.0111
	(4.78)	(7.26)	(0.00)	(3.79)	(7.37)	(0.09)
b1t*mrdf	0.00000236	0.00533***	0.0000126	-0.00000355	0.000000177	-0.0000194
	(0.65)	(6.55)	(0.00)	(-0.81)	(0.01)	(-0.03)
tg	-0.00848***		-0.00845	-0.00845***		
	(-5.92)		(-0.02)	(-5.26)		
Year	yes	yes	yes	yes	yes	yes
_cons	-0.0336***	0.0215***	-0.598	0.283***	0.0172	-0.339
	(-5.98)	(9.85)	(-0.01)	(9.47)	(1.57)	(-0.03)
N	349	121	451	401	1068	479
AR(2)	0.830	0.540	0.991	0.360	0.459	0.992
Hansen	0.742	0.150	0.745	0.749	0.168	0.637
instrument	26	27	26	26	27	27
Wald	1.e+08	3.24e+09	3.63e+08	6.31e+09	3.35e+09	2.79e+07

Table III.20- Externalities via Forward Linkages by Technological groups and size (science based industries)

	Small firms			Large firms		
Industry	**Pharmaceuticals**	**Computer and Electronics**	**Electrical Equipment**	**Pharmaceuticals**	**Computer and Electronics**	**Electrical Equipment**
tfp_{t-1}	-0.0159	0.0574	-0.321***	-0.00997	0.00791	-0.484
	(-1.25)	(0.38)	(-5.08)	(-1.33)	(0.46)	(-0.01)
$f1_{t-1}$	0.0000207	-0.000320	-0.523***	-0.0000247	-0.000124	0.000662
	(1.10)	(-0.48)	(-9.21)	(-1.18)	(-0.37)	(0.01)
$f1_{t-2}$	0.00000270	-0.000104	0.222***	0.000000705	-0.0000572	0.0000828
	(0.21)	(-0.16)	(6.29)	(0.04)	(-0.45)	(0.00)
df1*hfd	0.0000698	0.00838***			-0.00989***	
	(0.34)	(7.86)			(-7.52)	
df1*s	0.00841***		0.0188***	0.00844***	0.00989***	0.0104
	(9.50)		(17.91)	(5.51)	(7.56)	(0.04)
df1*mrdf	0.00000215	-0.00000135	-0.0444***	-0.00000355	0.000000139	-0.0000168
	(0.57)	(-0.38)	(-5.27)	(-0.81)	(0.01)	(-0.01)
kl	-0.000131***	-0.000313	-0.0377***	-0.000220***	-0.000124	-0.0000452
	(-7.47)	(-1.89)	(-7.56)	(-5.08)	(-0.92)	(-0.00)
tg					-0.00857***	
					(-7.10)	
Year	yes	yes	yes	yes	yes	yes
cons	-0.232***	0.0126	-0.185***	0.0458***	0.0182	0.140
	(-9.54)	(0.32)	(-9.25)	(8.28)	(1.73)	(0.00)
N	349	4752	121	401	1068	479
AR(2)	0.291	0.711	0.476	0.004	0.459	0.995
Hansen	0.057	0.250	0.15	0.397	.	
instruments	26	27	27	26	27	27
Wald	4.21e+09	3.60e+10	4.21e+10	6.31e+09	3.37e+09	7.62e+07

Table III. 21-Horizontal Externalities by Technological groups (Supplier Dominated industries)

Industry	Textiles	Wearing Apparel	Leather	Wood	Paper	Printing
tfp_{t-1}	-0.143	-0.596***	-0.460		-0.184*	-0.00597
	(-0.30)	(-7.79)	(-1.54)		(-2.35)	(-0.07)
hor_t						
hor_{t-1}	-0.00285*	0.00128	-0.000361	0.0000752	-0.000316	-0.00133
	(-1.97)	(1.61)	(-0.31)	(0.03)	(-0.22)	(-1.08)
hor_{t-2}	-0.00336	0.00264*	0.000301	0.00000312	0.000247	-0.00120
	(-1.58)	(2.23)	(0.56)	(0.00)	(0.19)	(-1.68)
hor*hfd	0.00554	-0.000201	0.0120***	-0.00885	0.00978***	-0.00809***
	(1.74)	(-0.22)	(3.81)	(-0.55)	(8.48)	(-8.45)
hor*tg	-0.00368	-0.0103***	-0.0121***		-0.00972***	
	(-0.26)	(-7.30)	(-3.73)		(-8.28)	
hor*s	-0.00181	0.0105***		0.00883		0.00796***
	(-0.13)	(5.43)		(0.55)		(8.44)
hor*mrdf	-0.0000208	0.0000508	0.0000722	0.00000734	-0.0000187	0.000123
	(-0.23)	(1.52)	(0.49)	(0.06)	(-0.65)	(1.06)
tg				-0.00881		-0.00977***
				(-0.53)		(-4.98)
Year	yes	yes	yes	yes	yes	yes
cons	-0.886*	-0.269***	0.0134**	-0.0823	-0.000807	-0.0867
	(-2.05)	(-5.76)	(3.06)	(-0.82)	(-1.05)	(-1.44)
N	2010	3810	2730	560	2160	2890
AR(2)	0.475	0.211	0.339	0.935	0.111	0.138
Hansen	0.325	0.402	0.705	0.410	0.355	0.592
instrumen	28	28	28	28	28	27
Wald	3.11e+08	4.04e+09	1.23e+09	7.52e+08	3.30e+09	2.48e+08

Table III. 22-Externalities via Backward Linkages by Technological groups (Supplier Dominated industries)

Industry	**Textiles**	**Wearing Apparel**	**Leather**	**Wood**	**Paper**	**Printing**
tfp_{t-1}	-0.518*	-0.576***	-0.278		-0.107	0.207
	(-2.14)	(-6.13)	(-1.14)		(-0.53)	(0.39)
$b1_t$				0.00824***		
				(3.92)		
$b1_{t-1}$	-0.00136	0.000766	-0.000341	0.0000619	-0.000175	-0.000599
	(-1.58)	(0.11)	(-1.69)	(0.88)	(-0.08)	(-1.04)
$b1_{t-2}$	-0.00242	0.00196	0.0000424	0.0000310	0.000995	-0.000857
	(-1.40)	(0.45)	(0.06)	(0.71)	(0.48)	(-1.29)
b1t*hfd	-0.00953	0.0103			-0.0734	-0.00867***
	(-1.73)	(1.44)			(-0.16)	(-3.87)
b1t*s	0.00949		0.0126***			0.00867***
	(1.73)		(6.20)			(3.86)
b1t*mrdf	0.00000461	0.0000346	0.0000667	0.00000524	0.0734	0.0000298
	(0.07)	(0.28)	(1.11)	(1.15)	(0.16)	(0.96)
tg	-0.0131*				-0.00919***	-0.00865***
	(-2.30)				(-10.66)	(-7.12)
Year	yes	yes	yes	yes	yes	yes
cons	-0.538*	-0.228***	0.0111	0.285***	0.0250	0.410
	(-2.41)	(-3.71)	(1.33)	(6.55)	(0.23)	(1.34)
N	2010	3810	2730	560	2160	2890
AR(2)	0.150	0.604	0.677	0.154	0.650	0.504
Hansen	0.780	0.192	0.458	0.755	0.389	0.875
instruments	26	25	26	26	26	26
Wald	5.37e+08	1.18e+09	2.57e+09	2.26e+09	2.41e+09	6.79e+07

Table III. 23-Externalities via Forkward Linkages by Technological groups (Supplier Dominated industries)

Industry	Textiles	Wearing Apparel	Leather	Wood	Paper	Printing	Furniture
tfp_{t-1}	-0.487*	-0.577***	-0.287		-0.120	0.214	-0.487*
	(-2.03)	(-6.15)	(-1.08)		(-0.13)	(0.03)	(-2.03)
$f1_{t}$				-0.00233			
				(-0.33)			
$f1_{t-1}$	-0.00134	0.000780	-0.000350	0.0000571	-0.000136	-0.000594	-0.00134
	(-1.59)	(0.11)	(-1.73)	(0.82)	(-0.02)	(-0.03)	(-1.59)
$f1_{t-2}$	-0.00236	0.00197	0.0000274	0.0000140	0.000989	-0.000854	-0.00236
	(-1.40)	(0.45)	(0.03)	(0.27)	(0.11)	(-0.05)	(-1.40)
df1*hfd	-0.00953	0.0103	0.0126***		0.339	-0.00868	-0.00953
	(-1.75)	(1.44)	(5.79)		(0.35)	(-0.31)	(-1.75)
df1*s	0.00949			0.0105		0.00868	0.00949
	(1.75)			(0.90)		(0.32)	(1.75)
df1*mrdf	0.00000373	0.0000344	0.0000665	-0.000118	-0.330	0.0000304	0.00000373
	(0.06)	(0.28)	(1.11)	(-0.01)	(-0.34)	(0.05)	(0.06)
kl	0.00403	-0.000410	0.000582**	-0.000288**	-0.00105	-0.000327	0.00403
	(1.83)	(-0.17)	(2.87)	(-3.10)	(-1.12)	(-0.04)	(1.83)
tg	-0.0132*					-0.00864	-0.0102*
	(-2.34)					(-0.88)	(-2.01)
Year effects	yes	yes	yes	yes	yes	yes	yes
cons	0.867**	0.492***	-0.117	-0.224***	-0.428	0.114	0.867**
	(2.91)	(3.95)	(-0.93)	(-9.26)	(-1.66)	(0.05)	(2.91)
N	2010	3810	2730	560	2160	2890	2010
AR(2)	0.380	0.882	0.874	0.467	0.269	0.885	0.380
Hansen	0.155	0.606	0.703	0.710	0.207	0.425	0.155
Instrum	26	25	26	26	26	26	26
Wald Chi2	5.41e+08	1.19e+09	2.61e+09	2.76e+09	4.03e+09	5.72e+07	5.41e+08

Table III. 24- Horizontal Externalities by Technological groups and size (Supplier Dominated industries)

	Small firms					
Industry	**Textiles**	**Wearing Apparel**	**Leather**	**Wood**	**Paper**	**Printing**
tfp_{t-1}	-0.682***	0.511	-0.274			-0.00244
	(-8.81)	(0.25)	(-0.30)			(0.01)
hor_t						-0.0000214
						(-0.20)
hor_{t-1}	-0.000464	-0.000713	-0.0000169	-0.0000209	-0.000300	0.0000132
	(-1.42)	(-0.49)	(-0.10)	(-0.04)	(-0.94)	(0.10)
hor_{t-2}	-0.000506	0.00479	-0.0000148	0.0000185	0.000746	0.000259
	(-1.23)	(0.48)	(-0.18)	(0.10)	(1.64)	(0.74)
hor*hfd	-3.766***	0.00255	-0.0452			-0.00896***
	(-6.57)	(0.82)	(-0.15)			(-5.99)
hor*tg	-0.00236	-0.00830	-0.0122***	-0.00883***		0.00870***
	(-0.66)	(-1.31)	(-3.46)	(-7.32)		(6.40)
hor*s		0.00564	0.0574		-0.00281	0.0000116
		(0.58)	(0.19)		(-0.07)	(0.51)
hor*mrdf	3.768***	-0.0000177	-0.00000954	0.00885***	0.00279	0.000113
	(6.60)	(-0.14)	(-0.21)	(5.24)	(0.07)	(0.33)
tg					-0.00889***	
					(-4.89)	
Year	yes	yes	yes	yes	yes	yes
cons	1.215***	-0.942	0.0789	-0.00870***	0.0119***	
	(4.97)	(-0.69)	(1.17)	(-7.39)	(4.06)	
N	724	1130	1823	932	331	776
AR(2)	0.091	0.614	0.744	0.685	0.131	0.463
Hansen	0.051	0.135	0.287	0.112	0.998	0.087
instrumen	29	29	29	29	29	28
Wald	2.57e+09	1.10e+09	1.20e+10	5.31e+08	4.63e+10	4.53e+09

Table III. 24- Horizontal Externalities by Technological groups and size (Supplier Dominated industries) (cont.)

Large firms							
Industry	**Textiles**	**Wearing Apparel**	**Leather**	**Wood**	**Paper**	**Printing**	**Furniture**
tfp_{t-1}	-0.162	-0.603	-0.0883	-0.0313		-0.126	-0.682***
	(-0.60)	(-1.78)	(-0.24)	(-0.05)		(-0.86)	(-8.81)
hor_t					0.00649		
					(0.10)		
hor_{t-1}	-0.000333	0.00584	-0.0000510	0.0000470	-0.0000272	-0.000432	-0.000464
	(-0.09)	(1.71)	(-0.36)	(0.03)	(-0.01)	(-0.68)	(-1.42)
hor_{t-2}	-0.000531	0.00487	0.000151	-0.000000651	-0.0000566	-0.000231	-0.000506
	(-0.38)	(1.67)	(1.23)	(-0.00)	(-0.01)	(-0.08)	(-1.23)
hor*hfd						0.353	-1.205***
						(1.40)	(-6.57)
hor*tg	-0.0000227	-0.00993	-0.135	-0.00839		-0.00877***	-0.00236
	(-0.10)	(-1.90)	(-0.22)	(-1.68)		(-6.11)	(-0.66)
hor*s			0.135	0.00842	-0.00717	-0.182	
			(0.22)	(1.81)	(-0.11)	(-0.74)	
hor*mrdf	-0.0000269	0.0102	0.0000219	-0.0000280	0.00000716	-0.162	2.365***
	(-0.18)	(1.91)	(0.39)	(-0.05)	(0.02)	(-0.74)	(6.60)
tg	-0.00410		0.127	-0.0000834	-0.00878		
	(-0.25)		(0.20)	(-0.03)	(-0.33)		
Year effects	yes	yes	yes	yes	yes	yes	yes
cons	-0.866***	0.198	-0.167**	0.0870	-0.000382	-0.0574	1.215***
	(-3.45)	(0.12)	(-2.73)	(0.71)	(-0.38)	(-1.30)	(4.97)
N	906	1286	2680	907	229	1384	724
AR(2)	0.672	0.145	0.260	0.954	0.929	0.941	0.091
Hansen	0.781	0.455	0.642	0.774	0.478	0.182	0.051
instruments	29	29	29	29	29	29	29
Wald	1.52e+09	1.53e+08	3.14e+09	1.37e+10	2.15e+07	1.73e+09	2.57e+09

Table III.25-Externalities via Backward Linkages by Technological groups and size (Supplier Dominated industries)

	Small firms				
Industry	**Textiles**	**Wearing Apparel**	**Leather**	**Paper**	**Furniture**
tfp_{t-1}	-0.318	-0.995	-0.359	-0.134***	0.0304
	(-1.53)	(-0.05)	(-1.23)	(-12.28)	(0.78)
$b1_t$					0.00100
					(0.01)
$b1_{t-1}$	0.00232	-0.000509	-0.000391	-0.000313	0.00000276
	(0.81)	(-0.07)	(-1.32)	(-1.37)	(0.02)
$b1_{t-2}$	0.00283	-0.000416	-0.000527	-0.0000879	-0.000147
	(1.18)	(-0.08)	(-1.39)	(-0.30)	(-0.76)
db1*hfd				-0.00875***	-0.00167
				(-8.23)	(-0.02)
db1*s	0.00000225		-0.00000349	0.00877***	0.00799***
	(0.03)		(-0.11)	(13.91)	(8.20)
db1*mrdf	-0.0000393	-0.0000427		-0.00000717	0.0000122
	(-0.50)	(-0.02)		(-0.72)	(0.47)
tg	-0.00961***	-0.0127	-0.00734*	-0.00863***	
	(-6.42)	(-0.55)	(-2.41)	(-8.29)	
Year effects	yes	yes	yes	yes	yes
cons	-0.102	-0.0144	-0.253**	0.0832***	0.835***
	(-0.81)	(-0.02)	(-2.76)	(6.15)	(6.09)
N	2680	907	2018	1384	1984
AR(2)	0.298	0.916	0.264	0.482	0.232
Hansen	0.380	0.959	0.278	0.278	0.108
Instrum	26	27	27	27	26
Wald Chi2	9.13e+06	7.81e+07	2.29e+07	1.30e+09	2.65e+09

Table III.25-Externalities via Backward Linkages by Technological groups and size (Supplier Dominated industries) (cont.)

	Large firms						
Industry	**Textiles**	**Wearing Apparel**	**Leather**	**Wood**	**Paper**	**Printing**	**Furniture**
tfp_{t-1}	-0.358	-0.491	-0.448	0.0924		0.298	-0.0954
	(-1.47)	(-0.86)	(-1.18)	(0.33)		(0.01)	(-0.08)
$b1_t$	0.00110			-0.00740**			
	(1.40)			(-2.91)			
$b1_{t-1}$	-0.000469	0.00130	-0.0000237	0.000231	-0.0000602	-0.000651	0.000748
	(-0.86)	(0.37)	(-0.08)	(0.61)	(-0.13)	(-0.00)	(0.14)
$b1_{t-2}$	-0.000559	0.00724	-0.000322	0.0000972	-0.000181	0.00131	-0.0000743
	(-1.33)	(0.84)	(-0.51)	(0.25)	(-0.83)	(0.01)	(-0.05)
db1*hfd					0.0000860	1.561	
					(0.21)	(0.02)	
db1*s	0.00337			0.00748**	0.00850***	-0.805	0.00935
	(1.02)			(3.02)	(6.61)	(-0.05)	(0.61)
db1*mrdf	-0.0000292	0.0152	-0.0000486	-0.0000761		0.00000991	-0.00929
	(-0.61)	(1.20)	(-0.38)	(-0.60)		(0.00)	(-0.63)
tg			-0.00989***	-0.00689***		0.747	-0.00732
			(-5.64)	(-3.43)		(0.01)	(-1.53)
Year effects	yes	yes	yes	yes	yes	yes	yes
cons	0.341	0.349	-0.0304***	0.621***	-0.267***	0.0687	0.241
	(1.47)	(0.96)	(-5.57)	(4.86)	(-8.03)	(0.02)	(0.33)
N	724	1130	1823	932	331	776	250
AR(2)	0.088	0.446	0.515	0.893	0.540	0.977	0.884
Hansen	0.051	0.164	0.504	0.934	0.273	0.467	0.701
Instrum	27	26	27	27	27	27	27
Wald Chi2	2.19e+09	4.15e+07	4.00e+08	1.31e+09	1.69e+09	1.81e+06	3.42e+08

Table III. 26-Externalities via Forward Linkages by Technological groups and size (Supplier Dominated industries)

			Small firms		
Industry	**Textiles**	**Wearing Apparel**	**Leather**	**Paper**	**Printing**
tfp_{t-1}	-0.603***	-0.303	-0.0978		
	(-8.58)	(-1.45)	(-0.80)		
$f1_t$				0.00000570	
				(0.03)	
$f1_{t-1}$	-0.000138	0.00228	-0.000191	0.0000564	-0.000494
	(-0.56)	(0.94)	(-1.68)	(0.03)	(-0.78)
$f1_{t-2}$	0.0000641	0.00285	-0.000186	-0.0000366	0.000109
	(0.24)	(1.20)	(-1.39)	(-0.02)	(0.27)
df1*hfd			0.0116***		
			(7.29)		
df1*s	0.661***				0.00874***
	(3.68)				(4.71)
df1*mrdf	-0.521***	-0.0000393	0.0000416	0.00000346	-0.0000143
	(-3.68)	(-0.58)	(0.96)	(0.01)	(-1.38)
kl	-0.000751	0.000411	0.000349*	-0.000103	-0.000323
	(-0.73)	(0.64)	(2.10)	(-0.16)	(-0.74)
tg	-0.00822***	-0.00957***		-0.00866	
	(-3.95)	(-6.37)		(-1.36)	
Year effects	yes	yes	yes	yes	yes
cons	-0.459***	-0.408**	0.0175***	-0.00936	-0.597***
	(-7.59)	(-3.00)	(4.02)	(-0.44)	(-6.82)
N	1286	2680	907	229	1384
AR(2)	0.820	0.298	0.455	0.979	0.147
Hansen	0.270	0.390	0.268	0.344	0.977
Instrum	27	26	27	27	27
Wald Chi2	5.54e+09	4.06e+09	2.65e+09	8.71e+10	1.51e+11

Table III. 26-Externalities via Forward Linkages by Technological groups and size (Supplier Dominated industries) (cont.)

				Large firms			
Industry	**Textiles**	**Wearing Apparel**	**Leather**	**Wood**	**Paper**	**Printing**	**Furniture**
tfp_{t-1}	-0.285	-0.490	-0.534	0.0959		0.230	-0.0920
	(-1.45)	(-0.86)	(-1.49)	(0.33)		(0.04)	(-0.08)
$f1_t$				-0.00746**			
				(-3.22)			
$f1_{t-1}$	-0.000517	0.00131	-0.0000173	0.000234	-0.00000342	-0.000483	0.000754
	(-1.03)	(0.37)	(-0.07)	(0.63)	(-0.15)	(-0.02)	(0.29)
$f1_{t-2}$	-0.000712	0.00724	-0.000257	0.000100	-0.00000712	0.00111	-0.0000704
	(-0.97)	(0.84)	(-0.51)	(0.23)	(-0.11)	(0.12)	(-0.05)
df1*hfd						-0.00767	
						(-0.14)	
df1*s	0.00461		0.0100***	0.00747**	0.00881***	0.00759	0.0000770
	(0.83)		(7.35)	(3.20)	(6.70)	(0.14)	(0.24)
df1*mrdf	-0.0000333	0.000469	-0.0000470		0.0000357	0.00000972	-0.0000204
	(-0.68)	(0.96)	(-0.44)		(0.07)	(0.01)	(-0.09)
kl	0.00173	-0.000946	0.000513	-0.000803	-0.000147***	0.000238	-0.000402
	(1.22)	(-0.31)	(1.66)	(-1.33)	(-5.05)	(0.04)	(-0.47)
tg		-0.0148		-0.00688***		-0.00798	-0.00732*
		(-1.19)		(-3.41)		(-0.13)	(-2.00)
Year effects	yes	yes	yes	yes	yes	yes	yes
cons	-0.0898	0.349	0.00191	0.623***	0.00532***	-0.0340	-0.319
	(-0.39)	(0.96)	(0.15)	(4.63)	(5.56)	(-0.04)	(-1.43)
N	724	1130	1823	932	331	776	250
AR(2)	0.152	0.446	0.457	0.910	0.775	0.778	0.892
Hansen	0.196	0.375	0.377	0.183	0.485	0.994	0.769
Instrum	27	26	27	27	27	27	27
Wald Chi2	1.33e+09	4.15e+07	5.85e+08	1.26e+09	4.93e+10	7.00e+08	3.55e+08

Table IV.2- Foreign Direct Investment (EUR billion) in EU-28 (2011–2014)

	Outward FDI flows					Inward FDI flows				
	Value (billion EUR)				Share (%) 2014	Value (billion EUR)				Share (%) 2014
	2011	2012	2013	2014		2011	2012	2013	2014	
Extra EU-28	470.1	317.4	581.4	96.1	100.0	424.7	309.8	620.5	118.9	100.0
Europe (non-EU)	99.0	73.8	61.0	2.6	2.7	56.4	67.4	26.4	48.9	41.1
Africa	14.1	11.6	13.3	13.1	13.6	3.6	18.5	3.0	1.0	0.8
North America	198.4	141.1	287.8	-46.4	-48.3	260.8	132.0	461.7	-6.4	-5.4
Central America	41.5	8.3	86.3	20.7	21.5	43.2	62.1	61.8	42.8	36.0
South America	38.4	35.6	58.8	45.1	46.9	18.4	7.2	15.3	0.1	0.1
Asia	79.8	47.8	62.3	56.2	58.5	41.0	35.7	49.5	21.0	17.7
Oceania	-3.3	9.2	12.4	2.0	2.1	4.0	-14.0	5.4	1.8	1.5
Offshore financial centres	75.2	43.0	122.8	42.5	44.2	48.1	84.9	60.9	47.4	39.9

Notes: 2013–14: based on international standards BPM6 and BD4. The sum of data by continent does not always equal the extra-EU total because of non-allocated flows. *Source:* Eurostat

Table IV.3- Extra Eu-28 FDI Stocks (Eur Billion), by economic activity, EU-28 (End 2013)

	Outward				Inward			
	Value (billion EUR)			Share 2014	Value (billion EUR)			Share 2014
	2012	2013 (1)	2014 (1)		2012	2013 (1)	2014 (1)	
Extra EU-28	5.112.0	5.344.4	5.748.6	100.0	3.905.9	4.179.7	4.582.5	100.0
United States	1.627.8	1.812.6	1.985.3	34.5	1.543.9	1.756.0	1.810.8	39.5
Switzerland	664.8	665.9	632.3	11.0	500.6	484.1	509.4	11.1
Brazil	257.1	278.2	343.6	6.0	81.1	99.4	113.6	2.5
Canada	247.1	234.7	274.7	4.8	135.5	135.5	165.9	3.6
Russia	193.5	189.9	171.5	3.0	75.3	63.5	74.4	1.6
China	120.7	124.9	144.2	2.5	27.4	22.3	20.7	0.5
Mexico	82.4	109.6	119.2	2.1	21.4	23.8	28.3	0.6
Australia	141.0	126.9	115.3	2.0	30.7	24.2	26.4	0.6
Hong Kong	132.1	113.4	106.3	1.8	50.7	57.4	71.2	1.6
Singapore	92.6	91.9	102.9	1.8	47.7	35.7	43.8	1.0

Notes: Based on international standards BPM6 and BD4. Source: Eurostat

Table IV. 5- Main differences between 2007-2013 and 2014-2020 programming period

	2007-2013	**2014-2020**
Objectives	— Convergence — Regional Competitiveness and Employment — European Territorial Cooperation	— Investment For Growth and Employment In MS and Regions — European Territorial Cooperation
Formal Programming Steps	- Strategic Reference Framework - Operational Programmes	- Partnership Agreement - Operational Programmes
Geographical Scope	Objective of Convergence: - Nuts II regions eligible for funding (GDP per capita less than 75% of the EU-25 average GDP). - MS eligible for cohesion fund are those whose Gross National Income (GNI) *per capita,* measured in purchasing power and calculated from community data relating to 2001-2003, is less than 90% of the EU-25 average GNI, and have a program of compliance with the conditions of economic convergence. Objective of Regional Competitiveness and Employment: - Regions eligible for structural funds under the objective of regional competitiveness and employment are those that are not covered by paragraph 1 of art. 5th and paragraphs 1 and 2 of art. 8th. Objective of Territorial Cooperation European Parliament: - Nuts III regions eligible for funding.	New concept of categories of regions: less developed, in transition and more developed regions. Objective Investment for Growth and Employment: - Structural funds support regions Nuts II - Resources for the purpose of Investment in growth and Employment are allocated according to Three categories of Nuts II regions: - Less developed regions, with GDP *per head* below 75% of average GDP of the EU-27 - Transition regions, whose GDP *per Capita* is between 75% and 90% of average GDP of the EU-27 - More developed regions, with a GDP *per capita* above 90% of average GDP of the EU-27 European Territorial Cooperation Objective: - Cross - border cooperation: nuts III regions along the internal and external land borders; - Transnational cooperation: nuts II regions; - Inter-regional cooperation: the whole territory of the EU.
Ex Ante Conditionalities	- NSRF does not refer to the existence of *Ex ante conditionalities.*	- This is a requirement necessary for the effective and efficient implementation of the specific objectives established.

Source: http://ec.europa.eu/

Table IV. 5- Main differences between 2007-2013 and 2014-2020 programming period (cont.)

	2007-2013	2014-2020
Financial Instruments	- Financial engineering instruments intended for undertakings, in particular SMEs, such as venture capital funds, risk funds, guarantee funds and funds for loans.	- FEEI can be used to support financial instruments under a program, including through funds of funds, to contribute to the achievement of the specific requirements for a certain priority. - The support of financial instruments financing firms, including SMEs, should focus mainly on the support for the creation of new enterprises and promotion of innovation/ internationalization of the existing firms. - Financial instruments can be combined with other forms of support.
Maximum Rate of Funding	- 85% of the eligible expenditure	A) 85% for the cohesion fund; B) 85% for the less developed regions; C) 80% for the less developed MS not referred in (b), and all regions whose gdp per capita used as a criterion for eligibility in the 2007-2013 programming period is less than 75% of the eu-25 average in the same period, but whose gdp per Capita is greater than 75% of the eu-27 gdp, as well as for the defined in article 8 (1) of regulation (eu) no 1083/2006 which have received transitional support during 2007-2013; D) 60% for transition regions E) 50% for more developed regions
Evaluation	- ex - ante evaluation - on going (only in per performance reserve) - ex post evaluation	- ex - ante evaluation - evaluation during the Programming - ex post evaluation
Follow-Up	- Financial and strategic, within Monitoring Committees and annual meetings. - Strategic, with presentation of strategic reports.	- MS should monitor programs, to assess the implementation and the progress made in implementing the objectives of the program. - MS should establish committees to follow up the Operational Programs. - Annual meeting of assessment between the EC and each MS, with a view to analyze the performance of each program, taking into account the Annual Implementation Report. - Specific rules for follow-up committees should be established for the European Territorial Cooperation, given the special nature of these programs.

Source: http://ec.europa.eu/

Table IV.7- Flows and stocks of FDI (% GDP), Portugal (1986-2016)

Year	Flows	Stocks	Year	Flows	Stocks
1986	4	8	2002	1	19
1987	9	16	2003	3	22
1988	-2	12	2004	1	22
1989	7	18	2005	1	22
1990	2	17	2006	4	25
1991	2	17	2007	1	25
1992	1	17	2008	1	25
1993	1	18	2009	0	25
1994	1	17	2010	1	24
1995	0	16	2011	2	26
1996	1	16	2012	2	27
1997	1	16	2013	1	27
1998	2	16	2014	2	28
1999	1	16	2015	2	29
2000	3	18	2016	1	28
2001	3	19	**Average**	**2**	**20**

Source: author's calculations based in UNCTAD

Table IV.8- FDI inflows (USD Million) to EU Countries (1986-2016)

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Austria	4989	6648	6816	9208	10972	11511	12040	12106	14804	19720	19629	19522	23564	23471	30431	34329
Belgium	-521090	-181084	-294553	97389	-138324	-227052	-206200	-204039	-82242	-18504	-18233	-17279	-20766	-20362	-23492	-26347
Bulgaria	1032	-2633	904	108	112	168	210	250	355	445	554	1059	1597	2184	2704	2945
Cyprus	-1113	-1061	-999	-929	-802	-720	-613	-530	-454	-79	350	897	1242	2055	2910	3855
C.Repub	0	0	1291	1291	1363	1886	2889	3423	4547	7350	8572	9234	14375	17552	21644	27092
Denmark	4591	5629	5485	6905	9192	14712	14387	14618	18083	23801	22340	22268	35694	47643	73574	75438
Estonia	731	534	657	846	-603	14	96	258	473	674	825	1148	1822	2467	2645	3160
Finland	1680	2620	3040	3965	5132	4220	3689	4217	6714	8465	8797	9530	16455	18320	24273	24070
France	44465	49084	56287	69348	97814	110174	127883	135078	16344	19143	20015	19586	24621	24466	25977	29532
Germany	49277	64714	61526	84218	111231	123992	119965	116134	13915	16591	16251	15883	20677	23525	27161	27215
Greece	9071	10136	11632	13011	5681	6816	7960	8937	9918	10971	12029	13013	13084	15890	14113	13941
Hungary	10959	9786	9446	12942	570	2107	3424	5576	7087	11304	13282	17968	20733	23260	22870	27407
Ireland	36594	36917	37174	37367	37989	39351	40809	41887	42744	44187	46804	48940	62450	72815	12708	13405
Italy	25554	31353	36884	49391	59998	61576	49963	53949	60376	65350	74640	85468	10882	10863	12117	11343
Latvia	2298	722	1084	1778	343	145	176	221	436	615	936	1272	1558	1795	2084	2328
Lithuani	-607	-657	-193	-784	-26	97	107	137	321	352	700	1041	1625	2063	2334	2665
Luxemb	56320	107627	-91839	10848	-27533	-64537	-82537	-107994	5423	18504	18233	17279	20766	20362	23492	26347
Malta	308	327	368	420	465	542	582	651	416	562	844	858	1174	1872	2385	2551
Netherla	33354	43449	42546	52052	68731	72475	74440	74478	93409	11604	12654	12219	16447	19222	24373	28288
Poland	102732	39358	-1901	-37393	109	425	1370	2307	3789	7843	11463	14587	22461	26075	34227	41247
Portugal	4354	4870	5861	7670	10571	13020	14893	16427	17697	18982	21118	22392	30088	26910	32044	36023
Romania	0	0	0	0	0	44	122	215	402	821	1097	2417	4527	5671	6951	8339
Slovakia	17982	13295	-2394	189	282	363	463	642	897	1297	2046	2103	2920	3188	4746	5582
Slovenia	5804	3622	1636	1639	1643	1708	1819	1931	2048	2617	2730	2207	2777	2682	2893	2594
Spain	13436	22992	29578	41951	65916	79571	107840	100299	93148	10452	11976	10529	12605	12536	15634	17725
Sweden	6013	9234	9907	10920	12636	18085	14057	13127	22650	31043	34835	41454	51002	73301	93995	91942
U.Kingd	76283	109352	129654	15020	203905	208346	172986	179233	18958	19977	22864	25295	33738	38514	43863	50668

Source: UNCTAD

Table IV.8- FDI inflows (USD Million) to EU Countries (1986-2016) (cont.)

Country	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Austria	43508	53844	62336	69454	84025	126895	145796	169124	160615	152768	164714	178825	176607	164785	107110
Belgium	229513	351499	466548	478183	633296	748110	854426	967601	873315	942817	512712	571776	476405	468710	421839
Bulgaria	4074	6371	10108	13851	22867	36508	27846	32829	31510	28179	29633	29855	29660	26375	17408
Cyprus	4912	6728	8594	8688	14577	18414	180043	186227	212576	182687	185190	177461	149440	138263	95401
C.Republic	38669	45287	57259	60662	79841	101074	113174	125827	128504	120569	136493	134085	121512	113057	83662
Denmark	82799	100191	116486	115953	135408	146632	103957	103197	96984	98406	98302	94482	97216	100858	73626
Estonia	4226	7002	10064	11290	12664	16594	15449	15841	15551	16350	18937	21202	19712	18914	14942
Finland	33987	50257	57376	54585	67991	85237	83534	85163	86698	89232	96641	88762	93901	92340	65561
France	385202	527624	641807	628075	771545	1026081	563005	648012	630710	698871	717328	796488	729147	772030	594463
Germany	297785	394513	512066	475996	578786	629711	789256	963511	955881	997727	1077019	1088690	1089569	1121289	818541
Greece	15561	22454	28482	29189	41288	52838	38119	42097	35026	29060	24765	25850	22534	17688	12205
Hungary	36224	48340	62585	61970	81586	97397	88054	98876	90845	85331	104017	108517	98885	92132	63571
Ireland	182897	222960	204819	163530	156593	187184	188290	250103	285575	290495	364607	392915	378202	435490	431135
Italy	130819	180891	220720	224079	294876	364839	327911	364427	328059	355127	375029	364959	346824	335335	224674
Latvia	2751	3277	4529	4929	7476	10493	11309	11629	10935	12111	13534	15956	14668	14549	9893
Lithuania	3981	4960	6389	8211	10996	14679	12949	13216	13271	14266	15966	17542	15619	14440	9242
Luxembourg	34972	41730	49733	43721	66658	30176	125128	172217	172257	225725	167222	91396	180434	205029	135319
Malta	2413	3281	4018	4315	6498	7457	117077	125193	129770	146146	165530	184584	173838	163522	112830
Netherlands	349969	426611	477219	451078	502226	673430	647414	646292	588078	610677	628187	770976	715706	707043	445437
Poland	48320	57877	86623	90711	124530	142110	148417	167399	187602	164424	198953	229167	205581	213071	144888
Portugal	44637	60585	66970	63339	87959	114192	105511	118299	114994	103761	114573	124623	118918	114220	62821
Romania	7846	12202	20486	25817	45452	60921	64759	69883	68093	69513	76329	82688	73086	69112	46996
Slovakia	8530	14576	20910	23656	38335	40702	50416	52537	50328	51980	55124	58021	52488	48163	34196
Slovenia	4112	6308	7590	7259	8924	10350	11966	11277	10667	11490	12203	12269	12299	11847	7700
Spain	257106	339652	395984	370943	441039	537455	588901	632246	628341	628950	644677	638982	591709	533306	383980
Sweden	119368	158884	196290	171768	226385	254459	278802	332150	347163	349058	373444	386105	311786	281876	205770
U.Kingdom	523320	606158	701913	850963	1133437	1347688	901515	1015805	1057188	1145720	1428059	1489940	1744230	1457408	932741

Source: UNCTAD

Table IV.9-Growth Accounting in Manufacturing sector, Portugal (1986-2016)

Year	Labour	Capital	TFP	Year	Labour	Capital	TFP
1986	-0,5	2,1	0,4	2002	-0,5	1,2	-1,7
1987	0,2	1,0	3,7	2003	-1,0	0,5	-0,5
1988	-1,4	-0,5	7,7	2004	-0,4	0,5	0,1
1989	-0,8	2,1	6,9	2005	0,2	0,5	-2,4
1990	-1,9	2,2	4,4	2006	-0,6	1,0	-1,8
1991	-3,3	1,7	7,9	2007	1,1	1,0	-2,0
1992	-0,8	1,0	-1,9	2008	-0,1	-0,2	-1,6
1993	-0,8	1,7	-2,7	2009	0,1	1,3	-3,9
1994	-0,6	0,6	-5,5	2010	0,2	0,6	-1,7
1995	-1,1	1,3	4,0	2011	2,9	0,3	-5,8
1996	0,8	0,5	6,1	2012	0,4	0,5	-3,4
1997	-2,4	1,3	6,8	2013	-0,9	1,2	-0,5
1998	-1,5	1,4	2,7	2014	1,7	0,8	-4,9
1999	1,5	1,9	-3,8	2015	-2,0	-0,6	7,6
2000	0,2	2,3	-0,2	2016	-0,4	0,3	3,3
2001	-1,5	2,2	0,5	**Average**	**-0.4**	**1.0**	**0.6**

Note- values for 1986-1995 and 2006-2016 obtained by Multiple Imputation in Stata 13.0
Source: EUKlems database

Table IV.10- Share (%) of MNCs in Total Economy, Portugal (1986-2016)

Year	No.Firms	Employment	Value Added	Year	No.Firms	Employment	Value Added
1986	0.5	7.2	20.3	2002	0.1	2.7	8.1
1987	0.3	4.6	15.2	2003	0.2	4.5	17.6
1988	0.3	5.2	13.6	2004	0.2	4.4	14.5
1989	0.4	5.8	13.7	2005	0.3	5.1	16.4
1990	0.2	5.0	12.5	2006	0.4	5.4	16.5
1991	0.5	8.5	19.9	2007	0.4	5.7	17.0
1992	0.3	5.7	15.6	2008	0.4	6.9	17.5
1993	0.4	5.8	18.7	2009	0.4	6.9	17.6
1994	0.4	8.2	19.8	2010	0.4	7.2	18.4
1995	0.3	5.8	15.7	2011	0.5	7.3	18.7
1996	0.3	4.7	16.1	2012	0.5	7.2	18.6
1997	0.2	4.5	12.6	2013	0.4	7.5	18.8
1998	0.2	4.3	14.4	2014	0.3	5.1	11.8
1999	0.2	3.6	7.8	2015	0.3	4.6	10.6
2000	0.2	3.6	8.5	2016	0.1	2.7	8.1
2001	0.1	2.5	8.5	**Average**	**0.3**	**5.4**	**14.9**

Source- Author's calculations based in UNCTAD

Table IV.11-Share (%) of MNCs exports in Total, Portugal (1986-2016)

Year	MNCs exports in Manufacturing	% Total	Year	MNCs exports in Manufacturing	% Total
1986	1199	22	2002	6875	28
1987	1415	22	2003	6922	24
1988	1875	24	2004	9157	30
1989	2062	20	2005	12849	41
1990	4667	40	2006	8906	25
1991	3703	31	2007	17905	47
1992	5565	45	2008	9746	25
1993	1901	15	2009	13826	44
1994	2898	18	2010	16387	44
1995	3667	21	2011	17514	41
1996	6792	35	2012	20369	45
1997	6440	30	2013	11907	25
1998	4236	19	2014	25436	53
1999	5565	24	2015	17285	35
2000	11006	48	2016	25833	49
2001	10370	45	**Average**		**33**

Values in USD Million. Source: Author's calculations based in World Bank (World Development Indicators) and Eurostat.

Table IV.12-Contribution (%) of foreign firms to high-tech exports, Portugal (1986-2016)

Year	MNCs exports in science based industries (% Manufacturing)	Year	MNCs exports in science based industries (% Manufacturing)
1986	11	2002	5
1987	10	2003	7
1988	8	2004	9
1989	7	2005	12
1990	28	2006	13
1991	16	2007	17
1992	34	2008	8
1993	8	2009	20
1994	8	2010	17
1995	5	2011	16
1996	23	2012	18
1997	14	2013	11
1998	7	2014	17
1999	15	2015	12
2000	19	2016	16
2001	14	**Average**	**14**

Source: Author's calculations based in World bank Database (World Development Indicators), OECD Stat and UNCTAD (2013, p.30)

Table IV.13a- MNCs' Performance (Gross Operating Surplus) by industry, Portugal (1986-2016)

Industry	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Food products	203	217	190	204	167	205	212	194	156	173	196	199	193	178	198
Beverages	66	49	83	35	35	90	46	47	71	73	76	66	43	69	43
Textiles	14	37	36	11	22	28	22	20	23	14	29	13	12	10	34
Wearing apparel	2	6	6	6	4	5	5	7	4	3	5	5	3	5	3
Leather products	14	19	28	22	33	11	16	14	13	24	44	10	28	16	13
Wood	89	102	115	55	55	114	25	101	75	25	45	22	94	33	95
Paper products	51	66	71	58	67	53	58	49	52	65	59	71	48	49	62
Printing	30	37	15	8	32	56	2	66	6	32	50	32	15	63	31
Chemicals	52	181	83	157	81	147	72	102	173	195	156	186	147	67	153
Pharmaceuticals	122	85	123	114	101	98	110	122	124	105	124	115	106	111	103
Rubber and plastics	240	334	196	305	242	250	283	229	217	207	283	273	251	315	219
Other non-metallic minerals	109	204	194	142	214	109	163	208	158	202	126	204	152	142	211
Basic metals	44	47	50	37	36	55	65	54	38	55	52	66	60	39	49
Fabricated metal products	52	66	68	60	53	59	50	70	70	64	39	56	68	68	66
Computer & electronics	52	53	33	61	49	62	65	76	52	49	73	58	55	68	38
Electrical equipment	90	87	102	58	54	96	98	50	64	70	83	99	120	62	57
Machinery& Equipment	69	102	67	53	65	102	73	104	63	77	58	47	63	105	80
Motor vehicles	362	300	252	317	183	168	273	245	330	245	175	283	322	239	366
Other transport equipment	76	56	58	112	18	14	26	83	22	101	73	25	11	96	150
Furniture	11	41	11	44	29	6	20	29	14	8	38	7	43	40	19
Other manufacturing	47	51	48	49	47	46	45	51	50	51	41	41	40	52	44
Repair and installation	28	24	23	29	28	24	23	25	26	22	22	30	21	26	29

Source: EUROSTAT, Foreign control of enterprises by economic activity

Table IV.13a- MNCs' Performance (Gross Operating Surplus) by industry, Portugal (1986-2016) (cont.)

Industry	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Food products	162	155	192	194	155	194	204	222	216	202	158	150	141	145	157	169
Beverages	33	95	43	92	94	62	57	97	104	97	91	63	69	88	33	73
Textiles	37	14	24	25	27	9	33	18	6	30	32	25	38	6	24	19
Wearing apparel	3	3	3	4	4	6	7	6	1	6	4	-2	5	7	5	5
Leather products	16	47	17	13	17	18	15	10	8	21	9	13	12	22	41	19
Wood	44	19	37	22	22	17	10	24	13	18	18	19	18	19	10	17
Paper products	72	60	49	60	59	61	56	56	61	76	61	58	64	72	75	65
Printing	37	11	39	12	46	4	4	6	4	2	1	1	0	2	11	18
Chemicals	157	126	159	164	129	110	128	196	140	188	179	51	70	103	159	155
Pharmaceuticals	108	88	86	116	115	85	106	106	124	89	84	94	88	104	107	115
Rubber and plastics	234	324	235	292	279	216	235	165	192	240	272	301	337	340	345	267
Other non-metallic minerals	156	103	182	160	214	150	209	135	103	132	114	92	102	214	106	191
Basic metals	61	61	48	36	41	69	54	35	-24	39	14	10	23	51	64	35
Fabricated metal products	43	55	43	58	49	64	49	69	64	71	38	40	47	62	69	52
Computer & electronics	60	68	38	34	61	59	34	57	54	84	81	62	64	64	40	38
Electrical equipment	68	108	71	121	64	59	106	173	157	165	143	97	106	103	104	108
Machinery& Equipment	92	50	87	65	106	71	42	112	36	63	54	71	56	66	72	98
Motor vehicles	143	221	328	191	303	132	192	284	245	362	394	329	328	366	332	139
Other transport equipment	85	39	114	157	124	2	71	102	149	10	-29	-99	-10	-12	99	155
Furniture	38	8	38	6	12	38	25	-6	2	9	6	4	24	27	38	44
Other manufacturing	48	48	49	40	43	40	42	35	39	41	52	45	46	44	50	51
Repair and installation	21	25	24	29	30	26	22	29	31	24	22	29	24	21	22	24

Table IV.13b- MNCs' Performance (Number of Employees) by industry, Portugal (1986-2016)

Industry	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Food products	4292	4410	6676	3369	5096	3317	5887	3196	2164	2742	4079	4322	8156	10903	3936
Beverages	6768	4597	1201	4149	1355	3408	3094	2456	3195	2439	3713	4016	2884	2704	1243
Textiles	5878	4776	3804	3488	4986	3569	6331	6886	5862	5412	3193	5574	7175	3382	2405
Wearing apparel	3528	3840	6602	2483	5408	4921	1517	591	2050	5756	2450	1619	475	5914	2390
Leather products	1495	8001	6608	8039	2736	4217	6469	7716	5737	4715	5994	6752	6832	5917	6011
Wood	1221	2434	6359	8064	3916	2440	3611	3398	4972	4686	5100	3544	4005	7692	6435
Paper products	4697	5733	2441	2234	3772	3606	3500	2964	4693	3976	7429	6434	7724	3658	2169
Printing	364	738	507	490	694	627	514	371	160	389	740	430	466	661	773
Chemicals	3133	8315	6367	4063	6143	7262	5620	4283	2705	645	2196	6682	2049	4874	4669
Pharmaceuticals	5664	3771	2828	3822	4432	2595	4139	3082	3120	2166	4372	7437	8300	9196	3310
Rubber and plastics	6219	4375	4729	5884	5205	3212	6744	6693	5841	5392	4624	2316	6595	5389	4056
Other non-metallic minerals	5296	5174	1800	1384	1705	1466	1753	5954	7657	2138	7310	8123	6190	3474	1790
Basic metals	1745	1546	7842	2125	3196	6565	4939	2023	3982	2708	4420	7103	1618	1950	5782
Fabricated metal products	9645	7270	6039	7843	4897	7610	7491	9938	8028	6413	5589	4007	4089	5031	6595
Computer & electronics	8021	8074	4779	8203	1757	5212	1543	3326	2760	3252	2262	7465	8184	6625	5704
Electrical equipment	4740	9474	8140	4484	2301	2452	3341	2733	3094	5220	8990	10210	6097	8444	5601
Machinery& Equipment	3563	3044	4794	4722	2392	7324	2050	1745	4473	4281	4872	4971	6185	7510	5684
Motor vehicles	10628	14484	13096	12780	13481	13114	9130	13874	17469	13931	16650	17240	16620	11786	17755
Other transport equipment	5517	7300	5173	7527	7092	7365	7327	4552	4697	3139	3916	5505	8658	5895	5655
Furniture	2027	4558	6612	3517	2933	1033	2276	2092	1556	2996	6941	8045	4314	5067	4287
Other manufacturing	5458	4252	3525	3535	2930	4386	3643	5170	4610	5713	6087	3282	1645	10206	2682
Repair and installation	4554	3174	6889	7009	5143	3159	4119	3770	5106	4531	5557	5601	3769	2082	2881

Table IV.13b- MNCs' Performance (Number of Employees) by industry, Portugal (1986-2016) (cont.)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Food products	3932	4242	3076	7437	8680	6131	8795	9427	7124	8873	8999	8593	8394	9592	8718	5967
Beverages	2753	3878	2772	1270	2364	3453	3154	2684	2590	2395	2380	2302	1991	2265	3595	1260
Textiles	3810	4286	3921	1209	2098	7715	6519	4014	3592	3363	3197	2694	2772	2964	4030	3659
Wearing apparel	3684	4310	5868	3664	4927	5906	3880	4692	3737	3638	3534	3396	3410	3375	4906	4100
Leather products	4262	4806	3002	4468	6831	4327	6809	4963	4601	6759	3681	4102	4746	5262	5678	2270
Wood	5550	2332	3947	4351	4842	3618	2233	1369	1250	1241	1267	1219	1146	1405	1253	1731
Paper products	2797	2628	2743	2519	1040	3756	1320	2275	2206	2168	2064	2036	2180	2360	2763	1069
Printing	563	981	963	503	732	492	415	477	454	392	386	379	271	292	146	264
Chemicals	3801	7241	5754	4351	5711	6774	5237	5488	5094	5169	5092	4897	4556	4597	5049	4536
Pharmaceuticals	7050	4458	2876	2506	4651	3287	2158	2157	2432	2401	2416	2518	2339	2442	2940	2527
Rubber and plastics	6099	7548	5604	6543	6493	8424	8415	6055	5556	5751	6163	6179	6073	6437	3004	5221
Other non-metallic minerals	3734	3683	4192	5276	7446	6884	5863	6277	5811	5611	5448	5228	5329	6413	5588	7095
Basic metals	6599	7446	3448	3193	4307	4046	2498	2562	2271	2251	2307	2067	2154	2622	2313	1162
Fabricated metal products	7599	6617	8141	3441	6037	4575	3675	4698	4410	4420	4353	4248	4743	4988	2184	4410
Computer & electronics	4462	6953	6644	6000	5161	3039	3953	4763	5828	5978	5650	5502	5080	5288	6533	5075
Electrical equipment	4292	5594	3901	4293	9330	7949	6448	9149	8947	9145	9496	9444	9573	9430	8833	7025
Machinery& Equipment	7411	3073	4028	3477	6638	5002	6735	5902	3693	4080	4273	4909	4233	4458	7265	6589
Motor vehicles	11095	11380	12310	15769	11398	15029	22352	22874	19999	18831	19108	19163	19315	19591	18828	14371
Other transport equipment	4389	5589	9110	3312	7513	6053	5011	3620	6207	1492	3584	2643	1586	1610	1859	4483
Furniture	3121	2123	1035	2909	1360	2355	2407	1872	1502	2098	2110	2301	2247	2318	2229	2910
Other manufacturing	3986	2324	1814	3185	7246	6136	2860	2368	2531	2513	2717	2770	2737	2611	1769	1865
Repair and installation	6408	4712	7339	5897	3340	2036	2481	2676	2758	2743	2867	2746	2651	2747	3362	2910

Source: EUROSTAT, Foreign control of enterprises by economic activity

Table IV.14- Most common innovation and absorptive capacity indicators

Measure	Studies	Main advantages	Main drawbacks
		Innovation indicators	
Process innovations	West et al. (2003)	Reflects improvements in processes and methods	Focus solely on processes
Ratio of sales of new products to total sales	Czarnitzki & Kraft (2004)	Indicator of market success	Since it is a very broad indicator, it may reflect the impact of other factors besides innovation
Total R&D spending; Number of employees in R&D	García-Morales et al. (2008)	Easy to obtain	Does not provide indication of innovation efficiency
Patents or patent applications	Jung et al. (2008)	Measures technological progress	Nearly 95% of patents lack any market relevance and 99% fail to bring any profit to the firm (Stevens & Burley, 1997)
New products or product improvements; New markets entered	Elenkov & Manev (2009)	Indicator of radical innovation; reflects concrete implementation	Only about 60% of new products succeed
Ratio of sales of new products to R&D expenditures	Gumusluoglu & Ilsev (2009)	Indicator of R&D efficiency	Difficulty to establish a valid baseline
Patent citations	Makri & Scandura (2010)	Measures importance of patents	Patents may be self-cited
R&D expenditures (% GDP); number of patent applications by residents; number of scientific publications.	Castelacci and Natera (2013)	Easy to obtain, measures technological progress	Does not indicate innovation efficiency; patents usually lack market relevance; publications may be self-cited

Source: adaptation based on Duchek (2013), Flatten et al. (2011), Jimenez-Barrionuevo et al. (2011) and Murovec and Prodan (2009).

Table IV.14- Most common innovation and absorptive capacity indicators (cont.)

Absorptive Capacity indicators			
Total Number of Publications based on dollars spent on research annually	Cockburn, Henderson [1998]	Generally accepted measure that can be used for international comparisons. Data on patents are easily and internationally available.	Purely quantitative measure. Data are not readily available. International and sectoral differences in patenting behaviours. There are differences in patenting between large and small firms. Same weight is given to very important and less important patents.
Number of Patents	Ahuja, Katila [2001]; George et al. [2001]		
Participation in life-long learning; Employment in medium/high-tech industries	Kutlača (2008)	Employment in medium/high-tech industries is easy to obtain	Participation in life-long learning is difficult to obtain, due to incipient tracking down system. Systematized indicator for European Countries is recent. Employment in medium/high-tech industries have a limited explanatory power considering that there are several other sources of absorptive capacity.
GDP per capita, purchasing power parity; International Trade (Imports+ Exports % of GDP); Number of Total Graduates; Electric Power Consumption; Gini Index	Castelacci and Natera (2011)	Generally accepted measure that can be used for international comparisons. Data are easily and internationally available.	GDP per capita is an average measure. International Trade is not the main vehicle of technological transfer (see section 2.1 of chapter 1 for a discussion on the topic)

Source: adaptation based on Duchek (2013), Flatten et al. (2011), Jimenez-Barrionuevo et al. (2011) and Murovec and Prodan (2009).

Table IV.15- Correlations between FDI flows and Inovation system indicators and gap, 1986-2016

	FDI	R&D	Publications	Patents	GDPpc	Trade	Graduates	Electric	Gini	GAP
FDI	1.0000									
R&D	0.6601*	1.0000								
Publications	0.1892	0.2820	1.0000							
Patents	0.8477*	0.7133*	0.1952	1.0000						
GDPpc	0.8936*	0.4830*	0.0404	0.6518*	1.0000					
Trade	0.7629*	0.4902*	0.1840	0.6722*	0.7757*	1.0000				
Graduates	0.8885*	0.5090*	0.2004	0.7429*	0.8384*	0.7199*	1.0000			
Electric	0.8927*	0.4425*	0.0513	0.6523*	0.9603*	0.6983*	0.8353*	1.0000		
Gini	-0.5664*	-0.4642*	-0.1628	-0.6338*	-0.4742*	-0.3481	-0.6098*	-0.4463*	1.0000	
GAP	0.3788*	-0.0245	-0.0880	0.0656	0.5361*	0.1817	0.3705*	0.6687*	-0.1215	1.0000

Note- * significant at 5% level. Source: own calculations in Stata 13.0

Table IV. 16- Goals of Technological Plan, aiming to reduce the technological gap, 2005

	Goal
Human resources allocated to R&D and scientific publications in international journals	+50%
Number of PHDs in Portugal and abroad	1500
Private expenditure on R & D	+300%
Public expenditure on R & D	1% do PIB (+200%)
Public R & D activities	+1000 jobs
Number of registered patents	+300%

Source: Technological Plan (2005) in https://infoeuropa.eurocid.pt/files/database/000035001000036000/000035449.pdf, p.26

Table IV.17- Goals of Portugal 2020, aiming to converge with the EU-28 average, 2014-2020

Indicator	Objective	Measure	Goal (PT2020)
Innovative capability	Reinforcement of R&D and Innovation	R&D (% GDP)	2.7%- 3.3%
Absorptive capacity	More and better education	% Population with higher education or equivalent (30-34 years old)	40.0%
	Fight poverty and social inequalities	People at risk of poverty (compared to 2008)	-200,000

Source: Adapted from http://ec.europa.eu/europe2020/pdf/nd/prgrep2013_portugal_pt.pdf, p.9

Table IV. 18-Components of the Ex-Ante Evaluation of FDI and Industrial policies

Policy				
Goals	**Constraints**	**Measures/Instruments**	**Expected Results**	**Recommendations**
Strengthen the manufacturing sector, consolidate poles of competitiveness, according to a specialization strategy	-Privatization has increased deindustrialization - Manufacturing is organized in highly fragmented value chains -Competition from emerging economies	-Horizontal measures (targeting all sectors) -Creation of an environment conducive to entrepreneurship - Promotion of businesses angels and venture capital -Flexibility of the labour market -Access to credit -Strengthen the internal market (intellectual property rights, competition policy, infrastructures, and standards)	-MNCs in scale-intensive industries may be the major contributors regarding turnover, employment, value added and gross operating surplus - Foreign firms may have a major role regarding Gross Operating Surplus in the automotive industry, rubber and plastics and non-metallic minerals - Subsidiaries may create a larger number of jobs in the automotive, food and electrical equipment industries.	-Policies need to tailor to the specific requirements of investors, and be difficult to replicate elsewhere -Industrial policy should contribute to: achieving higher levels of competitiveness through increased industrial productivity. Accordingly, it should: - Address systemic failures and attract FDI projects that lead to positive externalities -Conceal horizontal policies that support the manufacturing sector, with vertical policies targeting specific sectors
Reduce the technological gap	-Lack of fluidity in the technology transfer processes from universities and other R&D institutions to domestic firms - Low level of innovation capabilities of domestic firms - Government incentives for innovation have been reduced - Difficulty in adopting modern production techniques, organizational practices and in creating new products	Technological Plan: - Stimulate innovation - Enhance cooperation between firms and scientific and technological organizations -Inclusion of PhDs in domestic firms through financial incentives for SMEs -"Horizontal" emphasis on research strategies and the promotion of industry-wide innovation to increase productivity and economic growth	At aggregate level (manufactuing sector), the technological gap has a positive effect (0.198) on the TFP growth of domestic firms in the upstream industries of foreign firms, which suggests the technology-accumulation hypothesis, according to which if the gap is too large, domestic firms do not possess the necessary "absorptive capacity" to incorporate the knowledge of foreign firms.	-Innovation facilitates structural change towards economic activities with high added value -Structural change via technological change. - The change of Portugal's specialization towards techno-low and capital-intensive products should continue.

Notes- Because the measure of technological gap is inverse, i.e., constructed as the ratio of labour productivity of domestic firms to foreign firms, the higher the value the greater the technological sophistication of domestic firms.
Source-Author's own elaboration

Table IV.18- Components of the Ex-Ante Evaluation of FDI and Industrial policies (cont.)

Policy				
Goals	**Constraints**	**Measures/Instruments**	**Expected Results**	**Recommendations**
Real convergence of productivity	- Erosion of competitiveness and aggravation of external accounts - investment and allocation of resources (labour) for non-tradable services - Specialization in sectors of low technological intensity and weak capacity to generate knowledge adaptable to production needs - Low average labour qualification and low level of innovation can hinder TFP's growth	Focus on the manufacturing as a driver of economic recovery	Reduce the disparity in labour productivity in the Portuguese economy	The convergence process in Portugal must be assisted by a reinforcement of supply-side measures with an integrated industrial policy, favouring certain industries where there is evidence of positive externalities from FDI
Attract FDI and promote economic growth and employment	-Investment policy moving from national to European level -Stiff public budget -Limited scope of most FDI strategies through incentives - Difficulty of IPAs in identifying business opportunities for target firms	-Encourage FDI through incentives funded by Structural Funds -Special visa regime -Priority industries: heavy industry; traditional industries; and industries with comparative advantage (electrical equipment, computers and electronics). -Transparency of public finances - Promptness of judicial procedures - Liberalization of the product market -Improve regulation	- An increase of one percent in turnover of foreign firms in downstream and upstrem industries may contribute to an increase in 0.0629 and 0.306 percentage points of domestic firms'TFP.	FDI policy should: -Compare the benefits of attracting FDI projects with the costs in terms of the public budget - Align investor motivation with the country's development strategy - Protect and enable investment liberalization by removing obstructions (Particularly in the framework of mergers and repatriation of income) State aid rules need to: - Adopt a sectoral and multisector approach - Consider the economic impact of the project and the fulfilment of the contractual obligations; - Consider the tax laws of the country of origin and the agreements governing taxation between the two countries.

Notes- Because the measure of technological gap is inverse, i.e., constructed as the ratio of labour productivity of domestic firms to foreign firms, the higher the value the greater the technological sophistication of domestic firms.
Source-Author's own elaboration

Table IV.19- Summary of our empirical results on externalities from FDI in priority manufacturing industries

		Priority Industries (AICEP)					
Externality	**Period**	**Heavy Industries**		**Traditional Industries**		**Comparative Advantage Industries**	
		Value	**Industry**	**Value**	**Industry**	**Value**	**Industry**
Horizontal	t	0.00000793	Basic Metals				
	t-1			0.0557 0.000789 0.000540	Other Transport Rubber and Plastics Food		
	t-2			0.0713 0.00264 0.000686	Other Transport Wearing Apparel Food		
Via Backward linkages	t			0.334 0.00824	Beverages Wood		
	t-1	0.000987	Basic Metals	0.0617	O.Transport Equipment		
	t-2			0.0198	O.Transport Equipment	0.0227	Computer and Electronics
Via Forward linkages	t			0.249 0.00871	Beverages O.Transport Equipment		
	t-1	0.00107	Metal Products				
	t-2			0.103	Beverages	0.222	Electrical Equipment

Source- Own elaboration based on empirical results of chapter 3, tables III.3 to III.27.

APPENDIX C

Construction of variables

We describe how we constructed the variables that proxy the foreign presence at horizontal level (*hor*) and vertical level (*back* and *for*). We start by calculating the variable *hor* as indicated in equation (II.9) and whose basic statistics are in Table II. 7. Alternative measures hor, *hoz and hoz1 were* constructed, using turnover, tangible assets and value added, respectively.

Next, we used the OECD IO tables to calculate the coefficients δ_{jk} and λ_{kj} of equations (II.10) and (II.11). Since we have only two years available for all countries (1995 and 2000), we use the coefficient of 1995 for years 1995 to 1999 and the coefficient of 2000 for years 2000 to 2007. We are assuming that these coefficients are constant over time.

Table C1 shows that the IO tables from OECD are not fully harmonized regarding the currency.

Table C1-Description of the OECD Input-Output Tables

Country	1995 Table	1995 Currency	2000 Table	2000 Currency
Germany	total use	millions DEM	basic prices	millions EUR
Italy	basic prices	millions EUR	basic prices	millions EUR
Korea	total use	millions KRW	basic prices	millions KRW
Netherlands	basic prices	millions EUR	basic prices	millions EUR
Portugal	total use	millions EUR	basic prices	millions EUR
Spain	total use	millions ESP	basic prices	millions EUR
Sweden	basic prices	millions SEK	basic prices	millions SEK
UK	basic prices	millions GBP	basic prices	millions GBP
USA	producer prices	millions USD	producer prices	millions USD
Austria	basic prices	millions EUR	basic prices	millions EUR
Belgium	basic prices	millions EUR	basic prices	millions EUR
Brazil	basic prices	Thousand BRL	basic prices	Thousand BRL
Canada	basic prices	millions CAD	basic prices	millions CAD
Denmark	basic prices	millions DKK	basic prices	millions DKK
Finland	total use	millions FIN	basic prices	millions EUR
France	total use	millions FRF	basic prices	millions EUR
Japan	producer prices	millions JPY	basic prices	millions JPY
Luxembourg	basic prices	millions EUR	basic prices	millions EUR
Norway	basic prices	millions NOK	basic prices	millions NOK

Source: author’s analysis

Indeed, in addition to the Euro, other currencies serve as reference in IO tables from Canada, Denmark, United Kingdom, Japan, Korea, Norway, Sweden, USA, and Brazil. However, for our analysis what matters is the ratio between the intermediate consumption of each sector to total manufacturing intermediate consumption.

The manufacturing sectors in the OECD IO tables are classified according to classification ISIC Rev.3, as shown in Table C2. We allocate another code of our own designation when we introduce the technical coefficients in Stata 13.0.

Table C2- Equivalence of ISIC Rev.3 codes used in OECD Input-Output tables into NACE Revision 2 codes

ISIC Rev.3	Description	Our codes	NACE Rev. 2
15-16	Food Products, Beverages, and Tobacco	4	10-12
17-19	Textiles, Textile Products, Leather, and Footwear	5	13-15
20	Wood and Products of Wood and Cork	6	16
21-22	Pulp, Paper, Paper Products, Printing, and Publishing	7	17-18
23	Coke, Refined Petroleum Products, and Nuclear Fuel	8	19
24ex2423	Chemicals Excluding Pharmaceuticals	9	20
2423	Pharmaceuticals	10	21
25	Rubber and Plastics Products	11	22
26	Other Non-Metallic Mineral Products	12	23
271 2731	Iron & Steel	13	24
272 2732	Non-Ferrous Metals	14	24
28	Fabricated Metal Products, Except Machinery and Equipment	15	25
29	Machinery and Equipment, N.E.C.	16	28
30	Office, Accounting, and Computing Machinery	17	26
31	Electrical Machinery and Apparatus, NEC	18	27
32	Radio, Television, and Communication Equipment	19	33
33	Medical, Precision and Optical Instruments	20	32
34	Motor Vehicles, Trailers, and Semi-Trailers	21	29 e 30
351	Building and Repairing of Ships and Boats	22	30
353	Aircraft and Spacecraft	23	30
352, 359	Railroad Equipment and Transport Equipment N.E.C.	24	29
36-37	Manufacturing Nec; Recycling	25	31

Source: author’s classification based in EUROSTAT

In order to calculate the coefficients δ_{jk} in equation (II.10), for example for sector 4, we divide each matrix *element* by the *column* sum (see Table C3). In other words, we calculate: a4-4/ΣJ-4 , ... , a25-4/Σaj-4, where the a_{ij} are the technical coefficients from the IO tables. However, we exclude the main diagonal coefficients (in this example, we exclude the element a4-4) because they are included in the calculation of the variable *Hor*.

Table C3- Example of a matrix to calculate the Backward coefficients

Sectors	**4**	**....**	**25**
4	a_{4-4}	.....	a_{4-25}
......	.....	......	......
25	a_{25-4}	....	a_{25-25}
X	$\sum a_{j-4}$	.....	$\sum a_{j-25}$

Source: author's analysis

Likewise, we calculate the coefficients λ_{kj} in equation (II.11) for sector 4, by dividing each matrix *element* by the line *sum* (see Table C4). In other words, we calculate: a4-4/Σa4-i , ... , a4-25/Σa4-i. We exclude the main diagonal coefficients because they are included in the calculation of the variable *Hor*.

Table C4- Example of a matrix to calculate the Forward coefficients

Sectors	**4**	**....**	**25**	**Y**
4	a4-4	.....	a4-25	∑a4-i
......	.....	......	......	.....
25	a25-4	....	a25-25	∑a25-i

Source: author's analysis

Subsequently, we need to convert the coefficients in OECD tables which now have our own codes (4 to 25) into NACE Revision 2 (10-33). Since some coefficients gather together two or more industries, we need to allocate them to every industry of NACE Rev.2.

Hence, we summed the IO coefficients for sectors 10-12 in the table of domestic production at basic prices for 2006, from Portuguese National Accounts, and calculate the share of each sector in the total of the three sectors. We proceeded using the same methodology for the remaining aggregated sectors as shown in Table C5.

Table C5- Criteria for conversion of OECD coefficients for aggregated sectors into NACE sectors

Sector codes Our codes	Nace Rev. 2	Shares (%)
4	10	87
	11	12
	12	1
5	13	27
	14	54
	15	19
7	17	34
	18	66
21	29	89
	30	11

Source: author's analysis

We are assuming that the shares from foreign countries do not differ much from the Portuguese and that they are stable over time.

Next, we multiply each share by the respective IO coefficient. We performed these calculations for each of the 18 foreign investors in the Portuguese manufacturing industries. We obtain the average *back* and *for* coefficients by summing the coefficients of each investor Country and dividing by the number of investors in the industry.

For example, in industry 10, our sample contains 10 investor countries. In order to calculate the average backward coefficient, we sum the coefficients back $_{11\text{-}10}$, ... , $back_{33\text{-}10}$ for the respective countries and divide by 10.

To calculate the forward coefficients, we proceed similarly. The average forward coefficient for sector 10 is obtained by summing the coefficients $forw_{10\text{-}11}$, ... $forw_{10\text{-}33}$, for all investor Countries and dividing by the number of countries.

The basic statistics for coefficients backward (Cba) and forward (Cfo) for 1995 and 2000 are shown in Table C6.

Table C6- basic statistics for coefficients of backward and forward externalities, 1995 and 2000

Year	Variable	Obs	Mean	Std. Dev.	Min	Max
1995	Cba	5045	0.17	0.23	0.0006	0.86
1995	Cfo	5045	0.49	0.30	0.0006	0.89
2000	Cba	5045	0.19	0.20	0.0006	0.82
2000	Cfo	5045	0.41	0.26	0.0007	0.83

Source: author's calculations in Stata 13.0

We obtain three measures of foreign presence in downstream industries *b1, b2* and bb, by multiplying the IO coefficients by *hor, hoz* and *hoz1*, respectively. The same procedure was performed to obtain three measures of foreign presence in upstream industries *f1, f2* and *ff*.

APPENDIX D

Correlations between Input-Output tables

Researchers use the IO coefficients to calculate the flows of technology. The use of host country's IO technical coefficients implies that MNCs have the same production technology as local firms (Barrios et al, 2010). This procedure challenges the assumption of externalities from FDI arising from contacts with MNCs that possess superior technology (e.g., Markusen, 2002). The International Business literature has provided evidence that the sourcing policy of a MNC depends largely on its nationality. Moreover, the evidence suggests that MNCs use similar production technology in the host country to that used at home, hence, it is likely that their supply strategies are also similar. Therefore, Barrios et al. (2010) suggest that before using host country IO coefficients, researchers should test their correlation with the IO coefficients of the investor country to conclude whether the domestic coefficients are a good proxy of foreign technology.

We calculate the correlation between the IO tables from OECD. Our database contains foreign investors from 18 countries. Hence, we assign numbers from 1 to 19 for Portugal and each of investor countries, as shown in Table D1.

Table D1- Country codes

Code	Country	Code	Country
1	Germany	11	Belgium
2	Italy	12	Brazil
3	Korea	13	Canada
4	Netherlands	14	Denmark
5	Portugal	15	Finland
6	Spain	16	France
7	Sweden	17	Japan
8	United Kingdom	18	Luxembourg
9	USA	19	Norway
10	Austria		

Source: author's analysis

We calculate the variables *back* and *for* as explained in Appendix C. Then, we calculate the partial correlation of these coefficients for country 5 (Portugal) with the respective coefficients for the foreign investor countries. Tables D2 and D3 show the correlation of Cba and *Cfo*, respectively.

Table D2- Partial correlation between the variables that proxy backward linkages for foreign investor countries with the respective variable for Portugal

Variable	Corr.	Sig.	Variable	Corr.	Sig.	Variable	Corr.	Sig.
Cba1	-0.2616	0.671	Cba8	0.4157	0.486	Cba14	0.1903	0.759
Cba2	0.3823	0.525	Cba9	-0.7392	0.153	Cba15	-0.5894	0.296
Cba3	0.8286	0.083	Cba10	0.1093	0.861	Cba16	0.1326	0.832
Cba4	0.3106	0.611	Cba11	-0.0024	0.997	Cba17	0.4846	0.408
Cba6	0.5922	0.293	Cba12	0.3350	0.582	Cba18	-0.2226	0.719
Cba7	-0.2266	0.714	Cba13	-0.3351	0.581	Cba19	-0.0984	0.875

Note- the numbers of each *Cba* correspond to country code. Source: author's calculations in Stata 13.0

Regarding the variable that proxies backward linkages, the only countries where the coefficient is strongly correlated with Portugal are Korea and Spain. Moreover, this variable has a significant negative correlation with the coefficients for the USA and Finland.

Table D3-Partial correlation between the variables that proxy forward linkages for foreign investor countries with the respective variable for Portugal

Variable	Corr.	Sig.	Variable	Corr.	Sig.	Variable	Corr.	Sig.
Cfo1	-0.8405	0.075	Cfo8	-0.7834	0.117	Cfo14	0.8612	0.061
Cfo2	0.4994	0.392	Cfo9	0.8180	0.091	Cfo15	0.6906	0.197
Cfo3	0.8133	0.094	Cfo10	0.8628	0.060	Cfo16	-0.8357	0.078
Cfo4	0.5700	0.316	Cfo11	0.2743	0.655	Cfo17	0.6162	0.268
Cfo6	-0.0507	0.935	Cfo12	-0.7581	0.138	Cfo18	0.8356	0.078
Cfo7	0.8288	0.083	Cfo13	-0.2057	0.740	Cfo19	-0.8071	0.099

Note- the numbers of each *Cba* correspond to country code. Source: author's calculations in Stata 13.0

The variable that proxy forward linkages for Portugal (C5) is strongly correlated with the ones for Korea, Netherlands, Sweden, USA, Austria, Denmark, Finland, Japan, and Luxembourg. However, it has a significant negative correlation with the coefficient for the UK, Germany, Brazil, France, and Norway. Hence, we chose to use home countries' IO tables instead of those for Portugal.

APPENDIX E

GMM estimation in first differences

Considering the AR(1) model

$$\hat{tfp}_{ijt} = \beta_0 + \beta_1 \hat{tfp}_{ijt-1} + \beta_2 F_{ijt} + \beta_3 X_{ijt} + \eta_i + \gamma_t + u_{it} \quad , \tag{E1}$$

with $u_{i,t} = \mu_i + \varepsilon_{it}$ for i=1,…,N and t=2,…, T and $|\delta|<1$

we assume that μ_i and $\varepsilon_{i,t}$ are independently distributed across *i* and have the usual error components structure in which

$$E(\mu_i) = E(\varepsilon_{i,t}) = E(\mu_i \varepsilon_{i,t}) = E(\varepsilon_{i,s}\varepsilon_{i,t}) = 0, \forall s \neq t \quad \text{for i=1,…,N and t=2,…, T} \tag{E2}$$

The standard assumption on the initial conditions:

$$E(\hat{tfp}_{i,t}\varepsilon_{i,t}) = 0 \quad \text{for i=1,…,N and t=2,…, T}$$

In equation (1) the lagged dependent variable $\hat{tfp}_{i,t-1}$ may be correlated with the error term $\varepsilon_{i,t}$ and with the unobserved fixed effects η_i. Differencing equation (1) removes the unobserved fixed effects (μ_i) since it does not change over time.

$$\Delta \hat{tfp}_{i,t} = \delta \Delta \hat{tfp}_{i,t-1} + \Delta u_{i,t} \tag{E3}$$

$$\Delta u_{i,t} = u_{i,t} - u_{i,t-1} = (\mu_i - \mu_i) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) = \varepsilon_{i,t} - \varepsilon_{i,t-1}$$

However, there is the autocorrelation issue, since $\hat{\omega}_{i,t-1}$ in $\Delta \hat{tfp}_{i,t-1} = \hat{tfp}_{i,t-1} - \hat{tfp}_{i,t-2}$ is correlated with $\varepsilon_{i,t-1}$ in the error term $\Delta u_{i,t} = \varepsilon_{i,t} - \varepsilon_{i,t-1}$.

Arelano and Bond (1991) propose using the lagged dependent variable two or more periods as a valid instrument to deal with the autocorrelation issue.

For example, the IV $\hat{tfp}_{i,t-2}$ is correlated with $\Delta \hat{tfp}_{i,t-1} = \hat{tfp}_{i,t-1} - \hat{tfp}_{i,t-2}$, but not with the error term $\Delta u_{i,t} = \varepsilon_{i,t} - \varepsilon_{i,t-1}$, since we assume that $E(\varepsilon_{i,s}\varepsilon_{i,t}) = 0, \forall s \neq t$.

Given the assumptions (2) and (3), the moment condition m= (T-2) (T-1) for the first-differenced equation (3) is given by:

$$E(\hat{tfp}_{i,t-s}\Delta u_{i,t}) = 0 \quad \forall s = 2,....,(t-1) \quad t=3,....,T \tag{E4}$$

A more compact form of the moment condition (4) can be expressed as

$$E(z'_{di}\Delta u_{it}) = 0 \tag{E5}$$

where Z_{di} is a *(T-2) *m* matrix and Δu_i the *(T-2)* vector is given by:

$$Z_{di} = \begin{bmatrix} \hat{tfp}_{i,1} & 0 & 0 & ... & 0 & ... & 0 \\ 0 & \hat{tfp}_{i,1} & \hat{tfp}_{i,2} & ... & 0 & ... & 0 \\ ... & ... & ... & ... & ... & ... & ... \\ 0 & 0 & 0 & ... & \hat{tfp}_{i,1} & ... & \hat{tfp}_{i,T-2} \end{bmatrix} \quad \Delta u_i = \begin{bmatrix} \Delta u_{i,3} \\ \Delta u_{i,4} \\ ... \\ \Delta u_{i,T} \end{bmatrix} \tag{E6}$$

According to Arelano and Bond (1991), the generalised method of moments estimator based on these moment conditions minimises the quadratic distance ($\Delta u' Z_d$)A_N($\Delta u' Z_d$), where:

$\Delta u = \Delta\hat{tfp} - \delta\Delta\hat{tfp}_{-1} = (\Delta u_1^{'};...;\Delta u_N^{'})'$ is a (*T-2*) vector:

$Z_d = (Z_{d1}^{'};...;Z_{dN}^{'})$ is a *N(T-2)*m* matrix.

The GMM estimator δ is given by:

$$\hat{\delta}_d = (\Delta tfp_{-1}^{'} Z_d (A_{dN})^{-1} Z_d \Delta tfp_{-1})^{-1} (\Delta tfp_{-1}^{'} Z_d (A_{dN})^{-1} Z'_d \Delta tfp) \tag{E7}$$

where $\Delta\hat{tfp}_i = (\hat{tfp}_{i3,...}\Delta\hat{tfp}_{iT})'$ is a *(T-2)* vector; $\Delta\hat{tfp}_{i,-1} = (\hat{tfp}_{i2,...}\Delta\hat{tfp}_{iT-1})'$ is a *(T-2)* vector).

A_{dN} is a positive *m*m* matrix and According to Arelano and Bond (1991) it is given by:

$$A_{dN} = \left(N^{-1} \sum_{i=1}^{N} Z'_{di} H Z_{di} \right)^{-1}$$

where H is a *(t-2) *(t-2)* matrix:

$$H=\begin{bmatrix} 2 & -1 & \dots & 0 \\ -1 & 2 & \dots & 0 \\ 0 & -1 & \dots & 0 \\ \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & 2 \end{bmatrix}$$

GMM estimation in levels

Arellano and Bover (1995) suggest the use of the lagged first differenced dependent variable as a IV in equation (1) in levels if the explanatory variable in levels is correlated with the fixed effect η_i but the first difference is not.

The initial conditions satisfy

$$E(\hat{tfp}_{i,2}\mu_i) = 0 \quad \text{for } i=1, .., N \qquad \text{(E8)}$$

assuming (2), (3) e (8), then the additional moment condition which is valid for equation (1) in levels, *m=(T-2) (T-1)* is given by :

$$E(\hat{tfp}_{i,t}u_{i,t}) = 0 \qquad \forall s = 1,...., (t-2) \quad t=3,\dots,T \qquad \text{(E9)}$$

A more compact form of the moment condition (9) can be expressed as

$$E(z'_u u_i) = 0 \qquad \text{(E10)}$$

where Z_u is a *(T-2)*m* matrix e u_i is a *(T-2)* vector given by:

$$Z_u = \begin{bmatrix} \Delta\hat{tfp}_{i,2} & 0 & 0 & \dots & 0 & \dots & 0 \\ 0 & \Delta\hat{tfp}_{i,2} & \Delta\hat{tfp}_{i,3} & \dots & 0 & \dots & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & \Delta\hat{tfp}_{i,2} & \dots & \Delta\hat{tfp}_{i,T-1} \end{bmatrix} \quad u_i = \begin{bmatrix} u_{i,3} \\ u_{i,4} \\ \dots \\ u_{i,T} \end{bmatrix} \qquad \text{(E11)}$$

The GMM estimator δ is given by:

$$\hat{\delta}_l = (tfp'_{-1}Z_l(A_{lN})^{-1}Z_l tfp_{-1})^{-1}(tfp'_{-1}Z_l(A_{lN})^{-1}Z'_l\, tfp) \qquad \text{(E12)}$$

where $\Delta \hat{tfp}_i = (\Delta \hat{tfp}_{i3,....}\Delta \hat{tfp}_{iT})'$ is a *(T-2)* vector; $\Delta \hat{tfp}_{i,-1} = (\Delta \hat{tfp}_{i2,....}\Delta \hat{tfp}_{iT-1})'$ is a *(T-2)* vector.

A_{dN} is a positive *m*m* matrix and according to Arelano and Bond (1991) is given by:

$$A_{dN} = \left(N^{-1} \sum_{i=1}^{N} Z'_{di} H Z_{di} \right)^{-1}$$

where *H i*s a (*t-2) *(t-2*) matrix:

$$H = \begin{bmatrix} 2 & -1 & ... & 0 \\ -1 & 2 & ... & 0 \\ 0 & -1 & ... & 0 \\ ... & ... & ... & ... \\ 0 & 0 & ... & 2 \end{bmatrix}$$

System-GMM

Blundell e Bond (1998) suggest the use of system-GMM which combines the moment condition in first differences (4) and in levels (9) to deal with the econometric issues related with equation (1). The moment conditions are *m=(T-2) (T+1)* :

$$E(\hat{tfp}_{i,t-s} \Delta u_{it}) = 0 \qquad \forall s = 2,....,(t-1) \quad \text{t=3,….,T}$$

$$E(\Delta \hat{tfp}_{i,t-s} u_{it}) = 0 \qquad \forall s = 1,....,(t-2) \quad \text{t=3,….,T}$$

A more compact form of the moment conditions is:

$$E(z'_{si} P_i) = 0 \qquad \text{(E13)}$$

where

$$Z_{si} = \begin{bmatrix} Z_{di} & 0 \\ 0 & z_{li}^b \end{bmatrix} = \begin{bmatrix} Z_{di} & 0 & 0 & ... & 0 \\ 0 & \Delta \hat{tfp}_{i,2} & 0 & ... & 0 \\ 0 & 0 & \Delta \hat{tfp}_{i,3} & ... & 0 \\ 0 & 0 & 0 & ... & \Delta \hat{tfp}_{i,T-1} \end{bmatrix} \quad p_i = \begin{bmatrix} \Delta u_i \\ u_i \end{bmatrix} \qquad \text{(E14)}$$

and Z_{di} is a matrix in equation (7) and z_{li}^b is a non-redundant subset of natrix (11)
The GMM estimator δ is given by:

$$\hat{\delta}_s = (q'_{-1} Z_s (A_{sN})^{-1} Z_s q_{-1})^{-1} (q'_{-1} Z_s (A_{sN})^{-1} Z'_s q) \quad \text{(E15)}$$

where $q_i = (\Delta \hat{tfp}'_{i,....} \hat{tfp}_i)'$; $q_{i,-1} = (\Delta \hat{tfp}'_{i,-1}, \hat{tfp}'_{i,-1})'$

APPENDIX F

Table F1- Portuguese Innovative System Database: description and basic statistics, 1986-2016

Obs=31

Variable	**Description**	**Unity**	**Mean**	**Std. Dev.**	**Min**	**Max**	**Source**
rdeu	R&D expenditure EU-28	% GDP	1.81	0.11	1.63	2.02	PORDATA
rdpt	R&D expenditure Portugal	% GDP	0.94	0.38	0.40	1.58	PORDATA
patenteu	Patents EU-28	Number	16,713.84	7,123.95	5,526.00	26,816.00	PORDATA
patentpt	Patents Portugal	Number	214.55	207.27	54.00	722.00	PORDATA
publeu	Scientific publications EU-28	Number	1,195.06	156.07	933.00	1,526.37	OCES Ministry of Science
publpt	Scientific publications Portugal	Number	677.54	353.58	33.00	1,336.00	OCES Ministry of Science
gdpppseu	GDP PPS EU-28	pps	20,070.03	6,208.78	10,183.00	33,582.00	PORDATA
gdpppspt	GDP PPS Portugal	pps	15,803.29	4,704.40	7,713.00	25,385.00	PORDATA
tradeeu	(imports+exports) EU-28	% GDP	65.35	11.93	49.00	83.00	PORDATA
tradept	(imports+exports) Portugal	% GDP	65.22	7.03	54.01	79.90	PORDATA
graduateseu	Graduates EU-28	Number	130,635.30	26,674.09	79,526.00	180,095.00	PORDATA
graduatespt	Graduates Portugal	Number	64,688.38	18,147.94	27,182.27	94,867.00	PORDATA
eleceu	electric power consumption EU-28	Kwat	5,751.96	512.52	4,825.00	6,568.00	PORDATA
elecpt	electric power consumption Portugal	Kwat	3,839.40	1,053.64	1,974.54	5,342.17	PORDATA
ginieu	Gini Index EU-28	Number	29.41	0.80	28.00	31.00	PORDATA
ginipt	Gini Index Portugal	Number	36.25	1.45	34.00	39.00	PORDATA

Source- Author’s own elaboration