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SOLBJERG PLADS 3
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DANMARK

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Federico Clementi

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CBS COPENHAGEN BUSINESS SCHOOL
HANDELSHØJSKOLEN

Essays on multinational production and international trade

Federico Clementi

Supervisor: Pascalis Raimondos

PhD School in Economics and Management
Copenhagen Business School

Federico Clementi
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Foreword

This thesis is the result of my work as a Ph.D. Fellow at the Economics Department at Copenhagen Business School. I am grateful for the funding provided by Copenhagen Business School which allowed me to live in Copenhagen, work on my projects and travel to participate in conferences and workshops.

I would like to thank a number of people who have helped and supported me in these years. First and foremost, I wish to thank my supervisor Pascalis Raimondos for his advice, suggestions and the enlightening comments he gave me throughout my PhD. During all these years Lakis was always happy to help and never too busy to answer my questions. I could not have asked for a better supervision. Thank you, Lakis.

I had also the pleasure to work with Lakis on a fourth project which is not part of this Thesis. I would like to thank him and our coauthors, Søren Bo Nielsen and David Dreyer Lassen, for our collaboration. I learned a lot working with you. I also wish to thank my second supervisor, Lisbeth La Cour, for the help she offered me in these years. I am very grateful to Dario Pozzoli and Frederic Warzynski for carefully reading my papers and providing me with useful comments and suggestions in the closing seminar. I have included some of them in this version and I am looking forward to make use of the rest of them in my future work. I would also like to thank all the members of the Economics Department for making it a great place to work and making me feel part of it. During my PhD I spent a semester at Columbia University in New York City. These months were very inspiring and represented a truly enriching experience. My deepest appreciation to Eric Verhoogen for arranging my stay. Moreover, I spent the last semester visiting the Economics Department of Queensland University of Technology where I could benefit from the constant supervision of Lakis in order to finish working on this Thesis. Thank you, Lakis, for this opportunity.

A special mention should go to Friedrich Bermann who is coauthor of the second chapter

of this Thesis. Thank you Friedrich, for the great conversations we had, for your friendship and all the hard work you put in our project. It was a great pleasure working with you.
I would like to thank many people who were part of my life during these years: Cazza, Alice, Vittorio, Yun, Claes, Lasse, Marie, Pat, Anna, Luis, Tobin, Sara, Alex, Chloe and Layne, Julie, Philip, Diego, Jacek, Natalie Stefano and the Escøbar Boys.
Finally, I wish to especially thank my family, Enrico, Grazia and Valeria for supporting and encouraging me during these years.
I am solely responsible for any errors in my Thesis.

Abstract

This Thesis consists of an introduction followed by three independent chapters. Each chapter is a self-contained paper that can be read independently. They cover different topics of international economics with a specific focus on multinational production and international trade. A common feature to all the papers is that they are micro-based empirical analyses of the effects of globalization on the competitiveness of companies. The first and last chapters are solo papers, while the second is coauthored with Friedrich Bermann, PhD student at Copenhagen Business School.

The first paper studies the impact of foreign direct investment on the intensity of competition in the host economy. In this chapter I use firm-level data of Romanian manufacturing companies active between 2001 and 2008 and I measure the impact of foreign ownership on the market power of affiliates and local competitors. The empirical evidence shows that foreign ownership is associated to a higher market power, which I proxy with firms' estimated markups. Moreover, I find that higher competition of foreign affiliates is associated to a decrease in the markups charged by domestic firms.

In the second chapter we analyze how the strategy of vertical integration of foreign multinationals modifies the nature of productivity spillovers perceived by local suppliers (i.e. backward spillovers). Building on the results of previous research on productivity spillovers and on multinational production, we argue that backward productivity spillovers should be weaker if foreign multinationals are vertically integrated in the industry of local suppliers. We test this hypothesis using a panel dataset of firm-level data of European manufacturing companies. We find that the vertical integration of foreign multinationals does in fact modify the intensity of spillovers to local suppliers. Domestic firms benefit only

from the activity of foreign clients that are not vertically integrated in their industry.

In the last chapter, I use a detailed dataset of international transactions of Danish companies to study the impact of Chinese competition on the pricing strategy of Danish exporters. I also explore the role of quality differentiation in determining the nature and intensity of this effect. I find that Chinese export represents a source of stiffer competitive pressure for Danish exporters that are forced to reduce the prices they charge. This effect depends on the quality of Danish products. I find the producers of low-quality goods reduce their prices less intensively than producers of high-quality ones. This is because producers of low-quality varieties react to Chinese competition upgrading the quality of their products. This mitigates the downward pressure on prices. I finally reconcile these results by using quality-adjusted prices. Using this measure I find that quality does in fact protect Danish exporters from the pressure of Chinese competition.

Dansk Resume

Denne afhandling består af en introduktion efterfulgt af tre kapitler. Hvert kapitel er selvstændigt og kan læses uafhængigt af de andre. De dækker forskellige emner indenfor international økonomi med specielt fokus på multinationale virksomheders produktion og international handel. Et fællestræk ved alle papirerne er, at de indeholder mikro-baserede empiriske analyser af effekter af globalisering på virksomheders konkurrenceevne. Det første og det sidste papir har mig som eneforfatter, mens papir nummer to er skrevet sammen med Friedrich Bergmann, som er PhD studerende på Copenhagen Business School.

Det første papir fokuserer på effekterne af udenlandske virksomheders direkte investeringer på intensiteten af konkurrencen i værtslandet. I dette kapitel bruger jeg data fra virksomheder i den rumænske fremstillingssektor for virksomheder, der var aktive i årene 2003 – 2008, og jeg måler effekten af udenlandsk ejerskab på lokale datterselskaber og lokale konkurrenter. De empiriske resultater viser, at udenlandsk ejerskab er forbundet med større markedsmagt, hvor en virksomheds markedsmagt er målt som virksomhedens estimerede markup. Endvidere finder jeg, at forøget konkurrence fra udenlandske datterselskaber er forbundet med et fald i de hjemlige virksomheders markup.

I det andet papir analyserer vi, hvordan de udenlandske multinationale virksomheders vertikale integration modificerer den produktivitetsspredning, som de lokale leverandører oplever (dvs. backward spillovers). Udfra tidligere forskningsresultater for produktivitetsspredning og multinational produktion argumenterer vi for, at spredningseffekter til lokale leverandører vil være svagere, hvis de udenlandske multinationale selskaber er vertikalt integrerede i den sektor, hvor den lokale leverandør hører hjemme. Vi benytter et panel datasæt på virksomhedsniveau for europæiske virksomheder i fremstillingssektoren til at teste denne hy-

potese. Vi finder, at vertikal integration i de multinationale, udenlandskejede virksomheder faktisk modificerer spredningseffekterne i forhold til de lokale leverandører. De indenlandske virksomheder får kun fordel af udenlandskejede kunders aktivitet, hvis de udenlandske virksomheder ikke er vertikalt integrerede i branchen.

I det sidste kapital benytter jeg et detaljeret datasæt over danske virksomheders internationale transaktioner for at undersøge, hvilken effekt konkurrencen fra Kina har på de danske eksportørers prisfastsættelsesstrategier. Jeg undersøger også, hvilken rolle kvalitetsdifferentiering har på denne effekts karakteristika og intensitet. Jeg finder, at den kinesiske eksport er en kilde til et forøget konkurrencepres på danske eksportører, som bliver tvunget til at nedsætte deres priser. Denne effekt afhænger af de danske produkters kvalitet. Jeg finder, at virksomheder, der producerer lavkvalitetsvarer reducerer deres priser mindre end virksomheder, der producerer højkvalitetsvarer. Dette skyldes, at producenter af lavkvalitetsvarer vil øge kvaliteten af deres produkter som følge af kinesisk konkurrence. Dette forhold dæmper det nedadgående pres på priserne. Til sidst underbygger jeg disse resultater ved at benytte kvalitetsjusterede priser. Ved at bruge de kvalitetsjusterede priser finder jeg, at kvalitet rent faktisk beskytter de danske eksportører i forhold til presset fra den kinesiske konkurrence.

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Introduction

This Thesis consists of three chapters that investigate different topics in international economics with a specific focus on multinational production and international trade. All three chapters are quantitative micro-based studies that explore the effects of globalization on the competitiveness of companies. Each chapter is self-contained and can be read independently.

By refocusing the analysis from countries and sectors to firms, the theoretical and empirical research in international economics in the last decade has improved our understanding of the patterns of international trade and of the role of multinational corporations (MNCs). In particular, the literature has highlighted the relevance of the heterogeneity of firms in explaining their involvement in international trade and investment abroad and their reaction to international competition (e.g. Melitz 2003, Helpman et al 2004, Bernard et al 2007).

The first two chapters of this Thesis use firm-level data to analyze the impact of multinational production on local companies in terms of enhanced competitive pressure and diffusion of know-how through productivity spillovers along the value chain. The third and last chapter uses a highly detailed dataset of firm level trade data to study the effect of international competition from a low-income country (China) on the pricing and quality differentiation strategies of exporters located in a developed economy (Denmark).

The first chapter investigates the impact of foreign direct investment (FDI) on the intensity of competition in the local economy in the contest of an emerging market, namely Romania. Changes in the market power of companies have relevant policy implications as they affect the welfare of local consumers and the profitability of domestic companies. While large part of the literature on foreign direct investment has focused on productivity spillovers, this paper analyses how foreign ownership modifies the market power of acquired companies and of competing firms.

In order to perform my analysis, I use a panel dataset of manufacturing firms that have been operating in Romania between 2001 and 2008. As companies' market power is not readily available in the data, I proxy it with companies' markups that I estimate implementing the De Loecker and Warzynski (2012) methodology. I then relate the measured markups to the companies' ownership and to the activity of foreign-owned competitors. Several results emerge. I show that foreign ownership is associated to higher markups. The difference between local firms and foreign affiliates' markups is statistically and economically significant. I also show that local firms increase their market power when they are acquired by foreign entities. The growth in price-cost ratios is rapid as the main part of it happens in the year of the acquisition. Finally, my results show that higher competition of foreign affiliates is associated to a decrease in the markups charged by domestic companies. These findings are new to the literature and shed a new light on the role of foreign affiliates in determining the intensity of competition on the local markets.

The second chapter, coauthored with Friedrich Bergmann, investigates how the organization of multinational production managed by multinational corporations affects the transfer of know-how from foreign affiliates to local companies. Specifically, it studies the implications that the strategy of vertical integration pursued by multinational business groups has for the intensity of productivity spillovers perceived by local suppliers (i.e. for backward productivity spillovers). In order to improve our understanding of the mechanisms that facilitate and deter this transfer of know-how, we build on the results of previous research on productivity spillovers and explore the insights of the literature on the organization of multinational production.

We argue that the make-or-buy decision of MNCs and their choice to invest in interconnected industries affects the likelihood and intensity of backward spillovers. Because of reasons of technological complementarity, affiliates of vertically integrated MNCs mainly purchase their inputs within the boundaries of their business groups and are therefore less likely to interact with local suppliers. This results in a weaker potential for productivity

spillovers.

We empirically test this hypothesis using a panel dataset of nearly one million European manufacturing companies. Using detailed input-output tables we measure the degree of interconnections between industries. First, we study the structure of the multinational business groups in our sample. We find that the organization of multinational business groups reflects a strategy of vertical integration and of internal sourcing. Then, we estimate the productivity of local companies and relate it to the activity of foreign affiliates in downstream industries. In order to test whether backward productivity spillovers depend on the MNCs' strategy of vertical integration, we develop two new indexes of vertical penetration that distinguish vertically integrated FDI from non-vertically integrated ones. Our empirical evidence shows that positive backward productivity spillovers arise only from the activity of foreign clients whose business groups do not invest in the industry of local companies (i.e. non-vertically integrated FDI).

Although policy recommendations are beyond the scope of this study, we believe that these results have strong policy implications. Our analysis shows that backward productivity spillovers are not automatic, but they heavily depend on the characteristics of multinational corporations. Local governments and public authorities that aim at facilitating the diffusion of knowledge by attracting inward FDI should design incentive schemes targeted to foreign companies that do not pursue strategies of vertical integration as these are more likely to collaborate with local suppliers.

The third and last chapter studies how quality differentiation modifies the impact of Chinese competition on the pricing strategies and the decision of quality upgrading of exporters. As discussed in the paper, this study relates to the literature on international competition and the role of quality differentiation in determining its effects. While the large part of previous research has used macro data and has estimated the effects of international competition at the aggregate level, this paper takes the focus to the micro-level. Using a detailed dataset of firm-level international transactions I estimate the quality of Danish

goods and I use it to investigate how varieties with different qualities react to the competitive pressure. I proxy prices of exported goods with unit-values that I compute at the firm-product-destination level and estimate how they change with the presence of Chinese competing products that I measure using the COMTRADE data on bilateral trade flows of goods.

One of the biggest challenges I face is represented by the measurement of products' quality which is not readily available in the data. I estimate an index of quality using the methodology developed by Khandelwal et al (2013). This allows me to compute a measure of relative qualities of Danish varieties as a residual of demand functions. The intuition is straightforward, higher qualities are assigned to varieties that have larger market shares conditioning on price. In this framework, the estimated qualities have to be intended as the characteristics of the goods that the consumers value other than price.

With this measure in hand, I can estimate how the impact of Chinese competition on the pricing strategy of Danish exporters depends on quality differentiation. Using raw data, I find that the competition of Chinese export pushes producers of varieties with high-quality to reduce their prices proportionally more than low-quality varieties. However, this result hides another related reaction of Danish exporters to Chinese competition. In order to escape from it, producers of low-quality varieties improve the attractiveness of their products more intensively that those whose varieties are up on the quality ladder. This mitigates the downward pressure on prices. Therefore, Chinese competition leads to a convergence of prices and of qualities. In order to account for movements in varieties' quality, I estimate quality-adjusted prices. Using this measure, I find that the downward pressure on quality-adjusted prices is stronger for varieties of lower quality.

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Chapter 1:

Market power and competitive pressure from FDI

Market power and competitive pressure from FDI

Federico Clementi*

Abstract

Little is known about the impact that multinational production has on the market power of companies in the host economies. Foreign direct investment (FDI) is presumed to have technological advantages that can be transferred to domestic companies. At the same time FDI can increase the competitive pressure in the host markets. To study how foreign direct investments affect the market power of target companies and local competitors, I estimate firm-specific markups of Romanian firms active in 2001-2008 and I relate them to the firms' ownership and the presence of FDI in the same industry. Several results emerge. I find that foreign affiliates charge higher markups than domestic firms. Companies increase their price-cost ratios when acquired by foreign investors. Finally, the average markups of local firms decrease with the presence of competing foreign companies. These findings show evidence of enhanced competitive pressure from foreign firms' activity, shedding new light on the effects of FDI in host economies.

*fc.eco@cbs.dk; Department of Economics, Copenhagen Business School

1 Introduction

Many countries undertake costly investments to attract foreign direct investments (FDI) in their national territories. These policies are driven by the wide-spread belief that the presence of multinational companies (MNCs) may introduce new technologies and commercial practices that can improve the productivity and competitiveness of local companies. These effects are expected to be stronger in developing countries, where the technological gap between local companies and foreign affiliates and the potential for productivity spillovers are larger.[1]

However, the activity of FDI brings about a number of effects in the host market in addition to the introduction of advanced know-how. Foreign ownership is associated to competitive advantages that allow the affiliates to compete with local companies. Their activity can modify the competition intensity in local markets and affect the market power of domestic companies with potentially relevant (long-run) consequences for the welfare of consumers and the competitiveness of local firms. On the one hand, lower markups can be beneficial for final consumers and client firms as these seize a larger surplus in transactions. On the other hand, smaller margins can hinder the capacity of local firms to accumulate profits and invest to upgrade their technology and innovate. This lack of investments may weaken companies' capacity to compete with foreign firms and ultimately harm the growth potential of the local economy.

Despite having relevant policy implications, the competition effects of MNCs have received limited attention, perhaps because of the difficulty of gauging firms' market power. The empirical literature on the effects of FDI in host countries has focused almost exclusively on the measurement of productivity spillovers.[2]

Given the relevance of the potential impact of foreign investments on the intensity of competition in the host economy and of its implications for consumers' welfare and profitability of the firms, this paper analyses how foreign ownership and the competition of foreign affiliates affect the market power of local companies in an emerging economy, namely Romania.

Foreign affiliates have asset and transaction competitive advantages that allow them to compete with local firms in the host markets (Caves 1974, Dunning 1988, Markusen 1995). Advanced technologies improve the production efficiency of foreign affiliates reducing their marginal costs. Moreover, thanks to the higher quality endowment of their products and the reputation of their brands, FDI may be able to charge higher prices. Lower marginal costs and higher prices can allow foreign affiliates to have larger markups than domestic competitors.

[1] In this paper I alternatively refer to firms controlled by foreign investors as *FDI* and *foreign affiliates*.

[2] I refer the reader to Bruno and Cipollina (2014) for literature review.

The activity of foreign affiliates might also affect the profitability and the market power of local companies. These latter can learn from foreign competitors and/or be pushed to invest to innovate and improve their own competitiveness. At the same time, highly productive FDI may take away market shares from domestic companies and prevent them from exploiting economics of scale and scope, to the detriment of their competitiveness (Aitken and Harrison 2001). By paying higher prices for intermediates and higher wages, MNCs purchase the most sophisticated inputs and drain qualified labor force on the market (Aitken et al. 1996). The competition of FDI can curb the market power of local firms that may have to pay more for inputs and/or reduce the price of their products. Higher marginal costs and lower prices result in smaller markups. Javorcik (2008) discusses the results of three enterprise-based surveys conducted in Czech Republic and Latvia for the World Bank, showing that the entry of MNCs affects the local companies through multiple channels. The most relevant effects of the FDI entry in the same sectors are increased competition and loss of market shares. Domestic firms face a fiercer competition and have their market power reduced upon entry of foreign affiliates. Using Spanish firm-level data, Sembenelli and Siotis (2008) find weak evidence of a negative effect of MNCs' competition on the markups of domestic companies that disappears in the long-run.

In order to shed light on the role of foreign affiliates in determining the intensity of competition in local markets, this paper answers three research questions. First, I test whether FDI charge higher markups than local competitors. Second, I analyze how the acquisition of a local firm by a foreign investor leads to a change of the market power of the target company. Third, I test whether the activity of foreign multinationals affects the market power of local competitors.

To perform my analysis, I use a panel dataset of domestic and foreign manufacturing firms that have been operating in Romania between 2001 and 2008. As firms' market power is not readily available in the data, I proxy it with markups that I measure using the methodology designed by De Loecker and Warzynski (2012). I then relate price-cost ratios to firms' ownership and to foreign affiliates' competition.

The results of my analysis can be summarized as follows. FDI have larger markups than domestic companies and the difference is economically and statistically significant. Foreign affiliates on average charge 12% higher price-cost ratios than their domestic counterparts. The change in status from local company to foreign affiliate is associated with an increase in the market power of the target firm. Finally, my results provide evidence of the existence of competitive effects of FDI. The activity of foreign affiliates is associated with a decrease of the markups charged by local competitors. These effect is stronger in low-concentrated and low-tech industries.

These are novel results that have clearly relevant policy implications. As mentioned, the decrease

in local firms' market power may correspond to an improvement of consumers' welfare, but also to a decrease of firms' profitability and a reduction of their capacity to invest. Although making policy recommendations goes beyond the scope of this paper, policy makers should consider these effects when designing FDI policies. In the light of the results presented in this paper, one may be tempted to advocate in favor of industrial policies that stimulate or deter inward FDI, depending on their priorities. However, the impact on competition intensity is only one of the many effects that the activity of foreign affiliates has in the local markets (e.g. job creation and productivity spillovers). Therefore, it would be incautious to limit the analysis to this aspect when defining FDI policies.

The remainder of the paper is organized as follows. In the next section I briefly discuss FDI inflows in Romania. I then present the data I use and the criteria I adopt to identify the foreign affiliates and measure their presence in an industry. The subsequent section provides a detailed explanation of the methodology I implement to estimate firms' markups. I then present the results of my estimations and my interpretation. The final section concludes and discusses the implications of the evidence I find.

2 FDI in Romania

Previous research on productivity spillovers has often used Romania as a case study to study the impact of FDI activity on the local economy (e.g. Altomonte and Pennings 2009, Javorcik and Spatareanu 2011).

After the collapse of the Soviet Union, Central and East European countries (CEECs) have represented a relevant destination of foreign direct investments that were attracted by the availability of cheap labor force, a rich endowment of natural resources and the proximity to the rich west European markets. Compared to other CEECs Romania in the '90s was slow in undertaking the economic reforms needed to attract inward FDI. Table 1 displays the value of inflow of foreign capital in the six most attractive CEECs during the period of my analysis. It is easy to see how in 2001 Romania was one of the least successful countries in attracting FDI, while the situation changed drastically in the following years to the extent that the annual inflow of foreign capital in 2008 was over ten times the level of 2001. Therefore, the year 2001-2008 appear to be an appropriate choice for my analysis: arguably, this is the period when the FDI activity might have modified the competition intensity in the local market.

Table 1: **FDI inflow in mln USD**

	FDI inflow									FDI inflow per capita
Country	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**1999-2008**	**1999-2008/Pop**
Poland	5701	4123	4588	12874	10293	19603	23561	14839	112298	2937
Czech Republic	5642	8482	2103	4974	11653	5463	10444	6451	66527	6478
Romania	**1158**	**1141**	**2196**	**6436**	**6483**	**11367**	**9921**	**13909**	**54694**	**2478**
Hungary	3936	2994	2137	4266	7709	6818	3951	6325	44212	4369
Slovakia	2275	5865	2976	4029	3110	5803	4017	4868	36091	6689
Croatia	1313	1071	1989	1179	1825	3231	4928	5938	23977	5456

Source: UNCTAD

3 The dataset

To perform my empirical estimations, I use a dataset of domestic and foreign-owned firms that have been operating in Romania in the period 2001-2008. I collect firms' balance-sheet and ownership data from eight different releases of the commercial database *Amadeus* compiled by *Bureau van Dijk*, a consulting company. I include 22 manufacturing sectors identified by two-digit NACE Rev.2 codes (10-32). In this paper I will refer to a two-digit NACE code as a *sector*, a three-digit NACE code as an *industry*, while I define a four-digit NACE code classification as a *products' group*. I retrieve information on the four-digit NACE code each firm operates in and yearly balance sheet data on revenues (sales S_{it}), tangible fixed assets (capital K_{it}), costs of materials (M_{it}), number of employees (L_{it}) and total wage bill (W_{it}), and ownership of the company's shares.

The use of different DVDs provides me with year-specific ownership information for each firm. This allows me to trace changes in the ownership. Thus, I know when a firm changes its status from domestic to FDI, making my dataset quite unique in the literature.

I deflate sales and materials using the appropriate two-digit NACE Producer Price Index, while capital is deflated using the an average of the PPI deflators of five sectors that produce the bulk of capital inputs used in manufacturing. [3] In cleaning the data, I eliminate all observations that report zero or negative values of any of the production variables and I only keep observations of companies that have at least 2 employees in an year. To eliminate outliers from my analysis I drop the bottom and top 1% values of production variables ratios and production variables' annual growth rates. Finally, I keep only observations with at least two consecutive years as this needed for the markups' estimation. This leaves me with an unbalanced panel containing a total of 125,401 firm-year observations, 18,121 (14%) of which refer to foreign affiliates.

Table 2 reports summary statistics of companies in this dataset. Besides the log of production

[3] Like in Javorcik (2004), these sectors are: machinery and equipment; office, accounting and computing machinery and apparatus; motor vehicles, trailers, and semi-trailers; other transport equipment.

variables, I include statistics on the firms' average wage and capital intensity, the companies' age (time since the year of the company's incorporation) and the number of years they are in the sample. I also report statistics on aggregate indexes that refer to the industry in which the firms operate. These are the FDI presence in the industry measured as described in the next section (HP_{jt}), the Herfindhal Index (HHI_{jt}) of the sector companies operate in and the log of total sales of companies active in the four-digit product group (y_{pt}). I finally include two dummies that indicate whether the companies operate in high-concentrated industries and in a high-tech industry. I define as high-concentrated (HC) the industries that have an average Herfindhal index higher than the 90th percentile of their distribution. To identify high-tech (HT) and low-tech (LT) industries, I adopt the Eurostat classification of industries which is based on R&D intensity.[4]

To compute the indexes of FDI horizontal penetration (see section 3.1), I use the most complete information possible. Although information on one or more of the productions variables may be missing, I know that the firm is operating in an industry and I want to account for it. Therefore, I keep all observations with non-missing positive values of sales. This allows me to estimate FDI presence using a much larger sample of 387,467 firm-year observations.

[4] I exclude from my estimations the tobacco industry (NACE code 12) as the the small number of observations makes impossible to estimate the production function. I refer the reader to Appendix for a description of the database, of the trimming strategy I adopt to eliminate outliers, and the list of HT and LT industries.

Table 2: Summary statistics

	Domestic		FDI	
Variable	Mean	sd	Mean	sd
LogS_{it}	5.07	1.54	6.34	1.77
LogK_{it}	3.63	1.81	5.01	2.05
LogL_{it}	2.49	1.25	3.55	1.52
LogM_{it}	4.23	1.73	5.30	2.00
Log$(K/L)_{it}$	1.14	1.21	1.46	1.32
Log$(W/L)_{it}$	2.04	1.38	3.12	2.34
Age_{it}	8.93	4.33	7.87	4.03
firm's # years in the sample	6.89	1.52	7.01	1.33
HP_{jt}	0.37	0.16	0.42	0.17
HHI_{jt}	0.03	0.06	0.05	0.08
y_{pt}	12.65	1.26	12.49	1.29
HC_{jt} $(HHI_j > HHI_{p90})$	0.09	0.29	0.13	0.34
HT_{jt}	0.11	0.31	0.16	0.36
Observations	107,280		18,121	

Financial variable are expressed in 1,000 Euros.

To check whether my data show some of the well-documented differences between domestic firms and foreign affiliates, I perform a preliminary analysis of FDI premia and report the results in Table 3. In line Bernard and Jensen (1999), I estimate FDI premia through the following OLS regression:

$$lnY_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 l_{it} + \delta_{jt} + \epsilon_{it} \tag{1}$$

where Y_{it} is the variable of interest for firm i active in industry j at time t. As all the dependent variables are expressed in natural logarithms, the β_1 measures the FDI premia in percentage terms compared to local firms in the same three-digit industry in the same year.

Table 3: FDIpremia

	(1)	(2)	(3)
Employment	1.056	0.956	
Sales	1.276	1.209	0.212
Average wage	0.370	0.339	0.215
Capital intesity	0.326	0.352	0.251
Market share	1.379	1.209	0.212
Controls	Year fixed effects	Time*Industry	Time*Industry, log employment
N.Obs	125,401	125,401	125,401

All premia are significant at 1% level.

Not surprisingly FDI outperform their domestic counterparts in every dimension: the value of their sales is on average 23 percent higher ($e^{.212} = 1.27$), pay 23 percent higher wages, and their capital intesity is 28 percent higher.

3.1 Foreign Direct Investments classification

I use two criteria to identify foreign firms based on the information that I have on direct shares' ownership and on global ultimate ownership. First, I classify firm i as a FDI at time t if there is a foreign investor that directly owns at least 10% of the company's shares. As a second criterion, I use the information on the Global Ultimate Owner to know whether a firm is ultimately controlled by a foreign entity.[5]

To measure the presence of foreign affiliates in an industry-j at time-t, I calculate it as the FDI share of sales. Therefore, the Horizontal Penetration (HP_{ijt}, henceforth) is constructed as:

$$HP_{ijt} = \frac{\sum_{f=1,\neq i \text{ in } jt}^{N} SALES_{ft} * FDI_{ft}}{\sum_{f=1 \text{ in } jt}^{N} SALES_{ft}} \tag{2}$$

Where FDI_{ft} is the FDI dummy that indicates if firm is a foreign affiliate f at time t.

Clearly, this indicator of foreign presence change over time and across industries, but is by definition

[5] *Global Ultimate Owner* is identified as the independent company that directly or indirectly ultimately controls at least 50% of the target company. The 10% and 50% thresholds are commonly identified as the level of ownership necessary for a direct investment interest to exist. These thresholds are also adopted by international organizations (e.g. UNCTAD, IMF, OECD) to identify foreign subsidiaries of MNEs.

identical for all the domestic firms active in the same industry in an year ($HP_{ijt} = HP_{kjt}$, for any pair of domestic firms i and k active in industry-j).

4 Methodology

As discussed before, in order to gauge the firms' competitiveness and the intensity of competition I implement the De Loecker and Warzynski (2012) procedure to estimate firms' markups, as these seem to be a natural choice to proxy the companies' market power.

The estimation of markups has a long history in the industrial organization literature. In his seminal paper Hall (1988) proposes a simple strategy to estimate markups using production data by comparing the growth rates of the output to the ones of inputs.[6] However, this procedure has two important drawbacks. Hall shows that the primal (quantity based) Solow residual can be rewritten as a combination of productivity growth and a market power index. In order to estimate this latter and recover the markups, one has to instrument the productivity growth. To find good instrumental variables in micro level data is often very challenging, making this approach difficult to implement. Furthermore, the Hall's procedure provides sector-specific markups making it impossible to relate the firm-specific market power to its characteristics, such as size, export behavior or, as I do in my analysis, to its ownership.

Roeger (1995) builds on these insights and modifies Hall's approach to estimate markups presenting a simple solution of Hall's need of instrumenting productivity growth. The author shows that one can derive a second Solow residual and rearrange the equation of output growth so that the productivity component cancels out and has no need to be estimated. However, this solution has a critical downside: Roeger needs to impose constant returns to scale on the production function. This represent a strong assumption and may raise severe concerns about the accuracy and truthfulness of the estimations.[7]

De Loecker and Warzynski (2012) develop a simple and elegant methodology to estimate firm-specific markups. They rely on the mild assumption of cost-minimization and combine output elasticities of variable inputs to their revenue shares in order to estimate price-cost ratios using standard balance-sheet data.

In the next subsection I explain in detail the methodology I adopt to estimate the firms' price-cost ratios.[8]

[6] See also Hall (1986) and Hall (1989) on this topic.

[7] Hall (1989) discusses the importance of allowing for increasing returns and market power in estimating the Solow residual.

[8] Practically, I estimate firms' production functions and their markups adapting the STATA/MATA code written by De Loecker and Warzynski (2012), available on the AER website, to my specification.

4.1 Markups

Consider the following production function for a firm i at time t:

$$Q_{it} = \Omega_{it} F_{it}(L_{it}, M_{it}, K_{it}) \tag{3}$$

Here Q represents quantity of gross output produced using labor (L), materials (M) and capital (K). In this framework I make four assumptions. First, the production function is continuous and twice differentiable with respect to at least one of its arguments. Second, that the productivity $\Omega_{it} \equiv e^{\omega_{it}}$, used here as an index of production efficiency, enters the production function in a Hicks-neutral fashion. Third, this productivity is specific to the firm, it does not change across its products. As I do not have information on products manufactured by the firms, I must assume that all the firms in my sample are single-product manufacturers.

In order to estimate firm-specific markups I need an additional mild assumption, namely that producers minimize costs. This minimization problem is associated with the following Lagrangian function:

$$\mathbf{L}(L_{it}, M_{it}, K_{it}, \lambda_{it}) = P_{it}^{L} * L + P_{it}^{M} * M + r_{it} * K_{it} + \lambda[Q_{it} - Q_{it}(L_{it}, M_{it}, K_{it})] \tag{4}$$

Here λ is a Lagrangian parameter interpreted as marginal cost. The F.O.C. for each input X^V is:

$$\frac{d\mathbf{L_{it}}}{dX_{it}^{V}} = P_{it}^{V} - \lambda \frac{dQ_{it}}{dX_{it}^{V}} = 0 \tag{5}$$

Defining the markup $\mu_{it} \equiv \frac{P_{it}}{\lambda_{it}}$ and dividing by $\frac{Q_{it}}{X_{it}^{V}}$, one can easily re-arrange Eq. (5) and derive the following equation:

$$\mu_{it} = \frac{\theta_{it}^{Q,X}}{\alpha_{it}^{X}} \tag{6}$$

where $\theta_{it}^{Q,X}$ is the elasticity of output with respect to the (variable) input X_{it} and α_{it} is the input's revenue share $\frac{P_{it}^{X} X_{it}}{P_{it} Q_{it}}$.

This result turns out to be very flexible. It provides me with the estimation of firm-year specific markups and it is compatible with different types of competition and markets. I do not need to impose any structural constraint neither on the shape of the production function (other than continuity and differentiability) nor on the characteristics of the demand that the firms serve.

Practically, in my analysis I use materials as a perfectly variable intermediate input in order to estimate the price-cost margins, whereas I consider labor and capital as non-freely adjustable and quasi-fixed inputs respectively. I choose to do so as in emerging economies labor markets are likely far from being perfectly flexible. These market frictions along with labor hoarding practices might

affect the firms' choices of hiring and firing. Therefore, the use of labor as a variable input might bias my estimations, as the wedge between the labor's elasticity and its revenue share would not only represent the markup that a firm charges, but it would also include an additional component due to these inefficiencies that make the firms to have a sub-optimal use of labor force.

I perform my estimations assuming two different production functions forms, the Cobb-Douglas and the Translog production function, using the latter as my preferred specification.
The estimated elasticity of materials in the Translog case is:

$$\frac{dQ_{it}}{dM_{it}}\frac{M_{it}}{Q_{it}} \equiv \hat{\theta}_{it}^{Q,M} = \hat{\beta}_m + 2\hat{\beta}_{mm}m_{it} + \hat{\beta}_{ml}l_{it} + \hat{\beta}_{mk}k_{it} + \hat{\beta}_{mlk}l_{it}k_{it} \tag{7}$$

Clearly in the case of Cobb-Douglas this elasticity is reduced to the first coefficient only ($\hat{\theta}^{Q,M} = \hat{\beta}_m$). The Cobb-Douglas specification of production function implies constant elasticities across firms active in the same sector. Thus all the variance of markups within a industry is due to differences of revenues shares across firms. On the contrary, the Translog specification makes the inputs' elasticities depend on the level of the inputs used by each firm making them firm- and year-specific. In this case the variation of markups comes from the differences in revenue shares *and* from the heterogeneity of output elasticities across firms in a given industry.

4.2 Estimation of output elasticities

Since revenue shares of the inputs (α_{it}^M) are readily observable in the data, I now need to estimate the inputs' elasticities ($\theta_{it}^{Q,M}$) in order to measure markups μ_{it} as in Eq. (6). This section describes my strategy to estimate the production function parameters and then presents the estimated markups.

Consider the following log transformation of the gross-output production function Eq. (3):

$$q_{it} = f(m_{it}, l_{it}, k_{it}; \beta) + \omega_{it} + \epsilon_{it} \tag{8}$$

where the lower cases represent the natural logarithms of the variables. Thus, q_{it} is the log of gross output, l_{it} log of labor, m_{it} the log of intermediate inputs, k_{it} is the log of capital. The vector β contains the function's coefficients and a constant term. The term ω_{it} is the productivity shock observed by the firm but not by the researcher, finally ϵ_{it} represents the measurement error and idiosyncratic unexpected productivity shock, unobserved by both the econometrician and the company.[9]

[9]Since I do not have observation on quantities and prices of the output and inputs used by the firm, I have to rely on deflated sales and material costs to proxy the physical output and inputs. Klette and Griliches (1996) argue that the use of industry-wide indexes might create a bias in my production function estimations, and therefore in the measured markups. De Loecker (2011) develops an elegant method to eliminate the bias due to demand shocks and unobserved price when relying on deflated balance-sheet data in order to estimate firms' productivity. However, I prefer not to

I estimate the production function separately for each sector. Once I identify the production coefficients I can obtain the elasticity of output with respect to material inputs and measure the price-cost ratios. To control for endogeneity of input usage in estimating the inputs' coefficients of the production function, I closely follow the two-step procedure developed by Ackerberg et al. (2015, ACF hereafter).

De Loecker (2013) and De Loecker et al. (2016) discuss the importance of including in the productivity's law of motion relevant elements that could affect the firm's efficiency. I assume that productivity evolves over time as a Markov process that depends on ownership status and foreign affiliates' activity. In other words, I consider a law of motion of productivity defined as follows:

$$\omega_{it} = g(\omega_{it-1}, FDI_{it-1}, HP_{jt-1}) + \xi_{it} \tag{9}$$

where ξ_{it} represents the innovation shock. The ownership status and the measured presence of FDI are included in the law of motion to account for the fact that foreign ownership and the activity of foreign affiliates *may* affect productivity. Indeed, the presence of foreign shareholders might be associated with a transfer of know-how and technologies that can affect and improve the productivity of the firm. In line with the results of the literature on productivity spillovers, the activity of FDI can induce changes in the productivity of competing firms. For instance, local companies can improve their own efficiency imitating FDI production procedures or acquiring advanced know-how by hiring employees who have a past working experience in MNCs. Moreover, foreign affiliates' competition can push local firms to invest, possibly eliminate X-inefficiencies and improve their own productivity. At the same, the stiff FDI competition can reduce the market share of local companies that cannot exploit economies of scale and become less productive. In this specification these variables *are allowed* to have an impact on productivity, but this does not mean that they will necessarily affect it.

In the first step of the ACF procedure, I estimate of $\hat{\phi}_{it}$ and $\hat{\epsilon}_{it}$ in

$$q_{it} = \phi_{it} + \epsilon_{it} \tag{10}$$

where $\phi_{it} = f_{it}(m_{it}, l_{it}, k_{it}; \beta) + h(m_{it}, l_{it}, k_{it}, FDI_{it}, HP_{jt}, \delta_t, \delta_p)$, with h(.) representing the inverse material demand function that I use to proxy the unobserved productivity term. The elements included in this function are allowed to affect the demand for materials of firm-i.

As it emerges in Javorcik (2008), foreign affiliates often adopt different sourcing decisions from domestic counterparts. Due to reasons of technological complementarity and specific inputs needs,

follow his strategy as it would require to restrict the utility of the demand to be a specific function. In order to keep the estimations compatible with a wide range of settings I choose not to impose any restriction on the demand system.

they are more likely to import intermediate inputs from abroad or to purchase them from other multinationals active in the host market. As mentioned in section 1, foreign affiliates compete with local companies on the inputs and output markets (Aitken et al. 1996, Aitken and Harrison 2001). This competition can affect the cost and quality of inputs and the production scale of companies in the industry, modifying their consumption of intermediate inputs. In order to capture the impact of foreign ownership and the activity of competing foreign affiliates on the inputs' demand, I include the dummy FDI_{it} and the index HP_{jt} in the control function. The vectors δ_t, δ_p represent a set of year and products' groups-dummies reflecting output shocks and specific demand components.

The estimate of the polynomial expansion ϕ_{it} measures the output net of the unexpected output shock and measurement error ϵ_{it} in Eq. (10). To recover the innovation shock $\xi_{it}(\beta)$, I define productivity $\omega_{it}(\beta)$ as $\hat{\phi}_{it} - f_{it}(X_{it};\beta)$ and I non-parametrically regress it on the third order polynomial of its lag and the first lags of the other elements included in the productivity law of motion.

In the second step, the production function coefficients are estimated through GMM, using as valid instruments the inputs orthogonal to the unexpected productivity shock.
The moments that identify the production parameters are:

$$E[\xi_{it}(\beta)I_{it}] = 0 \tag{11}$$

where $I'_{it} \equiv (1, l_{it-1}, m_{it-1}, k_{it}, l^2_{it-1}, m^2_{it-1}, k^2_{it}, l_{it-1}m_{it-1}, l_{it-1}k_{it}, m_{t-1}k_{it}, l_{it-1}m_{it-1}k_{it})$ is the vector of instruments. In the Cobb-Douglas specification this system becomes computationally much simpler as the vector of parameters β is reduced to $\beta = (\beta_0, \beta_l, \beta_m, \beta_k)$ and $I'_{it} = (1, l_{it-1}, m_{it-1}, k_{it})$. These instruments are all orthogonal to the unexpected innovation component of the productivity as they all were decided before the productivity shock is realized.[10]

I can now estimate the markups as

$$\hat{\mu}_{it} = \frac{\hat{\theta}^{Q,M}_{it}}{\alpha^M_{it}} \tag{12}$$

while I measure the productivity as the revenue-based total factor productivity $\varphi_{it} = \hat{\phi}_{it} - f(X_{it}, \hat{\beta})$.

In Table 4 I report summary statistics of firms' markups and productivity distinguishing companies by ownership status. *Domestic* observations refer to companies that are Romanian at time *t*, *FDI* observations refer to companies that are foreign affiliates at time *t*. *Starter* are observations of companies that become *FDI* during the sample period, while *Always FDI* refer to firms that are foreign controlled throughout the whole period of analysis.[11].

[10]Finally, I remove the measurement error to purify my material revenue share correcting for the first stage error as in De Loecker and Warzynski (2012).

[11]I refer the reader to the Tables in Appendix D for sector-specific information on the estimated production function parameters and markups.

Table 4: Productivities and markups

		Domestic					FDI				
F(X,β)	Variable	Mean	p10	p50	p90	sd	Mean	p10	p50	p90	sd
Cobb Douglas	φ_it	1.29	0.98	1.26	1.68	0.30	1.38	1.03	1.36	1.82	0.40
	μ_it	1.37	0.94	1.25	1.85	0.55	1.69	1.02	1.43	2.47	1.09
Translog	φ_it	1.30	0.99	1.25	1.68	0.30	1.40	1.05	1.37	1.84	0.37
	μ_it	1.34	0.92	1.23	1.80	0.49	1.62	1.00	1.40	2.39	0.90
Observations		107,280					18,121				
		Starter					Always FDI				
F(X,β)	Variable	Mean	p10	p50	p90	sd	Mean	p10	p50	p90	sd
Cobb Douglas	φ_it	1.54	1.04	1.52	2.07	0.40	1.57	1.05	1.54	2.12	0.42
	μ_it	1.78	0.72	1.26	3.25	1.74	1.58	0.70	1.15	2.77	1.51
Translog	φ_it	1.36	1.02	1.34	1.79	0.37	1.36	1.01	1.33	1.82	0.42
	μ_it	1.67	1.00	1.41	2.44	1.08	1.64	1.01	1.38	2.36	1.02
Observations		12,052					7,481				

5 Results

This section consists of three subsections, each of which answers one my research questions. I first test whether firms with a foreign ownership have an advantage in terms of price-cost ratios. Then, I study how a change in ownership from domestic to foreign is associated to a change in the market power of the acquired firm. I finally measure how the activity of foreign companies affects the average markups of domestic companies.

In order to assess whether the impact of foreign ownership and of foreign competition differ across industries, I split my sample in low-tech (LT) and high-tech (HT), and in low- (LC) and high-concentrated (HC) industries. Indeed, one might expect the foreign investors to transfer their know-how to the subsidiaries more intensively in high-tech industries, where the technological advancement and vertical differentiation can be more valuable, resulting in larger market power premia. In splitting the industries in HC and LC I follow the intuition of Konings and al. (2005). The market concentration reflects differences in the competition intensity and in the average market power of companies. In more concentrated markets companies are supposed to have higher market power and be able to charge higher prices and markups. In industries where production is more dispersed companies are supposed to compete more intensively on prices. Therefore, in low-concentrated indus-

tries differences in their market power and measured markups should mirror more closely differences in marginal costs. If foreign ownership and FDI competition modify companies' markups, they should affect more intensively prices (marginal cost) in high-(low-)concentrated industries. Simple OLS regressions confirm that markups are on average 16% higher in high-tech sectors than in low-tech ones and 10% higher in concentrated markets than in the more competitive ones.[12]

Before presenting my results, I must warn the reader against potential concerns about the precision of my estimations of productivity and markup premia as the FDI might have characteristics I cannot control for that may modify their competitiveness and market power. As said, I do not have information on quantities, prices and the imports and exports decisions of the firms. Therefore, the estimated differences between the efficiency and markups of FDI and domestic firms might not be due exclusively to the foreign control, but also to other business characteristics that I do not observe, possibly associated with the foreign ownership.

I cannot observe the destination of firms' sales: FDI have a higher productivity and, therefore, are more likely to export. Using Chinese firm-level transaction data, Manova and Zhang (2012) show that firms charge different prices in different export destinations. The markup premia that I find may be partly reflecting the wedge between prices charged in different markets - possibly caused by differences in demands' elasticities - rather than pure differences in markups between foreign affiliates and domestic firms that compete with them in the same markets. Differences in marginal costs - and associated differences in markups - may be due to higher bargaining power of FDI rather than to technical efficiency (Javorcik 2008). The results should be interpreted heeding these warnings.

5.1 Do FDI have higher market power?

Like in section 3.1, to estimate the difference between the markups of foreign and domestic firms I adopt Bernard and Jensen (1999) strategy and I run the following regression:

$$ln\mu_{it} = \beta_0 + \beta_1 FDI_{it} + \beta_2 age_{it} + \beta_3 l_{it} + \beta_4 ln(K/L)_{it} + \delta_{jt} + \epsilon_{it} \tag{13}$$

I perform this estimation considering the two production specifications separately. The results of FDI markup premia estimations appear in Table 5. I will mainly refer to the results I found under the assumption of translog production function as this is my favourite specification.

The value of β_1 measures the percentage difference between average markups charged by FDI and local competitors. As shown in section 3, foreign affiliates are younger, larger and more capital intensive

[12] I refer the reader to Appendix C for the list of HT and LT industries and for the presentation of the empirical estimations I perform to measure markup differences across industries.

than local companies. These firms' characteristics are likely associated to companies' market power. Therefore, I include in the RHS of the equation the company's age, its size (log of the number of employees), and capital intensity as control variables. Using these measures allows me to refine the estimation of the effect of foreign ownership on the market power of the company. The set of industry-time dummies δ_{jt} captures industry-specific trends and differences across industries, making the values of markups comparable. The standard errors are clustered at the firm level in order to account for potential heteroskedasticity and autocorrelation.

I find strong evidence of the fact that foreign affiliates charge higher markups than domestic companies. As this is a simple pooled analysis I do not interpret the statistical significance of this coefficient as a causal relationship, but rather as evidence of an existing statistically and economically significant difference in the markups of foreign and local companies.

Foreign affiliates have statistically and economically significant higher market power. The markup premium is larger than 12% both under the CD and the TL specification of the production function. There are several non-exclusive explanations for this evidence. The FDI markup premium may be driven by more efficient and cheaper production technologies reflected in lower marginal costs. Similarly, the foreign ownership might be associated with advanced strategies (for instance, market segmentation or exporting) that make the firm exploit the differences in demands' elasticities and charge higher prices: this again, keeping marginal costs constant, would imply higher markups.

Due to data limitations, I cannot discriminate among these mechanisms. However, the separation into HT vs LT and HC vs LC sectors can offer some help in interpreting this evidence. The FDI premia are highest in LT and LC markets where vertical differentiation and average market power are lower and companies face stiffer competition. Arguably, higher competition causes downward pressure on output prices. This suggests that FDI have higher markups mainly due - but not exclusively - to lower marginal costs and higher efficiency of their production.

These findings are novel to the literature and these differences have been documented by only a few empirical studies. The analysis that is closest to mine is represented by Konings and al. (2005). Using a sample of large Romanian companies active in the late '90, the authors obtain similar results modifying the Roeger method to account for differences in the ownership of companies. The De Loecker-Warzynski method, instead, allows me to directly estimate firm-specific markups without imposing assumptions on production functions.

The negative coefficient of age shows that older companies have lower market power. Arguably, young companies have more efficient and employ more advanced technologies than their older competitors. Larger firms lower markups. Companies seem to reduce the markups they charge in order

to compete and expand their size. Finally, capital intense firms have lower markups in LC and LT industries and higher markups in HC and HT ones. Higher capital intensity may represent higher costs of inputs and materials that reduce the markups companies can charge. In high-concentrated and high-tech industries though, firms that are more capital intense are also more profitable. In these industries, higher capital intensity might be associated to a larger vertical differentiation that results in higher markups.

Table 5: Estimation results : Markup premia

	Cobb-Douglas					Translog				
	All	LT	HT	LC	HC	All	LT	HT	LC	HC
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FDI_{it}	0.153***	0.165***	0.080***	0.170***	0.015	0.123***	0.129***	0.091***	0.128***	0.082***
	(0.007)	(0.008)	(0.019)	(0.008)	(0.018)	(0.004)	(0.005)	(0.008)	(0.005)	(0.008)
age_{it}	-0.002***	-0.002***	0.000	-0.002***	-0.002	-0.001***	-0.002***	0.001	-0.001***	-0.000
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
l_{it}	0.018***	0.026***	-0.028***	0.024***	-0.025***	-0.008***	-0.011***	0.005**	-0.009***	-0.005**
	(0.002)	(0.002)	(0.005)	(0.002)	(0.005)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
$ln(K/L)_{it}$	-0.032***	-0.033***	-0.022***	-0.032***	-0.024***	-0.008***	-0.011***	0.010***	-0.011***	0.017***
	(0.002)	(0.002)	(0.006)	(0.002)	(0.006)	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year*Industry dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N.obs.	125,401	110,681	14,720	113,286	12,115	125,401	110,681	14,720	113,286	12,115
R2	.41	.36	.59	.39	.53	.57	.54	.7	.56	.62

,,*** Statistically significant at 10, 5, 1%, respectively. Robust standard errors in brackets.

5.2 Analysis of dynamics

As I have described in section 3, my dataset allows me to trace the firms' ownership over time and see when in my sample period they are acquired by foreign investors. I can therefore implement an analysis of these dynamics and test whether the changes in ownership lead to changes in firms' market power. I classify firm-year observations in six different groups that correspond to the firms' current status. In my sample I observe firms that are domestic and FDI during the whole period. These are *always domestic* and *always FDI*, respectively. The ownership of other firms change over time. Some companies are domestic in the first years (*future FDI*) and then become FDI (*new FDI*). Other firms (few) become domestic (*new domestic*) after being FDI (*former FDI*). In order to compare the markups of these six groups, I run the following regression where I include the five dummy indicator for the companies' status:

$$ln\mu_{it} = \gamma_1 futureFDI_{it} + \gamma_2 newFDI_{it} + \gamma_3 formerFDI_{it} + \gamma_4 newDOM_{it} + \gamma_5 alwaysFDI_i + \gamma_X X_{it} + \delta_{jt} + \epsilon_{it} \tag{14}$$

The dummy *future* FDI_{it} is =1 for a firm-i that is domestic at time-t, but will be purchased by a foreign entity; *New* FDI_{it} is = 1 when firm-i becomes a FDI and afterwards. *Former* FDI_{it} is = 1 as long as firm i is a FDI and =0 when it becomes a domestic company, while the variable *new domestic*=1. Clearly *always* FDI_i is = 1 for every observation of foreign-owned firm i that does not change status.

I include the same set of control variables (age, labor and capital intensity) and indutry-time dummies as in section 5.1. Thus the value of the coefficient of the FDI indicators will measure the markup premium of each group compared to similar *Always domestic* firms active in the same industry-j and year-t, the omitted category in the regression. This regression model allows me to see whether the MNCs' markup premia depend on the firm's ownership history.

I present the results of my regressions in Table 6. The first five columns report the results when assuming a Cobb-Douglas production function, columns 6-10 report results under the assumption of a Translog production function. Again, I focus on estimations obtained when I use markups derived under the Translog production function specification.

In some industries *future fdi* have higher markups than domestic counterparts. This evidence suggests a practice of cherry-picking by foreign investors. However, compared to the premia associated to different statuses, the markup premia of *future fdi* are small and significant only in LT and LC industries, suggesting that the companies that will become FDI have a small competitive advantage in marginal costs over other domestic competitors but are not very different from them. Foreign

ownership is associated with significantly higher markups. *New FDI* and *Always FDI* have always positive and highly significant coefficient. Firms that are acquired by foreign entities have on average 12,5% higher price-cost ratios than the domestic counterparts. Similarly, the firms that have always been FDI perform better than domestic companies. The test of equality of premia of *New fdi* and *Always fdi* never rejects the null hypothesis that the two groups have equal markup premia. On the contrary, the tests show strong evidence of differences in the market power of *New fdi* and *Future fdi*. I report the corresponding p-values in the last rows of the Table.

Table 6: Estimation results : Dynamics

	Cobb-Douglas					Translog				
	All	LT	HT	LC	HC	All	LT	HT	LC	HC
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
$futureFDI_{it}$	0.042***	0.051***	-0.025	0.050***	-0.034	0.021***	0.024***	0.001	0.025***	-0.015
	(0.014)	(0.015)	(0.037)	(0.015)	(0.041)	(0.008)	(0.009)	(0.018)	(0.009)	(0.018)
$newFDI_{it}$	0.179***	0.186***	0.120***	0.194***	0.031	0.125***	0.130***	0.100***	0.129***	0.093***
	(0.010)	(0.010)	(0.028)	(0.010)	(0.026)	(0.006)	(0.006)	(0.010)	(0.006)	(0.011)
$formerFDI_{it}$	0.089***	0.084***	0.109	0.097***	-0.015	0.094***	0.094***	0.096**	0.096***	0.078*
	(0.027)	(0.026)	(0.098)	(0.028)	(0.071)	(0.020)	(0.023)	(0.041)	(0.022)	(0.045)
$newDOM_{it}$	-0.007	0.008	-0.144	-0.006	-0.066	0.034**	0.039**	0.003	0.032**	0.047
	(0.029)	(0.029)	(0.105)	(0.031)	(0.061)	(0.014)	(0.015)	(0.039)	(0.015)	(0.034)
$alwaysFDI_{it}$	0.125***	0.145***	0.035	0.144***	-0.003	0.124***	0.131***	0.083***	0.131***	0.070***
	(0.011)	(0.012)	(0.026)	(0.012)	(0.025)	(0.007)	(0.008)	(0.010)	(0.008)	(0.012)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year*Industry dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N.obs.	125,401	110,681	14,720	113,286	12,115	125,401	110,681	14,720	113,286	12,115
R2	.41	.36	.59	.39	.53	.57	.54	.7	.56	.62
F-test ($newFDI_{it} = futureFDI_{it}$)	1.7e-19	1.3e-16	.00035	4.1e-19	.13	1.6e-31	2.2e-26	5.9e-08	1.8e-26	4.5e-09
F-test ($newFDI_{it} = alwaysFDI_{it}$)	.00021	.0094	.02	.0015	.33	.88	.91	.21	.82	.12

Notes: All specifications include age_{it}, l_{it}, $\ln(K/L)_{it}$ as controls.

,,*** Statistically significant at 10, 5, 1%, respectively. Robust standard errors in brackets.

In order to test whether a change of status from domestic to foreign owned firm is associated with an increase in market power, I restrict my analysis to only those companies that become foreign affiliates in the sample period and estimate the the fixed effect models defined in eq. (15) and eq. (16). These specifications, borrowed from Braguinsky et al (2015), allow me to control for time-invariant firm's characteristics that might affect the companys' markups. The within-estimation identifies the effect of becoming a foreign affiliate using only the within-firm variation of company's ownership over time.

$$ln\mu_{it} = \alpha_i + \beta_1 FDI_{it} + \beta_X X_{it} + \delta_{jt} + \epsilon_{it} \tag{15}$$

$$ln\mu_{it} = \alpha_i + \gamma_1 sbaq_{it} + \gamma_2 aq_{it} + \gamma_3 saaq_{it} + \gamma_4 laaq_{it} + \gamma_X X_{it} + \delta_{jt} + \upsilon_{it} \tag{16}$$

In the first regression I use the dummy FDI_{it} as main regressor, while in the second I use a set of dummies the represent the two years *before* the acquisition ($sbaq$), the year of the acquisition of the company (aq), the two years *after* the acquisition ($saaq$) and the following years ($laaq$), respectively. The significance of β_1 in eq. (15) answers the question of whether the new foreign ownership is associated with increased markup. The values of the γ_1,γ_2, γ_3, γ_4 in eq. (16), instead, measure how markups change over time before, in the year of, and after the change in ownership. [13]

I display the results of these estimations in Table 7. The results of these estimations show that local firms do in fact increase their market power by over 10% when acquired by a foreign entity. There seems to be no movement in markups before the acquisition. The increase of markups appears to be immediate. The most relevant change happens in the year of the acquisition, while in the following years markups premium remains stable.

Foreign investors are likely to transfer to the new affiliate know-how that allows it to increase its productivity and lower their marginal costs. At the same time, the plausible introduction of new production technologies and products and the access to new markets may allow the new FDI to charge higher prices. Interestingly, the increase in firms' markups is higher in HT and HC than in LT and LC industries, respectively. As in high-tech and high-concentrated industries the degree of vertical differentiation and average market power are higher, companies face a weaker price competition and can define more freely their pricing strategies. Hence, foreign ownership seems then to be associated to an increase in prices charged by local companies. This could be because acquired companies benefit from the costumers' recognition of their new brands. Moreover, foreign ownership may introduce

[13] In eq.(15) the omitted category includes all years before acquisition, while in eq. (16) three years or longer before acquisition. All regressions defined by eq.(16) are robust to the inclusion of dummies for the year of acquisition (which have the same values 0,1 for all companies acquired in a specific year) and to the exclusion of the firm-specific indicator of the acquisition-year (which implies that aq_{it} regressor is excluded from the model).

new marketing strategies (e.g. market segmentation) that can allow firms to target specific groups of costumers and increase their price. New ownership could also offer access to new foreign rich markets (e.g. through participation in global value chains) where companies can demand higher prices. This is arguably particularly relevant in high-tech industries.

Table 7: Estimation results : Within-firms dynamics

	Foreign ownership					Foreign ownership Time				
	All	LT	HT	LC	HC	All	LT	HT	LC	HC
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
FDI_{it}	0.109***	0.105***	0.137***	0.107***	0.128***					
	(0.009)	(0.010)	(0.018)	(0.009)	(0.019)					
$sbaq_{it}$						0.014	0.015	0.010	0.014	0.021
						(0.009)	(0.010)	(0.018)	(0.010)	(0.021)
aq_{it}						0.121***	0.116***	0.150***	0.119***	0.136***
						(0.014)	(0.016)	(0.026)	(0.015)	(0.033)
$saaq_{it}$						0.133***	0.127***	0.165***	0.128***	0.175***
						(0.018)	(0.020)	(0.037)	(0.019)	(0.046)
$laaq_{it}$						0.138***	0.131***	0.180***	0.135***	0.178***
						(0.022)	(0.025)	(0.049)	(0.024)	(0.062)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year*Industry dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
N.Obs	12,052	10,391	1,661	10,677	1,375	12,052	10,391	1,661	10,677	1,375
R2	.56	.51	.78	.53	.77	.56	.51	.78	.53	.77
F-test ($aq_{it} = saaq_{it}$)						.13	.19	.37	.27	.064
F-test ($aq_{it} = laaq_{it}$)						.14	.22	.3	.21	.28
F-test ($saaq_{it} = laaq_{it}$)						.41	.56	.42	.39	.88

Notes: All specifications include age_{it}, l_{it}, $\ln(K/L)_{it}$ as controls.

,,*** Statistically significant at 10, 5, 1%, respectively. Robust standard errors in brackets.

In the foreign ownership model the omitted category include all years before aquisition.

In the foreign ownership time models the omitted category includes three years or longer before acquisition.

5.3 Foreign firms' presence and markups

In this section I present my strategy to test whether the activity of foreign firms in Romania modifies the intensity of competition and the results of my estimations.

In order to test for the existence of a competitive effects from the activity of foreign affiliates, I relate the firms' markups to the presence of FDI in the same industry.
I estimate these relationships using the following fixed effects model:

$$ln\mu_{it} = \alpha_i + \beta_1 HP_{jt} + \beta_2 age_{it} + \beta_3 ln(K/L)_{it} + \beta_4 l_{it} + \beta_5 HHI_{jt} + \beta_6 y_{pt} + \delta_{st} + \epsilon_{it} \qquad (17)$$

The sign of β_1 of the main regressor HP_{jt} identifies the nature of the net impact of foreign competition on the market power of companies. Besides the index HP_{jt} that measures the presence of foreign-owned competitors as described in section 3.1, I control for other variables that may influence the market power of the company, namely firm's age, its capital intensity and its size, the total production at the product level y_{pt}, the Herfindhal index HHI_{jt} of the industry and time-sector dummies δ_{st}. These controls limit concerns about a potential bias in the estimated competitive effect of FDI activity, due to the endogeneity of foreign investments. Foreign investors, indeed, may invest in more profitable sectors where markups are higher. The use of the set of dummies δ_{st} controls for differences and trends in profitability across sectors and over time. Additionally, the y_{pt} and HHI_{jt} capture differences in demand and in the competition intensity across industries. Finally, I cluster the error terms at year-industry level, as this is the dimension at which HP_{jt} is defined (Moulton 1990).

Table 8 displays my results. In column (1) I report the results from eq. (17) without distinguishing by ownership while in all other columns the dependent variable is the log of markups of local firms only. In column (2) I display the results of the regressions that include domestic firms in all industries. The following columns present the estimations obtained distinguishing by industry.

The results I obtain are consistent and point at a similar evidence. I find that the expansion of foreign companies leads to a decrease in the markups of competing firms. Thanks to their advanced technologies and managerial practices, FDI represent a source of fiercer competition that curbs the market power of local companies.

The intensity of the negative effect of FDI activity on local companies' market power seems to depend on the characteristics of the industry they operate in. Interestingly, the activity of FDI seems to increase the competitive pressure perceived by local firms more intensively in low-tech industries and in low-concentrated sectors, where FDI seem to have a competitive advantage in terms of cost-effectiveness. As said, in these industries movements in markups likely reflect changes in marginal costs. The competition of FDI does not affect the market power of domestic firms active in HT.

Arguably in these industries the vertical differentiation of products is higher and can lead to a segmentation of the market. Thus, the overlap of products offered by local and foreign companies might be limited. As a consequence, the activity of foreign affiliates does not affect the markups of local companies. In HC industries the competition of FDI does not seem to be as strong as in LC industries. In these industries, production is more concentrated and firms can exploit a stronger market power and suffer less from the competition of foreign affiliates.

The coefficients of control variables are of the expected sign. The positive sign of age's coefficient is probably reflecting a learning-by-doing effect and the firms' accumulation of market knowledge that makes them improve their competitiveness and profitability over time. In line with the results of the cross-section analysis presented in section 5.1, capital intensity has a significant positive effect only in concentrated and high-tech industries where prices can be increased more easily. Companies decrease their markups when become larger. The signs of the Herfindahl index and of the total value of production show that the average markups increase when production becomes more concentrated.

Table 8: Competitive pressure

	All firms	**Domestic firms**				
	All	All	LT	HT	LC	HC
Variable	(1)	(2)	(3)	(4)	(5)	(6)
HP_{jt}	-0.070***	-0.069***	-0.053**	-0.019	-0.100***	-0.064**
	(0.019)	(0.021)	(0.021)	(0.034)	(0.037)	(0.025)
age_{it}	0.152***	0.148***	0.145***	0.019***	0.102***	0.063***
	(0.010)	(0.010)	(0.010)	(0.004)	(0.010)	(0.001)
$\ln(K/L)_{it}$	0.000	0.002	-0.001	0.022***	-0.001	0.021***
	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.004)
l_{it}	-0.016***	-0.015***	-0.020***	0.034***	-0.017***	0.009
	(0.005)	(0.004)	(0.005)	(0.007)	(0.005)	(0.006)
HHI_{jt}	0.135***	0.143***	0.031	0.111***	0.201	0.140***
	(0.034)	(0.041)	(0.064)	(0.040)	(0.191)	(0.036)
y_{pt}	-0.006**	-0.009***	-0.005*	-0.035***	-0.007*	-0.014***
	(0.003)	(0.003)	(0.003)	(0.009)	(0.004)	(0.004)
Year*Sector dummies	YES	YES	YES	YES	YES	YES
N	125,401	107,280	95,394	11,886	97,513	9,767

Notes: *,*,*** Statistically significant at 10, 5, 1%, respectively.

Standard errors clustered at Industry*year level.

6 Conclusions

This paper examines how, in the context of an emerging market, firms' market power is affected by foreign ownership and the competition of foreign affiliates. I argue that foreign ownership may enable the controlled firms to benefit from technological advancements that lower their marginal costs. Moreover, foreign investors can transfer to the company advanced know-how that allows them to employ sophisticated marketing strategies and enter new richer markets where they can charge higher prices. Lower marginal costs and higher prices result in larger markups. At the same time, the activity of FDI in the economy can modify the market equilibria and firms' market power through an increased competitive pressure. Highly productive FDI represent a source of competitive pressure for local companies that need to lower their prices. FDI competition can also damage local companies by reducing the scale of their operation through market stealing and by competing with them on input markets for intermediates. FDI competition on input and output market increases the marginal costs and reduce the prices of local companies that loose market power and are force to reduce their markups.

Changes in the market power of local companies have relevant policy implications as they can affect the welfare of consumers and the profitability of local companies. Lower markups can result in higher welfare of consumers. However, lower markups can also represent a threat for the long-run growth of local economy as the capacity to invest of local firms is reduced. Therefore, understanding what are the effects of FDI activity on the profitability and market power of firms is relevant in the analysis of FDI effects in the host economy.

To measure firms' market power, I use a balance-sheet data of manufacturing firms active in Romania between 2001 and 2008 and I estimate the firm-specific markups using the De Loecker and Warzynski (2012) procedure.

Several results emerge from my analysis. First, I show that foreign affiliates have higher market power than domestic firms. This difference is likely due both to lower marginal costs and to higher prices of FDI. On average, foreign affiliates have 12% higher markups. These markup premia seem to be, on average, higher in the low-tech and low-concentrated industries, suggesting that the core of the FDI premium comes from comparative advantages in production technology and lower marginal costs. I also find that companies newly acquired by foreign entities and firms that are foreign affiliates throughout my entire sample period have a markup premium larger than 12% and the difference between the premia of the two groups is not significant. The length of the foreign ownership does not seem to be relevant. This is probably because great part of the increase in market power of a company

associated to a change in ownership happens in the first years after the company becomes an FDI and then beneficial impact of the new foreign ownership decreases over time and markups stabilize.

Moreover, the activity of FDI affects the competition intensity in the host economy. I find evidence that average price-cost ratios of local companies decrease with the presence of foreign competitors. This suggests that the presence of FDI forces domestic companies to lower their profit margins to stand up to the stiffer competition that curbs their market power. These effects seem to depend on the characteristics of the industry the companies operate in. The impact of foreign competition appears to be strongest in the low-tech sectors and in markets that are less concentrated, where vertical differentiation and firms' average market power are lower. Therefore, the impact of the activity of foreign affiliates seems to occur mainly through an increase of the marginal costs of local companies. These results offer a possible explanation for why previous empirical literature has found evidence of negative productivity spillovers in developing and transition countries.

These new results are clearly relevant in terms of policy implications. They call, at least, for a better analysis of foreign affiliates' competitive advantages and of the actual benefits that the domestic companies and consumers could have from the presence of foreign producers.

As every empirical study, my analysis has limitations. Certainly, the most relevant is the lack on information on firms' prices. My results are based on estimation of firms' markups. It would be useful to observe firms' prices. This would expand the range of research questions to which a researcher might answer and allow for a finer analysis of the impact that competition effects of FDI have on firms' pricing strategies and, ultimately, of the implications for consumers' welfare in these emerging economies. I consider these promising lines of research.

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Appendices

A The Database

The source of information on balance-sheet accounting data and on companies' ownership is the commercial *Amadeus* database compiled by *Bureau van Djik* (BvD), a consulting company. BvD gathers firm-level information from different local data providers (the *Romanian Chamber of Commerce and Industry* for Romania) and makes the information standard and comparable across countries.
Although this database has been broadly used in the literature, an extensive data management was required. In preparing the dataset, I closely follow Kalemli-Ozcan et al (2015).

Typically a single release of the database contains information on financial data that cover the previous ten years but includes only the latest available information on firms' sector of activity and ownership figures. Moreover, companies tend to fall out of the database when they do not report information for some consecutive years. This means that the most recent releases of the database might not contain information on those companies that stopped their business or moved from the manufacturing to a different sector during the first years of the period covered by a single issue.

In order to include all manufacturing companies that operate during my sample period and track changes in ownership, I use several releases of the database, namely the 2003-2010 issues. Every observation in each release of the database is uniquely identified by the firm BvD identifier and the year it refers to. In some cases the BvD identifiers (BvD-ID) assigned to single companies change over time. Before merging the data from different issues, I use conversion tables I received from BvD to replace old BvD-IDs with the new ones. When two or more DVDs report financial data for the same firm-year I keep the one from the newest release as this is usually the most complete.
I start by retrieving information on firms' financial data from the 2010 release of database which covers the full sample period (2001-2008). In order to fill missing observations, identify the ownership status of of companies and the industry in which firms operate in each year and to include in my sample manufacturing companies for which information is not available in the 2010 issue, I use the information referring to the last available year in each of the previous releases. Using these data I can reconstruct the time-series of financial variables of companies that are not in the 2010 issue's sample and of the industry codes for each company in the final sample.

An additional complication comes from the change in the NACE industry classification from NACE REV 1.1 to NACE REV 2 that was introduced in 2008. For all companies included in the 2009 and 2010 issues, I have information on the NACE Rev 2 four-digit code of the industry of activity that

refers to the last year available. Using the time-specific information on NACE Rev.1 I assess whether single companies moved from an industry to another. If the NACE Rev 1 codes of a single company are the same in every period , I assume it was active in the same NACE Rev. 2 throughout the sample period and I use the information from the new releases. If companies change their main activity or are nor included in the latest releases of the database, I use the information from early releases of the database (2003-2008) and I convert the NACE Rev 1 four digit industry codes into corresponding NACE REV 2 codes using the official Eurostat conversion tables. In most of the cases the conversion is unique. When more than one NACE REV 2 code correspond to a single NACE REV 1.1, they are sorted by level of *closeness* between the industries. The first code corresponds to the one that is recognized as the most similar. In these cases, I use the first NACE REV 2 code listed in the conversion table.[14]

A.1 Ownership information

As explained in section 3.1, I classify a company as a FDI if at least 10% of its shares are controlled by a foreign shareholder or it is ultimately controlled (direct or indirect control of at least 50% of its shares) by a foreign entity. For each company I have information on the name and BvD identifiers, countries of origin and total number of shares of direct shareholders and ultimate global owner. I use this information to detect FDI in my dataset.

I reconstruct the ownership structure in three steps. First, I identify the accounting year (and month) to which each ownership information refers to. Typically, a single release of contains information on ownership that refers to two years before the year of the release or earlier. When two or more releases have conflicting information for the same year (few cases) I give priority to the most complete one or to the oldest, as I believe this should be the most accurate as it is closer in time. When information refers to the first three months of the accounting year, I assume also pertains to the previous year. Second, I detect foreign shareholders and global ultimate owners using the information on their countries of origin. Finally, I define a company as a FDI if either of (or both) my criteria applies. I then carry the information over to the following periods if no update is reported. If a company has missing or incomplete information in a given (and previous) year, I assume it is a domestic firm. This means that if the earliest ownership information I have for a firm defines it as a FDI and the company was active in previous years, I assume that this company was owned only by local investors and becomes a FDI in the year I observe foreign ownership.

[14]The tables are available at the following url: `http://ec.europa.eu/eurostat/web/nace-rev2/correspondence_tables`.

B Trimming strategy

In order to identify and eliminate outliers I trim the data in several dimensions. First, I eliminate outliers *before* the estimation of production functions using ratios of production function variables and their growth rates. Second, I drop extreme values of estimated markups and of their growth rates. In each step I first identify all outliers and then drop them. As the ACF procedure requires complete information on production variables for at least two consecutive years, I keep in the sample only firm-year observations that have non-missing information on all variables at time-t and time-t-1. In both steps I define the relevant distributions of the variables within their year-sector pairs.

- *Before* production functions' estimation
  - I exclude companies that change ownership status more than once. These are very few companies that start in the sample as domestic, become FDI and then are domestic again.
  - I keep observations that report positive values of all production function variables.
  - I eliminate firm-year observations for which I observe only one employee.
  - I identify as outliers the top and bottom 1% of the following variables: capital per employee (capital intensity), sales per employee (labor productivity), material inputs over total sales (materials' revenue share)
  - I identify as outliers observations that in two consecutive years have extreme growth rates (the top and bottom 1%) of the following variables: sales, number of employees, material inputs, capital.
  - I drop outliers
- *After* production functions' estimation
  - I identify as outliers top and bottom 1% of markups under each specification of the production function
  - I identify as outliers observations that in two consecutive years have extreme growth rates (the top and bottom 1%) of markups under either assumption of production function
  - I eliminate all observations in sectors for which I estimate one (or more) negative coefficient of the Cobb-Douglas production (i.e. 108 observations in *Coke and refined petroleum products* sector, nace code 19)
  - I keep observations that have positive markups under both assumptions of the production
  - I drop outliers

C Industries classification

To define industries as high- and low-tech I adopt the Eurostat classification. This classification is based on the R&D intensity of economic activities the industry, i.e. expenditures in R&D in relation to value added. Industries and sectors are clustered in four technology groups, namely *Low-technology manufacturing*, *Medium-low-technology manufacturing*, *Medium-high-technology manufacturing* and *High-technology manufacturing*.[15]

I reduce the groups to high-tech and low-tech. In the Table 9 here below I report the list of industries.

Table 9: Industry classification: HT vs LT

Sector\Industry	LT	HT	Sector\Industry	LT	HT	Sector\Industry	LT	HT
Food	✓		Chemicals		✓	Transport equip., airspace	✓	
Beverages	✓		Pharmaceuticals		✓	Furniture	✓	
Tobacco	✓		Rubber and plastic	✓		Other manufacturing	✓	
Textiles	✓		Other non-met. mineral	✓		Weapons & ammunition		✓
Clothing	✓		Basic metals	✓		Ships and boats	✓	
Leather products	✓		Fabr. metal prod. excl. machinery	✓		Medical & dental instruments		✓
Wood products	✓		Computers, electronic & optical prod		✓	Repair & installation machinery	✓	
Paper products	✓		Electrical equipment		✓			
Printing & Rep. rec. Media	✓		Machinery		✓			
Coke and petroleum products	✓		Motor vehicles		✓			

To test the intuition that markups should be higher in HC (HT) than in LC (LT) industries, I regress the markup of companies on indicators of industry classification (IC_j).

I estimate the following OLS regressions using markups derived under the Translog specification:

$$ln\mu_{it} = \beta_0 + \beta_1 IC_j + \beta_2 l_{it} + \beta_3 ln(K/L)_{it} + \delta_t + \epsilon_{it} \tag{18}$$

Where IC_j presents a dummy indicator for high-tech industry ($=HT_j$) in a first regression and dummy indicator for high-concentrated industry ($=HC_j$) in a second. In these models, the coefficients of the main regressors IC_j define the average markup premia of companies active in HT (HC) industries compare to those that operate in LT (LC) industries. I include the number of employees and capital intensity as controls. The coefficient β_1 measures the markup premia of companies in HC (HT) industries compare to LC (HC). Markups in HC are 10% higher than in LC, where production is more dispersed and companies have on average a lower market power. Markups are 16% higher in high-tech industries than in low-tech. This

Moreover, I formally test whether the FDI markup premia are differ cross industries. To this end, I include in the regressions defined by eq.(3) an interaction term between the indicator of foreign

[15]The Eurostat classification of HT and LT industries is available at the following url:`http://ec.europa.eu/eurostat/statistics-explained/index.php/High-technology_versus_low-technology_manufacturing`

ownership (FDI_{it}) and the indicators of industry classification (IC_j).

$$ln\mu_{it} = \gamma_0 + \gamma_1 FDI_{it} + \gamma_2 IC_j * FDI_{it} + \beta_3 age_{it} + \gamma_4 l_{it} + \gamma_5 ln(K/L)_{it} + \delta_{jt} + \epsilon_{it} \tag{19}$$

The coefficients γ_1 measures the markup premia of foreign affiliates in LC and LT industries. The coefficients γ_2 represent the deviations of FDI premia in HC and HT industries. I report the results of these estimation in Table 10. In line with the results displayed in Table 5, both the interaction coefficients are negative, meaning that the difference in markups between local companies and foreign affiliates are larger in LC (LT) than in HC (HT).

Table 10: Inductry classification

Variable	$\ln\mu_{it}$	$\ln\mu_{it}$	$\ln\mu_{it}$	$\ln\mu_{it}$
HC_j	0.108***			
	(0.003)			
HT_j		0.159***		
		(0.003)		
FDI_{it}			0.127***	0.125***
			(0.002)	(0.002)
FDI_{it}*HC_j			-0.030***	
			(0.006)	
FDI_{it}*HT_j				-0.015***
				(0.005)
Controls	YES	YES	YES	YES
Year dummies	YES	YES	NO	NO
Year*Industry dummies	NO	NO	YES	YES
N.obs.	125,401	125,401	125,401	125,401
R2	.23	.25	.57	.57

,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors in brackets.

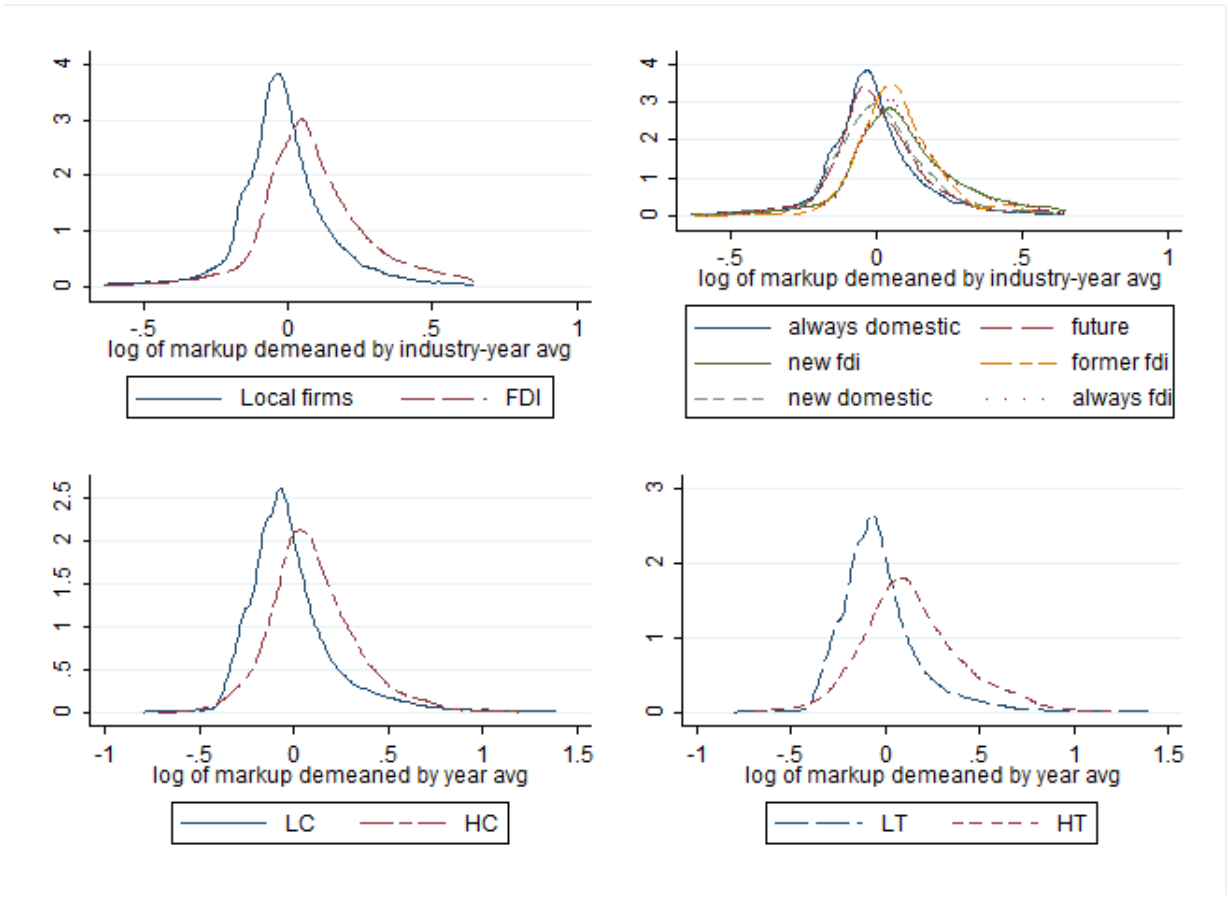
D Estimated markups

Table 11: Mean elasticities and markups

	Cobb-Douglas				Translog			
	β_l	β_m	β_k	μ	θ_l	θ_m	θ_k	μ
Food	0.25	0.59	0.17	1.15	0.26	0.67	0.13	1.12
Beverage	0.29	0.66	0.11	1.84	0.27	0.68	0.11	1.50
Textiles	0.43	0.37	0.16	1.48	0.25	0.55	0.14	1.63
Wearing apparel	0.51	0.34	0.17	1.69	0.46	0.41	0.16	1.43
Leather and rel.d products	0.53	0.35	0.14	1.71	0.58	0.73	-0.03	2.56
Wood, cork etc	0.23	0.65	0.10	1.34	0.19	0.68	0.12	1.30
Paper and paper prods	0.30	0.63	0.09	1.33	0.29	0.69	0.08	1.29
Printing and reproduction of rec	0.43	0.45	0.13	1.39	0.31	0.55	0.12	1.43
Chemicals and ch.prods	0.49	0.38	0.15	0.88	0.12	0.79	0.13	1.51
Basic pharmaceutical prods	0.62	0.35	0.07	0.95	0.33	0.64	0.15	1.47
Rubber and plastic prods	0.25	0.61	0.12	1.27	0.19	0.71	0.11	1.29
Other non-metallic mineral prods	0.19	0.66	0.14	1.74	0.26	0.65	0.12	1.47
Basic metals	0.09	0.69	0.15	1.64	0.21	0.68	0.09	1.34
Fabricated metal prods, no machi	0.28	0.55	0.14	1.47	0.34	0.57	0.14	1.26
Computer, eletronic and optical	0.70	0.17	0.20	0.91	0.41	0.44	0.21	1.43
Electrical equipment	0.31	0.49	0.15	1.52	0.27	0.62	0.09	1.47
Machinery and equipment n.e.c.	0.09	0.58	0.18	1.94	0.49	0.73	0.04	2.05
Motor vehicles, trailers and sem	0.46	0.33	0.20	0.94	0.29	0.59	0.09	1.33
Other transport eq.	0.44	0.35	0.20	2.00	0.46	0.42	0.15	1.66
Forniture	0.26	0.65	0.11	1.31	0.24	0.69	0.11	1.26
Other manufacturing	0.48	0.46	0.10	2.09	0.48	0.47	0.10	1.66
Average	0.32	0.53	0.14	1.42	0.31	0.62	0.12	1.38

Table 12: Median Elasticities and markups

	Cobb-Douglas				Translog			
Sector	β_l	β_m	β_k	μ	θ_l	θ_m	θ_k	μ
Food	0.25	0.59	0.17	0.85	0.27	0.67	0.13	1.02
Beverage	0.29	0.66	0.11	1.30	0.25	0.70	0.11	1.34
Textiles	0.43	0.37	0.16	0.94	0.26	0.57	0.15	1.48
Wearing apparel	0.51	0.34	0.17	1.19	0.47	0.42	0.16	1.33
Leather and rel.d products	0.53	0.35	0.14	1.03	0.56	0.74	-0.02	2.17
Wood, cork etc	0.23	0.65	0.10	1.18	0.18	0.69	0.12	1.22
Paper and paper prods	0.30	0.63	0.09	1.11	0.28	0.71	0.07	1.22
Printing and reproduction of rec	0.43	0.45	0.13	1.10	0.31	0.56	0.12	1.39
Chemicals and ch.prods	0.49	0.38	0.15	0.66	0.16	0.80	0.13	1.42
Basic pharmaceutical prods	0.62	0.35	0.07	0.76	0.33	0.64	0.16	1.33
Rubber and plastic prods	0.25	0.61	0.12	1.04	0.17	0.74	0.10	1.25
Other non-metallic mineral prods	0.19	0.66	0.14	1.38	0.26	0.66	0.11	1.35
Basic metals	0.09	0.69	0.15	1.28	0.22	0.67	0.09	1.25
Fabricated metal prods, no machi	0.28	0.55	0.14	1.15	0.34	0.58	0.14	1.20
Computer, eletronic and optical	0.70	0.17	0.20	0.48	0.41	0.43	0.22	1.12
Electrical equipment	0.31	0.49	0.15	1.08	0.27	0.62	0.09	1.32
Machinery and equipment n.e.c.	0.09	0.58	0.18	1.46	0.49	0.72	0.04	1.86
Motor vehicles, trailers and sem	0.46	0.33	0.20	0.69	0.29	0.61	0.09	1.22
Other transport eq.	0.44	0.35	0.20	1.36	0.47	0.42	0.14	1.58
Forniture	0.26	0.65	0.11	1.16	0.24	0.69	0.10	1.20
Other manufacturing	0.48	0.46	0.10	1.57	0.47	0.48	0.10	1.58
Average	0.26	0.59	0.14	1.09	0.29	0.63	0.12	1.27



Note: Extreme values in the bottom and top 1% are excluded from the graphs

Figure 1: Markups by firms' status

Chapter 2:

Vertically Integrated Multinationals and Productivity Spillovers

Vertically Integrated Multinationals and Productivity Spillovers

Friedrich Bergmann*and Federico Clementi†

Abstract

How does the activity of foreign multinationals affect the competitiveness of local companies in the host countries? Previous studies have identified the interactions of domestic firms with foreign clients as main mechanism of diffusion of knowledge (i.e. backward spillovers). However, backward productivity spillovers are not automatic. In this paper, we study how these spillovers are affected by the vertical integration strategy of foreign multinationals. Our analysis, based on firm-level data of European manufacturing companies, shows that local firms perceive positive backward spillovers only if foreign clients are not vertically integrated in their industry.

*fbe.eco@cbs.dk; Department of Economics, Copenhagen Business School

†fc.eco@cbs.dk; Department of Economics, Copenhagen Business School

1 Introduction and objectives

Governments invest in costly policies aimed at attracting foreign direct investments (FDI) in their national territories.[1] These policies are driven by the wide-spread belief that the presence of multinational companies (MNCs) may introduce new technologies and commercial practices that local companies can acquire and use to improve their own competitiveness. The main mechanism of transfer of technology and know-how has been identified to be the collaboration between local suppliers and foreign-owned clients. In order to have inputs of high quality that can meet their production needs, foreign affiliates can have an incentive to transfer knowledge to local companies that provide them with intermediates. Moreover, the demand for higher quality and better standards pushes local suppliers to improve their own production efficiency and invest in research and development which result in higher productivity. The activity of FDI can also expand the size of demand served by local suppliers that may exploit economies of scale and scope increasing their productivity. Through these interactions local companies can learn and improve their own efficiency and competitiveness. Yet there is no conclusive consensus on which are the mechanisms that facilitate these transfers of technology and know-how.

This paper analyses how the organization of production of MNCs affects this diffusion of knowledge. By combining two branches of the literature on multinational corporations we shed new light on this issue. Specifically, we explore the insights of previous research on the organization of multinational production to study the implications that the MNCs' strategy of vertical integration has for the nature and intensity of backward spillovers that local firms perceive. The make-or-buy decisions of multinational business groups and their choice to invest in interconnected industries along the value chain will affect the likelihood and the intensity of collaborations between FDI and local suppliers. Indeed, every foreign-owned company has to decide whether to purchase its inputs from other firms in their business group or buy them from (local) unrelated parties. We offer an example of a vertically integrated multinational business group in section 3.

Early studies on productivity spillovers focused exclusively on the effects of the activity of FDI on the productivity of domestic competitors in the same sector. The empirical evidence on horizontal spillovers is still mixed. Javorcik (2004) represents a milestone in this branch of research. Using Lithuanian data, the author shows that the most relevant channel of productivity spillovers is through backward linkages: local firms improve their productivity by serving foreign affiliates, whereas the interactions with foreign suppliers and foreign competitors are not as relevant.

[1] See Haskel et al. (2007)

Although this mechanism has been broadly recognized as the main channel of transfer of knowledge, backward spillovers are not automatic. Previous research has shown that they heavily depend on the sourcing strategy of client FDI. The presence of FDI in downstream sectors is beneficial for local companies when the foreign affiliates purchase their inputs on the local market (Barrios et al. 2011). The sourcing decision of FDI depends on the characteristics and strategies of their business groups. For example, the geographical distance from head quarters affects the sourcing strategy of foreign affiliates and consequently the spillovers local firms benefit from (Javorcik and Spatareanu 2011).

We expand the analysis of productivity spillovers using the results and the insights of another stream of the literature on multinational production. This branch of research has shown that business groups' decisions to undertake foreign direct investments respond to complex strategies and are determined by the companies' characteristics. MNCs companies can invest abroad through green-field FDI or through M&A of local companies (Nocke & Yeaple 2007). Moreover, the organization of multinational production managed by MNCs depend on the nature of the production processes and their costs (Baldwin & Venables 2013).

A vast body of theoretical and empirical literature has analyzed the organization of MNCs' multinational production and firms' decision between (international) vertical integration and outsourcing. Recent theoretical contributions have shown that these strategies vary between heterogeneous companies and across sectors. The equilibrium outcome depends on firms' productivity and on the characteristics of the sector in which they operate, such as relative importance of head quarter activity compared to manufacturing tasks, the substitutability and complementarity of inputs, the distance from final consumption, the elasticity of demand and trade costs (Antras 2003, 2005, Antras and Helpman 2004; Antras and Chor 2013; Alfaro et al 2016).

Empirical studies have highlighted the relevance of vertically integrated MNCs. Most of American affiliates represent vertical FDI and multinational companies invest in industries closely interconnected to their own along the value chain (Alfaro and Charlton 2009). This investment strategy suggests a substantial trade of intermediates within the boundaries of the business group and between countries. The intensity of internal sourcing depends on the trade costs, on characteristics of host countries, and varies with the relative size of foreign affiliates (Hanson et al 2005, Ramondo et al 2016).

In this paper, we use firm-level data of European manufacturing companies and empirically test how the intensity of backward productivity spillovers depends on the degree of vertical integration of foreign multinationals. We argue that, because of needs of technological complementarity and compatibility, foreign affiliates mainly rely on related firms within their business group (BG) as suppliers. Furthermore, the transaction costs are lower for companies controlled by the same group than for

unrelated parties. As a consequence, affiliates of foreign groups likely source from unrelated parties only as a second option. The more intense the vertical integration of MNCs is, the weaker the positive productivity spillovers to domestic firms will be. Relevant backward spillovers are more likely to arise from the interactions with foreign-owned clients whose business groups do not control firms in the industry of the local companies, whereas the spillovers from the activity of foreign affiliates that are vertically integrated the industry of their suppliers should be weaker or non-existent.

As a first step, before studying the effects of different MNCs on the competitiveness of local firms, we analyze the structure of MNCs. This will allow us to understand better what is the extent of potential collaboration between foreign affiliates and local companies. Similarly to what shown in Alfaro and Charlton (2009) and Ramondo et al (2016) for American multinationals, we observe that the organization of multinational production of MNCs in our dataset seems to mainly rely on the rationales of vertical integration. From our empirical analysis the investments of multinationals appear to be clustered in two dimensions: multinational business groups own firms that operate in different industries deeply interconnected in the supply chain and that are also located in geographically close areas. We interpret this result as suggestive evidence of intra-group sourcing of intermediates.
As this strategy of vertical integration appears to be a common characteristic of multinational investments and to be driven by the purpose of intra-group sourcing, we expect the strongest backward productivity spillovers to arise from the presence of FDI affiliated to business groups that do invest in the industry of domestic firms.

We empirically test this hypothesis using a dataset of European manufacturing firms. In order to estimate the degree of vertical integration of MNCs and compute their presence in local economies we make use of American Input-Output Tables that offer information on industries' interconnections at a highly detailed level of aggregation. We measure local companies' total factor productivity and we analyze how it varies with the activity of foreign-owned affiliates in downstream industries. To correct for the bias due to the endogeneity of inputs usage, we estimate the production function and firms' productivity employing the semiparametric method designed by Ackemberg, Caves and Frazer (2015). In line with De Loecker (2013) and De Loecker et al. (2016), we adopt an endogenous law of motion of productivity that includes several firms' characteristics and the indexes of foreign affiliates' activity that we expect to have an impact on firms' competitiveness.

Our results are consistent with the existence of backward spillovers. Local companies benefit from the presence of foreign affiliates in client sectors. However, the empirical evidence shows that the intensity of spillovers significantly depends on the vertical integration of foreign groups. The beneficial effects come only from the activity of companies that are not integrated in the industry

of the local firms. Such results have clear implications for policy. In order to maximize positive backward spillovers, governments should aim at attracting primarily MNCs that do not pursue vertical integration strategies.

The remainder of the paper is organized as follows. The first section presents the data we use and our criteria to identify the (multinational) business groups. The subsequent section presents a description of firms characteristics and an analysis of the business groups' strategies of vertical integration. Then we explain how we calculate the presence of FDI in host countries and introduce a new measure to account for the MNCs' vertical integration. After a detailed explanation of the methodology used to estimate firms' productivity, we present the results of our empirical estimations and our interpretation. The last section concludes and discusses the implications of our results.

2 Data

To test our hypothesis, we use a dataset of domestic and foreign-owned firms active in Europe in the period 2001-2008. We combine firms' balance-sheet and ownership data from eight dvds different releases of the Bureau van Dijk's *Amadeus* database. We restrict our sample to companies that have their main activity in a manufacturing industry according to NACE Revision 1 *and* NAICS 2007 classification. Manufacturing industries correspond to sectors 15-36 and sectors 31-33 in NACE Rev. 1 and NAICS 2007 classification, respectively. Our empirical analysis is primarily based on the NAICS industry classification. In the rest of the paper we will refer to NAICS 4-digit codes as *industries* and to NAICS 3-digit codes as *sectors*. We retrieve yearly, unconsolidated balance sheet data on revenues (S_{it}), tangible fixed assets (K_{it}), costs of materials (M_{it}), number of employees (L_{it}) and total wage bill (W_{it}), and ownership of the company. To identify all NACE and NAICS industries in which single firms are active in, we combine the information on primary and secondary industry codes. The main activity of a firms is classified as the industry in which the company realizes the largest total value added. To measure the degree of interconnections between industries and calculate the index of vertical integration of BGs, we rely on the I/O coefficients retrieved from the American Input-Output, direct requirement and total requirement tables compiled by the Bureau of Economic Affairs (BEA).

In order to identify the affiliation of firms, we rely on the information on ultimate owner: this is defined as the legal independent entity that directly or indirectly controls at least 50% of the firm's shares. Companies that are not controlled by any entity are called *unaffiliated* firms. We define as a *business group* (BG) the group of companies that in a given year are ultimately controlled by the same single entity. We define independent entities that control the affiliates in the group as

Head Quarters (HQ). We identify as *foreign direct investment* (FDI) the affiliates that are located in a country different from the one of their ultimate owner. Business groups that have at least one FDI are *Multinational Corporations* (MNCs). In the rest of the paper, we will refer to MNCs also as *Multinational Business groups*. We call *Domestic Business groups* (*DOM BG*) those that do not control any FDI. *Head Quarters* are called *DOM/MNE HQ* depending on whether they control *Domestic BGs* or *Multinational BGs* (MNCs). Each (multinational) Business Group consists of a Head Quarter (*DOM/MNC HQ*), of its *local affiliates* (*DOM/MNC LA*) that are located in the same country of the *HQ* and of its foreign affiliates (*FDI*). Hence, MNCs and DOM BGs represent two specific categories of BG. We identify the *core business* as the industry that has the highest value of sales within the BG in a country-c at time-t. This means that the same MNC has a core business in each country it invests in.

Not all firms in our dataset report complete financial information. When we identify the industries the business groups invest in and compute the indexes of FDI horizontal penetration and vertical penetration we do our best to use the most complete information available. Although information on one or more of the production variables may be missing, we know that the firm is operating in an industry and we want to use this information. Therefore, we consider all companies in our sample when we map the set of industries in which the groups invest. The use of different releases of the database provides us with year-specific information on the ownership and the set of industries each firm operates in. This allows us to trace changes in the ownership structure and identify which industries firms and business groups operate at time-t.

In order to limit the loss of observations due to lack of information on one (or more) variables, we interpolate each production function variable and assume that ownership did not change from previous years, when this information is missing. We deflate sales and materials using the appropriate 2-digit NACE Producer Price Index, while capital is deflated using the country-average of the PPI deflators of five sectors that produce the bulk of capital inputs used in manufacturing.[2]
We eliminate all observations that report zero or negative values of any of the production variables. To eliminate outliers from our analysis we drop the bottom and top 1% values in year-sector-country specific distributions of production variables' ratios and annual growth rates. This leaves us with an unbalanced panel that consists of a total of 2,024,899 firm-year observations, 3,13% of which refer to MNCs. [3]

[2]Like in Javorcik (2004), these sectors are: machinery and equipment; office, accounting and computing machinery and apparatus; motor vehicles, trailers, and semi-trailers; other transport equipment.

[3]We refer the reader to Appendix A for a description of the datasets we use at different steps of our analysis and for the explanation of our interpolation strategy and of our trimming procedure.

3 Investment structure of multinational business groups

To have a better understanding of the MNCs' organization, we also look at several specific cases of multinational production that we can observe in our firm-level dataset.

An example that well explains our story is given by Siemens AG. Siemens is an integrated technology company that operates in the industry of electronics and electrical engineering and has Head Quarters located in Munich, Germany. Its portfolio spans industry automation, industrial software and drives products and its German *core* business is *Engine, Turbine, and Power Transmission Equipment Manufacturing* (NAICS code 3336). The Siemens Business group controls 174 manufacturing subsidiaries of which 136 are located abroad. Only 8 of these foreign affiliates are horizontal FDI that operate in the industry of the Siemens' *core* business in Germany. The vast majority of the affiliates represents vertical FDI. Along the supply chain, Siemens invests most heavily in the following industries: *Navigational, Measuring, Electromedical, and Control Instruments Manufacturing* (NAICS code 3345), *Electrical Equipment Manufacturing* (NAICS code 3353), *Other Electrical Equipment and Component Manufacturing* (NAICS code 3359), *Other Fabricated Metal Product Manufacturing* (NAICS code 3329), *Communications Equipment Manufacturing* (NAICS code 3342).

All of these industries are highly interdependent as they have high shares of trade of intermediate goods. Therefore, Siemens' structure corresponds to a vertical production network and seems to be driven by a strategy of vertical integration. We expect the interactions between MNCs with a similar structure and local suppliers active in the industries in which the MNCs invest to be limited and produce weak transfers of know-how.

3.1 Analysis of the vertical integration and the geographical dispersion of multinational production

To test whether the structure of MNCs suggests the existence of sourcing strategies that could affect spillovers, we answer the following questions: Do MNCs tend to invest in multiple industries? If so, do they own firms in interconnected industries along the value chain? Do MNCs invest in close locations?

While previous research has analyzed how the characteristics of firms' industries, comparative advantages of countries, and the complementarity between firms' and countries' characteristics affect the location choices of FDI (e.g. Yeaple 2003), this study focuses on the intensity of interconnections between the industries in which multinational business groups invest. The classical theory on firms' boundaries would predict that intermediates are traded between related affiliates if a BG is vertically integrated. The sourcing strategy of the single affiliates depends on the *make or buy* decisions of the

business group they belong to. As mentioned in section 1, we argue that single affiliates are endowed with a group-specific technology that makes the products of other affiliates in their group the best match for their needs in terms of technological standards of their inputs. Therefore, firms controlled by MNCs should primarily purchase their inputs within the boundaries of the group.

As we do not have information on transactions, we cannot directly study this prediction. However, we exploit the information on the industries the groups invest in, and on the geographical location of the affiliates. If vertical integration was an important driver of the MNCs' decisions to invest abroad, we should find that multinationals invest in industries that intensely trade intermediates and control affiliates that are geographically clustered to reduce shipment costs.

In line with Alfaro and Charlton (2009) and Antras et al (2012), we measure the intensity of industries' integration in the supply chain using two indexes. These are *direct requirement* (dr_{ij}) and *proximity* ($proximity_{ij}$). Both are based on the coefficients of inter-industry trade in goods between each pair of industries i and j reported in the 2007 I/O Tables provided by the Bureau of Economics Activity (BEA). The BEA Tables are designed at 6-digit code level, we reduce the level of detail to 4-digit as this is the level of aggregation we use to identify relevant industries.[4]

The higher the values of these indexes the more interdependent the two industries are in the supply chain. *Direct requirement* (dr_{ij}) is the value of goods from industry-j that industry-i needs to produce one dollar of its own output. This first index measures how important the products of industry-j are as inputs in industry-i's production. The index *proximity* ($proximity_{ij}$) is constructed as the share of output of industry-j directly purchased by industry-i over industry-i's total use of industry-j's products. It measures how much of industry-j's output is directly used as an input by industry-i and not as a component embodied in other inputs. Similarly to *direct requirement*, the higher its value the closer the two industries are on the supply chain.

Besides the input/output relationships between the industries of affiliates we also look at their geographical location. We use the measures of geographical distance computed in Meyer and Zignano (2011).[5]

For each company we have information on the set of primary and secondary industries in which it operates and on the country where it is located. To analyze the dispersion of investments and relate it

[4]The coefficients of direct requirement are readily available on BEA's website, while we had to calculate proximity indexes as in Alfaro and Charlton (2009).

[5]Specifically, we use the measures of pairwise geographical distances between the capital cities of the countries and the same measures weighted by population densities within each country. These data is provided by CEPII. Several measures of intra-country distances are available. The results of the estimations we present are based on simple distances. The results are robust to the use of the alternative measures of geographical distances.

to the I/O connections between industries, we follow Ramondo et al (2016) and aggregate the single MNCs investments at the country-industry level. Hence, the country-industry pairs become our unit of observation.

We match each country-industry pair $\{n0, c0\}$ with all possible country-industry $\{n1, c1\}$ pairs. For each year, our sample consists of 35x35 countries and 78x78 possible industry pairs, for a total of 7,452,900 combinations or quartets {n0,c0,n1,c1} with full information on relevant variables. We consider only primary industries of each firm. To avoid double counting, we keep in $\{n0, c0\}$ only core business of their MNCs, while we keep all investments when we pair the observations with all possible $\{n1, c1\}$ combinations. Given the large amount of combinations that we create and use in our estimations, we restrict our sample to one single year (2006) in order to make computations feasible.[6]

We estimate the following OLS models:

$$D(INV_{n0n1c0c1}) = \alpha_1 geod_{C0C1} + \alpha_2 dr_{01} + \alpha_3 dr_{10} + \alpha_4 geod * dr_{01} + \alpha_5 geod * dr_{10} + \delta + \epsilon_{n0n1c0c1} \quad (1)$$

and

$$ln(Nf_{n0n1c0c1}) = \beta_1 geod_{C0C1} + \beta_2 dr_{01} + \beta_{23} dr_{10} + \beta_4 geod_{C0C1} * dr_{01} + \beta_5 geod_{C0C1} * dr_{10} + \delta + \upsilon_{n0n1c0c1} \quad (2)$$

D($INV_{n0n1c0c1}$) in eq. (1) is a dummy that equals one if we observe at least one MNC that controls firms in *both* industry-*n0* in country-*c0 and* in industry-*n1* in country-*c1*. In equation (2) we use the total number of firms in $\{n0, c0\}$ and in $\{n1, c1\}$ controlled by the same MNCs. The variable dr_{xz} is the direct requirement of goods from the affiliate-x's industry for production of the affiliate-z's industry. The variable $geod_{C0C1}$ is the log of geographical distances between the countries $c0$ and $c1$. In order to control for features of industries and for the characteristics of countries that could affect the decision of FDI location, we include a set of industries and country dummies δ ($\delta_{n0}, \delta_{C0}, \delta_{n1}, \delta_{C1}$). Error terms are clustered by $\{n0, c0\}$.

Table 1 and Table 2 below display the results of the estimation of eq.(1) and of eq.(2), respectively. For the sake of presentation, we limit the discussion to the estimation of eq.(1).
The estimated coefficient for the number of investments in eq.(2) are consistent and provide a similar evidence. Similarly, when we replace direct requirement indexes with proximities the results remain virtually unchanged.

[6]We exclude from the analysis same industry combinations ($z = x$, 92,820 observations, with 13,253 of investments), while we keep combinations of industries in the same country ($c0 = c1$). The number of possible quartets therefore becomes equal to 7,357,350 (=35x35x78x77). In 63,498 of them we observe realized investments, 92.2% of which (58,506 observations) involve multinational production ($c0 \neq c1$). We provide a list of the countries in our sample in Appendix A.

The coefficients $\alpha_1, \alpha_2, \alpha_3$ in the first and second columns are highly significant and show that MNCs are likely to invest in close locations and in industries that are highly interconnected. Similar to the results of Alfaro and Charlton (2009), MNCs tend to own firms in supplier and client industries of the one in which they establish their core business.

The use of the interactions terms between the indexes of interconnections and geographic distances provides a novel result to the literature on multinational production. The coefficients are negative and significant. The more interdependent are the industries in which MNCs invest, the closer the affiliates are located. This evidence is consistent with the existence of a prominent vertical integration strategy among MNCs and intra-group trade of intermediate goods. Thus, the interactions between local suppliers and vertically integrated MNCs should be lower compared to MNCs that do not invest in supplying industries, resulting in weaker spillovers.

Table 1: Investments

Variable	$INV_{n0n1c0c1}$	$INV_{n0n1c0c1}$	$INV_{n0n1c0c1}$	$INV_{n0n1c0c1}$	$INV_{n0n1c0c1}$
$geod_{C0C1}$	-0.004***	-0.004***	-0.004***	-0.003***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
dr_{01}		0.268***		1.198***	
		(0.020)		(0.167)	
dr_{10}		0.268***		1.066***	
		(0.014)		(0.087)	
$prox_{01}$			0.016***		0.071***
			(0.001)		(0.006)
$prox_{10}$			0.017***		0.080***
			(0.001)		(0.005)
$geod_{C0C1} * dr_{01}$				-0.133***	
				(0.022)	
$geod_{C0C1} * dr_{10}$				-0.114***	
				(0.012)	
$geod_{C0C1} * prox_{01}$					-0.008***
					(0.001)
$geod_{C0C1} * prox_{10}$					-0.009***
					(0.001)
δ_{C0}	YES	YES	YES	YES	YES
δ_{C1}	YES	YES	YES	YES	YES
δ_{n0}	YES	YES	YES	YES	YES
δ_{n1}	YES	YES	YES	YES	YES
N.Obs	7,357,350	7,357,350	7,357,350	7,357,350	7,357,350
R2	.013	.017	.017	.018	.017

,,*** Statistically significant at 10, 5, 1%, respectively.

Table 2: # Firms

Variable	$ln(Nf)$	$ln(Nf)$	$ln(Nf)$	$ln(Nf)$	$ln(Nf)$
$geod_{C0C1}$	-0.115***	-0.116***	-0.116***	-0.113***	-0.093***
	(0.008)	(0.008)	(0.008)	(0.009)	(0.008)
dr_{01}		1.443***		2.400**	
		(0.139)		(1.178)	
dr_{10}		1.426***		1.999***	
		(0.094)		(0.720)	
$prox_{01}$			0.179***		0.436***
			(0.015)		(0.122)
$prox_{10}$			0.146***		0.325***
			(0.012)		(0.084)
$geod_{C0C1} * dr_{01}$				-0.142	
				(0.166)	
$geod_{C0C1} * dr_{10}$				-0.084	
				(0.102)	
$geod_{C0C1} * prox_{01}$					-0.038**
					(0.018)
$geod_{C0C1} * prox_{10}$					-0.026**
					(0.012)
δ_{C0}	YES	YES	YES	YES	YES
δ_{C1}	YES	YES	YES	YES	YES
δ_{n0}	YES	YES	YES	YES	YES
δ_{n1}	YES	YES	YES	YES	YES
N.Obs	63,498	63,498	63,498	63,498	63,498
R2	.12	.13	.13	.13	.13

,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors clustered at $\{n0, c0\}$ level.

3.2 Analysis of firms' characteristics

In this section, we present the characteristics of single firms and we analyze how these relate to the strategy of vertical integration of the groups they belong to. In Table 3, we report the summary statistics of firms distinguishing by type of affiliation, namely unaffiliated firms, companies affiliated to domestic business groups and firms controlled by multinational companies. Besides information on activity data, we present the statistics of the degree of groups' vertical integration, the number of industries, countries and firms in which firms and business groups invest.

Since the focus of our analysis is on the strategy of vertical integration of BGs we complete our analysis of MNCs' structures that we have performed in the previous section using two indexes that measure intensity of vertical integration. First, we construct a simple dummy variable *Multi-industry* MI_{gt} that takes value one if the BGs controls firms in more than one industry. Second, for each industry-j where a BG-g operates we compute an index of vertical integration in upstream industries. This index ($upVI_{jgt}$), inspired to the one developed by Acemoglu et al (2009), is BG-industry specific and is defined as follows:

$$upVI_{jgt} = \sum_{k \neq j} dr_{kj} \mathbb{1}(INV_{kgt} = 1) \tag{3}$$

As explained in the previous section, each index dr_{kj} measures the value of industry-k's output that companies in industry-j use as inputs to produce their own goods. The indicator $\mathbb{1}(INV_{kgt} = 1)$ takes value one if the business group-g controls at least one firm in industry-k at time-t.

For each group-g and industry-j, we compute the index as the sum of direct requirements of the output of the upstream industries in which the business group invest. This index measures the dollar value of inputs produced by industries in which the BG invests that is needed by each company to produce one dollar worth of its main product in a given industry-j. Higher values of $upVI_{jgt}$ are assigned to groups that control affiliates in industries ($k \neq j$) that provide higher value of inputs used by companies in industry-j. This index is monotonically increasing in the number of upstream industries the BG invests in *and* in the relevance of these industries as direct suppliers of inputs. Hence, the higher the value of this index the larger the scope for intra-group sourcing. Since we will relate this index to firms' characteristics, we first compute the index for each group-g and industry-j and we then assign the values to the groups' affiliates according to their primary industry's code.

As it appears from the Table 3, companies affiliated to business groups are much larger than unaffiliated ones in every dimension.[7] They are bigger in terms of size (no. employees L_{it} and sales S_{it}) and endowment of capital. Both local and multinational business groups invest in several industries, but on average multinationals control more affiliates and invest

[7]Financial variables are reported in thousands Euro

Table 3: Summary statistics

		Mean	p10	p50	p90	sd
Unaffiliated firms	S_{it}	3629.24	71.00	682.40	6384.21	30511.26
	L_{it}	31.69	2.00	9.00	56.00	150.97
	M_{it}	1947.04	19.00	253.00	3187.00	20003.16
	K_{it}	799.08	6.07	90.13	1389.06	6971.03
	$upVI_{jgt}$	0.00	0.00	0.00	0.01	0.02
	MI_{gt}	0.24	0.00	0.00	1.00	0.43
	$\#\ industries_{it}$	1.49	1.00	1.00	2.00	1.31
	$\#\ industries_{gt}$	1.49	1.00	1.00	2.00	1.31
	# countries	1.00	1.00	1.00	1.00	0.00
	# firms	1.00	1.00	1.00	1.00	0.00
	FDI_{it}	0.00	0.00	0.00	0.00	0.00
Observations				1,799,586		
Domestic Business groups	S_{it}	15930.48	474.64	3577.98	28829.82	134544.29
	L_{it}	106.73	5.00	30.00	204.00	703.07
	M_{it}	8778.05	119.00	1454.00	15335.00	91038.65
	K_{it}	3091.78	25.77	437.30	5778.93	22939.52
	$upVI_{jgt}$	0.01	0.00	0.00	0.03	0.04
	MI_{gt}	0.49	0.00	0.00	1.00	0.50
	$\#\ industries_{it}$	1.39	1.00	1.00	2.00	0.95
	$\#\ industries_{gt}$	2.23	1.00	1.00	4.00	2.50
	# countries	1.00	1.00	1.00	1.00	0.00
	# firms	2.55	1.00	2.00	4.00	4.09
	FDI_{it}	0.00	0.00	0.00	0.00	0.00
Observations				134,121		
Multinationals	S_{it}	109716.75	2477.08	20527.70	171301.83	908671.06
	L_{it}	350.90	15.00	108.00	700.00	1653.98
	M_{it}	62503.16	832.00	9686.00	89818.00	647862.61
	K_{it}	17029.31	123.67	2852.45	30781.21	94556.42
	$upVI_{jgt}$	0.08	0.00	0.03	0.25	0.11
	MI_{gt}	0.90	0.00	1.00	1.00	0.30
	$\#\ industries_{it}$	1.51	1.00	1.00	3.00	1.13
	$\#\ industries_{gt}$	10.08	1.00	6.00	24.00	10.09
	# countries	6.55	2.00	4.00	15.00	5.68
	# firms	28.95	2.00	11.00	76.00	50.53
	FDI_{it}	0.69	0.00	1.00	1.00	0.46
Observations				91,192		

To test whether the differences between firms that we presented in Table 3 are statistically and economically significant, we estimate a set of OLS regressions based on the model of Bernard and Jensen (1999):

$$lnY_{it} = \beta_0 + \beta_1 DOM\ BG_{it} + \beta_2 MNC_{it} + \beta_3 l_{it} + \delta_{ntc} + \epsilon_{it} \tag{4}$$

where Y_{it} is the variable of interest for firm i active in industry-n, country-c in a given year-t. The vector Y_{it} consists of number of employees L_{it}, value of sales S_{it}, intermediate goods M_{it}, capital K_{it} and total wage bill W_{it}. As all the dependent variables are expressed in natural logarithms, the βs measure the premia associated to each status of firms in percentage terms compared to unaffiliated firms in the same country, industry and year.

We present the results of our estimation in Table 4. As expected, firms that are affiliated to BGs are larger than *unaffiliated* companies in every dimension. Furthermore, firms that belong to MNCs have higher premia than local BGs. In the last row of the Table we report the p-values of the F-tests of equality. The null hypothesis is always rejected.

Table 4: Companies' affiliation

Variable	lnL_{it}	lnS_{it}	lnM_{it}	lnK_{it}	lnW_{it}
$DOM\ BG_{it}$	1.179***	0.234***	0.280***	0.163***	0.060***
	(0.008)	(0.004)	(0.006)	(0.007)	(0.002)
MNC_{it}	1.984***	0.510***	0.595***	0.407***	0.168***
	(0.012)	(0.005)	(0.008)	(0.009)	(0.003)
l_{it}	NO	YES	YES	YES	YES
δ_{nyc}	YES	YES	YES	YES	YES
N.obs.	2,024,199	2,024,199	2,024,199	2,024,199	2,011,516
R2	.32	.87	.77	.7	.87
F-Test ($DOM\ BG = MNC$)	0.00	0.00	0.00	0.00	0.00

,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors clustered at firm-level.

In the light of the results presented in section 3.1, MNCs seem to be vertically integrated and to invest in close locations. We now test whether the intensity of vertical integration is higher for MNCs' affiliates than for local BGs and we analyse how it is associated to the firms' characteristics.

To do so, we limit our analysis to companies that are part of business groups. We measure the intensity of upstream vertical integration using the index $upVI_{jgt}$. As explained, this index measure the relevance of other industries in which the BG is investing as suppliers of inputs to industry-j. To measure how this index correlates with the characteristics of the affiliates, we include it in the RHS

of the regression 6.

$$upVI_{jgt} = \beta_1 MNC_{it} + \beta_2 l_{it} + \beta_3 \#industries_{it} + \beta_4 \#industries_{gt} + \delta_{ntc} + \epsilon_{it} \quad (5)$$

$$lnY_{it} = \beta_1 upVI_{jgt} + \beta_2 MNC_{it} + \beta_3 upVI_{jgt} * MNC_{it} + \beta_4 l_{it} + \beta_5 \#industries_{it} + \beta_6 \#industries_{gt} + \delta_{ntc} + \epsilon_{it} \quad (6)$$

Table 5 displays the results of these regressions. In order to make the indexes of upstream vertical integration comparable across firms and industries, we include as controls the firm's size (measured as number of employees l_{it}), the number of industries in which firm-i operates ($\#industries_{it}$), the number of industries in which its group-g invests ($\#industries_{gt}$) and country-industry-year triplet dummies. Including the number of industries in which the company and its group invest corrects for the size and differentiation of investments of the group.

The first column displays the results of the estimation of eq.5. It shows that the intensity of vertical integration is on average higher in MNC than in local business groups' affiliates. The scope for intra-group sourcing seems to be larger for international business groups than for business groups that invest only locally.

As the second and third columns show, the $upVI_{jgt}$ is positively correlated with the size of the affiliates. Even more important, the higher the intensity of interconnections with the upstream sectors in which their BG invests, the larger is the firms' consumption of intermediates. Therefore, the companies' demand of intermediate inputs varies with the vertical integration choices of the BG. Again, the BGs decisions of investing in different sectors appears to be due to strategic choices of vertical integration. In order to have control on the stages of their production, BGs invest in multiple sectors closely related to each other within the supply chain so that their affiliates can purchase their inputs within the group.

The interaction term ($upVI_{jgt} * MNC_{it}$) shows that positive relation between upstream vertical integration and the consumption of intermediates is mitigated for international business groups. The demand of intermediate of multinational business groups grows with the level of vertical integration, but with a weaker intensity than for local business groups. This results suggests that the inputs' demand functions of the two type of business groups differ.

As $upVI_{jgt}$ represents the dollar value of inputs, we believe that one possible explanation for this evidence is the practice of transfer pricing. In order to move profits exploiting tax differentials between countries, MNCs' affiliates charge less for their products when they sell them to related affiliates based abroad. Another tentative explanation might be in price differences due to the higher efficiency of MNCs' affiliates. Higher efficiency allows these companies to charge lower prices to related firms. These latter will then have lower expenses for their inputs.

Since we do not have direct information on transactions and price of inputs we cannot test these intuitions.

Table 5: Business groups: upstream vertical integration

Variable	$upVI_{it}$	$\ln L_{it}$	$\ln S_{it}$	$\ln M_{it}$	$\ln K_{it}$	$\ln W_{it}$
MNC_{it}	0.017***	0.811***	0.253***	0.312***	0.176***	0.140***
	(0.001)	(0.016)	(0.007)	(0.011)	(0.013)	(0.004)
$upVI_{jgt}$		2.230***	0.703***	1.211***	1.209***	0.161***
		(0.199)	(0.107)	(0.144)	(0.168)	(0.055)
MNC_{it}*$upVI_{jgt}$		-1.237***	-0.082	-0.450***	-0.246	-0.041
		(0.218)	(0.112)	(0.154)	(0.177)	(0.059)
l_{it}	YES	NO	YES	YES	YES	YES
$\#industries_{it}$	YES	YES	YES	YES	YES	YES
$\#industries_{gt}$	YES	YES	YES	YES	YES	YES
δ_{ntc}	YES	YES	YES	YES	YES	YES
N.obs.	223,621	223,621	223,621	223,621	223,621	223,621
R2	.58	.38	.89	.8	.77	.84

,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors clustered at firm-level.

3.3 FDI horizontal and vertical penetration indexes

We measure the presence of FDI in each four-digit industry-j at time-t in country-c as the share of sales of foreign affiliates. This Horizontal Penetration (HP_{jct}, henceforth) is constructed as follows:

$$HP_{jct} = \frac{\sum_{i=1,\text{ in } jct}^{N} SALES_{it} * FDI_{it}}{\sum_{i=1 \text{ in } jct}^{N} SALES_{it}} \tag{7}$$

Where FDI_{it} is a dummy indicating whether the firm-i is a foreign affiliate at time-t. When computing this index we consider only the primary industry of activity of each firm. In other words, we assume that every firm realizes the entire value of sales in its primary industry. Clearly, this indicator of foreign presence changes over time and across industries, but is by definition identical for all the domestic firms that have their primary activity in the same industry-j and country-c in a given year-t.

In line with Javorcik (2004), to estimate the effect of foreign affiliates on the productivity of local suppliers, we will relate the estimated total factor productivity (*tfp*) of domestic companies to the presence of FDI in downstream industries. We follow the author's method to compute what we call

the *generic* index of downstream vertical penetration (VP_{jct}). This is defined as:

$$VP_{jct} = \sum_{k=1,\neq j \text{ in } ct}^{N} \alpha_{jk} HP_{kct} \tag{8}$$

For each industry-j in country-c, this index measures the total presence of FDI in downstream industries in a given year-t without distinguishing for the investment decisions of multinational business groups.

We then modify this measure taking into account the choice of vertical integration of foreign business groups. This modification allows us to define and measure for a each industry-j two new *specific* indexes of downstream vertical penetration.

The first (VP^{j}_{jct}) measures the presence of foreign affiliates that belong to a business group-g that *also* controls a firm in industry-j. This index VP^{j}_{jct} is constructed as follows:

$$VP^{j}_{jct} = \sum_{k=1,\neq j \text{ in } ct}^{N} \alpha_{jk} HP^{j}_{kct} \tag{9}$$

where HP^{j}_{kct} is defined as

$$HP^{j}_{kct} = \frac{\sum_{i=1 \text{ in } kct}^{N} SALES_{it} * FDI_{it} * \mathbb{1}(INV_{gjt}=1)}{\sum_{i=1 \text{ in } kct}^{N} SALES_{it}}$$

The indicator INV_{gjt} defines whether the multinational business group-g controls (at least) an affiliate in industry-j at time-t. When we define this variable, we consider *all* the MNC's investments, regardless of their location. This means that the BG might control a firm in industry-j in a different country.

The coefficients α_{jk} are used to weight the HP_{kct} by their relative importance for industry-j. These coefficients are defined as the ratio of flows of industry-j's output supplied to industry-k over total sales of industry-j used as intermediate inputs.

The second index (VP^{-j}_{jct}) represents the total presence in client sectors of foreign multinationals that are *not* investing in industry-j. Formally, the index VP^{-j}_{jct} is constructed as:

$$VP^{-j}_{jct} = \sum_{k=1,\neq j \text{ in } ct}^{N} \alpha_{jk} HP^{-j}_{kct} \tag{10}$$

where HP^{-j}_{kct} is defined as:

$$HP^{-j}_{kct} = \frac{\sum_{i=1 \text{ in } kct}^{N} SALES_{it} * FDI_{it} * \mathbb{1}(INV_{gjt}=0)}{\sum_{i=1 \text{ in } kct}^{N} SALES_{it}}$$

Because the majority of MNCs invests in multiple industries, the populations of FDI of which sales are used to compute HP^{-j}_{kct} and HP^{j}_{kct} overlap across industries. Multinational groups that do

not invest in industry-j ($INV_{gjt} = 0$) are likely integrated in a different industry-x ($INV_{gxt} = 1$). Therefore, the HPs and VPs consist of groups of foreign affiliates that are alike in several dimensions.

As Table 6 shows, on average 17% of the sales within an industry are made by foreign affiliates. The *generic* index of downstream FDI penetration (VP_{jct}) is on average 9%. The two *specific* indexes of vertical penetration that account for vertical integration must be smaller than VP_{jct} since they measure the presence of specific subgroups. The average presence in downstream industries of FDI affiliated to MNCs that control companies also in industry-j (VP^{j}_{jct}) is 3%, while VP^{-j}_{jct} is 6%.

Table 6: FDI Indexes

	Mean	p10	p50	p90	sd
HP_{jct}	0.17	0.01	0.10	0.40	0.17
VP_{jct}	0.09	0.00	0.06	0.21	0.10
VP^{-j}_{jct}	0.06	0.00	0.04	0.13	0.06
VP^{j}_{jct}	0.03	0.00	0.02	0.08	0.06
	Correlations				
	HP_{jct}	VP_{jct}	VP^{-j}_{jct}	VP^{j}_{jct}	
HP_{jct}	1				
VP_{jct}	0.35	1			
VP^{-j}_{jct}	0.28	0.81	1		
VP^{j}_{jct}	0.27	0.78	0.26	1	
Observations	2,024,899				

4 Total Factor Productivity estimation

This section describes our strategy to estimate the production function parameters and firms' productivity. Once we identify the production coefficients, we can retrieve the productivity as a residual. Consider the following log transformation of a generic gross-output production function,

$$q_{it} = f(m_{it}, l_{it}, k_{it}; \beta) + \omega_{it} + \epsilon_{it} \tag{11}$$

The lower cases represent the natural logarithms of the production variables. Thus, q_{it} is the log of gross output, l_{it} log of labour, m_{it} the log of intermediate inputs, k_{it} is the log of capital. The production coefficients (and a constant term) are grouped in the vector (β). The element ω_{it} is the output shock observed by the firm but not by the researcher, finally ϵ_{it} represents the measurement

error and idiosyncratic unexpected productivity shock, unobserved by both the econometrician and the company.

Arguably, the production function of multinational firms and local companies may be very different. Using a sample of local companies and MNCs' affiliates would imply the assumption that the two types of firms share a common production function. This might cause a bias in the estimation of production function coefficients of local companies and, as a consequence, of their productivity. Therefore, we estimate the production functions separately for each country-sector pair excluding the multinational firms from the sample. This allows for possible differences in the productions functions of local companies active in different sectors and countries. For each group we estimate productivities assuming two specification of production function, namely the Cobb-Douglas and the Translog. The first is the standard specification adopted in the literature, while the second offers the advantage of making the production functions more flexible as these are approximated using a polynomial of higher (second) degree. We estimate production functions for all country-sector pairs with at least 100 observations. This allows us to use a substantial sample for each estimation and to be able to achieve reliable estimates of production functions' coefficients and of firms' productivities. Our sample consists of 376 country-sector combinations in 22 countries and 19 sectors.

To control for endogeneity of input usage in estimating the inputs' coefficients of the production function, we closely follow the two-step procedure developed in Ackerberg et al (2015) (hereafter ACF). As De Loecker (2013) discusses, if one expects economic variables to affect the productivity of firms, then it is theoretically consistent to include them in the law of motion of tfp. The law of motion indeed identifies which elements *may* have an impact on productivity. The author shows that the exclusion of relevant variables from the law of motion may lead to a bias in the estimation of production functions and, as a consequence, of the estimated total factor productivity. We follow that intuition of De Loecker and al (2016) that both firms' characteristics and aggregate variables - export behaviour and trade tariffs in their application - can affect firms' competitiveness and should therefore be included in the tfp law of motion.

In order to estimate the vector of production function paramenters (β) we implement the ACF procedure and define moments based on the innovation shock ξ_{it} in the evolution of productivity. We consider an endogenous law of motion of productivity that evolves over time according to a Markov process. We *allow* the evolution of productivity to depend on the characteristics of the business group-g to which firm-i is affiliated - whether it invests in multiple industries (MI_{gt}), the number of its affiliates (Nf_{gt}) and the relative importance of industry-j for the group ($rank_{jgt}$) - and on the

activity of foreign affiliates in industry-j (HP_{jt}) and downstream industries (VP_{jt}).[8]
Formally, we consider a law of motion defined as follows:

$$\begin{aligned}\omega_{it} &= g(\omega_{it-1}, MI_{gt-1}, rank_{jgt-1}, Nf_{gt-1}, HP_{jt-1}, VP_{jt-1}) + \xi_{it} \\ &= \alpha_1\omega_{it-1} + \alpha_2\omega_{it-1}^2 + \alpha_3\omega_{it-1}^3 + \beta_1 MI_{gt-1} + \beta_{12} rank_{jgt-1} + \beta_3 Nf_{gt-1} + \gamma_1 HP_{jt-1} + \gamma_2 VP_{jt-1} + \xi_{it}\end{aligned} \tag{12}$$

The characteristics of firm-i's business group and the measured presences of FDI are included in the law of motion to account for the fact that these elements *may* affect productivity. Indeed, the affiliation of firms to a (vertically integrated) business group is likely associated with specific business strategies and transfer of technologies that may affect and improve the productivity of the single affiliates.
The presence of foreign-owned companies in the economy is expected to affect the competitiveness of local firms through multiple channels. Previous research on productivity spillovers has shown that the activity of FDI in the same or in downstream industries can induce changes in the productivity of local firms (e.g. Javorcik 2004, Carluccio and Fally 2013). For instance, local firms can imitate foreign competitors and adopt efficient management practices or acquire advanced know-how by hiring managers with a working experience in foreign affiliates. Moreover, the interaction of local companies with foreign-owned clients may allow them to learn new and more efficient technologies or it might induce them to directly invest in R&D to meet the clients' quality and timing requirements and improve their own competitiveness.
We emphasize again that in this specification these variables are *allowed* to impact productivity, but this does not mean that they will necessarily nor mechanically have an effect.[9]
In the first step of the ACF procedure, we estimate $\hat{\phi}_{it}$ and $\hat{\epsilon}_{it}$ in

$$q_{it} = \phi_{it} + \epsilon_{it} \tag{13}$$

where $\phi_{it} = f_{it}(m_{it}, l_{it}, k_{it}) + h(m_{it}, l_{it}, k_{it}, z_{it}, \delta_t)$, with h(.) representing the inverse material demand function that we use to proxy the unobserved productivity term. The estimate of the polynomial expansion ϕ_{it} measures the output net of the unexpected output shock and measurement error ϵ_{it} in eq.(13). We collect in z_{it} all the elements - other than expenditures in input variables - that affect firm-i residual demand and consequently its optimal consumption of intermediates.

[8]Clearly, for *unaffiliated* firms the variables Nf_{gt} and $rank_{jgt}$ are constant and equal to one, whereas the groups-specific variable MI_{gt} becomes firm-specific (MI_{gt}=MI_{it}), measuring how many industries the single firm is active in.

[9] As a robustness check we exclude all additional elements z_{it} from the law of motion. The results remain consistent (see Appendix E).

These are $\{upVI_{jgt}, rank_{jgt}, BG_{gt}, HP_{jt}, VP_{jt}\}$. In section 3.2 we have shown that the firms' consumption of intermediates varies with the level of upstream vertical integration ($upVI_{jgt}$) in their industry of the business group their are affiliated to and with the relative importance of their line of business for the group ($rank_{jgt}$). Due to reasons of technological complementarity and specific inputs needs, companies affiliated to a (vertically integrated) business group (BG_{gt}) are more likely to coordinate with related firms and comply with the strategy of the business group. Finally, through competitive pressure and technological spillovers, the activity of foreign affiliates may modify the residual demand of local firms affecting their productivity and demand of materials. For example, foreign competitors may steal market shares from local companies. At the same time, foreign-owned companies compete also on the inputs markets with domestic companies. These latter would not be able to exploit economies of scale and would modify their demand of inputs. In order to meet the quality requirements of foreign clients, local firms may be have to change their sourcing strategy, purchasing inputs of higher quality or importing inputs endowed with foreign technologies.

To recover the innovation shock $\xi_{it}(\beta)$ for any value of β, we define productivity $\omega_{it}(\beta)$ as $\hat{\phi}_{it} - f_{it}(X_{it}, \beta)$ and we non-parametrically regress it on the third order polynomial of its lag and the first lags of the other elements included in the productivity law of motion defined in eq. (12).
In the second step, the production function coefficients are estimated through GMM, using as valid instruments the inputs orthogonal to the unexpected productivity shock. The moments that identify the production parameters are:

$$E[\xi_{it}(\beta)I_{it}] = 0 \tag{14}$$

where $I'_{it} \equiv (1, l_{it-1}, m_{it-1}, k_{it}, l^2_{it-1}, m^2_{it-1}, k^2_{it}, l_{it-1}m_{it-1}, l_{it-1}, k_{it}, m_{t-1}k_{it}, l_{it-1}m_{it-1}k_{it})$ is the vector of instruments under the assumption of Translog production function. In the Cobb-Douglas specification this system becomes computationally much simpler as the vector of parameters β is reduced to $\beta = (\beta_0, \beta_l, \beta_m, \beta_k)$ and $I'_{it} = (1, l_{it-1}, m_{it-1}, k_{it})$. These instruments are all orthogonal to the unexpected innovation component of the productivity as they all are decided before the productivity shock is realized. We can now estimate the revenue-based total factor productivity as $\varphi_{it} = \hat{\phi}_{it} - f(X_{it}, \hat{\beta})$. We provide in Appendix D summary statistics of the production function coefficients.

Since we do not observe quantities and prices of the output and inputs used by the firm, we have to rely on deflated sales and input costs to proxy the physical output and inputs.[10] We are able to estimate revenue-based productivity (TFPR) that we use as a proxy of firms physical productivity (TFPQ). In the rest of the paper we will refer to the estimated TFPR as productivity. As formally discussed by

[10] Klette and Griliches (1996) argue that the use of industry-wide indexes might create a bias in our production function estimations.

De Loecker and Goldberg (2014), revenue-based productivity measures physical productivity and a combination of output and inputs' price deviations from industry price indexes. As these differences vary with firms' market power, the effects of FDI activity on local firms that we measure in the next section may partly capture the impact of foreign companies on local firms' markups rather than on their physical efficiency. The impact of FDI on local firm's markups does not have to be the same as the impact on their physical efficiency. Hence, the sign of the bias in our estimations is, at least, not clear. The reader should interpret our results heeding these considerations.

5 Results

In this section we present our strategy to test whether the choices of vertical integration of business groups affect the backward productivity spillovers perceived by local suppliers and the results of our estimations.

As a first step, we estimate the existence and intensity of backward spillovers without making any distinction between vertically integrated and non-vertically integrated MNCs. This exercise is primarily aimed at testing whether, overall, local companies benefit from the activity of FDI in client sectors. We estimate the following fixed effect model under the assumption of Cobb-Douglas and Translog production function separately:

$$tfp_{ijct} = \alpha_i + \alpha_1 VP_{jct-1} + \alpha_2 HP_{jct-1} + \alpha_X X_{it} + \delta_t + \delta_{ct} + \delta_{st} + \epsilon_{it} \tag{15}$$

We use as dependent variable the total factor productivity of local firm-i that has its main activity in industry-j in country-c at time-t. In line with our specification of the productivity's law of motion defined in eq.12, the activity of foreign competitors and clients is allowed to affect the efficiency of local companies after a one-year period. Indeed, we assumed that the diffusion of know-how is not immediate and that local companies need time to react to the interactions with foreign firms. Besides the index HP_{jct-1} that measures the presence of foreign competitors, we control for a set of other variables (X_{it}) that may influence the productivity of the company. These are the log of firm's capital intensity, the Herfindhal index HHI_{jct} and time, sector and country dummies δ. These controls limit concerns about a potential bias in the estimated effects of FDI activity, due to the endogeneity of foreign investments. The set of time δ_t, sector-time δ_{st} and country-time δ_{ct} dummies controls for differences and trends in profitability across sectors and countries over time. Finally, we cluster the error terms at year-industry-country level, as this is the dimension at which VP_{jct} and HP_{jct} vary (Moulton 1990).

The results of the regressions are reported in column (1) and (5) of Table 7. The coefficient α_1 measures

the net impact of the activity of FDI in client industries on the productivity of local companies. This coefficient is positive and highly significant indicating that domestic firms productivity increases with the presence of foreign affiliates in client industries.

As presented in section 3.3 we construct two indexes of FDI presence in client industries VP^{j}_{jct} and VP^{-j}_{jct} that account for the strategy of vertical integration of MNCs. Now, we use these *specific* indexes as main regressors in the following fixed effect model and estimate their impact on the productivity of domestic firms.

$$tfp_{ijct} = \alpha_i + \beta_1 VP^{j}_{jct-1} + \beta_2 VP^{-j}_{jct-1} + \beta_3 HP_{jct-1} + \alpha_X X_{it} + \delta_t + \delta_{ct} + \delta_{st} + \upsilon_{it} \tag{16}$$

The coefficient β_1 measures the effect of the presence in client sectors of FDI that belong to BGs that control firms in industry-j, while β_2 measures the backward productivity spillovers that come from the activity of affiliates of MNCs which are not investing in industry-j where local firm-i operates. In order to formally test whether the intensities of spillovers are different for the two groups, we perform a F-test of equality of the two estimated coefficients. Table 7 displays in columns (2)-(4) and (6)-(8) our results. We first include the two indexes separately (second and third columns in each specification) and then together (fourth columns). In these latter we can perform the test of equality. We report the p-values of the F-tests in the last row of the Table.

The results we obtain provide a strong evidence which is consistent with our theory. We find that only the coefficient of VP^{-j}_{jct-1} is positive and significant, whereas the coefficient VP^{j}_{jct-1} is always insignificant. The difference is statistically and economically significant. Under the assumption of either production function's specification the F-test reject the hypothesis of equality of coefficients. This evidence shows that the strategy of vertical integration of MNEs does in fact matter for the intensity and nature of productivity spillovers perceived by domestic companies. Local firms benefit from positive spillovers *only* from affiliates of MNCs that *do not* invest in their industry.

The positive sign of the coefficient of HP_{jct-1} (only significant in the case of Cobb-Douglas) suggests a positive net impact of FDI competition on the competitiveness of local companies. The competition of foreign-owned companies makes local firms improve their own productivity. Domestic companies may be pushed by stiffer competitive pressure to reduce their X-inefficiencies or might be learning from foreign competitors. The positive sign of capital intensity suggests that the more companies invest in capital, the more efficient they become. Finally, the coefficient of the Herfindhal index is never significant, there is not a strong relation between the intensity of competition and the evolution of firms' efficiency.

Table 7: Productivity spillovers

F(X,β)	Cobb-Douglas				Translog			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VP_{jct}	0.072***				0.056***			
	(0.020)				(0.019)			
VP^{j}_{jct}		-0.018		0.014		-0.029		-0.001
		(0.021)		(0.023)		(0.021)		(0.023)
VP^{-j}_{jct}			0.130***	0.134***			0.118***	0.118***
			(0.026)	(0.026)			(0.022)	(0.023)
HP_{jct}	0.012**	0.013**	0.012**	0.012**	0.006	0.006	0.006	0.006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$ln(K/L)_{it}$	0.014***	0.014***	0.014***	0.014***	0.001***	0.001***	0.001***	0.001***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
HHI_{jct}	0.014	0.014	0.013	0.013	0.000	-0.001	-0.001	-0.001
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
δ_t	YES	YES	YES	YES	YES	YES	YES	YES
δ_{ct}	YES	YES	YES	YES	YES	YES	YES	YES
δ_{st}	YES	YES	YES	YES	YES	YES	YES	YES
N.obs.	1,291,934	1,291,934	1,291,934	1,291,934	1,291,934	1,291,934	1,291,934	1,291,934
R2	.34	.34	.34	.34	.66	.66	.66	.66
$VP^{j}_{jct} = VP^{-j}_{jct}$				.00014				.000022

,,*** Statistically significant at 10, 5, 1%, respectively.

S.e. clustered by industry-year-country.

6 Conclusions

Previous literature has shown that backward productivity spillovers from FDI to domestic firms arise if the domestic companies serve intermediates to the foreign clients. In this study we relate the intensity of backward spillovers to the organization of multinational production in which foreign affiliates are involved. We argue that backward spillovers from FDI are not automatic and crucially depend on the make-or-buy decisions of foreign multinationals. Foreign affiliates of vertically integrated MNCs will primarily purchase their inputs from related companies within the boundaries of their business group. Therefore, the likelihood and intensity of interactions with local suppliers are lower for companies that are vertically integrated in their industry. This results in a reduced potential for productivity spillovers. Relevant productivity spillovers should instead arise from the activity of foreign companies that do not control affiliates in the industry of local suppliers.

We empirically test our theory using a firm-level panel dataset of nearly one million European manufacturing companies. The results provide evidence that productivity spillovers to local companies come *only* from the activity of foreign clients whose multinational business groups do not invest in the industry of the local firms, whereas the presence of foreign clients that control affiliates in their industries does not seem to affect the competitiveness of domestic suppliers.

Our results have important policy implications. Governments and policy makers in advanced and developing economies have been heavily investing to attract foreign multinationals in their countries. These policies were led by the belief that MNCs would introduce advanced know-how that local companies, and especially domestic suppliers, may acquire and use to improve their own competitiveness (i.e. the presence of FDI would be associated to productivity spillovers). However, our analysis shows that backward spillovers are not automatic and arise with stronger intensity when foreign affiliates are not vertically integrated in the industries of local suppliers.
If productivity spillover to local firms are the main objective of these investments, then policy makers should design incentive schemes to attract mainly companies that do not pursue strategies of vertical integration. These firms will more likely start collaborations with local suppliers that can benefit from these interactions acquiring new technologies and know-how.

As every empirical study, our analysis has limitations. Certainly, the most relevant is the lack on observation of transaction data. Ideally, if we had information on commercial deals and partnerships, we could identify the interactions between local and foreign companies. This would expand the range of research questions one might answer and allow a finer analysis of the impact of heterogeneous MNCs on the competitiveness of local companies. We consider these as promising lines of research.

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Appendices

A The Dataset

The main source of information on firms' unconsolidated accounting data and ownership information is the commercial database *Amadeus* compiled by *Bureau van Dijk*, a consulting company. For each company we retrieved yearly information on financial variables, the NACE REV.1 and REV.2 and NAICS 2002 and 2007 codes of the primary and secondary industries each firm operates in and ownership information. This latter consists of an index of independence of the company, the ultimate owner's BvD identifier, its name and country. Each Amadeus release reports only latest available information on ownership and industry of operations. Therefore we created the panel dataset of financial data for the entire sample period using the 2010 release and used several issues of the database (2003-2010) to keep track of changes of firms' ownership and industry of activity. The use of early vintages of the database also allowed us to include in our sample companies that are not in the 2010 version of the database and recreate the time-series of their financial data. In a few cases the BvD identifiers (BvD-ID) assigned to single companies change over time. Before merging the data from different issues, we used conversion tables we received from BvD to replace old BvD-IDs with the new ones. When information on ownership and industrial codes was missing we assumed it did not change from the most recent previous year we have information for. In a minority of cases, we had information from different releases for the same year. In these cases, we used the most complete information available and gave priority to the oldest releases when the information was conflicting (few cases). For both variables, we observe limited variation over time. Hence, the structures of (multinational) business groups remain fairly stable.

After a careful analysis, we decided to use the 2007 NAICS industry codes as the 2007 Tables compiled by the Bureau of Economic Analysis (BEA) are more detailed that the 2002 versions. We converted firms' industry NAICS 2002 codes that we retrieved from early releases of the database (2001-2006) to the corresponding NAICS 2007 ones using official BEA conversion tables. The vast majority of codes did not change, while we observe a unique conversion for almost all codes that were modified. The BEA IO Tables report information the 6-digit level. We aggregate the figures to the 4-digit level as this is the level of aggregation we adopt to identify relevant industries. This is indeed the level that has been used in the literature to study industries' interconnections and MNEs' vertical integration (e.g. Alfaro and Charlton 2009). [11]

[11] Since inter-industry relationships may be different across countries and may change over time, it would be ideal to

We dropped single observations if we had no information on the identity of the ultimate or direct owners, but we knew that 50% or more of the shares of the firm were controlled by some different entity. When we had no information on ultimate owner of the company in a given year (or the previous ones) and we knew it was independent (or the independence index was missing) we assumed that the companies were local and unaffiliated. This left us with a dataset of 6,921,984 firm-year observations with (imputed) ownership information. This original sample corresponds to 959,886 firms in 78 industries. Unaffiliated companies represent the vast majority of cases: these are 863,378. We indentify 109,086 BGs of which 16,813 are MNCs that control 37,798 foreign affiliates. Our observations are limited to investments in Europe. Therefore, extra-European investments (including extra-European Head Quarters) of MNCs fall out of our sample. Moreover, most of the HQs report only consolidated data and are excluded from our analysis to avoid double counting. While we use this dataset to reconstruct the structure of (multinational) business groups, most of the observations miss information on one or more of the production variables.

After interpolating production variables (see next section), we can work with a sub-sample of 3,694,096 that report information on sales - that we use to compute HPs - and a sub-sample 2,024,899 firm-year observations with full information on all the relevant variables we need in order to perform our analysis, in particular the production functions' estimations and final regressions.

Bureau van Dijk gathers firm-level information from different local data providers (private organization or official national bodies) and makes the information standard and comparable across countries. The data providers in different countries apply different rules on the type of information that firms have to communicate. In some countries firms are not required to report information on all production variables. In particular, reporting cost of material inputs is not always mandatory. Therefore the groups of companies in these countries completely or partly (complete information is still available for some firms) fall out of our sample as we cannot estimate production functions and tfp spillovers. However, we still have information on their ownership and location. Therefore, we can make use of this information when we reconstruct the MNCs' group structure and identify the industries in which they invest. Table 8 provides a list of the countries and of local information providers included in our analysis of MNCs structure and for the estimation of production functions and the measurement of spillovers.

use country-year specific tables. Unfortunately, IO tables at this level of disaggregation are available only for the USA. The reader should bear in mind this caveat in interpreting our results.

Table 8: Country coverage

Country	MNC structure	TFP & Spillovers	Info Provider
Austria	✓	✓	Creditreform Austria
Belgium	✓	✓	National Bank of Belgium
Bosnia and Herzegovina	✓	✓	Creditreform Belgrade
Bulgaria	✓	✓	Creditreform Bulgaria
Croatia	✓	✓	Creditreform Croatia
Czech Republic	✓	✓	Credit Czech Republic, s.r.o.
Denmark	✓		Købmandstandens Oplysningsbureau
Estonia	✓	✓	Krediinfo
Finland	✓	✓	Suomen Asiakastieto
France	✓	✓	Coface SCRL
Germany	✓	✓	Verband der Vereine Creditreform
Greece	✓		ICAP
Hungary	✓	✓	Creditreform-Interinfo
Iceland	✓		CreditInform Group
Ireland	✓		Jordans
Italy	✓	✓	Honyvem
Latvia	✓		Creditreform Latvia
Lithuania	✓		Creditreform Lietuva UAB
Luxembourg	✓		BvD
Macedonia	✓		Creditreform
Moldova	✓		SeeNews
Netherlands	✓		LexisNexis
Norway	✓	✓	CreditInform Group
Poland	✓	✓	InfoCredit
Portugal	✓	✓	Coface MOPE
Romania	✓	✓	Chamber of Commerce and Industry of Romania
Russia	✓		Creditreform St.Petersburg
Serbia	✓	✓	Creditreform Belgrade
Slovakia	✓	✓	CreditInform Slovakia, s.r.o.
Slovenia	✓	✓	Coface Slovenia
Spain	✓	✓	Informa
Sweden	✓	✓	UC
Switzerland	✓		Worldbox
Ukraine	✓	✓	Creditreform Bulgaria
United Kingdom	✓		Jordans

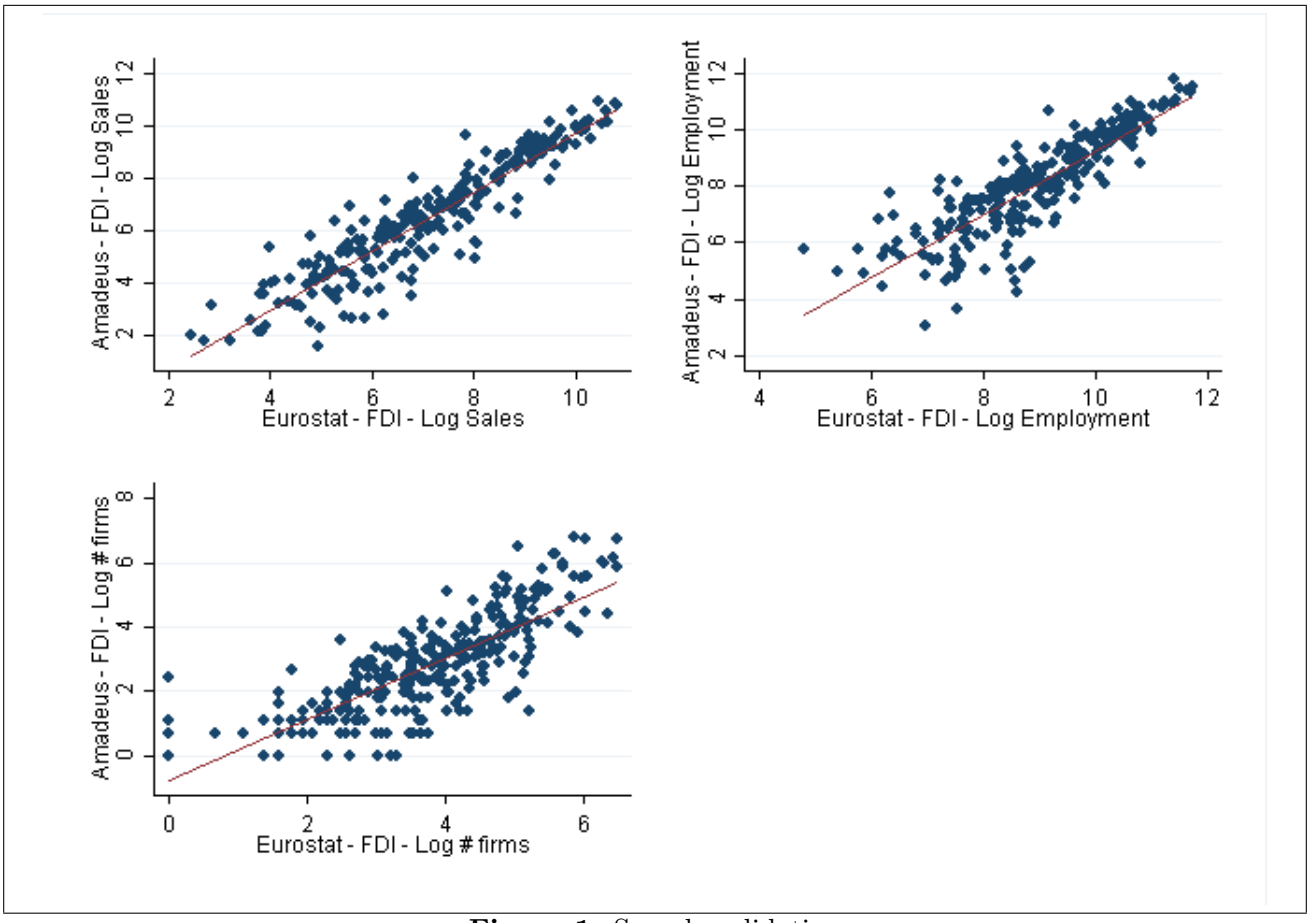


Figure 1: Sample validation

A.1 Sample validation

To give a sense of the coverage of the Amadeus dataset, we compare relevant statistics we compute using our firm-level sample with Eurostat's official *Structural Business Statistics* on *inward FATS*. These latter are available at country-sectoral level. Therefore, we aggregate our observations at the same level in order to calculate the total value of sales of FDI, their total number of employees and their number. In Figure 1 we plot the values we obtain from our sample against the official Eurostat statistics in 2006. The country-specific correlations are sticking, suggesting that the distribution of FDI across countries and sectors in our dataset well matches the one in Eurostat.[12]

[12]In order to validate our sample, we use the NACE REV.1 classification of sector as this is the classification adopted by the European Commission and Eurostat. In this subsection, we refer to NACE REV.1 2-digit codes as sectors.

B Data management

B.1 Interpolation of production variables

As we mentioned in the previous section an extensive data management had to be done. One of the issues we faced was that in many cases we missed information on one or more of the production variables (S_{it}, K_{it}, L_{it}, M_{it}). In particular material inputs were often missing. In order to address this issue and keep in our sample as many observations as possible we interpolate production variables. To do so, we modify the raw data and fill in observations. We replace missing and non-positive values of each variable with the value predicted with a linear trend. In practice, we use the *STATA* commands *tsfill* and *ipolate*. This latter generates a linear interpolation of missing variables over time.[13] We report in Table 9 here below the information on the number of interpolated variables for the sample of local companies that we use to estimate production functions and tfp spillovers. Over 90% of observations have no interpolated variable. Hence, the interpolation procedure is unlikely to affect the results of our estimations.

Table 9: Interpolated variables

# interpolated variables	Freq.	Percentage	Cumulated
0	1,847,042	91.20	91.20
1	134,689	6.65	97.87
2	4,855	0.24	98.11
3	3,857	0.19	98.30
4	34,456	1.70	100
N. firm-year Obs.		2,024,899	

B.2 Data Trimming

In order to identify and eliminate outliers we trim the data in several dimensions. First, we eliminate outliers *before* the estimation of production functions using ratios of production function variables and their growth rates. Second, we drop extreme values of estimated productivities and of productivity growth over time. In both steps we first identify all outliers and then drop them. Because we limit the estimation production functions and productivities to local companies, in the second step of the data trimming we only use the sample of domestic companies for which we can estimate productivity. As the ACF procedure requires complete information on production variables for at least two consecutive

[13] Notice that we neither generate a balanced dataset nor extrapolate new values of relevant variables. Therefore, the panel dataset remains unbalanced, but we limit the number of gaps in the panel.

years, we keep in the sample only firm-year observations that have non-missing information on all variables at time-*t* and time-*t-1*.

In both steps we define the relevant distributions of the variables within their year-country-sector triplets.

- *Before* production functions' estimation
  - We identify as outliers the top and bottom 1% of the following variables: capital per employee (capital intensity), sales per employee (labour productivity), material inputs over total sales (materials' revenue share)
  - We identify as outliers observations with extreme growth rates (the top and bottom 1%) of the following variables in two consecutive years: sales, number of employees, material inputs, capital.
  - We drop outliers
- *After* production functions' estimation
  - We identify as outliers top and bottom 1% of productivities under each specification of the production function
  - We identify as outliers observations with extreme growth rates (the top and bottom 1%) of tfp in two consecutive years under either assumption of production function
  - We eliminate all observations in sector-country bins for which we estimate one (or more) negative coefficient of the Cobb-Douglas production
  - We drop outliers

C Additional analysis of firms' characteristics

In this section we present an additional analysis of firms' characteristics.

In Table 10 we report the estimation of eq.17. In this equation we estimate the premia of specific types (Head quarters, local affiliates, FDI) of companies compared to unaffiliated firms. This estimation mirrors eq.4. The results of the estimations are consistent with those reported in Table 4. Moreover, we test whether the premia of MNCs' foreign affiliates are larger than the ones of local affiliates. The report in the last row the p-values of corresponding F-tests of equality.

$$lnY_{it} = \beta_0 + \beta_1 DOM\ HQ_{it} + \beta_2 DOM\ LA_{it} + \beta_3 MNE\ HQ_{it} + \beta_4 MNE\ LA_{it} + \beta_5 FDI_{it} + \beta_6 l_{it} + \delta_{ntc} + \epsilon_{it} \tag{17}$$

All affiliated companies are bigger, more capital intense and more productive than single firms. Moreover, the F-tests always reject the null hypothesis of equality of premia of FDI and local affiliates of MNCs. Foreign affiliates are larger and more productive than local affiliates of multinational business groups. This results suggests that higher costs of investment abroad imply stronger selection among foreign affiliates. In order to cope with higher costs, affiliates of foreign MNCs have to be more productive and larger than local affiliates.

Table 10: Estimation results : Companies status

Variable	lnL_{it}	lnS_{it}	lnM_{it}	lnK_{it}	lnW_{it}
$DOM\ HQ_{it}$	1.623***	0.386***	0.434***	0.410***	0.106***
	(0.022)	(0.011)	(0.015)	(0.018)	(0.006)
$DOM\ LA_{it}$	1.118***	0.213***	0.259***	0.130***	0.053***
	(0.008)	(0.004)	(0.006)	(0.007)	(0.002)
$MNC\ HQ_{it}$	2.239***	0.347***	0.406***	0.359***	0.061***
	(0.058)	(0.023)	(0.033)	(0.039)	(0.011)
$MNC\ LA_{it}$	2.062***	0.434***	0.507***	0.382***	0.070***
	(0.022)	(0.009)	(0.014)	(0.015)	(0.005)
FDI_{it}	1.942***	0.549***	0.639***	0.421***	0.213***
	(0.014)	(0.006)	(0.009)	(0.011)	(0.004)
l_{it}	NO	YES	YES	YES	YES
δ_{nyc}	YES	YES	YES	YES	YES
N.Obs	2,024,199	2,024,199	2,024,199	2,024,199	2,011,516
R2	.32	.87	.77	.7	.87
MNE LA = FDI	0.00	0.00	0.00	0.02	0.00

,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors clustered at firm-level.

We also exploit the within-group heterogeneity of affiliates and test how the characteristics of single companies relate to the relative importance of their industry within multi-industry groups. Specifically, we test how the different characteristics of single affiliates vary with the distance of their primary industry-j from the *core* of their group-g in the country. As main regressor in the OLS regressions we use the dummy $CORE_{ijgt}$ which is equal 1 if the company-i mainly operates in the core industry-j of the business group-g at time-t and 0 otherwise. Furthermore we use a measure of distance from the core business, the (log of the) rank of industry-j in terms of relative importance for the group-g in

country-c. We estimate the following OLS model: [14]

$$ln(Y)_{it} = \beta_0 + \beta_1 CORE_{jgt} + \beta_2 l_{it} + \delta_{gct} + \delta_{ntc} + \epsilon_{it} \tag{18}$$

Table 11 displays the results of the estimations. The affiliates operating in the *core business* are larger, consume more intermediate inputs, are more capital intense and are also much more productive than others. The differences in labour productivity are indeed statistically and economically significant: firms in the second and third most relevant industries are on average respectively 21% (=-.320*ln(2)) and 35% (=-.320*ln(3)) less productive than the affiliates in the core industry.

Table 11: Within Group Characteristics

Variable	$\ln L_{it}$	$\ln S_{it}$	$\ln M_{it}$	$\ln K_{it}$	$\ln W_{it}$	$\ln(S/L)_{it}$	$\ln(S/L)_{it}$
$CORE_{ijgt}$	0.970***	1.234***	1.360***	1.201***	0.065***	0.264***	
	(0.019)	(0.021)	(0.023)	(0.026)	(0.006)	(0.009)	
$lnRank_{ijgt}$							-0.320***
							(0.012)
l_{it}	NO	YES	YES	YES	YES	YES	YES
δ_{gt}	YES	YES	YES	YES	YES	YES	YES
δ_{ntc}	YES	YES	YES	YES	YES	YES	YES
N.obs.	81,394	81,394	81,394	81,394	80,943	81,394	81,394
R2	.7	.75	.73	.7	.92	.84	.84

,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors clustered at firm-level.

We complete the analysis of vertical integration of business groups using the index of upstream vertical integration using the index designed by Acemoglu et al (2009). The authors assume that the BGs' head quarters produce the final good of the company. However, this assumption seems too strong given the data we have. Therefore, we make the weaker assumption that the CORE business in each country where the (multinational) BGs invests in represent the most relevant source of profit in the country for the group. As a consequence, the BGs' strategy of vertical integration should develop primarily around these businesses.

Therefore, we calculate the index of upstream vertical integration of each CORE business in our

[14] The index $Rank_{ijgt}$ is based on the value of total sales, $Rank_{ijgt}$ =1 for core business, = 2 for the second most important industry, = 3 for the third and so on. For the sake of results' presentation, we report only the effect of $lnRank_{ijgt}$ on firm's labour productivity. All other results are consistent with those displayed in Table 11

sample. This index is defined as follows:

$$upVI_{jcgt,core} = \frac{1}{\#industries_{gt}} \sum_{k \neq j} dr_{kj} \mathbb{1}(INV_{kgt} = 1) \tag{19}$$

For each CORE business we sum the direct requirements coefficients of all industries in which the BG invests, we then divide it by the number of these industries. We now replicate the analysis we performed in section 3.2 using this new index as main variable.

$$upVI_{jcgt,core} = \beta_1 MNC_{it} + \beta_2 l_{it} + \delta_{ntc} + \epsilon_{it} \tag{20}$$

$$lnY_{it} = \beta_1 upVI_{jcgt,core} + \beta_2 MNC_{it} + \beta_3 upVI_{jcgt,core} * MNC_{it} + \beta_4 l_{it} + \delta_{ntc} + \epsilon_{it} \tag{21}$$

We present the results of these estimations in Table 12. We find consistent evidence with the results in Table 5. MNCs produce a larger value of inputs required by companies in their core business than local BGs. Higher vertical integration is associated with larger size of the companies and larger consumption of intermediates. These relations are again weaker for MNCs.

Table 12: CORE Business: BG affiliation and vertical integration

Variable	$upVI_{jcgt,core}$	$\ln L_{it}$	$\ln S_{it}$	$\ln M_{it}$	$\ln K_{it}$	$\ln W_{it}$
MNE_{it}	0.004***	0.928***	0.296***	0.356***	0.184***	0.153***
	(0.000)	(0.017)	(0.008)	(0.012)	(0.014)	(0.004)
$upVI_{jcgt,core}$		10.553***	2.879***	4.270***	3.324***	0.459***
		(0.692)	(0.355)	(0.473)	(0.547)	(0.177)
$upVI_{jcgt,core} * MNC_{it}$		-6.210***	-1.031**	-1.882***	1.225*	-0.180
		(0.933)	(0.435)	(0.607)	(0.701)	(0.215)
l_{it}	YES	NO	YES	YES	YES	YES
δ_{nyc}	YES	YES	YES	YES	YES	YES
N.obs.	181,868	181,868	181,868	181,868	181,868	181,249
R2	.27	.41	.89	.81	.78	.84

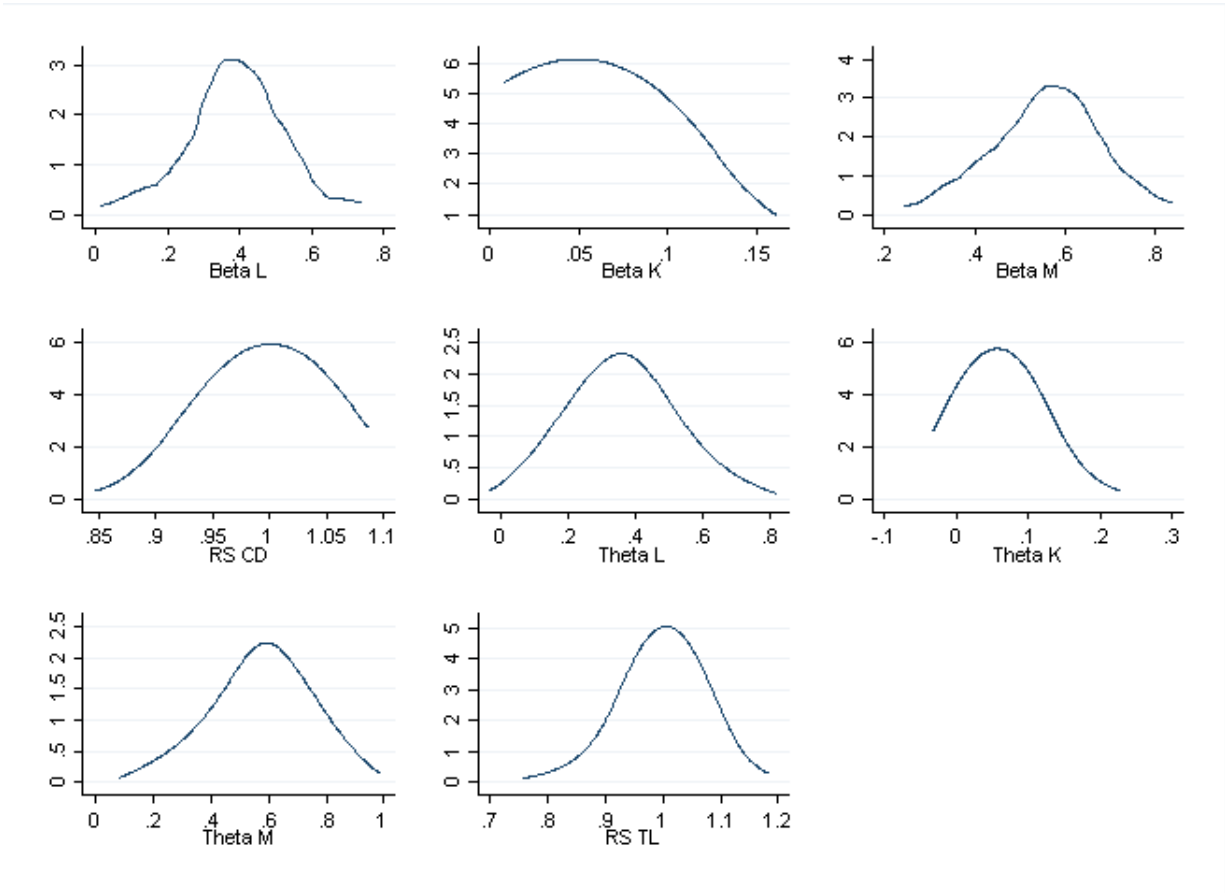
,,*** Statistically significant at 10, 5, 1%, respectively.

Robust standard errors clustered at firm-level.

D Production function coefficients

Table 13: Production function coefficients

F(X,β)	Coeff.	Mean	p10	p25	p50	p75	p90	sd
Cobb-Douglas	β_L	0.39	0.20	0.32	0.38	0.49	0.54	0.14
	β_K	0.05	0.02	0.03	0.04	0.06	0.11	0.04
	β_M	0.56	0.38	0.48	0.56	0.62	0.71	0.14
	RS	1.00	0.95	0.97	1.00	1.02	1.05	0.08
Translog	θ_L	0.36	0.14	0.24	0.36	0.47	0.59	0.18
	θ_K	0.06	0.01	0.03	0.05	0.08	0.12	0.05
	θ_M	0.58	0.33	0.46	0.58	0.70	0.81	0.19
	RS	1.00	0.91	0.97	1.00	1.04	1.08	0.08
Observations				1,291,934				



Note: Extreme values in the bottom and top 1% are excluded from the graphs

Figure 2: Distribution of production function coefficients

E Robustness

As a robustness check, we implement the estimation of production functions and productivities of local companies imposing an exogenous law of motion. Therefore, it is defined as follows:

$$\omega_{it} = g(\omega_{it-1}) + \xi_{it} = \alpha_1\omega_{it-1} + \alpha_2\omega_{it-1}^2 + \alpha_3\omega_{it-1}^3 + \xi_{it} \tag{22}$$

These results, that we show in in Table 14, provide an evidence consistent with the one presented in the section 5, leaving the estimation qualitatively unchanged.

Table 14: Productivity spillovers, with exogenous tfp law of motion

F(X,β)	Cobb-Douglas				Translog			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VP_{jct}	0.078***				0.051**			
	(0.019)				(0.021)			
VP^j_{jct}		0.019		0.046**		-0.050**		-0.020
		(0.021)		(0.023)		(0.023)		(0.025)
VP^j_{jct}			0.102***	0.113***			0.132***	0.127***
			(0.025)	(0.025)			(0.028)	(0.029)
HP_{jct}	0.009	0.009	0.009	0.009	0.006	0.007	0.006	0.006
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
$ln(K/L)_{it}$	0.014***	0.014***	0.014***	0.014***	0.005***	0.005***	0.005***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
HHI_{jct}	-0.012	-0.012	-0.013	-0.012	-0.027***	-0.028***	-0.028***	-0.029***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
δ_t	YES	YES	YES	YES	YES	YES	YES	YES
δ_{ct}	YES	YES	YES	YES	YES	YES	YES	YES
δ_{st}	YES	YES	YES	YES	YES	YES	YES	YES
N.obs.	1,230,329	1,230,329	1,230,329	1,230,329	1,230,329	1,230,329	1,230,329	1,230,329
R2	.31	.31	.31	.31	.61	.61	.61	.61
VP^j_{jct}=VP^{-j}_{jct}				.022				.000027

,,*** Statistically significant at 10, 5, 1%, respectively.

S.e. clustered by industry-year-country.

Chapter 3:

Chinese competition and quality differentiation

Chinese competition and quality differentiation

Federico Clementi*

Abstract

In this paper I investigate the impact of Chinese competition on the pricing strategy of exporters located in a developed economy. I explore the role of quality in determining the nature and the intensity of this effect. Using a detailed dataset of international transactions of Danish companies, I estimate the quality of export varieties and I use it to identify whether quality heterogeneity modifies the impact of Chinese competition on foreign markets. Using raw prices, I find that low-end varieties decrease their prices less than varieties of high-quality. This result reflects the reaction of producers in terms of quality improvements. I show that, due to stiffer competitive pressure, low-quality producers improve the quality of their varieties more intensely than producers of products of high quality to react . Finally, I use quality-adjusted prices in order to account for quality changes. Using this measure, I find that varieties endowed with higher-quality suffer less from Chinese competition than the low-end ones.

*fc.eco@cbs.dk; Department of Economics, Copenhagen Business School

1 Introduction

The extraordinary double-digit growth of Chinese export over the last two decades has represented a new source of competitive pressure for firms in developed economies. Chinese manufacturing export to the US increased from 9 million USD in 1972 to 176 billion USD in 2005, corresponding to a growth of its market shares from 0.04% to 19.26% (Schott, 2008). Vigorous political debate and economic research have focused on the role of Chinese export in reshaping world's economy.

This paper analyses the effect of Chinese competition on foreign markets on the pricing strategies of exporters located in a small open economy, namely Denmark. In particular, it explores how quality heterogeneity of Danish products modifies this impact.

The literature has mainly focused on the impact of Chinese competition on the labour markets of rich destination countries. Autor et al (2012) analyse the effects of increased penetration of Chinese products in the US and find that higher exposure to Chinese competition reduces employment and wages of workers in American companies. Similarly, Utar (2012) shows that employment and sales of Danish textile companies were negatively affected by Chinese competition after China became a member of WTO.

Another branch of the literature on international competition has investigated the role of Chinese competition as trigger of technological change. Bernard et al (2006) show that technological advancements protect American firms from competition of low-income countries. Bloom et al (2016) investigate the role of international trade and Chinese competition in inducing technological change. The authors show that the entry of China in the WTO group and the growth of Chinese import in Europe has triggered investments in technology of European companies that faced stiffer competition. Using survey data of Italian companies, Bugamelli et al (2010) show that the growth of Chinese export in Italy had pro-competitive effect in forcing domestic companies to reduce the price of their products.

Finally, previous studies have highlighted the relevance of vertical differentiation and quality in determining the nature and intensity of the impact of imports from low-wage countries and, in particular, China. Schott (2008) shows that China's export bundle has progressively overlapped with the ones of OECD countries, increasing the number of products that China and developed countries export to the US at the same time. Moreover, the author shows that Chinese products have a lower quality (measured by unit-prices) than products of developed countries and that firms in developed countries were pushed to improve the quality of their own goods in order to escape Chinese competition.
Vandenbussche (2014) obtains similar results implementing the methodology developed by Di Comite et al (2014) that allows researchers to disentangle quality from cost and consumers' taste effects.

Using data on international export flows to the European Union the author shows that there is a strong heterogeneity in the quality content of export from different countries. Related to the focus of this paper, China mainly exports products of low-quality, whereas Scandinavian countries, including Denmark, are specialized in the export of high-quality products.[1]

Khandelwal (2010) shows that increased Chinese competition was associated with a decrease in American employment, but this effect was mitigated in sectors with higher quality differentiation. A similar result emerges from Amiti and Khandelwal (2013). These authors show that increased international competition acts as a trigger of investments in quality for varieties that are already close to the world's quality frontier, while tougher competition discourages low-end companies from investing in upgrades of quality.

While large part of the literature above has used aggregate trade flows and calculated quality at the country level and studied the reaction of companies to competition on the domestic markets, this paper takes the focus to the micro level. Using a detailed dataset on firms' international transactions, this study investigates the impact of international competition on foreign markets on the pricing strategies of firms in a developed economy. Moreover, it explores the role of quality differentiation in determining how international competition modifies the export strategies and pricing decisions of companies. Specifically, the focus of the paper is the susceptibility of Danish export to Chinese competition on foreign markets.

One of the biggest challenges I face is represented by the measurement of products' quality, which is not readily available in the data. Quality is usually an unobserved characteristic of the variety and only a handful of studies could directly use observable measures of it (e.g. Crozet et al, 2012). When, like in my case, objective measures of quality are not available in the data, researchers have adopted empirical methodologies to estimate it. Estimating demand functions and products' quality has proven to be a challenging task. Khandelwal (2010) and Khandelwal et al (2013) developed two pioneer approaches that rely on industrial organization methodologies and international trade models in order to measure the quality of single varieties. In this paper, I follow Khandelwal et al (2013) and I measure quality as a residual of estimated demand functions as I explain in the next section.

Certainly, the closest studies to this analysis are offered by Martin and Mejean (2014) and Pivetau and Smagghue (2014). The authors of these studies study the reaction of exporters to competition of low-income countries on foreign markets. Martin and Mejean (2014) adapt the Khandelwal et al (2013)

[1]Schott (2004) and Hummels and Klenow (2005) show that richer countries produce products of higher quality. Morevoer, Hallak and Schott (2011) show that countries with higher endowment of capital and skilled labour force export products of higher quality.

method to French data in order to estimate products' quality and show that increased international competition led to an increase of quality of French export through relocation of market shares from low-quality varieties to high-quality ones. Similarly, Pivetau and Smagghue (2014) use French data and show that the competition of low-income countries pushed exporters to improve the quality of their products. Using data on international transactions and domestic production of Danish apparel firms, Smeets et al (2014) analyse the implications of offshoring and import competition from China on the quality of products. The authors show that both elements modify the quality of single products over time and the distribution of qualities across firms. Moreover, the authors show that these effects depend on the relative quality of goods.

To the best of my knowledge, no previous research has analysed the impact of international competition on the pricing strategies of exporters exploring the role of quality in determining it. The analysis of these effects is the main contribution of this paper.

The results of my empirical estimations show that prices of Danish products decrease with the penetration of Chinese export in destination markets. The increase of Chinese export in foreign markets enhances the competitive pressure for Danish companies that have to reduce the prices they charge for their products. Using raw prices I find an apparently surprising result: the impact of Chinese competition on the price of Danish varieties is stronger for varieties with higher quality. This result goes against the expectation that quality and quality differentiation could protect Danish export from foreign competition. If Chinese products have, on average, lower quality than Danish goods, then quality differentiation should protect Danish export and varieties with higher quality should be shielded from Chinese competition.

However, this result hides another mechanism. Chinese competition triggers the upgrade of quality of Danish low-end varieties. Firms that produce these products are the ones that improve the quality of their goods in order to escape from competition, while companies that produce high-end products do not react as strongly, resulting a shortening of the quality ladder. These different reactions in quality upgrading explain why varieties of low quality reduce prices by a lower extent. Quality upgrades allow them to mitigate the impact of Chinese competition on prices. These mechanisms combined lead to a shortening of the quality ladders of Danish exports and to a reduction of price dispersion.

I then use quality-adjusted prices in place of raw prices in order to test how Chinese competition affects the pricing decisions of Danish export. Using prices adjusted by quality, I measure the effect of Chinese competition on prices net of the changes in the value that consumers attribute to the single varieties. I find that quality does in fact protect Danish exports from low-income countries' competition as products of lower quality reduce their quality-adjusted prices while the decrease of relative

quality of high-end products is proportionally larger than the decrease in their prices.
In this sense, the expected intuition that quality might protect companies from international competition is confirmed when one looks at quality-adjusted prices and not simply at raw prices.

The rest of the paper is structured as follows. Section 2 explains how I estimate variety's quality. Section 3 introduces the data I use in my analysis. Next, section 4 presents the analysis of estimated qualities. In the following section (5) I present my estimation strategy. Section 6 presents the empirical evidence. The last section concludes.

2 Measuring quality

The main variable of interest is the quality of Danish varieties exported to foreign markets. I define as a *variety* a product-p sold by a company-f in a given destination country-d, where products are defined by 6-digit HS codes. In the rest of the paper I will also refer to the combination product-p-destination country-d-time-t as a *market*. Therefore, in a given market I observe several varieties that correspond to different Danish exporters.

As mentioned in the previous section, varieties' quality is an unobserved characteristic of the Danish products. Therefore, I need to estimate it. To this end, I adopt the methodology developed in Khandelwal et al (2013). The authors show that an index of *relative* quality can be retrieved as a residual in estimated demand functions. The identification is based on two assumptions: demand functions are CES and quality acts as a demand shifter.
Consider a standard CES demand equation defined as follows:

$$Q_{fpdt} = P_{fpdt}^{-\sigma_p} \Lambda_{fpdt}^{\sigma_p - 1} P_{pdt}^{\sigma_p - 1} Y_{pct} \tag{1}$$

The quantity (Q) of product-p that firm-f sells in destination-d at time-t depends on average price index and total expenditures in the foreign market (P_{pdt}, Y_{pdt}), and on the vatiety's price (P_{fpdt}) and its quality (Λ_{fpdt}). Quality acts as at demand shifter and can be interpreted as any variety's characteristic (other than its price) that is valued by consumers.
In logs eq. (1) can be rearranged as:

$$logQ_{fpdt} + \sigma_p * logP_{fpdt} = (\sigma_p - 1)log\Lambda_{fpdt} + (\sigma_p - 1)logP_{pdt} + logY_{pct} \tag{2}$$

Martin and Mejean (2014) show that when one takes eq. (2) to the data the equation is translated into the following empirical model:

$$logQ_{fpdt} + \sigma_p * logP_{fpdt} = \underbrace{(\sigma_p - 1)logP_{pdt} + logY_{pct}}_{\text{market-specific}} + \epsilon_{fpdt} \tag{3}$$

Where $\epsilon_{it} = (\sigma_p - 1)log\Lambda_{it}$. The use of market fixed effects in the empirical estimations captures market-specific components of the demand equation. After imposing product-specific sigmas, I can estimate eq. (3) and retrieve the variety-time specific quality as a residual of the regression. I follow Khandelwal et al (2013) in calibrating the equation using product specific demand elasticities (σ_p) estimated by Broda and Weinstein (2006).

Hence, measured quality is defined by the following formula:

$$\lambda_{fpdt} \equiv log\Lambda_{fpdt} = \hat{\epsilon}_{fpdt}/(\sigma_p - 1)$$

As I include market fixed effect in the regression, the quality is to be intended in *relative* terms. The estimated quality index (λ_{fpdt}) defines the *deviation* of every variety's quality from the *average* quality of *Danish varieties* sold in a given market. The interpretation is straightforward: a higher quality is assigned to varieties with larger market shares, conditional on price. Hence, this index is a cardinal unit-free measure, centered around zero in every market.

Finally, I complete the analysis using another index of relative quality. This is the *proximity to the frontier* (PF_{fpdt}) that I construct as in Khandelwal and Amiti (2013). This index is a monotonic transformation of the estimated quality. It is defined as the ratio of qualities (in levels) over the highest (level of) quality which defines the frontier within the market.

$$PF_{fpdt} = \Lambda_{fpdt}/max_{pdt}(\Lambda_{fpdt}) \tag{4}$$

where $\Lambda_{fpdt} = exp(\lambda_{fpdt})$. This index takes values between (0,1]. The higher its value, the closer the variety's quality is to the frontier. Varieties at the top of the quality ladder have a value of PF_{fpdt} have approaches one, while those at the bottom have a value of PF_{fpdt} close to zero. As this index has strictly positive values, the use of this variable may offer an easier interpretation of results compared to the use of quality index which is has positive and negative values.

3 Data

To perform my empirical estimations I combine several datasets and I focus my analysis on the period 1996-2007. Restricting my analysis to the years before 2008 allows me to avoid my results to be driven by the 2008-2009 trade collapse.

The main source of information is the international transactions dataset of Danish companies (*UHDI*), provided by *Denmark Statistics*. This dataset reports comprehensive yearly custom data of the universe of Danish firms. It contains the value and weight of international transactions by destination/origin at 8-digit Combined Nomenclature. As I need to combine the information on

export with external datasets that are available only at 6-digit level I aggregate trade flows at this level. This leaves me with a dataset of more than 4 million firm-year-country-product observations.[2]

In order to measure the prices of Danish export varieties, I use unit values that I compute as F.O.B value of export over its weight by firm, destination, product and year. The value of international transactions, and of unit values, is known to be noisy. Aggregating these values at a coarser level of aggregation (from 8-digit to 6-digit) can in fact make this issue worse. To mitigate this problem I clean the data in several dimensions. After cleaning the data and combining them with external dataset, I am able to work with 2,752,236 firm-product-country-year observations. [3]

To test the validity of my estimations and assess how measured qualities relate to firms' observable characteristics, I merge this dataset with firms' balance-sheet data through firms' unique identifier. Accounting information is reported in the dataset *FIRE* also provided by *Denmark Statistics*. The use of these data will be limited to the consistency tests I preform in the next section.[4]

Moreover, I merge my data with six-digit HS product-level import elasticities provided by Broda and Weinstein (2006). These elasticities of substitution (σ_p) allow me to estimate the quality of Danish export varieties as I explained in the previous section.[5]

Finally, I merge my data with the UN-COMTRATE dataset of bilateral trade flows of goods over the period 1996-2006. I use information on import flows by destination-country, country of origin, six-digit HS product and year to measure the penetration of Chinese export in foreign markets.

In Table 1 I provide summary statistics of relevant variables for my final sample. As explained, the quality index is a unit-free and is centered around zero. The estimated qualities have average zero

[2]The Combined Nomenclature is a classification system defined by European Union to record trade. The first 6-digits are the same of the HS classification, while the last two are chosen by the reporting country. Once I aggregate the firm-product transactions at the six-digit level I can combine them with aggregate information of trade flows reported at this level. I use concordance tables provided by the UN to harmonize product codes to 1996 classification and make them consistent over time.

[3]I refer the reader to Appendix A for the description of my trimming strategy.

[4]The *FIRE* database contains data of a representative population of firms with less than 50 employees, while covers the population of larger companies. Moreover, it is limited to manufacturing and construction firms before 2000, while it includes all sectors afterwards. More information on the datasets can be found at the following url: `http://www.dst.dk/da/TilSalg/Forskningsservice/Data/Register_Variabeloversigter.aspx`.

[5]For each HS six-digit product I use the median elasticities that the authors compute at 10 digit level. When the elasticities are not available at six-digit, I use coarser level of aggregation (four and two-digit). Moreover, elasticities are not available for Animal products and Vegetable products. Therefore, these products are excluded from my sample. Finally, I exclude from my analysis tobacco, military and art products. For these categories the interpretation of quality seems to be more challenging than for other products as the demand might be particularly hard to define.

and a standard deviation equal 2.3. In order to discuss the role of quality heterogeneity I will refer to *low-end varieties* as those varieties that have a quality one standard deviation below the average (i.e. quality = -2.3) and to *high-end varieties* as those with a quality one standard deviation above the average (i.e. quality = +2.3). As I restrict the analysis to markets where I observe at least two varieties, this is the minimum number of varieties in the sample. On average varieties stay in my sample for roughly two years. A large part of products are sold on multiple markets by their producers (2.3 markets on average). I will exploit this feature of Danish exporters to estimate the response of Danish varieties to international competition in terms of quality upgrade (section 6.2).

Table 1: Summary statistics

	mean	p10	p25	p50	p75	p90	sd
estimated quality (λ_{fpdt})	0.00	-2.08	-0.86	0.02	0.89	2.07	2.29
estimated proximity to the frontier (PF_{fpdt})	0.37	0	0	0.19	.75	1	0.38
# varieties by market	5.2	2	2	3	5	10	7,74
# products by firm-year	6.91	1	1	3	6	14	31.89
# destinations by firm-year	4.7	1	1	1	2	5	7.4
# destinations by firm-product-year	2.32	1	1	1	2	5	3.55
# years by variety	1.98	1	1	1	2	4	1.81

4 Making sense of quality estimates

In this section I offer an analysis of the quality index. In order to test the reliability of this variable, I assess how quality correlates with observables. Specifically, I test how quality varies with the firms' and varieties' observable characteristics. I must highlight that the results of the estimations I present in this section cannot be interpreted as evidence of causality, but rather of correlation.

First, in Table 2 I present an analysis of the composition of quality. I separately regress quality on a set of dummies: these are *firm* (δ_f), *firm-product* (δ_{fp}), *firm-destination* (δ_{fd}), *variety* (δ_{fpd}) dummy. The comparison of R2 allows to understand to what extent each component of quality explains it. Not surprisingly, the variety component explains over 80% of quality, as quality is only allowed to move over time. Interestingly, the *firm-product* fixed effects explain over 50% of differences in quality. I interpret this element as a combination of brands' reputation. This component of quality is, indeed, constant across different products sold by the same company across different destinations. At the same time, it can also be seen as evidence of a strong relationship between firms' characteristics and

the appeal of its products.

Table 2: Quality analysis: decomposition

Dep Var	λ_{fpdt}	λ_{fpdt}	λ_{fpdt}	λ_{fpdt}
δ_f	YES	NO	NO	NO
δ_{fp}	NO	YES	NO	NO
δ_{fd}	NO	NO	YES	NO
δ_{fpd}	NO	NO	NO	YES
δ_t	YES	YES	YES	YES
N.Obs	2,752,236	2,752,236	2,752,236	2,752,236
R2	.11	.54	.25	.83

I now test whether varieties' market shares within their markets and their price positively correlate with measured quality. To do this I run POLS regressions in which I use variety's quality λ_{fpdt} alternatively as a dependent variable or as main regressor.

As the first two columns of Table 3 show, the quantity of varieties, positively correlate with quality, also conditioning on price. In line with the assumptions of CES function for consumers' utility, demand is increasing in the quality of the variety and decreasing in its price. The third column shows the relationship between quality and variety's time in the market, that I call "experience". The longer a variety stays in the market, the higher its perceived quality. As mentioned, I do not claim causality for these results. This evidence may suggest that firms learn about foreign markets and make their products more appealing over time, but also that products of lower quality drop out of the markets more easily.

Finally I test whether quality correlates with the price of the variety. The result in column four and five show that there is a strong positive correlation between the two measures both across-varieties and within-variety over time. Higher quality is associated to a higher willingness-to-pay of foreign consumers and higher prices charged by Danish exporters.

Table 3: Quality analysis: variety level

Dep Var	$logQ_{fpdt}$	$logQ_{fpdt}$	λ_{fpdt}	$logP_{fpdt}$	$logP_{fpdt}$
λ_{fpdt}	0.417***	0.691***		0.162***	0.099***
	(0.002)	(0.004)		(0.001)	(0.001)
$logP_{fpdt}$		-1.687***			
		(0.004)			
$experience_{fpdt}$			0.196***		
			(0.001)		
δ_{pdt}	YES	YES	YES	YES	YES
δ_{fpd}	NO	NO	NO	NO	YES
N.Obs	2,752,236	2,752,236	2,752,236	2,752,236	2,752,236
R2	.61	.81	.026	.78	.99

Standard errors clustered at variety level.

*,**,*** Statistically significant at 10, 5, 1%, respectively.

Furthermore, I try to relate quality to observable firms' characteristics. Since the quality measures I have in hand are variety-time specific, I have to aggregate them at the firm level in order to estimate a firm-level measure of quality.

I define the firm's quality λ_{ft} as the weighted sum of the quality of its varieties, using varieties' share of sales within the firm as weights. Formally, I define it as follows:

$$\lambda_{ft} = \sum_{fpdt} sh_{fpdt} * \lambda_{fpdt} \tag{5}$$

Therefore, firms with higher average quality produce varieties of higher quality and (or) are specialized in production of varieties that have higher qualities then their competitors. With this new measure in hand, I can test how firms' qualities vary with firms' characteristics. I do so by running a set of OLS regressions using the firm-level quality as dependent variable and different firm's characteristics (in logs) as main regressors. I order to net out differences across industries and over time I include industry (δ_j) and time (δ_t) dummies.[6]

$$\lambda_{ft} = \beta_1 logX_{ft} + \beta_j + \beta_t \tag{6}$$

I present the results of these estimations in Table 4.

[6]Clearly the number of observations drops as I use only one observation per firm-year and I can only include companies for which balance-sheet data are reported in the accounting dataset.

Table 4: Quality analysis: firm level

Dep Var	λ_{ft}	λ_{ft}	λ_{ft}	λ_{ft}	λ_{ft}
$log(E/L)_{ft}$	0.340***				
	(0.005)				
$log(L)_{ft}$		0.234***			
		(0.007)			
$log(K/L)_{ft}$			0.003		
			(0.007)		
$log(W/L)_{ft}$				0.406***	
				(0.025)	
$log(GDP^I)_{ft}$					0.058***
					(0.006)
δ_t	YES	YES	YES	YES	YES
δ_j	YES	YES	YES	YES	YES
N.Obs	118378	118378	116523	116049	100279
R2	.21	.088	.057	.062	.062

Standard errors clustered at firm level.

*,**,*** Statistically significant at 10, 5, 1%, respectively.

Firms' qualities positively correlate with their labor productivity, which I proxy with the ratio of total export per employee ($log(E/L)_{ft}$), with their size, measured as number of employees ($log(L)_{ft}$), and average wage ($log(W/L)_{ft}$). These results are in line with the evidence shown in the literature (e.g. Verhoogen 2008, Crozet et al 2012). Furthermore, I relate firms' quality to the average GDP per capita of the countries the company sources its inputs from ($log(GDP^I)_{ft}$). GDP per capita can be seen as a proxy of the quality of products produced in the country. I find that firms that source their intermediates from richer countries produce goods of higher quality. This is consistent with what shown in the literature (e.g Kugler and Verhoogen 2012, Manova and Zhang 2012). Companies that purchase expensive high-quality products also sell products of higher quality.
In the light of these results, I believe I can rely on the measure of quality I estimate and I can therefore make use of it in the rest of my analysis.

5 Estimation strategy

In order to estimate the impact of Chinese competition on the prices of Danish export I implement a set of fixed effect regressions using as dependent variables the log of prices. The main regressors in these models are Chinese import penetration in foreign markets lagged by one period (CNP_{pdt-1}) and its interaction with the variety's quality in the first year it appears in my sample (λ_{fpd0}) and with the variety's first-year proximity to the frontier (PF_{fpd0}).
The penetration of Chinese products is defined as the China's share of imports in the foreign country. Hence, for each product-destination-year (pdt), I measure it as the ratio of import from China over the destination-country's total import. I exclude from the total imports of destination countries the import of Danish products. I do so in order to avoid reverse causality in my final estimations, in which I use the price of Danish export as dependent variable. Indeed, keeping Danish export as part of the denominator could create a bias in the measurement of the impact of Chinese competition on Danish export as the changes in the measure might rather reflect changes in the competitiveness of Danish export itself and therefore bias the estimations.

This index is calculated as follows:

$$CNP_{pdt} = \frac{I^{CN}_{pdt}}{\sum_{o \neq DK \text{ in } pdt} I^{O}_{pdt}} \tag{7}$$

In order to estimate the impact of Chinese competition on the pricing strategy of Danish exporters, I make use of within-variety changes in export prices (P_{fpdt}) estimating the following fixed effects regression:[7]

$$logP_{fpdt} = \alpha_{fpd} + \beta_1 CNP_{pdt-1} + \delta_{dt} + \upsilon_{fpdt} \tag{8}$$

In order to limit endogeneity concerns I use lagged penetration of Chinese products and first-year estimated qualities, restricting my sample to non-first year observations. Excluding first-year observations allows me to capture the effect of Chinese competition on incumbent Danish exporters and avoid confusion with its effect on the selection of new exporters that start exporting new products to the destination market at time-t. Moreover, using the lagged index of penetration allows me to fully capture its effect on Danish export. The reaction of Danish companies could indeed take some time. Export strategies and prices can be slow to adjust to changes in the intensity and nature of the competition they face.

The coefficient of CNP_{pdt-1} determines the impact of Chinese competition in foreign markets on the performance of Danish exporters. Destination-year fixed effects control for trends and shocks that happen to the destination's economy (e.g. change in the economic conditions and in consumers' wealth or taste) and for exchange rates movements that can modify the attractiveness and the cost of imported products for foreign costumers.

In order to measure how the impact of Chinese competition depends on the quality of Danish products, I interact the measure of Chinese penetration (CNP_{pdt-1}) with a time-invariant variety's (relative) quality measured in the first year I can compute it for (λ_{fpd0}).
Thus, the model is defined as follows:

$$logP_{fpdt} = \alpha_{fpd} + \beta_1 CNP_{pdt-1} + \beta_2 \lambda_{fpd0} * CNP_{pdt-1} + \delta_{dt} + \upsilon_{fpdt} \tag{9}$$

As the model includes variety fixed effects, the time-invariant first-year quality measure is captured by the fixed effects. The coefficient of the interaction term (β_2) provides a measure of differences in the impact of Chinese competition on the prices of varieties that are endowed with heterogeneous qualities.

[7]Since all of my estimations include multiple sets of fixed-effects I perform my regressions using the new *STATA* command *reghdfe* developed by Correia. This command can handle linear and instrumented regressions with many levels of fixed effects.

Moreover, I use the first-year PF_{fpd0} in place of λ_{fpd0} in the interaction term of eq.(9). In this specification, the coefficient β_1 determines the impact of Chinese competition on the quality of low-end varieties, for which PF_{fpd0} tends to zero. The coefficients of the interaction term β_2 allows to measure how the impact of Chinese competition on prices changes for varieties with higher quality.

Threats to identification While using interactions with first-year qualities limits endogeneity concerns, the penetration of Chinese competition may still be endogenous. For instance, a negative productivity shock in a third country-k would decrease country-k's export to the destination market-d, modifying competitive pressure both for Danish and Chinese export. Lesser competition would allow Chinese export to (mechanically) expand its market share and would modify the pricing strategies of Danish firms, that could increase the prices they charge.
Moreover, a shift of foreign demand in favour of low-end products would arguably increase the share of Chinese products *and* of Danish products of lower quality. The simultaneity would bias the interaction coefficients downward.

Therefore, I need an exogenous instrument that can explain changes in Chinese penetration in foreign markets which is independent of Danish firms' export choices. I implement a iv strategy inspired by Autor et al (2013). I instrument the Chinese penetration in every destination and its interaction with first-year quality using the average Chinese shares across all other destinations for the same product and in the same year ($\overline{CNP}_{d'pt}$, where $d' \neq d$). The movements of average penetration in other destinations should capture changes in the supply of Chinese products that determine the competitiveness of Chinese export, purging from the estimations the effects due to shocks of local demands and reallocation of consumption across products.

6 Results

In this section I present the results of my estimations. The first subsection presents the estimation of the effect of Chinese competition on prices charged by Danish producers on foreign markets. The following subsection presents the analysis of its effects on the quality upgrade of Danish varieties. Finally, the third and last subsection presents the estimation of the impact of Chinese competition on quality-adjusted prices.

6.1 Raw prices

Table 5 reports the results of my estimations. The first column displays the results of first regression defined by eq. (8), while the column (2) and column (3) report the results of estimation of eq. (9)

which includes interaction terms. The evidence shows that Chinese export does indeed modify pricing strategy of Danish exporters forcing them to lower their prices. As the coefficient β_1 in column one shows, a 10 percentage points increase in Chinese penetration leads to a 1% decrease in export prices of Danish varieties.

As the final goal of my analysis is to estimate the role of quality in determining the impact of international competition, I focus on column (2) and (3) that report the results that include the interaction term of Chinese penetration and the measures of first-year quality of Danish varieties. The interaction term in column (2) is negative, suggesting that firms with higher quality decrease their prices proportionally more than varieties with low quality. A 10 percentage points increase in Chinese penetration leads to a 1% decrease of price of varieties with average quality (quality = 0), while high-end varieties (with a quality one standard deviation above the average, quality = +2.3) decrease their prices by 1,89% and low-end varieties (with a quality one standard deviation below the average, quality = -2.3) decrease their prices by 0.12%. The results in column (3) provide a similar consistent evidence. A 10 percentage point increase in Chinese penetration leads to a 0.3% decrease in the price of varieties at the bottom of the quality ladder and a decrease of 1.98% for varieties at the top of the ladder.

As mentioned above, I face several threats to my identification. If in my sample period there was a shock to supply from a third country (e.g. productivity shock), the changes in this competitor's supply would affect both Chinese market share *and* modify the competitive pressure on Danish prices. Moreover, if an unobserved shock in demand makes the market shares of low quality products increase, my estimations would be biased as the coefficient of the interaction terms would pick up common movements of prices of low quality Danish products and Chinese export. To address this possible endogeneity issue, I instrument Chinese penetration in each destination market with the average penetration of Chinese products in the rest of the world so that movements in the variable should be motivated by changes in competitiveness of Chinese products and not by changes in the demand. The F-tests of the excluded instruments indicate that the iv strategy performs well. I display the results of the first stage regressions in Table 10 in Appendix B.

I present the results column (4)-(6). While the coefficients are much larger, the results confirm the evidence found in my basic regressions. A 10 percentage points increase of Chinese penetration leads to a 7% decrease in Danish prices. The prices of high-end varieties decrease by 12% and the ones of low-end varieties by 2.4%. The impact of Chinese competition on the price of Danish export is stronger for high-quality varieties than for varieties of lower quality. Again the interaction with first-year proximity to the frontier offers a similar evidence.

These results are surprising as one might expect squality to shield Danish export from Chinese competition. One possible reason for this evidence is in the reaction of Danish export in terms of quality upgrade. Indeed, as I have shown in section 4, prices are positively correlated with quality across varieties and over time for the same variety. Therefore, *if* companies that are exporting low-quality products upgrade their quality more intensely than high-quality producers in order to stand up to international competition, then they would improve the attractiveness of their product and limit the downward pressure on the prices they charge. As a consequence, the negative coefficient I find for the interaction term may (partly) reflect this mechanism. In the rest of this section I test whether this mechanism is in action.

Table 5: Prices

	Dependent variable: prices lnP_{fpct}					
	(1)	(2)	(3)	(4)	(5)	(6)
CNP_{pdt-1}	-0.103***	-0.101***	-0.031***	-0.699***	-0.679***	-0.300***
	(0.008)	(0.008)	(0.012)	(0.031)	(0.031)	(0.037)
$\lambda_{fpd0} * CNP_{pdt-1}$		-0.038***			-0.189***	
		(0.004)			(0.012)	
$PF_{fpd0} * CNP_{pdt-1}$			-0.167***			-1.022***
			(0.019)			(0.057)
δ_{fpd}	YES	YES	YES	YES	YES	YES
δ_{dt}	YES	YES	YES	YES	YES	YES
N.Obs	1,379,599	1,379,599	1,379,599	1,379,599	1,379,599	1,379,599
R2	.97	.97	.97	.97	.97	.97
Kleibergen-Paap F-Stat				6636	3314	3486

*,**,*** Statistically significant at 10, 5, 1%, respectively.

Standard errors clustered by destination,HS6,year.

6.2 Quality upgrading

In order to test whether the heterogeneity of quality modifies the extent to which Danish exporters upgrade their products quality to react to Chinese competition and to see how international competition modifies the distribution of quality along the quality ladders, I perform two complementary tests.

First, I implement the model defined by eq. (9) using varieties' quality at time-t as dependent variable. Since, qualities are in relative terms and center around zero, I cannot test how direct competition moves the average quality. Therefore, the coefficient β_1 is to be expected to be insignificant. However, the interaction term can still tell how heterogeneous first-year qualities modify the effect of Chinese competition on quality upgrade. I display the results of estimation in columns (1)-(3) of Table 6.

Second, I follow Pivetau and Smagghue (2015) in constructing a variety-specific measure of Chinese competition, which is defined by the weighted average penetration of Chinese products that producers face in different markets for the same product their export to a given destination-d at time-*t-1*($OCNP_{fpdt-1}$), using first-year shares of sales as weights.
This measure is then defined as follows:

$$OCNP_{fpdt-1} = \sum_{k \neq d} sh_{fpk0} CNP_{pkt-1} \tag{10}$$

where $sh_{fpk0} = \frac{sales_{fpk0}}{\sum_{c \neq d} sales_{fpc0}}$. I include firm-products that are multi-market in the first year they appear in the sample ($t = 0$). Firm-products within the same market differ in the composition of other destinations where the product is sold. Therefore, this index differs across varieties within the same market. The identification strategy relies on the idea that relative quality of varieties of a given product sold by the same firm in different destinations are correlated. As a consequence, the impact of Chinese competition on different markets should reflect the effect of Chinese competition on quality in a given destination.
Again I follow the authors' estimation strategy in including variety and market fixed effects. These fixed effects allow me to exploit the variation over time of quality controlling for constant differences in varieties' characteristics that might explain differences in quality and their exposure to international competition and to control for common drivers of changes in quality.
The model is defined as follows:

$$\lambda_{fpdt} = \gamma_1 OCNP_{fpdt-1} + \gamma_2 \lambda_{fpd0} * OCNP_{fpdt-1} + \delta_{pdt} + \delta_{fpdt} + \upsilon_{fpdt} \tag{11}$$

As I interact the main regressor with the variety's first-year quality and first-year proximity to the

frontier, the coefficient of the interaction terms should tell whether the change of quality due to international competition depends on the relative quality of the variety. The results are reported in columns (4)-(6) of Table 6.

In both specifications the coefficient of the interaction terms are negative, suggesting that varieties with lower quality upgrade their quality more intensely than varieties that are up on the quality ladder. As previous literature has shown, Chinese products have a lower-quality than the ones produced in advanced countries. It seems therefore reasonable that the expansion of Chinese export intensifies competition at the bottom of the quality ladder of Danish varieties. The interaction with the first-year proximity to the frontier in column (6) offers an interesting result. The ratio of the coefficients γ_1/γ_2 defines the value of the proximity to the frontier above which the pressure to upgrade quality becomes too weak resulting in a downgrade of the relative quality of variety which are up on the quality ladder. This value ($0.85/2.76 = 0.30$) is above the median of PF_{fpdt} and below its average. The pressure to upgrade quality is higher for low-quality varieties that are pushed more intensely to upgrade quality. This upgrade increases the appeal of the products and makes their quality approach the one of products of higher quality. As a consequence, Chinese competition leads to a shortening of the quality ladder of Danish export and makes the distributions of quality denser around the average.

A possible threat to identification is represented by the entry of new Danish competitors. Indeed, if Chinese penetration makes competition more intense, self-selected new exporters will arguably have higher quality than incumbents. Their entry would shift the actual (non-centered) quality mean upward. This would result is a mechanical estimated reduction of relative qualities of incumbents, despite a possible actual improvement of their qualities. In order to purge the estimations from these effects I use a balanced sample. This keeps the sample constant: qualities are always measured as deviations from average quality of the *same* population of exporters. The results are displayed in the last three columns of Table 6. The evidence remains qualitatively unchanged. The negative coefficient of the interaction term represents a downgrade of quality of high-end varieties and an upgrade of low-end ones that are triggered by Chinese competition. This is arguably due to the need of producers of low-quality varieties to invest in the attractiveness of their products in order to escape from Chinese competition.

Table 6: Quality

	Dependent variable: quality λ_{fpct}								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CNP_{pdt-1}	0.020	0.046	0.437***						
	(0.028)	(0.029)	(0.048)						
$\lambda_{fpd0} * CNP_{pdt-1}$		-0.364***							
		(0.043)							
$PF_{fpd0} * CNP_{pdt-1}$			-0.970***						
			(0.077)						
$OCNP_{fpdt-1}$				-0.021	-0.090	0.850***	0.195	-0.442	2.482***
				(0.076)	(0.079)	(0.103)	(0.434)	(0.557)	(0.745)
$\lambda_{fpd0} * OCNP_{fpdt-1}$					-0.873***			-2.121***	
					(0.086)			(0.521)	
$PF_{fpd0} * OCNP_{fpdt-1}$						-2.764***			-4.202***
						(0.161)			(0.863)
δ_{fpd}	YES	YES	YES	YES	YES	YES	YES	YES	YES
δ_{dt}	YES	YES	YES	NO	NO	NO	NO	NO	NO
δ_{pdt}	NO	NO	NO	YES	YES	YES	YES	YES	YES
N.Obs	1,379,599	1,379,599	1,379,599	1,091,046	1,091,046	1,091,046	219,410	219,410	219,410
R2	.81	.81	.81	.91	.91	.91	.79	.79	.79

,**,*** Statistically significant at 10, 5, 1%, respectively.

Standard errors clustered at firm level.

6.3 Quality-adjusted prices

As I discussed in section 2, I have assumed a CES demand function for consumers' utility that depends on prices and qualities of varieties sold in the market. Therefore, the effects of changes in prices of Danish varieties on the utility of consumers depend on joint movements of varieties' prices *and* of their qualities. Moreover, as I have shown in section 4, quality and prices are strongly positively correlated both across varieties and within-variety over time. I have shown in the previous sections that Chinese competition affects both prices and perceived qualities of Danish products and that these effects depend on the relative quality of the varieties.

In the light of these results, it seems important to look at quality-adjusted prices, rather than to raw prices, as I have done thus far. Quality-adjusted prices can, indeed, give an idea of how prices react to international competition, accounting for changes in the value that consumers attribute to the variety.

As I have already in hand prices and estimated qualities, I can measure the logs of quality-adjusted prices as in Khandelwal et al (2013). These are the logs of the ratio of prices divided by their own quality index:

$$ln\tilde{P}_{fpdt} = lnP_{fpdt} - \lambda_{fpdt} \tag{12}$$

I can now use this weighed measure of prices to re-estimate the impact of Chinese competition on Danish export prices. Using $ln\tilde{P}$ as dependent variable in the model defined by eq. (9) allows me to measure changes in prices due to Chinese competition *net* of changes in the quality (variety's value for consumers) possibly triggered by the same competitive pressure. I present the results in Table 7. In columns (1)-(3) I report the results of OLS estimations, while in columns (4)-(6) I display the results of the estimations obtained using $\overline{CNP}_{d'pt}$ and its interaction with first-year qualities as instruments.

As quality-adjusted prices are not measured in physical or monetary units the interpretation of the intensity of their changes is not trivial. Therefore, I focus on the signs of the effects of Chinese competition rather than on the value of their measured intensity.

Compared to previous results, the only noticeable difference in the coefficients is in the interaction terms. Using quality-adjusted prices, I find that the relationship between the impact of Chinese competition and the variety's quality is reversed and is now positive. I interpret these coefficients as the impact of Chinese competition on the prices of Danish varieties net of the upgrade (downgrade) of quality that it (partly) triggers. As shown in column two, a 10 percentage point increase of Chinese penetration leads to a 1.46% decrease in quality-adjusted prices for varieties with average quality. High-end quality varieties instead increase their quality-adjusted prices by 6%. Low-end varieties, reduce

theirs by 9%. Although the coefficients are larger the instrumented results qualitatively confirm this evidence.

Finally, I implement again the estimation strategy of Piveteau and Smagghue (2015) using as dependent variable the quality-adjusted prices in the model defined in eq. (11). This approach allows me to use a variety-specific measure of Chinese penetration. Similarly to what explained in the previous section, the identification strategy relies on the assumption that quality-adjusted prices (and their components) are correlated across markets. Under this assumption, the impact on quality-adjusted prices measured using as regressor the weighted competition faced by the company on other markets reflects the impact of the competition on Chinese products on the same market. I present the results in columns (7)-(9). In the last two columns I include interaction terms with the measured first-year qualities. These estimations provide consistent results with those displayed in column (1)-(6).

High-end varieties suffer less from Chinese competition than low-end ones. The downward pressure on quality-adjusted prices that comes from Chinese competition decreases with varieties' quality. Although the relative quality of high-end varieties is reduced, the decrease in their prices is proportionally smaller, resulting in an increase of quality-adjusted prices. On the contrary, while the appeal of low-end varieties increases and gets closer to the one of high-end ones (i.e. closer measured quality), this does not fully compensate for the downward pressure on prices that comes from Chinese competition, resulting in a reduction of quality-adjusted prices that is stronger than the one perceived by producers of goods of higher-quality.

Table 7: Quality-adjusted prices

	Dependent variable: quality-adjusted prices $ln\tilde{P}_{fpct}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
CNP_{pdt-1}	-0.123***	-0.146***	-0.468***	-0.819***	-1.041***	-3.165***			
	(0.028)	(0.029)	(0.048)	(0.107)	(0.109)	(0.147)			
$\lambda_{fpd0} * CNP_{pdt-1}$		0.326***			2.078***				
		(0.042)			(0.111)				
$PF_{fpd0} * CNP_{pdt-1}$			0.803***			6.019***			
			(0.075)			(0.213)			
$OCNP_{fpdt-1}$							0.052	0.118	-0.711***
							(0.072)	(0.075)	(0.098)
$\lambda_{fpd0} * OCNP_{fpdt-1}$								0.828***	
								(0.085)	
$PF_{fpd0} * OCNP_{fpdt-1}$									2.421***
									(0.155)
δ_{fpd}	YES	YES	YES	YES	YES	YES	YES	YES	YES
δ_{dt}	YES	YES	YES	YES	YES	YES	NO	NO	NO
δ_{pdt}	NO	NO	NO	NO	NO	NO	YES	YES	YES
N.Obs	1,379,599	1,379,599	1,379,599	1,379,599	1,379,599	1,379,599	1,091,046	1,091,046	1,091,046
R2	.85	.86	.85	.85	.85	.85	.93	.93	.93
Kleibergen-Paap F-Stat				6636	3314	3486			

*,**,*** Statistically significant at 10, 5, 1%, respectively.

Standard errors clustered by destination,HS6,year.

7 Conclusions

In this paper I investigate how quality differentiation modifies the impact of Chinese competition on the pricing strategies of exporters in a developed country, namely Denmark.

I show that Chinese competition reduces the prices that Danish producers charge for the products they sell in foreign makerts. I also show that quality has a relevant role in determining the nature and the intensity of the effects of Chinese competition.

Using raw prices I find that an increase of Chinese penetration in foreign markets makes the price of low-end varieties decrease by a lower extent than the ones of high-quality varieties. This is a surprising result as quality would be expected to protect export from foreign competition.

This result, however, hides another related mechanism. I find that international competition pushes producers of varieties at the bottom of the quality ladder to improve their quality over time proportionally more than high-end ones, causing a shortening of the quality ladders. Quality upgrades allow firms to mitigate the pressure of Chinese competition to reduce prices.

In order to estimate the effect of Chinese competition on export prices net of quality changes, I use quality-adjusted prices. Using this measure, I find that quality shields export prices from international competition. High-end varieties in fact increase their quality-adjusted prices as a result of an increase of Chinese competition, whereas low-end products reduce theirs.

This study provides evidence of a relevant effect of Chinese competition on the pricing and quality differentiation strategies of exporters located in a rich country. Exporters react to the competition of low-income countries (in this case China) modifying the prices they charge *and* their quality. Quality differences determine the nature of the reaction.

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Appendices

A Data trimming

Trade data are known to be noisy. I trim the data in multiple dimensions, adopting criteria similar to the ones used in the literature (e.g. Khandelwal 2010, Piveteau and Smagghue 2014). I choose to do so, as, besides measurement errors, I am worried about possible composition effect in the measured changes of prices . Indeed, large changes and values of prices measured at 6-digit level might hide changes in the relevance of different 8-digit products within the 6-digit codes. These changes in the composition of products might harm the estimation of qualities and the measurement of the effect of Chinese competition on pricing strategies. I remind the reader that I define as a market the triplet destination-year-product:

- As a first step, I aggregate six-digit transaction over 8-digits keeping only transactions that are reported with comparable units of measurement by six-digit product, year, destination country. I exclude transactions with different units of measurement.
- I drop top and bottom 5% of unit prices in each market
- I drop varieties that show unreasonable changes in prices. Specifically, I drop the entire time-series of varieties that report variation of prices larger than 3 between two consecutive years. These values roughly correspond to the top and bottom 5% of the whole distribution of price changes.
- I exclude observations that report price over three times larger or lower than the median price charged by the same company for the same product across destinations in a given year.
- As my measure of quality is defined in relative terms, I keep only observations of export in markets where I observe at least two Danish varieties
- Finally, I also drop top and bottom 1% of estimated quality in each market

To compare the datasets, I compute total value of export by market in each dataset and I calculate pairwise correlations between datasets. I also measure the ratio of total exports which I compute as total value of export in "After" dataset /total value of export in "Before" dataset.

Table 8: Comparison of datasets before and after trimming the data

	Dataset	
	Before	After
Observations	4,160,046	2,752,236
Varieties	1,874,599	1,388,885
HS2 products	84	84
HS4 products	1,149	1,127
HS6 products	5,100	4,831
Countries	240	226
Pairwise correlation = 0.98		
Ratio of total export : median 0.99, mean = 0.86		

Table 9: Summary statistics

	Before						
	mean	p10	p25	p50	p75	p90	sd
# varieties by market	4.11	1	1	2	4	8	4.11
# products by firm-year	7,97	1	1	3	7	16	37.06
# destinations by firm-year	5.69	1	1	2	5	15	9.77
# destinations by firm-product-year	2.32	1	1	1	2	6	5.06
# years by variety	2.84	1	1	1	3	5	2.03
	After						
	mean	p10	p25	p50	p75	p90	sd
# varieties by market	5.2	2	2	3	5	10	7,74
# products by firm-year	6.91	1	1	3	6	14	31.89
# destinations by firm-year	4.7	1	1	1	2	5	7.42
# destinations by firm-product-year	2.32	1	1	1	2	5	3.55
# years by variety	1.98	1	1	1	2	4	1.81

B Tables

Table 10: First stage regressions

	(1)	(2)	(3)	(4)	(5)
Dep Var	CNP_{pdt-1}	CNP_{pdt-1}	CNP_{pdt-1}	$\lambda_{fpd0} * CNP_{pdt-1}$	$PF_{fpd0} * CNP_{pdt-1}$
$\overline{CNP}_{pt-1}$	0.799***	0.799***	0.816***	-0.006	0.008***
	(0.010)	(0.010)	(0.011)	(0.008)	(0.003)
$\lambda_{fpd0} * \overline{CNP}_{pt-1}$		-0.000		0.775***	
		(0.001)		(0.017)	
$PF_{fpd0} * \overline{CNP}_{pt-1}$			-0.041***		0.757***
			(0.011)		(0.009)
δ_{fpd}	YES	YES	YES	YES	YES
δ_{dt}	YES	YES	YES	YES	YES
N.Obs	1,379,599	1,379,599	1,379,599	1,379,599	1,379,599
R2	.93	.93	.93	.95	.93
F-Stat	6,636	3,327	3,362	1,085	3,843

*,**,*** Statistically significant at 10, 5, 1%, respectively.

Standard errors clustered by destination, HS6, year.

C Rise of Chinese export

Table 11: Chinese penetration

year	mean	p10	p25	p50	p75	p90	sd
1996	.049	0	0	.0027	.036	.14	.12
1997	.052	0	0	.0031	.04	.16	.12
1998	.055	0	0	.0034	.041	.17	.13
1999	.063	0	0	.0049	.053	.2	.14
2000	.077	0	.0001	.0088	.076	.25	.15
2001	.081	0	.00017	.01	.082	.27	.15
2002	.097	0	.0005	.016	.11	.33	.17
2003	.11	0	.0011	.024	.14	.38	.18
2004	.12	0	.0021	.032	.16	.4	.18
2005	.14	0	.0047	.05	.21	.45	.2
2006	.16	.00013	.0076	.064	.25	.49	.21
Average	.097	0	.0004	.015	.11	.33	.17

Conclusion

The three chapters study different topics of international economics. This Thesis offers a contribution to our understanding of the reaction of companies to the diffusion of multinational production and to the changes of international competition.

The first chapter contributes to the scarce empirical literature on the impact of foreign direct investment on the intensity of competition in the host market. The analysis is motivated by the relevance of the identification of the determinants of firms' market power as this affects the welfare of consumers and the profitability of companies. In order to measure how foreign ownership modifies the market power of acquired companies and of domestic competitors, I implement recent methodologies to estimate companies' production functions and markups using a panel dataset of Romanian manufacturing firms. The empirical evidence shows that foreign-owned companies charge economically significantly higher markups and their activity is associated to an enhanced competitive pressure for local firms. To stand up to this stiffer competition, domestic companies have to lower their price-cost ratios. I also find that these effects depend on the characteristics of the industry companies operate in. These findings shed a new light on the role of foreign direct investment in determining the intensity of competition in the host markets.

The second chapter analyzes the implications that the strategy of vertical integration of multinational business groups has for the spillovers from which local suppliers can benefit. In order to study this issue, we build on the results of previous research on productivity spillovers exploring the insights offered by the literature on the organization of cross-border production. We argue that affiliates of vertically integrated multinational business groups primarily rely on related companies to purchase their inputs. This reduces the likelihood of collaboration with unrelated local suppliers resulting in weaker productivity spillovers. We empirically test this intuition using a panel dataset of European manufacturing companies.

First we show that the structure of multinational production suggests a common strategy of vertical integration and internal sourcing. We estimate the total factor productivity of local firms using a recent semi-parametric methodology and relate it to the activity of foreign-owned affiliates in downstream industries. We modify the existent measures of vertical penetration and develop two new related indexes that measure the presence of client foreign companies in the host countries distinguishing between vertically integrated and non-vertically integrated business groups. The empirical evidence that results from our analysis confirms our intuition showing that positive productivity spillovers emerge only from the activity of FDI that are not integrated in the industry of local suppliers. These findings provide a contribution to our understanding of the mechanisms that favor the diffusion of knowledge associated to multinational production.

Finally, the last chapter studies the impact of Chinese competition on the pricing strategy of Danish exporters. I also explore the role of quality differentiation in determining the intensity of this effect. Using a detailed dataset of firm-level international transactions I estimate a measure of relative quality of Danish export that has to be intended as a measure of the value that consumers attribute to products' characteristics beside their price. I then perform a set of consistency tests that confirm the validity of this measure as it relates with observable characteristics of the products and of their producers as expected. In particular, I find that higher quality and quality upgrade are associated to higher prices. With this measure in hand, I study how the Chinese competition on foreign markets modifies the pricing strategy of producers of varieties that have different qualities. First, I measure how the price of Danish export react to Chinese competition, finding that varieties of high quality decrease their prices more intensively than producers of goods of low-quality. This evidence might be surprising as one may expect quality to protect from international competition. However, this result reflects the effect of international competition on the strategy of quality differentiation of Danish producers. Indeed, I find that in order to escape Chinese competition producers of low quality varieties increase their quality more intensively that producers of varieties with a higher quality endowment. This mitigates the downward pressure that

the competition puts on prices. In order to account for these changes, I use quality-adjusted prices and I find that quality-adjusted prices of low-quality varieties decrease by a larger extent that those of varieties that have a higher quality.

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