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Intra-Firm Trade and Employment in US Manufacturing

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JEL : F16, F23, J21, J23
Keywords: Multinational Companies (MNCs); intra-firm imports; intra-firm exports; employment; low-skilled workers; high-skilled workers

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1. Introduction

Production sharing is a very old process that dates back to the 19th century and the Industrial Revolution, mainly in the form of domestic outsourcing (Andreff, 2009, p. 6). However, since the early 1960s production sharing has become more and more international, with Foreign Direct Investment (FDI) in the epicenter. In particular, some specific developments in the global economy during the last three decades, such as multilateral trade liberalisation, free capital movement across borders, rapid technological change and development of Information and Communication Technologies (ICT), adoption of the Post-Fordist model of production,

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the NAFTA, China’s WTO membership, the EU 27, etc., have facilitated the rapid expansion of FDI.

In turn, this phenomenon has sparked an intriguing debate about whether FDI expansion has taken place at the expense of employment in the home country. More specifically, the extant empirical literature has examined whether employment in the foreign affiliates is a complement or a substitute for employment in the parent company, as well as, whether demand shifts towards high-skilled labour. Most of these studies have concluded that FDI is mainly horizontal (i.e. market seeking) rather than vertical (i.e. exploiting international factor-cost differentials) and therefore, they have found positive or negligible negative effects on home employment. Nonetheless, they have overlooked an essential factor, that is, the intra-firm trade (i.e. intra-firm imports and exports) between the parent companies and their foreign affiliates, which is mainly deemed as a byproduct of vertical FDI.

In this paper we study the FDI effects on home employment from this new perspective. That is, we take into consideration intra-firm trade between US parents and their affiliates abroad and test whether it has any impact on the employment level of all employees, as well as, of high- and low-skilled ones in the US manufacturing sector for the years between 1995 and 2005.

The great importance of intra-firm trade has been emphasised by a series of recent studies. In particular, Hanson, Mataloni and Slaughter (2001, p. 32) write explicitly: “Earlier research tends to overlook data on trade within US multinationals. US parents actually outsource a substantial amount of production to their foreign affiliates. Though this vertical FDI is concentrated in particular regions and industries, it is clearly an important part of the overall picture”.

More evidence on intra-firm trade shows that, in 1999, 68% of US exports shipped to majority-owned affiliates (MOFAs) were goods intended for further processing although this share varied substantially across US manufacturing industries (Mataloni and Yorgason, 2002; Borga and Zeile, 2004). Furthermore, intra-firm trade between US parents and their affiliates in low- or middle-income countries (i.e. China, Korea, Mexico, Taiwan, and those of Eastern Europe) increased substantially over the 1990s, while in 2000; two-thirds of US imports from Mexico were intra-firm due to the extensive maquiladora operations (OECD, 2002, p. 166 and p.164).

As regards the potential manufacturing-wide employment effects of intra-firm trade, we have one big reason to believe that such effects may be in force. That is, US parents dominate the manufacturing industry in which they operate in terms of employment and value added, and the manufacturing sector as a whole. Thus, we expect that any effect of intra-firm imports and intra-firm exports on employment in US parents to be transmitted to the employment level of the whole US manufacturing sector.

An extra channel through which manufacturing-wide effects may occur is related to the US domestic firms which are not MNCs. These firms in order to maintain or increase their competitiveness follow the lead of the MNCs and, based on their productivity level, become exporters, importers (i.e. through arm's length, etc.) or both. Such exporting or/and importing behaviour may have employment effects of the same kind as those of intra-firm exports and intra-firm imports respectively. In addition, some of these domestic firms which collaborate with the US affiliates abroad (i.e. provision of intermediate inputs to them) may increase their employment, while employment level in other firms which face fierce competition from these foreign affiliates may shrink (i.e. tasks which would have otherwise been outsourced to these US domestic firms by the US MNCs are transferred to their foreign affiliates to take advantage of wage differentials).

In order to test the link between intra-firm trade and home employment we create a panel of industry-level data on eight two-digit US manufacturing industries and on US affiliates in the equivalent industries abroad for the period 1995 – 2005. Our data sources are the OECD, the NBER-CES Manufacturing Industry Database, and the BEA. We derive three labour demand equations (one for all employees, and the rest two for low- and high-skilled employees) from the minimisation of a translog cost function. We then apply OLS and IV with industry- and time-specific fixed effects for all three equations.

An extra novelty of this paper is associated with the instrumental variables for intra-firm imports and exports being coined in order to deal with any potential issues of endogeneity which may bias our OLS estimates. The instruments are: the ratio of the unit wage cost in US affiliates abroad to the unit wage cost in US industry (relative foreign unit wage cost), the ratio of the value added in the affiliates to their total sales, and the weighted averages of the import and export maritime transport costs between the US and four main geographical regions (Canada, Europe, Latin America, Asia and Pacific).

Our regression analysis shows that intra-firm imports have a negative impact on aggregate home employment, while intra-firm exports a positive one. The former effect is smaller in magnitude than the latter which implies that an equal percentage increase in both flows leads to a net positive employment effect. We also find that the employment level of low-skilled employees is adversely affected by intra-firm imports while that of high-skilled ones remains unaffected. Simultaneously, while high-skilled labour benefits substantially from intra-firm exports, low-skilled labour seems to reap no benefits from them.

Based on the findings on the two types of workers one could argue that, since US parents are the primary channel for such manufacturing-wide effects to be in force, the value-added chain is sliced in such a way so that its low-skill intensive stages are mostly transferred to the foreign affiliates, while its high-skill intensive ones mostly remain within the US parent companies.

The remainder of this paper is structured as follows. In Section 2, we review the empirical studies on home employment effects of FDI. Section 3 presents our econometric framework. Section 4 is divided in two subsections. In subsection 4.1 we describe the match process of our three main databases which allows the collection of the relevant data. The description of the data and the construction process of some specific variables are shown in subsection 4.2. Section 5 discusses important econometric issues, while Section 6 reports the empirical results. Section 7 concludes.

2. Empirical evidence of FDI effects on home country employment

Most of the existing literature on labour market effects of FDI in the home country has been limited to examining the complementarity and substitution effects of employment in foreign affiliates on employment in their parent companies, as well as, any changes in the demand for high- and low-skilled labour.

The initial working hypothesis from the perspective of the developed country (i.e. the US) was the following. As soon as a firm decides to make an investment abroad (FDI) by setting up an affiliate, there may be an increase in the demand for high-skilled (i.e. professional, technical and managerial) labour in the parent company whose main goal is to support the operations of the foreign one either with the provision of intermediate inputs or administrative assistance (complementarity effect).[1] On the other hand, if FDI acts as a substitute for tasks previously achieved at home (i.e. assembly line, etc), and therefore, intermediate or finished goods are shipped from the affiliates to their parent company through intra-firm imports, this may result in lower demand for low-skilled labour at home (substitution effect). For example, Kravis and Lipsey (1988) argue that firms which run operations abroad are less likely to keep more labour-intensive and low-skill intensive activities at home. Especially, firms in the

[1] For a detailed description of four kinds of complementarity effects, see Lundan (2007, p. 13 – 14).

manufacturing sector, whose goods and components are tradable, transfer part of their production process abroad in order to take advantage of wage differentials. However, in the long-run, this negative effect may be reversed in case FDI improves MNC's competitive position. For instance, Jordan and Vahlne (1981) examine two Swedish MNCs and find that, in the long run, they are able to provide more advanced employment security for the domestic labour force due to the fact that they gain in competitiveness at a global level. Similar conclusions are drawn by Stopford (1979) and Sibertson and Strange (1985) for the UK, Van de Bulcke and Halsberghe (1979) for Belgium, Bailey (1979) for Germany, and Koshiro (1982) for Japan.

ECAT (1972)[2] and Stobaugh and Hayes (1976) report that the US FDI in the 1960s led to 550,000 and 600,000 more domestic jobs respectively, while, Ruttenberg (1971) finds that US FDI reduced domestic employment by 500,000 jobs for the same period. Estimates of other early studies range from a net decrease of 1 million to a net increase of 629,000 jobs (US Tariff Commission, 1970, Hawkins, 1972; Frank and Freeman, 1978; Magee, 1979). Hawkins (1976) also emphasises on the great variation across industries in terms of the net employment effect[3] and that FDI had a positive and a negative impact on high- and low-skilled labour demand respectively. In addition, Kujawa (1980) finds that average employment in US MNCs increased by 4.8% for the years 1973 – 1978, despite the fact that during the last year it fell by 2.6%.

More recent studies take into consideration both worker and FDI location heterogeneity. That is, they link the complementarity and substitution effects to whether the worker is high-skilled or low-skilled and to whether the foreign affiliate is located in a high- or a low-income country. A series of studies for the US find a negative impact of production transfer to developing (i.e. low-income) countries on domestic employment (Brainard and Riker, 1997; Blomstrom et al, 1997; Bruno and Falzoni, 2000; Lipsey, 2002a). Desai et al. (2005b) reject the above argument.

More on the US, Harrison and McMillan (2006) and Harrison et al. (2007) find a positive and a negative effect of employment in affiliates in high- and low-income countries respectively, on home employment. Ebenstein et al. (2009) also find that employment in affiliates in low-income countries has a negative effect on the employment level of workers who perform the most routine (i.e. low-skill intensive) tasks, while it has no effect on the employment level of

[2] Survey conducted by the Emergency Committee for American Trade on 74 manufacturing MNCs.

[3] Drug, Cosmetic, Office Machinery, and Electrical Equipment industries experienced net gains, while, Lumber, Wood, Furniture, Textile and Apparel industries experienced net losses.

those who perform intermediate- (i.e. medium-skill intensive) and least-routine (i.e. high-skill intensive) tasks.

Similar conclusions to those above are drawn for Japanese and Italian manufacturing firms (Head and Ries, 2002; Mariotti et al., 2003; Barba Navaretti, Falzoni, Turrini, 2001). The third study makes also a probit analysis through which they conclude that FDI in low-wage countries is more likely to be of vertical type and therefore, abundant intra-firm trade to occur.

Several studies on Swedish MNCs find that employment in affiliates located in other high-income countries substitutes for employment at home, while this is not the case for employment in affiliates in low-income countries (Branconier and Ekholm, 2000; Hakkala and Kokko, 2000; Fors and Kokko, 2001; Kokko, 2002). Their explanation for these findings is driven by the fact that the big majority of Swedish MNCs during that period were located mainly in high-income regions, such as the US and Europe. What is more on Sweden, Blomstrom et al. (1997) argue that lower skilled employment at home was benefited by affiliate employment in high-income countries, whereas higher skilled employment benefited more from affiliate employment in low-income countries. Lipsey, Ramstetter and Blomstrom (2000a, 2000b) draw the same conclusions for Japanese MNCs for the years 1986, 1989 and 1992.

Another group of studies compare the outcomes on employment between a firm that engages in FDI and a firm that does not, by applying the propensity score matching technique. Two studies on Italy and France find that domestic employment increased for the years 1993 – 2000 when FDI was directed either to high- or low- income countries (Barba Navaretti and Castellani, 2004; Barba Navaretti, Castellani and Disdier, 2010). Same positive FDI effects are also found for Germany and Japan (Kleinert and Toubal, 2007; Becker and Muendler, 2008; Hijzen, Inui and Todo, 2007).

In contrast, adverse effects of FDI in terms of its location have been found for Korea and Taiwan (Debaere et al., 2006; Liu and Huang, 2005; Chen and Ku, 2005; Liu and Nunnenkamp, 2011). The second and the third study emphasise on the negative impact of intra-firm imports on domestic employment, but the second of the two, adds that cost-saving production of intermediates in the foreign affiliates induces parent companies to keep more employment at home for the production of final goods. The fourth study also focuses on the FDI type, and finds that home employment effects of vertical and export-platform FDI are negative, while those of horizontal FDI tend to be positive.

Two studies focus on the essential role of international wage differentials. Hatzius (1997) uses a sample of Swedish MNCs and reports that higher foreign costs are positively related to domestic employment. Equivalently, Becker et al. (2005) conclude that affiliate employment works as a substitute for employment in the parent as a response to wage differentials internationally.

A recent set of studies derive their models from a translog cost function. Abraham and Konings (1999) argue that foreign competition from the countries of Central and Eastern Europe (CEEC) has a positive and a negative effect on the employment level of large and small EU companies, respectively. In similar studies, Konings and Murphy (2001, 2006), surprisingly, find that there is employment substitution effect only between parents and their affiliates in high-wage EU countries while there is no such effect between parents and their affiliates in low-wage EU and CEEC countries.

At the end of the day, the vast majority of the studies covered in this section may implicitly refer to the repercussions of intra-firm imports and exports on domestic employment, but hardly any of them incorporates these two flows in the models they estimate in order to figure out how employment and the tasks performed in the two entities (parent company and its affiliate) are linked. This paper goes in this new direction.

3. Econometric Framework

We build our econometric model by following the strand of the empirical literature which makes use of a translog cost function.[4,5] Thus, our empirical strategy is as follows.

To begin with, in our translog cost function we assume that capital in each of the eight industries in our sample is a quasi-fixed factor. Thus, minimisation of the cost function in each industry implies minimisation of the cost of the second important factor of production, labour. After solving the minimisation problem with respect to labour, we end up with the

[4] Other studies of particular interest to us, except for those mentioned in Section 2, mainly because they use a translog cost function to derive their models, are those which focus on skill upgrading: Berman, Bound and Griliches (1994), Feenstra and Hanson (1996a, 1996b, 2001), Autor et al (1997), Slaughter (2000), Head and Ries (2002) and Hansson (2005).

[5] The translog cost function was introduced by Diewert (1974, p. 139). It was first used in international trade literature by Kohli (1978, 1991). According to Slaughter (2000, p. 460, footnote 13): “The advantage of a translog functional form is that it imposes fewer restrictions on factor substitutability than either CES, or Cobb-Douglas, or Leontief production technologies.”

following labour demand equation in which we incorporate industry- and time-specific fixed effects:

$$\log L_{it} = u_i + \kappa_1 * \log \frac{W_{it}}{L_{it}} + \kappa_2 * \log \frac{K_{it}}{Y_{it}} + \kappa_3 * \log Y_{it} + \delta_1 * TD_t + \varepsilon_{1it} \qquad (1)$$

Where i indexes industries; t indexes time; L_{it} is the total number of employees; u_i is a full set of industry dummies (industry-specific fixed effects); W_{it} / L_{it} is the unit wage cost; K_{it} / Y_{it} is the capital intensity; Y_{it} is the value added output; TD_t is a full set of time dummies (time-specific fixed effects); ε_{1it} is the error or disturbance term.

Since both the dependent and independent variables in our model are in logs, all coefficients represent elasticities. Employment level and unit wage cost are negatively linked, thus, κ_1 is expected to be negative. Capital intensity accounts for any impact of investment on employment. Hence, a positive sign of κ_2 implies that capital investment stimulates employment. Value added controls for industry scale or, in other words, for general product market conditions in the industry. Thus, κ_3 is expected to be positive. Industry-specific fixed effects control for any unobserved industry characteristics that are time-invariant (i.e. non-time-varying differences in technology and innovation across industries, etc.), while time-specific fixed effects control for any unobserved factors common to all industries (i.e. US economy-wide demand shocks, US government spending, unit wage cost in other sectors (i.e. services, etc.), etc.).

We now add to Eq. (1) the two variables of our particular interest, intra-firm imports (M_{it}^{intra}) and intra-firm exports (X_{it}^{intra}). We also include some additional control variables such as: R&D intensity (the ratio of R&D expenditure to value added output) as a proxy for demand for technology or skill intensity in each industry[6], the high-skill share (the ratio of the number of high-skilled employees to the total number of employees) as an extra control variable for skill intensity, and the total factor productivity as a proxy for the average level of productivity in each industry. Then, we get our baseline estimating equation:

$$\log L_{it} = u_i + \alpha_1 * CV + \alpha_2 * \log M_{it}^{\text{intra}} + \alpha_3 * \log X_{it}^{\text{intra}} + \delta_2 * TD_t + \varepsilon_{2it} \quad (2)$$

[6] Konings and Murphy (2001, 2006) who also use R&D intensity as a proxy for skill intensity, calculate it as the share of the value of intangible assets in the total value of assets.

Where CV is a vector variable which comprises all control variables incorporated in Eq. (2) and α_1 is the corresponding vector coefficient:

$$CV = \begin{bmatrix} \log\frac{W_{it}}{L_{it}}, \log\frac{K_{it}}{Y_{it}}, \log\frac{R\&D_{it}}{Y_{it}}, \log\frac{L_{it}^{NPROD}}{L_{it}}, \log TFP_{it}, \\ \log Y_{it} \end{bmatrix}$$

As regards the additional control variables, we expect the coefficients of the two variables that capture skill intensity to be positive, while the coefficient of total factor productivity can be either positive or negative. That is, if it is positive, then, ceteris paribus, an increase in the average total factor productivity of the industry leads to a higher demand for labour, while if it is negative, it leads to a lower demand. Moreover, the intuition behind the two variables of our particular interest (intra-firm imports and exports) is that they try to capture any positive or negative effects of intra-firm trade on aggregate labour demand in each manufacturing industry. That is, if α_2 and α_3 are positive, then, ceteris paribus, an increase in intra-firm imports and exports results in an increase in domestic labour demand and vice versa.

At this stage, it is important to emphasise the reasons we believe that intra-firm trade between US parent companies and their foreign affiliates can have industry-wide employment effects. The primary reason is related to the fact that, in the vast majority of the cases, US parents dominate the industry in which they operate in terms of employment and value added.[7] They also dominate the whole manufacturing sector.[8] Thus, ceteris paribus, positive or negative effects of intra-firm imports and exports on employment level in US parents should be reflected to the industry-wide, as well as, the sector-wide level of employment.

Moreover, the US domestic firms which are not MNCs can be deemed as an additional channel through which industry-wide effects can occur. To be more specific, a significant part of these firms, based on their productivity level, follow the lead of the MNCs and become

[7] The average shares of US parents' employment in aggregate employment in the industry in which they operate for the period 1995 – 2005 are very high: 53% in Food et al., 64% in Chemicals et al., 60% and 95% in Total Machinery et al. and Transport Equipment respectively. Average shares are lower but still high in Textiles et al., Wood et al., Non-Metallic Mineral Products, and Basic and Fabricated Metal Products (24%, 38%, 30%, and 26% respectively). Similar results are found for the value added. The calculations are ours with the use of the BEA data. In addition, for a similar argument to ours, see Slaughter (2000, p. 461 – 462).

[8] For the period 1995 – 2005, employment in all US parents operating in the US manufacturing sector accounts, on average, for the 48% of total employment. The calculations are ours with the use of the BEA data.

exporters[9], importers (through foreign outsourcing[10]) or both. Thus, any employment effects of such exporting or/and importing behaviour of these firms can be of the same kind as those of intra-firm exports and imports respectively. In addition, some of these firms benefit from any supportive role they have in the operations of the foreign affiliates which is not undertaken by the MNCs themselves (i.e. dispatch of intermediates from US non-affiliated companies to the US affiliates abroad), while others are adversely hit by foreign competition because tasks which MNCs would have outsourced to them are instead performed within their foreign affiliates at a much lower cost.

The estimating equations for low- and high-skilled workers are shown below. All variables are the same as those in Eq. (2) except for the fact that the variables for employment and unit wage cost now refer to the two types of workers. In addition, R&D intensity and high-skill share are dropped since controlling for skill intensity is redundant.

Hence, the estimating equation for low-skilled (production) workers is:

$$\log L_{it}^{PROD} = u_i + \beta_1 * CV + \beta_2 * \log M_{it}^{\text{intra}} + \beta_3 * \log X_{it}^{\text{intra}} + \delta_3 * TD_t + \varepsilon_{3it} \quad (3)$$

Where CV is a vector variable which comprises all control variables incorporated in Eq. (3) and β_1 is the corresponding vector coefficient:

$$CV = \left[\log \frac{W_{it}^{PROD}}{L_{it}^{PROD}}, \log \frac{K_{it}}{Y_{it}}, \log TFP_{it}, \log Y_{it} \right]$$

And the estimating equation for high-skilled (nonproduction) workers is:

$$\log L_{it}^{NPROD} = u_i + \gamma_1 * CV + \gamma_2 * \log M_{it}^{\text{intra}} + \gamma_3 * \log X_{it}^{\text{intra}} + \delta_4 * TD_t + \varepsilon_{4it} \quad (4)$$

[9] For a link between productivity level of a firm and its exporting behaviour, see Melitz (2003). For the fact that exporters are bigger in size in terms of employment among other exporter premia, see Bernard, Jensen and Lawrence (1995), Bernard and Jensen (1999), Clerides, Lach and Tybout (1998), and Aw, Chen and Roberts (2001).

[10] According to Feenstra (2010, p. 6), foreign outsourcing implies that part of firm production is achieved abroad and outside its boundaries. For a link between productivity level of a firm and adoption of foreign outsourcing, see Antràs (2005).

Where CV is a vector variable which comprises all control variables incorporated in Eq. (4) and γ_1 is the corresponding vector coefficient:

$$CV = \left[\log \frac{W_{it}^{NPROD}}{L_{it}^{NPROD}}, \log \frac{K_{it}}{Y_{it}}, \log TFP_{it}, \log Y_{it} \right]$$

In Eq. (3), positive signs of β_2 and β_3 imply positive manufacturing-wide effects of intra-firm imports and exports respectively on the employment level of low-skilled workers, and vice versa. The coefficients γ_2 and γ_3 in Eq. (4) are interpreted similarly. Hence, different signs of these coefficients allow us to discern different effects of intra-firm imports and exports on the level of employment of these two particular groups.

4. Data Sources and Data Description

4.1. Data sources

In this paper we make use of industry-level data on the US manufacturing sector and on US MNCs' affiliates abroad from three different sources: the OECD, the NBER-CES Manufacturing Industry Database, and the Bureau of Economic Analysis (BEA). Since each database is developed by different institution, there are essential differences among each other in terms of their structure (i.e. name and SIC of industries, level of aggregation, etc.). Therefore, before making use of any of their data, we need first to match them accordingly, by using the OECD database as our benchmark. The OECD database comprises a panel of industry-year data at two-digit aggregation level (2-digit ISIC rev. 3). Table I.1, in Appendix I, reports the names and the two-digit SIC codes of the eight US manufacturing industries.[11]

For the special case of the NBER-CES database, since its original version contains a panel of four-digit SIC industry-year observations (SIC ranges from 2011 to 3999), before proceeding to its match with our benchmark database, we first convert it into a panel of two-digit SIC observations (SIC ranges from 20 to 39).

4.2. Data description

[11] Due to a high number of missing observations for some variables of utmost importance in our econometric specifications we exclude from our analysis the aggregated industries "Furniture, recycling and manufacturing n.e.c." with SIC codes 36 – 37.

The match of the three databases allows us to collect the industry-level data required for the period between 1995 and 2005. More analytically, data on the total number of employees, total payroll, total number of production workers and total amount of wages of production workers in the US manufacturing sector, are drawn from the NBER-CES Manufacturing Industry Database. By using these data we calculate the total number of nonproduction workers (i.e. we subtract the total number of production workers from total number of employees) and their total amount of wages (i.e. we subtract the total amount of production worker wages from total payroll). Production and nonproduction workers are used as proxies for low- and high-skilled labour respectively. From the same database we obtain data on the five-factor total factor productivity (TFP5) annual growth rate. We convert these growth rates into levels by setting the value of our first year (1995) equal to 100 and computing each next value through the multiplication of the value of the current year with the corresponding growth rate.

Moreover, data on intra-firm imports (imports of goods of US parents from their affiliates abroad), intra-firm exports (exports of goods of US parents to their affiliates abroad), gross fixed capital formation and R&D expenditure in the US manufacturing sector are drawn from the OECD database. As regards data on US affiliates abroad, these refer only to majority-owned affiliates (MOFAs) and to the industry in which they operate. Data on their value added, total compensation of employees, total number of employees and total sales (turnover) are collected from the OECD as well.

Furthermore, data on compensation and total number of production and nonproduction workers in US affiliates are obtained from the BEA. Nevertheless, these data are available only for the years 2004 – 2008. That is, we have real observations only for two out of the eleven years of our sample (i.e. 2004 and 2005). In order to fill the gaps for the period 1995 – 2003 we do the following: for the years 2004 – 2008, we calculate the ratios of the compensation and number of production and nonproduction workers to the compensation of all employees and total number of employees respectively. We then compute their median values. Having done that, we assume that the equivalent ratios for the period 1995 – 2003 are constant overtime and equal to these four median values. This allows us to calculate the compensation and number of employees by skill.

Finally, we collect OECD data on bidirectional ad valorem maritime transport costs of commodities[12] between the US and its trading partners in four main geographical regions

[12] Data comply with the Harmonised System (HS 1988, 2-digit) of Commodities.

(Canada, Europe, Latin America, Asia and Pacific)[13,14], and BEA data on the geographical breakdown of intra-firm imports and exports based on the aforementioned regions[15]. These data allow us to devise two variables which are used as instruments in our IV regressions. These are the industry-year ad valorem import and export transport costs between the US and the four geographical regions. Their construction process is as follows.

First, we map the HS 2-digit commodities into the 2-digit ISIC industries of our benchmark database. As a consequence, the bidirectional ad valorem transport costs between the US and each trading partner now correspond to our eight 2-digit manufacturing industries. Then, we calculate their median values by geographical region and by industry. Finally, we calculate the weighted averages of these median values by industry and year for both kinds of flows. As weights we use intra-firm imports and exports between US parents and their affiliates in the four main geographical regions as a share of total intra-firm imports and exports respectively.

5. Econometrics

As regards the estimation of equations (2), (3) and (4), we apply the OLS and IV (2SLS) methods with industry- and time-specific fixed effects. The second technique is used in order to tackle with any potential endogeneity problems in our three estimating models. Industry-wide shocks related to demand and productivity are captured by value added output and total factor productivity respectively, as we mentioned in Section 3. However, there may be shocks other than those related to demand and productivity, which are not captured by any of our control variables or the time- and industry-specific fixed effects. Therefore, they are included in the error term and may have a positive or negative impact on our independent variables. As a consequence, any effects of intra-firm imports and exports on domestic labour demand may be underestimated or overestimated (i.e. an industry-wide positive shock leads to an increase in the aggregate employment in the industry and, at the same time, in intra-firm imports and exports).

[13] For the two configurations of the geographical regions for the cases of ad valorem transport costs from a country to the US (i.e. import transport costs) and vice versa (i.e. export transport costs), see Appendix II.

[14] We assume that maritime transport costs from the US to Canada and vice versa are symmetric since we have available data only for one of the two directions (i.e. from Canada to the US).

[15] The Africa and Middle East region is excluded due to many missing observations on intra-firm imports and exports between affiliates in this region and their US parents in the BEA data. This is not an important problem though, since even in the few cases that there are observations, their shares in total intra-firm imports and exports respectively, are negligible.

Therefore, we need to find instruments for the variables in our models which are, at the same time, correlated with the instrumented variables but not with the error term. For the instrumentation of the unit wage cost, capital intensity, R&D intensity, high-skill share, total factor productivity and value added output, we use the same variables lagged by one period of time since we assume that, due to the existence of frictions, time adjustment for all these variables is one year.

As regards the instrumentation of intra-firm imports and intra-firm exports, we use four instruments for each of the two. For intra-firm imports we use: the intra-firm imports lagged by one year, the ad valorem import maritime transport costs, the ratio of the unit wage cost in US affiliates abroad to the unit wage cost in the corresponding US industry (relative foreign unit wage cost), and the ratio of the value added of foreign affiliates to their total sales. For intra-firm exports we use: the intra-firm exports lagged by one year, the ad valorem export maritime transport costs, and the same last two instruments as for intra-firm imports.

The intuition behind the use of intra-firm imports and exports lagged by one year as instruments is the following. Although during the last decades there has been a boost in FDI and as a consequence in intra-firm trade, the preparatory process undertaken by any MNC in order to make a new investment abroad, which may affect the volume of intra-firm trade, can be very demanding in terms of time. That is, it needs to make a business plan for this particular prospective investment, to conduct research on the labour, tax and environment protection laws, as well as, the political and business climate in the country or region in which is planning to invest. In addition, negotiations with local authorities (i.e. central or local governments, etc.) of host countries or regions on any possible subsidies that may be given to the MNC as an extra incentive for investment may also be time-consuming, especially when there is competition for the attraction of FDI among countries or even among different regions within the same country.[16]

Even in the case that an MNC wants to change its production strategy, by shutting down its affiliate or downsizing it by transferring a significant part of its production activities to a third (non-affiliated) foreign company through foreign outsourcing (i.e. arm's length, licencing, etc.), it needs to spend considerable time on searching and matching with the right foreign contractor so as to secure its business interests (i.e. prevention from imitation, etc.) and the smooth operation of its activities (i.e. procurement of intermediates or finished goods from

[16] See Hanson (2001, p. 19 – 21) for a more detailed description of such factors through the presentation of two very informative case studies on FDI of General Motors (GM) and Ford Motor Co. in Brazil, and of a third one on Intel's decision to invest in Costa Rica.

the foreign contractor in time and according to the quality standards set by the MNC, etc.).[17] Thus, due to the existence of such frictions we assume that time adjustment of intra-firm flows is equal to one year.

The correlation between intra-firm imports and exports and their respective ad valorem maritime transport costs stems from the fact that lower bidirectional transport costs favour intra-firm trade, and vice versa.[18] It is also very important that any unobserved industry-wide shock does not have any impact on transport costs. Hence, they are both uncorrelated with the error term.

What is more, one of the main factors that drive the manager's decision of the parent company to transfer part of the domestic production to the foreign affiliate is the unit labour cost abroad compared to the one at home (relative foreign unit wage cost). The lower this ratio becomes, the greater the incentive for the manager to make such a decision in order to achieve cost-effective production[19] and hence, the more likely bidirectional intra-firm flows to occur.

The ratio of value added to total sales of foreign affiliates indicates what part of inputs and outputs which comprise their total sales is produced in house.[20] In other words, a low ratio implies that the affiliates are specialised in specific tasks and are highly dependent on inputs from other firms, including their parents. Thus, the lower this ratio becomes the more likely the creation of intra-firm trade is.

As a final remark, all these instruments apply to all three estimating equations with the only difference that the domestic unit wage cost lagged by one year and the relative foreign unit wage cost correspond to all employees in Eq. (2), and to production and nonproduction workers in Eq. (3) and Eq. (4) respectively.

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[17] For extensive analyses about the conditions under which firms make agreements with foreign contractors (i.e. arm's length, etc.), see Antràs (2003, 2005), Antràs and Helpman (2004), and for a summary of them, see Helpman (2006).

[18] According to Korinek and Sourdin (2009, p.2), 90% of world trade by weight is carried by ship. The same authors also find a strong negative impact of maritime transport costs on trade.

[19] For several studies which argue about this, see Kravis and Lipsey (1988), Hatzius (1997), and Becker et al. (2005).

[20] For more details about the economic interpretation of this ratio, see Hanson, Mataloni and Slaughter (2001, p. 21).

6. Empirical Results

Table III.1, in Appendix III, reports the results for Eq. (2) of the OLS (column 1) and IV (2SLS) (column 2) with industry- and time-specific fixed effects and robust standard errors to heteroskedasticity. In the first regression the coefficient estimate of total factor productivity is positive while in the second it becomes negative. In both cases though, it is statistically insignificant. The coefficient estimates of the rest of our control variables have the expected signs and are statistically significant in both regressions except for the coefficient estimate of R&D intensity, which is not statistically significant in the IV regression. The first method also indicates that employment at home is positively affected by intra-firm exports but unaffected by intra-firm imports. However, when we account for endogeneity in our model and apply the IV method, it turns out that intra-firm imports have a negative impact on domestic employment while there is still a positive, and even greater in magnitude, effect of intra-firm exports.

The null hypothesis that our model is underidentfied is rejected (p-value = 0.0806 < 10%), and so is the null hypothesis of the weak identification test. Therefore, the instruments used are strongly correlated with our endogenous regressors. The Sargan-Hansen test (Hansen J statistic) indicates that the null hypothesis is accepted (p-value = 0.4840 > 10%). That is, the instruments are valid or, in other words, they are uncorrelated with the error term. Furthermore, goodness of fit is very satisfactory as R-squared is very high (92.65%) and the p-value of the F-statistic (0.000) is less than 10%.

Thus, we conclude that a 10% increase in intra-firm imports is associated with a roughly 1% decrease in home employment, while a 10% increase in intra-firm exports is associated with about a 1.25% increase in home employment.

OLS and IV results for Eq. (3) are reported in Table III.2. Although OLS results are very surprising since they imply that employment level of low-skilled workers is unaffected by both intra-firm imports and exports, we cannot rely on them since the coefficient estimates may be biased due to endogeneity. Indeed, IV results tell a rather different story. In particular, while intra-firm imports have a strong negative impact on their employment level (i.e. a 10% increase in intra-firm imports results in a 1.08% reduction in their employment level), intra-firm exports have no impact at all (i.e. the relevant point estimate is positive but not statistically significant).

Regarding the relevant tests to the IV regression, the underidentification, weak identification and Sargan-Hansen tests indicate that our instruments are strongly correlated with our endogenous variables while, at the same time, they are uncorrelated with the error term.

As far as the estimation results for Eq. (4) are concerned, Table III.3 shows that both OLS and IV point estimates of intra-firm imports are negative but statistically insignificant. This indicates that the employment level of high-skilled workers is not affected by intra-firm imports. In contrast, intra-firm exports exert a strong positive effect on their level of employment. That is, a 10% increase in intra-firm exports is associated with a 1.59% increase in their level of employment which is substantial. The three tests related to the IV regression imply that the instrumental variables are strongly correlated with the instrumented ones and uncorrelated with the error term.

To recap, aggregate employment level in the US manufacturing sector seems to be positively and negatively affected by intra-firm exports and intra-firm imports respectively. In particular, the magnitude of the first effect is greater than the magnitude of the second. That is, ceteris paribus, an equal percentage increase in intra-firm flows in both directions results in an overall positive effect on domestic employment. What is more, while low-skilled labour demand is adversely affected by intra-firm imports, it does not seem to benefit from intra-firm exports. In contrast, high-skilled labour benefits a lot from intra-firm exports and tends to be unaffected by intra-firm imports.

Since such manufacturing-wide effects occur primarily through the US parents, a plausible explanation for the last two findings could be the following. On the one hand, specific stages of the production process which require low-skilled labour (i.e. assembly line, etc.) are transferred from US parents to their foreign affiliates and a share of their output (i.e. finished or unfinished goods) is shipped to US parents (i.e. intra-firm imports). On the other hand, production stages which require high specialisation and therefore, high-skilled labour (i.e. R&D, design, marketing, etc.), take place within the US parent companies and a share of the output they produce (i.e. goods for further processing) is sent to their affiliates abroad (i.e. intra-firm exports).

7. Concluding remarks

The main aim of this paper is to study the effects of intra-firm trade between US parent companies and their foreign affiliates on the aggregate employment level, as well as, on the employment level of high- and low-skilled workers in the US manufacturing sector for the period 1995 – 2005.

Our main findings are summarised as follows. First, we find that intra-firm imports and exports have manufacturing-wide effects on domestic employment, and more specifically, a negative and a positive one respectively. Although both effects are strong in absolute terms, the former effect is milder than the latter.

Second, the employment level of low-skilled workers is negatively affected by intra-firm imports while it tends to be unaffected by intra-firm exports. Third, high-skilled workers are the ones who reap the benefits from intra-firm exports in terms of their employment level. At the same time, they remain unaffected by intra-firm imports.

The manufacturing-wide effects (which operate mostly through the US parents) on high- and low-skilled labour suggest that low-skill intensive tasks (i.e. assembly line, etc.) are mainly performed within the US affiliates abroad and part of their output (i.e. intermediates or finished goods) is dispatched to their parent companies (employment substitution effect on low-skilled labour), while sophisticated, and therefore, high-skill intensive tasks (i.e. R&D, etc.) are mostly kept within the boundaries of US parents and part of their output (i.e. goods for further processing) is dispatched to their affiliates abroad (employment complementarity effect on high-skilled labour).

All in all, this paper contributes to the better understanding of the association of intra-firm trade, and more generally of FDI, with home employment. Especially, when we account for heterogeneity across workers in terms of their skill, our findings become more illustrative and widespread concerns about any adverse effects of globalisation on the most vulnerable groups of workers are prone to be justified.

Nevertheless, further research needs to be done which will treat locations of foreign affiliates as heterogeneous (i.e. intra-firm trade between US parents and their affiliates located in high- and low-income countries-regions). Moreover, the displacement of low-skilled workers due to intra-firm imports along with the wholesome effect of intra-firm exports on high-skilled workers makes us suspect that demand shifts towards high-skilled labour within the US manufacturing sector. The displacement effect may also apply downward pressure on the wages of low-skilled labour; with an ensuing impinge on wage distribution. The last two very important issues should also be put under thorough examination.

Our aim is to shed more light on the implications of intra-firm trade on different aspects of domestic labour by going in the directions suggested above.

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Appendix I

Table I.1: Manufacturing Industries (level of aggregation: 2-digit ISIC rev. 3) – OECD Database

No	Industry	SIC Codes
1	Food Products, Beverages and Tobacco	15 – 16
2	Textiles, Textile Products, Leather and Footwear	17 – 19
3	Wood and Products of Wood and Cork, Pulp, Paper, Paper Products, Printing and Publishing	20 – 22
4	Chemical, Rubber, Plastics and Fuel Products	23 – 25
5	Other Non-metallic Mineral Products	26
6	Basic Metals and Fabricated Metal Products	27 – 28
7	Machinery and Equipment	29 – 33
8	Transport Equipment	34 – 35

Appendix II

Ad valorem import transport costs (from a US trading partner to the US)

The four geographical regions comprise the following countries:

- **Canada**
- **Europe:** Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, EU 15, Hungary, Latvia, Lithuania, Norway, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Switzerland, Turkey
- **Latin America:** Argentina, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama, Paraguay, Peru, Uruguay, Venezuela
- **Asia and Pacific:** Australia, Bangladesh, Cambodia, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Nepal, New Zealand, Pakistan, Philippines, Singapore, Taiwan, Thailand, Vietnam

Ad valorem export transport cost (from the US to its trading partner)

The four geographical regions comprise the following countries:

- **Canada**
- **Europe:** EU 15
- **Latin America:** Argentina, Brazil, Ecuador, Paraguay, Peru, Uruguay
- **Asia and Pacific:** Australia, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Singapore, Thailand, Vietnam

Appendix III

Table III.1: OLS and IV results with industry- and time-specific fixed effects for Eq. (2).

Dependent Variable: L_{it}	OLS	IV (2SLS)
W_{it} / L_{it}	-3.481***	-3.649***
	(0.328)	(0.706)
K_{it} / Y_{it}	0.281***	0.417***
	(0.054)	(0.103)
$R\&D_{it}$ / Y_{it}	0.081**	0.089
	(0.033)	(0.073)
L_{it}^{NPROD} / L_{it}	0.529***	0.707***
	(0.104)	(0.181)
TFP_{it}	0.012	-0.023
	(0.036)	(0.038)
Y_{it}	0.708***	0.883***
	(0.053)	(0.099)
M_{it}^{intra}	-0.002	-0.098**
	(0.021)	(0.040)
X_{it}^{intra}	0.074***	0.125*
	(0.028)	(0.067)
Industry fixed effects	yes	yes
Time fixed effects	yes	yes
Underidentification (p-value)	-	0.0806
Weak instruments	-	χ^2 = 0.635
Hansen J Statistic (p-value)	-	0.4840
Observations	88	80
R-squared	0.6489	0.9265
F-statistic (p-value)	0.0000	0.0000

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Instruments: unit wage cost, capital intensity, R&D intensity, high-skill share, total factor productivity, value added, intra-firm imports and exports, all lagged by one year; ad valorem import and export maritime transport costs, relative foreign unit wage cost, value-added-to-sales ratio in US affiliates.

Table III.2: OLS and IV results with industry- and time-specific fixed effects for Eq. (3).

Dependent Variable: L_{it}^{PROD}	OLS	IV (2SLS)
$W_{it}^{PROD} / L_{it}^{PROD}$	-2.599***	-2.648***
	(0.357)	(0.606)
K_{it} / Y_{it}	0.332***	0.372***
	(0.056)	(0.106)
TFP_{it}	-0.024	-0.063**
	(0.033)	(0.031)
Y_{it}	0.713***	0.915***
	(0.051)	(0.080)
M_{it}^{intra}	0.006	-0.108**
	(0.026)	(0.050)
X_{it}^{intra}	0.011	0.045
	(0.028)	(0.041)
Industry fixed effects	yes	yes
Time fixed effects	yes	yes
Underidentification (p-value)	-	0.0320
Weak instruments	-	$\chi^2 = 1.440$
Hansen J Statistic (p-value)	-	0.5378
Observations	88	80
R-squared	0.6141	0.9255
F-statistic (p-value)	0.0000	0.0000

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Instruments: unit wage cost, capital intensity, total factor productivity, value added, intra-firm imports and exports, all lagged by one year; ad valorem import and export maritime transport costs, relative foreign unit wage cost, value-added-to-sales ratio in US affiliates.

Table III.3: OLS and IV results with industry- and time-specific fixed effects for Eq. (4).

Dependent Variable: L_{it}^{NPROD}	OLS	IV (2SLS)
$W_{it}^{NPROD} / L_{it}^{NPROD}$	-3.547***	-4.043***
	(0.615)	(0.966)
K_{it} / Y_{it}	0.169**	0.233*
	(0.076)	(0.131)
TFP_{it}	0.110**	0.091*
	(0.051)	(0.052)
Y_{it}	0.629***	0.790***
	(0.070)	(0.123)
M_{it}^{intra}	-0.020	-0.074
	(0.035)	(0.060)
X_{it}^{intra}	0.142***	0.159**
	(0.044)	(0.063)
Industry fixed effects	yes	yes
Time fixed effects	yes	yes
Underidentification (p-value)	-	0.0253
Weak instruments	-	$\chi^2 = 1.116$
Hansen J Statistic (p-value)	-	0.6489
Observations	88	80
R-squared	0.5822	0.8126
F-statistic (p-value)	0.0000	0.0000

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Instruments: unit wage cost, capital intensity, total factor productivity, value added, intra-firm imports and exports, all lagged by one year; ad valorem import and export maritime transport costs, relative foreign unit wage cost, value-added-to-sales ratio in US affiliates.