Misallocation of intermediate inputs and Global Value Chains

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Abstract

This paper analyses how distortions in input markets are a source of factor misallocation in Spanish manufacturing. It uses recent firm-level misallocation measures for the three main inputs in a production function (capital, labor and intermediate inputs), with a particular focus on misallocation of intermediate inputs and its relation to Global Value Chains (GVCs). Previous literature has focused exclusively on capital or labor inputs, but not on the misallocation of intermediate goods. We find evidence that firms' participation in GVCs is behind a decline in the misallocation of intermediate inputs. This is confirmed not only through a two-way fixed effects estimator but also via a staggered difference-in-differences (DiD) methodology for causal inference and a DiD with a continuous treatment intensity approach that exploits the emergence and expansion of fibre-optic based ICT technology that facilitates the operation of GVCs. The decline in the misallocation of intermediate inputs is compatible with the increase in Total Factor Productivity that Spain has experienced since the 2008 crisis.

Keywords: Misallocation, Productivity, Firm-level data, Intermediate Inputs, Global Value Chains.

JEL codes: D24, F23, O47

Funding: Carolina Calatayud acknowledges the Spanish Ministry of Universities for funding under FPU20/02097 to support this research. Carolina Calatayud and María E. Rochina-Barrachina also thank financial support from Grant PID2021-124266OB-I00 funded by MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe" and from Grant TED2021-130232B-I00 funded by MCIN/AEI/10.13039/501100011033 and by the "European Union NextGenerationEU/PRTR".

Acknowledgements: We also acknowledge comments and suggestions from participants at the 17th ISGEP Workshop on "Trade, Innovation, and Global Value Chains" (2022, Pisa), the III Workshop of Young Researchers of the Department of Economic Analysis (2023, Valencia), the MEFIB 2023 (2023, Castellón), the XXV Applied Economics Meeting (2023, Toledo) and the XXIV Conference on International Economics (2023, Alcalá de Henares). The usual disclaimer applies.

1. Introduction.

As is common in the literature, misallocation is typically defined as the loss of aggregate output caused by distortions. In other words, misallocation, which refers to the misuse of available resources, occurs due to various types of distortions in input markets. Consequently, more efficient firms tend to be smaller than their optimal size, while less efficient firms tend to be larger than their optimal production scale.

Related literature has measured allocative efficiency of production factors in two different ways. The first, already in Hsieh and Klenow (2009), is based on the within-industry dispersion in marginal revenue products (MRPs) of inputs. Higher dispersion is expected to be associated to more barriers, distortions or frictions that impede the efficient allocation of inputs and generate the loss in aggregate output. The second, is a firm-level misallocation measure proposed by Petrin and Sivadasan (2013). It is equal to the absolute value of the gap between the value of the marginal product (VMP) and the marginal cost of an input. They show that this gap corresponds to the change in aggregate output that would occur if a firm were to shift the use of that input in the efficient direction by one unit holding aggregate input use constant. An efficient direction means that input units are reallocated from lower to higher marginal product firms. Since both approaches try to justify the evolution of aggregate output as a consequence of the reallocation of resources, the study of the misallocation of factors of production is not only relevant because of its implications for the growth of aggregate output in the economy, but also because of its implications for average total factor productivity (TFP) growth.

To understand the relationship between misallocation and average TFP growth, it is particularly important to first examine the evolution of TFP in Spain, as this study focuses on this country. Figure 1 presents the TFP trends for both the euro area and Spain, using data sourced from official statistics (AMECO), starting from 2000.

Figure 1. Evolution of TFP for the Euro area and Spain.

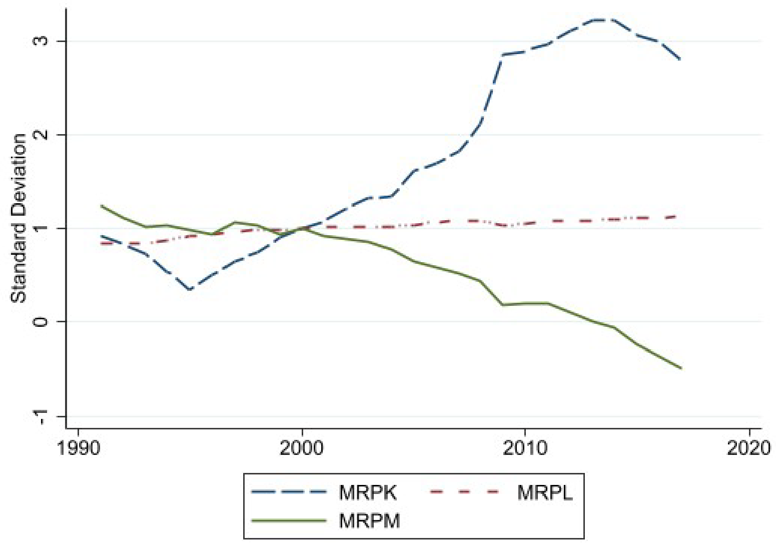
Notes: (i) Source: AMECO (ii) We normalise the TFP to base 100 in the year 2015.

The fall and deceleration of TFP in the Spanish economy until 2009 has been analysed by two recent papers that sought to relate misallocation with this poor performance of the Spanish TFP (Gopinath et al., 2017; García-Santana et al., 2020). These two papers on misallocation of production factors use the industry-level measure of within-industry dispersion of MRPs of inputs. Both papers use a different time span than ours (1999-2012 and 2000-2007, respectively, while we go from 1991 to 2017) and consider only the evolution of misallocation of capital and labour. They obtain a higher dispersion of the MRP of capital than of labour and a significant increase in the dispersion of the MRP of capital, while the dispersion of the MRP of labour remains stable. Thus, both papers consider and provide evidence that the evolution of the allocative inefficiency of capital must be behind the decline in TFP experienced until the crisis of 2008, since the allocative inefficiency of labour, by remaining stable, cannot explain the time pattern observed in TFP. However, its fall until 2009 starts to recover from then until the COVID pandemic in 2019.

Given that our time scope in this paper for the Spanish economy goes up to 2017, we ask whether there is an evolution of the allocative efficiency of production factors compatible with the pattern of TFP growth observed since 2009. For this purpose, at a descriptive and visual inspection level, and just for comparison with the other papers that for Spain have provided information about MRPs of capital and labour (Gopinath et al., 2017, for the period 1999-2012; García-Santana et al., 2020, for the period 2000-2007) we show in Figure 2 the evolution of the dispersion of the logged returns to capital, labour and intermediate inputs that we obtain with our data. In our work, we expand on previous research by incorporating information on intermediate inputs, which are the key inputs of interest in our study. Dispersion measures are calculated as the standard deviation of weighted input returns at the firm level within two-digit manufacturing industries (NACE classification) and year. In turn, for each year the aggregate measures for the whole manufacturing industry shown in Figure 2 are obtained by weighting those obtained by industry based on their respective share in total manufacturing production.[1] Using a different dataset and time interval, the Spanish Survey of Business Strategies (ESEE) for the period 1991-2017, we find an evolution of misallocation measures of production factors similar to previous work, i.e. an increasing dispersion for capital (with a deceleration since 2009) and a stable pattern for labour. However, already since 1991, and especially since 2000, we observe a significant decrease in the dispersion of marginal products of intermediate inputs, indicating greater efficiency in the allocation of this particular type of inputs. This, together with the fact that Figure 1 shows a positive evolution of TFP growth since 2009, may indicate that the deceleration of capital misallocation and, above all, the acceleration of a better allocation of intermediate inputs may be behind the improvement in TFP performance.

[1] For each industry a time-invariant weight is calculated as the average share in manufacturing production. In this way, dispersion measures purely reflect within industry variation over time.

Figure 2. Evolution of MRPK, MRPL and MRPM dispersions.

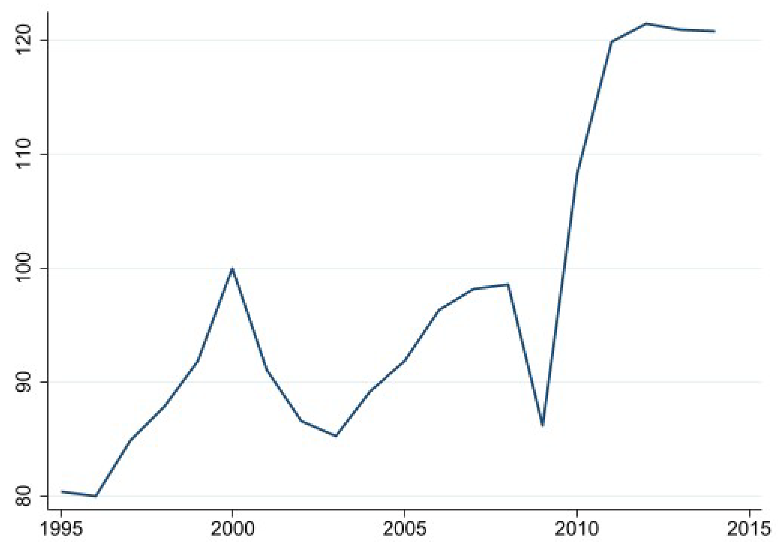


Note: (i) Source: Own elaboration with firm-level data from ESEE. (ii) MRPK, MRPL and MRPM are expressed in logarithms. (iii) We normalise the MRPs to base 100 in the year 2000.

Figure 2 shows an uneven evolution of the dispersions of the three inputs. That of capital increases, that of intermediate inputs decreases and that of labour remains stable. This points to the existence of distortions specific to each input market (Petrin and Sivadasan, 2013; Gopinath et al., 2017). Our interest is delving into de causes lying behind the decrease of intermediate input misallocation. To the best of our knowledge, this has not been widely studied in the literature, but our hypothesis is that the participation in Global Value Chains (GVCs) may be the factor leading to a better allocation of intermediate inputs. First of all, GVCs are directly related to the trade of intermediates (Antràs, 2020). Hence, firms participating in GVCs have different access to intermediate inputs, as they may have access to a wider variety, higher quality or cheaper intermediate inputs (Halpern et al., 2015; Máñez et al., 2020; Máñez Castillejo et al., 2020). Ultimately, by not being limited to domestic sourcing, they are expected to be less restricted in their choice of intermediate inputs. Finally, it is interesting to consider intermediate inputs, as their importance in world trade is evident and growing. Around 60% of the goods imported by EU countries are intermediate inputs. Moreover, they account for about half of their exports. Interestingly, Spain is among the top 10 EU countries in terms of imports of intermediate products, a value that has practically doubled since 2000 (European Commission, 2022).

In Figure 3, we plot the evolution for the Spanish economy of the Foreign Value Added (FVA) indicator of GVC participation. FVA is one of the main indicators of GVC participation, which represents the content of intermediate imports embodied in exports. The data are drawn from Borin and Mancini's (2019) novel dataset on GVC participation measures based on the World Input-Output Database (WIOD). Since 2003 there has been a general increase in the Spanish economy's participation in GVCs, with the sole exception of the trade debacle from 2008 to 2009 as a result of the initial effects of the Great Recession on trade. This growth in the Spanish economy's participation in GVCs may be behind the improvement in the allocative efficiency of intermediate inputs already observed in Figure 2. Additionally, this trend may also be reflected in the enhanced evolution of the average productivity level of the Spanish economy, particularly from 2009 up until the onset of the COVID-19 pandemic, as illustrated in Figure 1.

Figure 3. FVA in Spain.



Notes: (i) Source: World Input-Output Database (WIOD). (ii) We normalise FVA to base 100 in the year 2000.

In this paper, in addition to using measures of dispersion of marginal products of inputs for descriptive purposes and for comparison with previous work for Spain, our main measure of misallocation will be at the firm-level and following the methodology proposed by Petrin and Sivadasan (2013). Thus, we calculate the differences between VMPs and marginal costs for each input. Working with firm-level misallocation measures is not the only important difference between our work and most of previous papers. Previous literature only focused on studying the misallocation of capital and/or labour but did not pay attention to the possibility that misallocation affects a third relevant factor of production, intermediate inputs. Moreover, previous work did not have firm-level deflators in their databases and instead used deflators at the industry or economy-wide level. However, we do.

The results of the paper show that GVC participation helps alleviate intermediates misallocation. This is confirmed with a simple graphical analysis and with linear regression and two-way fixed effects (TWFE) regressions. Furthermore, we confirm causality by employing a staggered difference-in-differences (DiD) estimation procedure (Callaway and Sant'Anna, 2021). This approach allows us to examine the effects of firm participation in Global Value Chains (GVCs) using dichotomous indicators. Additionally, we employ a DiD with a continuous treatment intensity approach, leveraging the emergence and expansion of fibre-optic-based ICT technology, which facilitates GVC operations.

The paper proceeds as follows. Section 2 contains a review of the literature. Section 3 presents the methodology of measuring allocative inefficiency and GVC participation. Section 4 is devoted to the data and some descriptives. Section 5 provides details of estimation and the main results. Section 6 presents some robustness checks. Section 7 concludes.

2. Literature Review.

The literature has measured allocative efficiency of production factors in two different ways. The most traditional one has been focused on the within-industry dispersion of logged marginal revenue products (MRPs) of inputs, used as a measure of misallocation at the industry-year level. In this literature (which originates from Hsieh and Klenow, 2009), dispersion of MRPs is considered to be indicative of inputs misallocation, since it would be efficient to reallocate inputs from firms with low to high MRP until MRPs are equalised across firms. More recently, Petrin and Sivadasan (2013) proposed a measure of firm-level misallocation based on unrealised increases in aggregate productivity growth as a consequence of a firm shifting the use of an input in the efficient direction by one unit. Their measure is the difference between the marginal product and the marginal cost of the input. In the paper they prove that this gap measures exactly the change in aggregate output that would occur if a firm were to shift the use of that input in the efficient direction by one unit holding aggregate input use constant. An efficient direction means that input units are reallocated from lower to higher marginal product firms. In their paper, they focus on explaining labour gaps in Chilean manufacturing plants during the period 1982-1994 with firing costs.

Since the seminal work on misallocation (Hsieh and Klenow, 2009; Petrin and Sivadasan, 2013), subsequent empirical work has focused mainly on the dispersion of MRPs of inputs and, in particular, on the MRP of capital and distortions in this market. For example, there are some papers on misallocation of production factors for Spain using the approach of measuring within-industry dispersion of MRPs of inputs. A relevant one is the one by García-Santana et al. (2020). They are interested in explaining the fall in total factor productivity (TFP) that the country suffered during the boom years of 2000-2007. To support their argument, the authors demonstrate that during the same period, the economy experienced an increase in misallocation attributed to a decline in institutional quality. They contend that this rise in misallocation was responsible for the negative growth in TFP. They use measures of within-sector allocative inefficiency such as the dispersion of firm logged marginal revenue products (MRPs) of capital and labour and find that allocative efficiency deteriorates with a decline in institutional quality. This deterioration is more important for industries in which the connections with public officials is more relevant for success. These industries are the ones suffering more productivity losses due to misallocation. They use the BdE Micro Dataset in Almunia et al. (2018) and obtain larger dispersion of the marginal revenue product of capital than of labour.

Another relevant paper trying to explain the macroeconomic productivity slowdown in Spain between 1999-2012 is Gopinath et al. (2017). They use the ORBIS-AMADEUS data set for manufacturing. The paper is focused on capital allocation, since they find in their data that during this period there is a significant increase in the dispersion of the

MRP of capital but a stable dispersion of the MRP of labour. Therefore, this paper presents evidence of a rise in capital misallocation, which can be attributed to large capital inflows, declining interest rates resulting from Spain's entry into the EMU, and easy borrowing conditions (financial frictions). In addition, this paper provides evidence that the low productivity growth in Spain and South Europe during this period is accompanied by a significant increase in capital misallocation.

Empirical work on the second strand of the literature, which focuses on measuring and explaining firm-level misallocation using differences between marginal products and marginal input costs (and which follows the theoretical developments of Petrin and Sivadasan, 2013), is much scarcer and more recent. One such paper is Fontagné and Santoni (2019). First, they estimate the degree of firm-level input allocation for French manufacturing firms over the period 1993-2007. They focus on labour gaps, as their research question is how density influences matching in the labour market. Second, they show that firm misallocation is lower in denser areas, which they interpret as a consequence of better labour market matching mechanisms in these areas. They call it agglomeration economies linked to better access to a variety of inputs. A more recent one is Alpysbayeva and Vanormelingen (2022). They estimate the impact of labour market rigidities on labour misallocation (as measured by labour gaps). For this purpose, they exploit an increase in employment protection for blue-collar workers with respect to white-collar workers due to a policy change in Belgium. They show that the policy lowered allocative efficiency for blue-collar workers relative to white-collar workers.

Hence, the literature, either from an aggregate perspective or from a firm-level point of view, has focused on studying capital or labour misallocation, disentangling the frictions behind them. However, our interest is delving into intermediates misallocation. Asturias and Rossbach (2022) provide some theoretical reasons to expect misallocation of intermediate inputs. On the one hand, as they indicate, there is a large literature on optimal quantity discount pricing for suppliers (Monahan, 1984). On the other hand, from an empirical perspective, there can be misallocation in intermediate input usage due to contract enforcement strength (Boehm and Oberfield, 2020) or due to location that affects market access and transportation costs—both of which affect intermediate input cost and usage (Aggarwal et al., 2018). Thus, we consider as well this potential misallocation of intermediate inputs. In order to do so, we will delve into the factors lying behind intermediates misallocation. In this case, we will consider that GVC participation may help alleviate intermediates misallocation.

3. Methodology

3.1. Measuring misallocation.

Petrin and Sivadasan (2013) propose a firm-level measure of misallocation that uses production data to estimate the differences between the value of the marginal product of an input and its marginal cost.[2] To estimate the marginal products of inputs is required the estimation of production functions. Input expenditures are used to approximate marginal costs.

To estimate marginal products, we estimate a Cobb-Douglas production function following Wooldridge (2009). The function is written as:

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \omega_{it} + \eta_{it} \qquad (1)$$

where i indexes firms and t indexes time, q_{it} is the log of the real output, l_{it} is the log of the number of total hours worked in the firm, k_{it} is the log of the real capital stock and m_{it} is the log of the real intermediate inputs. As for the unobservables, ω_{it} is the firm productivity (not observed by the econometrician but observable or predictable by firms) and η_{it} is an i.i.d. productivity shock that is neither observed nor predictable by the firm.[3] A central advantage of our dataset is that it is possible to build firm level deflators for output, intermediate inputs and capital. These firm level deflators allow working with a "quantity-based" production function instead of a "revenue" one where nominal variables are deflated using industry deflators.

Moreover, we are employing the Gross Output approach to estimate the production function, meaning that we are relating the measure of output of a firm to a function of

[2] Table A1 in the Appendix displays a detailed definition of the variables used to build the misallocation measures.

[3] To obtain consistent estimates of input elasticities, we follow Wooldridge (2009) that modifies the Levinsohn and Petrin (2003) approach to address the problem of the simultaneous determination of inputs and productivity. We refer the reader to his paper for details of the estimation process.

capital, labour and intermediate inputs. The other option would have been to use a "value-added" production function, or in other words, we could have related the output of a firm to a function of capital and labour only. In this case, output would have been measured empirically as the "value added" by the firm (i.e., the value of gross output minus expenditures on intermediate inputs). However, using a "value-added" production function may underestimate the true extent of misallocation in the presence of intermediate input distortions. That is to say, the estimate of misallocation may be biased whenever intermediate input distortions are heterogenous across firms. However, using the Gross Output approach helps obtain a more accurate measure of misallocation (Wang, 2022). Thus, the use of the Gross Output approach is of special relevance for us, since we will be accounting for these potential intermediate input distortions. The production function is estimated separately for each of the 20 two-digit manufacturing sectors according to the NACE classification and, hence, elasticities with respect to inputs vary at the two-digit industry level. We estimate reasonable elasticities.[4]

Given the estimates of the elasticities of output with respect to individual inputs from (1) the marginal products of inputs are given by:

$$\frac{\partial Q_{it}}{\partial L_{it}} = \beta_l \cdot \frac{Q_{it}}{L_{it}},$$
$$\frac{\partial Q_{it}}{\partial K_{it}} = \beta_k \cdot \frac{Q_{it}}{K_{it}},$$
$$\frac{\partial Q_{it}}{\partial M_{it}} = \beta_m \cdot \frac{Q_{it}}{M_{it}},$$

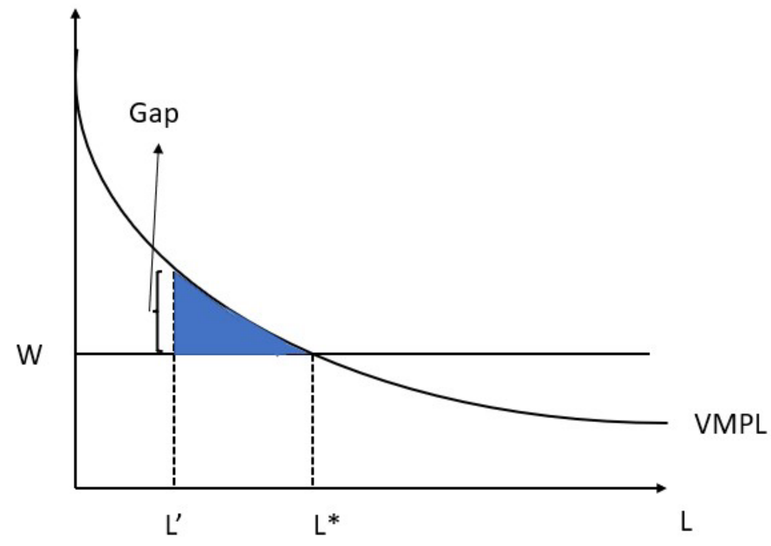
where firm-level output and inputs are not in logs but in levels. Multiplying marginal products by firm's output price renders the value of the marginal product (VMP) of a given input. The absolute value of gaps for each input is given by:

$$G_{it}^{l} = \left| VMP_{it}^{l} - w_{it} \right|,$$
$$G_{it}^{k} = \left| VMP_{it}^{k} - r_{it} \right|,$$
$$G_{it}^{m} = \left| VMP_{it}^{m} - P_{it}^{m} \right|,$$

[4] The average elasticity for materials is 0.518, for labour 0.22 and for capital 0.105. Table A2 in the Appendix shows the inputs coefficients by sector.

where w_{it} is the wage per unit of labour input, r_{it} is the cost per unit of capital, and P_{it}^m is the price per unit of intermediate input. We work like Petrin and Sivadasan (2013) with absolute gaps in real terms. Average costs per unit of input are used to approximate marginal costs.[5] From Lemma 1 in Petrin and Sivadasan (2013) "the average absolute gap for an input in any period is an approximate measure of the potential gain in productivity from a unit adjustment of that input in the optimal direction". It will be an average of the net increase in aggregate output when shifting one unit of input from a firm with a negative gap to one with a positive gap. Figure 4, taken from Petrin and Sivadasan (2013), shows the case of a firm with a positive gap between the VMP of labour and the wage. When the gap is eliminated, the firm can reach its optimal level of hiring at L^* and there is an allocative efficiency gain that increases output in the shaded area. With this example of a firm with a positive gap we illustrate that misallocation of resources implies that the most efficient firms tend to be smaller than their optimal size. The opposite will be true for firms with a negative gap. Frictions and distortions in input markets may prevent firms from adjusting their choice of inputs to reach optimal size.

Figure 4. Allocative efficiency gains from eliminating a positive gap.



Source: Figure 1 in Petrin and Sivadasan (2013).

[5] Previous literature studying misallocation has used average cost to approximate marginal cost, see for instance Petrin and Sivadasan (2013), Fontagné and Santoni (2019) or Alpysbayeva and Vanormelingen (2022), among others.

Prior to the work of Petrin and Sivadasan (2013), or even considerably later, most of the literature on misallocation focused on the within-industry dispersion of logged marginal revenue products (MRPs) of inputs, used as a measure of misallocation at the industry-year level. The MRPs of inputs are the equivalent to the VMPs of inputs when instead of estimating the elasticities of output with respect to individual inputs from a "quantity-based" production function they are estimated from a "revenue-based" production function. In this case, $\beta'_j = \beta_j[1+(1/\varepsilon)]$, were ε is the elasticity of demand and $j=l$, k or m. With "revenue-based" production functions, production function parameters are consistent if inputs are not correlated with the deviation of the firm-level price from the industry price index (otherwise, there can be a bias, De Loecker, 2011). Input elasticities β'_j are "revenue" elasticities that in the presence of markups are estimated as lower bounds for the true elasticities β_j. In this literature, within-industry dispersion in the MRPs is considered to be indicative of inputs misallocation, since it would be efficient to reallocate inputs from firms with low to high MRP until MRPs are equalized across firms. As we work with a "quantity-based" production function we get closer to the concept of misallocation as something generated from distortions in input markets, since with quantity-based output an input measures misallocation is "purged of substantial variation in markups across firms" (De Loecker et al., 2016). This is reinforced by the evolution of the dispersion of the MRP of the inputs shown in Figure 2. Since the dispersion of the three inputs considered evolves differently, increasing for capital, decreasing for intermediate inputs and remaining stable for labour, it is unlikely that there are distortions common to all inputs and what is likely is that there are input-specific distortions. The typical distortion in the literature that is expected to have an effect on the dispersions of all inputs is the one that might come from heterogeneity in price differentials when firm-specific price information is missing and we have to work with revenue data.

3.2. Distortions in intermediate input markets and their measurement.

In this paper, we examine how enhanced access to intermediate inputs for firms participating in Global Value Chains (GVCs) can potentially reduce distortions in intermediate input markets. This is because trade integration via GVCs is closely connected to the trade of intermediates. To identify GVC participation at the firm level, we will use different measures that can be divided into two groups. In the first group, we include measures of their intensive margin of participation that capture backward and forward integration of firms into GVCs. These intensive margin measures are, respectively, FVA (foreign value added) and IVA (indirect value added). In the second group, we include measures of firms' internationalization that capture their extensive margin of participation in GVCs.

FVA is based on foreign value added in exports, which measures imported intermediates embodied in exports. In particular, FVA refers to the value added of inputs that were imported to produce intermediate or final goods that are exported, or in other words, the content of intermediate imports embodied in exports. It is a measure of "Backward integration" and also of "Downstream participation".[6]

The indicator of GVC participation IVA is the domestic value added contained in intermediates exported to a partner economy that re-exports them to a third economy incorporated in other products. In other words, it is the domestic value added contained in inputs sent to third economies for further processing and export through value chains. It is a measure of "Forward integration" and also of "Upstream participation" (World Trade Organization, 2019).[7] However, we have not been able to fully account for the latter. This is because information on whether foreign firms importing our intermediate products re-export them to a third economy incorporated in other products is rarely available in databases derived from enterprise surveys, including the ESEE. In fact, we are not aware of any enterprise survey that contains this information. Still, we can reasonably assume that, in a globalised world, firms exporting intermediate inputs are likely to be engage in "forward integration" (i.e. they have a positive IVA value). The reason is that firms that import are often also exporters (Gal and Witheridge, 2019; Antràs, 2020).

[6] FVA is an indicator of the firm's backward integration into the GVC, which also indicates that the firm is closer to the final consumer than its international input suppliers, i.e. it has a more downstream position in the GVC than they do.

[7] IVA is an indicator of the firm's forward integration into the GVC, which also indicates that the firm is further away from the final consumer than its international input importers, i.e. it has a more upstream position in the GVC than they do.

In this paper we calculate FVA and IVA for each firm with the information available in the ESEE. Nevertheless, there is a scarcity of literature focusing on firm-level measures of GVCs due to the difficulty in accurately calculating measures of FVA and IVA using most firm-level databases, which often lack the necessary information (Antràs, 2020). As a result, the more commonly used approach is to employ a two-way trader dummy variable, which identifies firms engaged in both imports and exports, without providing information on whether the traded goods are final or intermediate. Thus, the firm-level literature on GVCs has focused more on the extensive margin of participation (Shepherd and Stone, 2013; Del Prete et al., 2017; Dovis and Zaki, 2020).

To measure the extensive margin of participation in GVCs, in this paper we use as a central measure a two-way trader dummy variable for firms that simultaneously import intermediate goods and export goods (either intermediate or final goods). In fact, the dummy variable that can be derived from the FVA intensive margin measure coincides with our two-way trader indicator. However, we also consider dummy variables on the presence of foreign capital in the firm (inward FDI) or whether the firm has stakes in firms in foreign countries (outward FDI). The reason why we consider FDI measures among our battery of variables that aim to capture participation in GVCs, is that GVCs may create synergies between trade and FDI and lead firms to organise their production by combining trade with investment (Andrenelli et al., 2019). Likewise, MNEs may prefer an organizational structure of production networks involving intra-firm integration, i.e. taking place within firm boundaries (Qiang et al., 2021). When FDI goes hand in hand with GVCs to guarantee contract enforcement, this points to *relational* GVCs (Antràs, 2020). Finally, we use a synthetic index of firms' participation in GVCs obtained through factor analysis applied to individual measures.

4. Data and Descriptives

In this paper, we use a firm-level panel dataset obtained from the Spanish Survey of Business Strategies (ESEE) for the period 1991-2017. The ESEE is an annual survey, sponsored by the Spanish Ministry of Industry and conducted by the SEPI Foundation, which is representative (by industry and size) of the manufacturing sector in Spain.

As discussed in previous sections, we identify firm-level misallocation using the methodology of Petrin and Sivadasan (2013), which is based on calculating the absolute values of input gaps between their VMPs and marginal costs. Since our main focus of the paper is disentangling the factors that may be alleviating intermediates misallocation, we will focus on this input. However, Table 1 displays the median for the capital, labour and intermediates gap also for comparison with previous papers.

Table 1. Descriptive Statistics - Gaps

	Median
$\lvert G_{it}^{k} \rvert$	0.21
$\lvert G_{it}^{l} \rvert$	5.85
$\lvert G_{it}^{m} \rvert$	8.51

Table 1 displays first of all, and for a matter of comparison with previous papers, that the median for the capital gap is 0.21€ and the median for the labour gap is 5.85€. The latter result can be compared with previous studies that have also dealt with the labour gap using the same methodology. For instance, Fontagné and Santoni (2019) found for France that their median gap was around 4€.[8,9] Regarding our gap of interest, the intermediates gap, the median is 8.51%. In this case we express it in variation terms, since we only have available the price per unit of intermediates in variation.

Moreover, GVC participation may be the determinant to alleviate intermediates misallocation. As discussed in section 3, we identify GVC engagement through a series of firm-level indicators, identifying the intensive margin (FVA and IVA) and the extensive margin (two-way trader, inward FDI and outward FDI). Table 2 displays a summary of the variables used and Table 3 shows some descriptive statistics of these measures.

[8] Fontagné and Santoni (2019) expressed their gap in € per worker, but we do it in € per hour worked. However, if we calculate the equivalence in € per hour for the result they found in their paper, we get this result of around 4€.

[9] We cannot compare the other gaps, since literature using this methodology is scarce.

Table 2. Definition of the GVC variables

	VARIABLE	DEFINITION	YEARS AVAILABLE
Distortions in intermediate inputs market	FVA	Content of intermediate imports embodied in exports. It is a measure of “Backward integration” or “Downstream participation”. It identifies the intensive margin of participation in GVCs.	2006-2017
	IVA	Domestic value added contained in inputs sent to third economies for further processing and export through value chains. It is a measure of “Forward integration” or “Upstream participation”. It identifies the intensive margin of participation in GVCs.	2006-2017
	TWO-WAY TRADER	Dummy variable that takes the value 1 if the firm imports intermediates and exports. It is the dummy variable of FVA. It identifies the extensive margin of participation in GVCs.	2006-2017
	INWARD FDI	Dummy variable taking value 1 if the capital of the firm has foreign participation.	1991-2017
	OUTWARD FDI	Dummy variable taking value 1 if the firm has participation in the capital of foreign firms.	2000-2017

Note: All variables come from the ESEE

Table 3. Descriptive statistics – GVC indicators

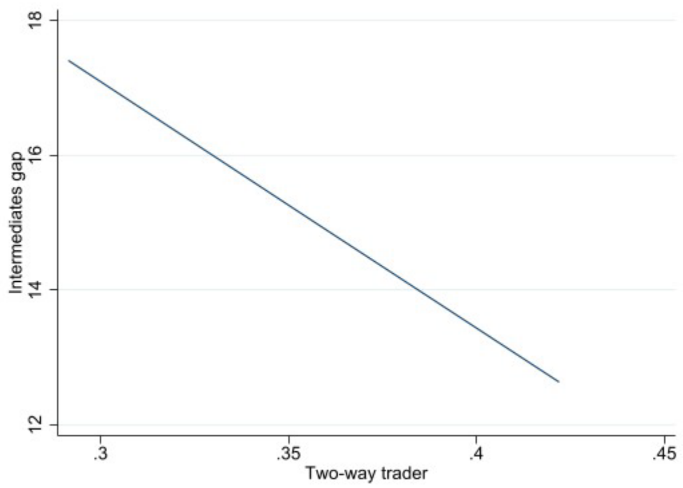
	Percentage of firms
Two-way trader	23%
IVA	18.7%
Inward FDI	19.2%
Outward FDI	7.8%

Note: (i) Recall that two-way trader is the dummy of having FVA. (ii) Data for two-way trader and IVA is only available from 2006, while data for outward FDI in only available from 2000.

Table 3 shows that 23% of firms are two-way traders, meaning that they import intermediates and export. This is the most widely used measure in the literature to identify participation in GVCs at the firm-level. Nevertheless, firms do not start to participate in GVCs from scratch. Normally, before becoming a two-way trader, either they import intermediates or they export, but in general they do not enter in GVCs without prior experience in the international markets. In fact, according to our data, only 29% of firms who are two-way traders started being so without previous experience importing intermediates or exporting. This seems to be a stylised fact in the trade literature focusing on the dynamic links between firms' imports of intermediate goods and export decisions (Kasahara and Lapham, 2013; Máñez et al., 2020; Máñez Castillejo et al., 2020). On the one hand, exporters with prior knowledge and experience in international markets may find it easier to incorporate foreign inputs into their production process. In addition, they may feel competitive pressure from other traders incorporating higher quality inputs. On the other hand, if importers of intermediate products benefit from the diffusion of new technologies and knowledge embodied in imported inputs and produce higher quality products, this may facilitate their exports. Therefore, the performance of one activity may increase the benefits expected from the performance of the other. Furthermore, as far as IVA is concerned, 18.7% of firms participate in GVCs. This percentage is lower than the percentage of firms having a positive FVA (23%), but this is reasonable as we are dealing with a developed country. Traditionally, developed countries tend to participate more in GVCs through backward integration, and this is what we retrieve as well for Spain. Finally, while around 19% of firms have inward FDI, only 8% have outward FDI.

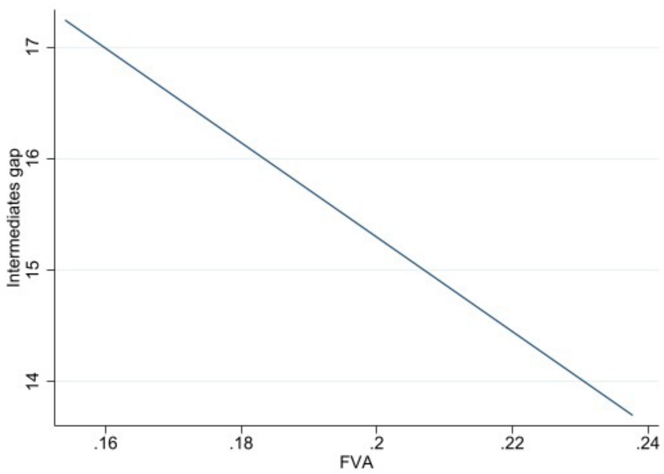
Next, we will start exploring the potential relationships between misallocation of intermediates and GVC participation with a graphical analysis. To do so, we will plot in several graphs the fitted line coming from scatter plots of the relationship between the yearly mean of the gaps and the yearly mean of the different distortions.[10]

Figure 5. Intermediates misallocation and two-way trader.



Source: ESEE.

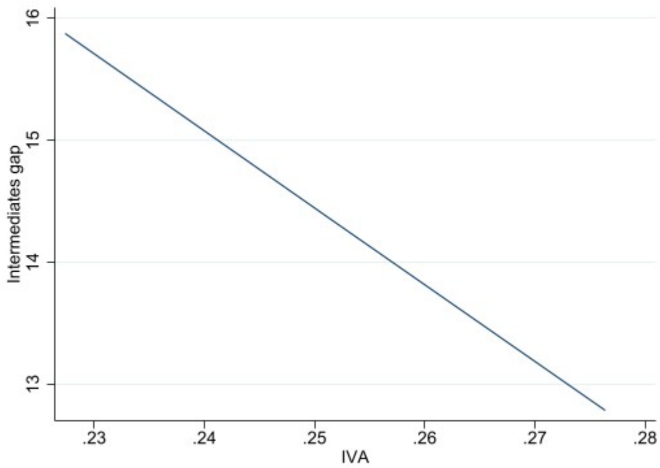
Figure 6. Intermediates misallocation and FVA.



Source: ESEE.

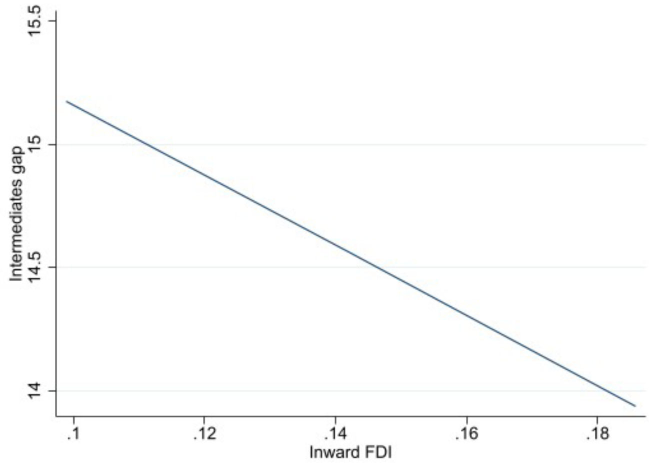
[10] Means are calculated by correcting for the representativeness of SMEs and large firms in the ESEE, as well as by taking into account the weight of industries in total manufacturing GDP.

Figure 7. Intermediates misallocation and IVA.



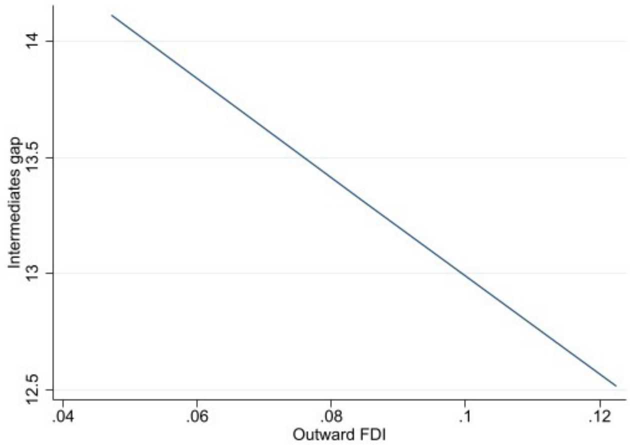
Source: ESEE.

Figure 8. Intermediates misallocation and inward FDI.



Source: ESEE.

Figure 9. Intermediates misallocation and outward FDI.



Source: ESEE.

Figures 5-9 show the relationships between the intermediates gap and the different measures of GVCs. Figure 5 includes the dummy of two-way trader, which takes the value 1 if the firm imports inputs and exports. Figure 6 plots the variable of Foreign Value Added (FVA), identifying the downstream participation (or backward integration). Or in other words, the content of intermediate imports embodied in exports. Figure 7 includes the Indirect Value Added (IVA) measure, which identifies the upstream participation or forward integration. Or what is the same, domestic value added contained in inputs sent to third economies for further processing and export through value chains. Figures 8 and 9 plot the dummies of inward and outward FDI, respectively. Hence, using all different measures of GVCs, we see that all these figures show a negative relationship between GVC participation and the intermediates gap. This gives first evidence of the role that GVC engagement may have alleviating intermediates misallocation. Moreover, this is also in line with the evolution of GVC participation in Spain (Figure 3) and the trend of intermediates misallocation (Figure 2). While GVC participation has been increasing, intermediates misallocation has been decreasing, what is consistent with the negative relationship shown in Figures 5-9.

5. Estimation Results

In what follows, we are interested in whether the intermediates gap responds to firm's GVC participation. In other words, we want to evaluate how GVC engagement affects intermediates misallocation. In order to do so, we start by estimating a linear regression, and then we exploit the panel structure of the data to implement what is called a "two-way fixed effects" (TWFE) estimator. The latter consists of including both firm fixed effects and time fixed effects in ordinary least squares estimation. This helps deal with the likely presence of unobserved heterogeneity, i.e. firms' individual effects, and removes potential changes in the economic environment that have the same effect on all firms (Wooldridge, 2021).

The baseline estimated equation is defined as:

$$|G_{it}^{m}| = \beta_0 + \beta_1 GVC_{i,t} + \delta_s + \delta_t + \delta_{s,t} + \delta_i + \epsilon_{i,t} \qquad (2)$$

Where $|G_{it}^{m}|$ is the absolute value of the intermediates gap in logarithms, $GVC_{i,t}$ is the variable identifying GVC participation, $\delta_s + \delta_t + \delta_{s,t}$ are industry, year and industry-year fixed effects, and δ_i are firm fixed effects included just when we estimate by TWFE.

Table 4. Intermediates misallocation – Linear Regression

	Absolute intermediates gap $\lvert G_{it}^{m}\rvert$					
	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS
Two-way trader	-5.533*** (0.594)					
FVA		-7.977*** (0.972)				
IVA			-2.516*** (0.777)			
Inward FDI				-5.136*** (0.433)		
Outward FDI					-4.011*** (0.440)	
Index GVCs						-2.871*** (0.252)
Constant	8.656*** (1.157)	8.383*** (1.105)	7.407*** (1.024)	24.713** (11.625)	12.411*** (1.675)	6.319*** (1.121)

Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES
Firm FE	NO	NO	NO	NO	NO	NO
Observations	19,114	19,080	18,593	42,065	26,776	17,674

Note: (i) Robust standard errors in parentheses (ii)*** p<0.01, ** p<0.05, * p<0.1 (iii) Clustered by firm

Table 5. Intermediates misallocation – TWFE

	Absolute intermediates gap $\|G_{it}^{m}\|$					
	(1) TWFE	(2) TWFE	(3) TWFE	(4) TWFE	(5) TWFE	(6) TWFE
Two-way trader	-0.692* (0.462)					
FVA		-3.620*** (1.398)				
IVA			-3.801 (3.959)			
Inward FDI				-1.089*** (0.737)		
Outward FDI					-0.684 (0.598)	
Index GVCs						-1.072*** (0.321)
Constant	15.321*** (0.431)	15.328*** (0.438)	15.637*** (0.508)	15.823*** (0.280)	14.068*** (0.218)	14.535*** (0.274)
Industry FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Industry-Year FE	YES	YES	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES	YES	YES
Observations	17,421	17,387	16,748	42,037	25,162	15,840

Note: (i) Robust standard errors in parentheses (ii)*** p<0.01, * p<0.1 (iii) Clustered by firm

Tables 4 and 5 show the results for intermediates misallocation. To identify GVC participation we use the two-way trader dummy (identifying the extensive margin of GVC participation), Foreign Value Added and Indirect Value Added (identifying the intensive margin of GVC participation) and the dummies for inward and outward FDI. Likewise, we construct a synthetic measure of firms' participation in GVCs using factor analysis and including all individual measures of GVCs we have. With this we get what we call "Index GVCs".

The results show that, in general, participating in GVCs alleviates intermediates misallocation. However, looking at Table 5, which displays the results using TWFE, we can see that the coefficient of interest is significant for two-way trader, FVA, Inward FDI and the synthetic Index. This means that when including firms' fixed effects, the significance is lost when we use IVA or outward FDI. These results suggest that what matters most for reducing the misallocation of intermediates is participation in GVCs as an importer of intermediate inputs incorporated in the production of other goods that the firm exports, and that your firm is participated by foreign capital. Both facts may not only involve flows of goods and materials from abroad to the firm, but also of intangibles such as information, technology or management knowledge (Timmer, 2017; Antràs, 2020).

However, the TWFE estimator has its limitations, as there can be some concerns interpreting its results as causal effects. Moreover, it considers that the treatment occurs for all individuals at the same time.[11] Nevertheless, this is not our case, since the change in the treatment does not occur for all firms at the same time. That is to say, not all firms engage in GVCs in the same year. Or in other words, this is not the typical case where there are two periods and two groups for evaluating a given treatment. Therefore, it is necessary to exploit the variation in treatment times, as firms may be treated at different times. In order to do so, we rely on Callaway and Sant'Anna's (2021) setup and implement a Difference-in-Differences (DiD) estimator with staggered adoption.[12]

We can only apply this methodology to discrete binary treatments. Thus, we can use the dummies of being a two-way trader, having positive IVA, or having outward or inward FDI.[13,14] Hence, in this paper, beyond descriptives, OLS and TWFE estimators, we can go a step forward towards causality by implementing this staggered DiD.

The idea behind staggered DiD is an extension of the original idea of combining propensity score matching with DiD to estimate treatment causal effects. In the standard or more traditional case of Difference-in-Differences (DiD) analysis, a control group of

[11] For a further discussion of the limitations of the TWFE estimator, please refer to Callaway and Sant'Anna (2021).
[12] A DiD with staggered adoption assumes that once units are treated, they remain treated in the following periods.
[13] Note that the dummy variable for FVA is the two-way trader dummy.
[14] We can transform the IVA variable (that identifies the intensive margin) into a dummy, so we can use in this case as a treatment.

firms' observations with the same probability of receiving the treatment (in our case, participating in GVCs) is obtained through the matching process. Subsequently, a DiD analysis is performed using the group of treated firms and their matched controls. This approach ensures that if treated firms have the same probability of receiving the treatment (conditional on a set of pre-treatment variables) as untreated firms, any difference between the two groups after the treatment can be attributed to the treatment itself.

The extension performed by the staggered DiD methodology consists of performing the matching for each generation (cohort) of treated, as they receive treatment at different times, and to allow for dynamics of the causal effects of treatment as the time since treatment increases. This methodology also allows parallel trends to be tested prior to treatment. To implement this methodology with our data and our treatment variables, we use the same specification as the one in equation 2, and we further consider a set of variables to perform a good matching between the treatment and control groups. This set of variables contains: Total Factor Productivity (TFP), the logarithm of the number of workers, the expenditure in R&D, the share of skilled workers and the gap of intermediates. All these variables are used in their pre-treatment values. Moreover, in the two-way trader and IVA regressions, we include among them whether the firm imports intermediates or exports in their pre-treatment values. As discussed before, the majority of firms have some experience importing intermediates or exporting before engaging in GVCs as two-way traders. That is why it is necessary to match on this previous experience to have cleaner results disentangling the effect of GVC participation. Likewise, in the inward (outward) FDI regression we include among the set of matching variables whether the firm had outward (inward) FDI in the pre-treatment period. This allows for better matching and helps to isolate the effect of inward (outward) FDI.

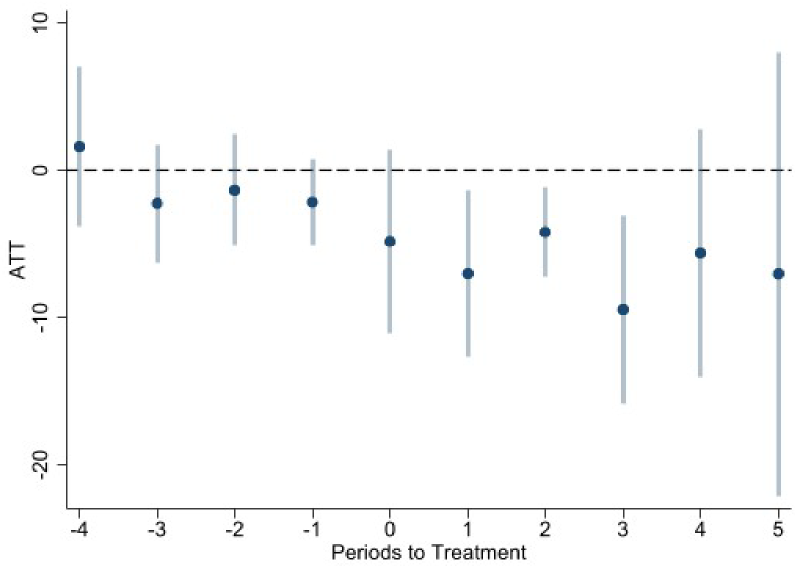
The results of Table 6 show the average treatment effect on the treated (ATT). The two-way trader dummy is the one showing the stronger results. This means that, when a firm engages in GVCs being a two-trader, what is the same as having FVA, it reduces the intermediate gap by 6.368% on average. In Figure 9 we see this effect over time. The effect of being a two-way trader reduces the intermediates gap from the first year after the treatment to the third year after the treatment. Afterwards the effect disappears. Furthermore, having FDI inflows indicates in Table 8 that it also reduces the gap, although the ATT is on the borderline of being significant. The latter is behind the fact that there is no clear time effect of this variable after treatment (see Figure 12). On the other hand, having IVA or outward FDI has no significant effect on the intermediates gap, neither on average nor over time (see Figures 11 and 13). These results are in line with those found in Table 5.

Table 6. Intermediates misallocation – Staggered DiD

	Absolute intermediates gap $\|G_{it}^m\|$			
Two-way trader	-6.368*** (2.025)			
IVA		0.460 (1.673)		
Inward FDI			-2.152[†] (1.392)	
Outward FDI				-1.817 (1.316)
Observations	9,586	10,565	20,727	21,670
Pretrend test	-1.030 (1.383)	-1.789 (1.510)	-1.127 (3.210)	-1.472 (1.399)

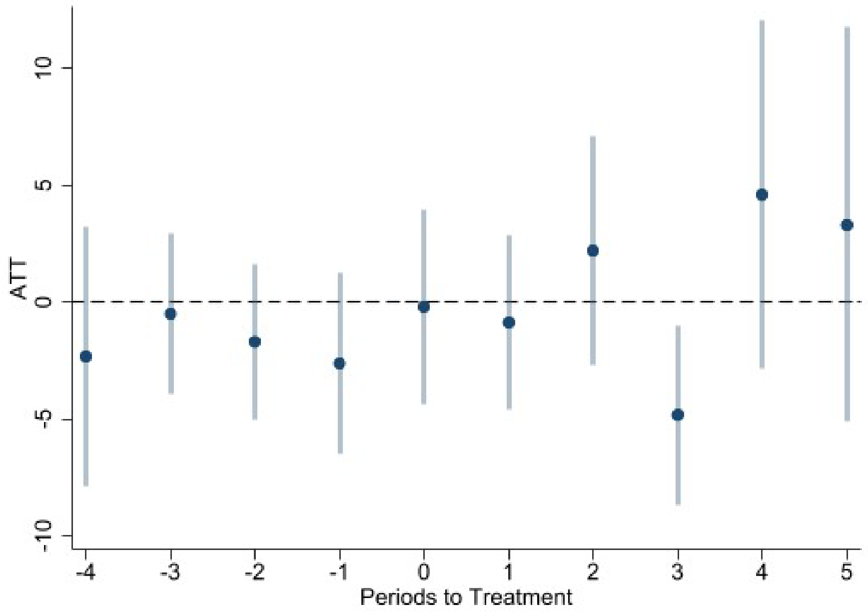
Notes: (i) Doubly robust inverse probability weighting method used for estimating standard errors (Sant'Anna & Zhao, 2020) (ii)*** p<0.01, [†] slightly above 0.1 (iii) The pretrend test tests if all the pre-treatment effects are all equal to 0. Thus, if we do not reject the null, we can confirm that there were parallel trends prior to the treatment.

Figure 10. ATT – The effect of two-way trader on intermediates gap



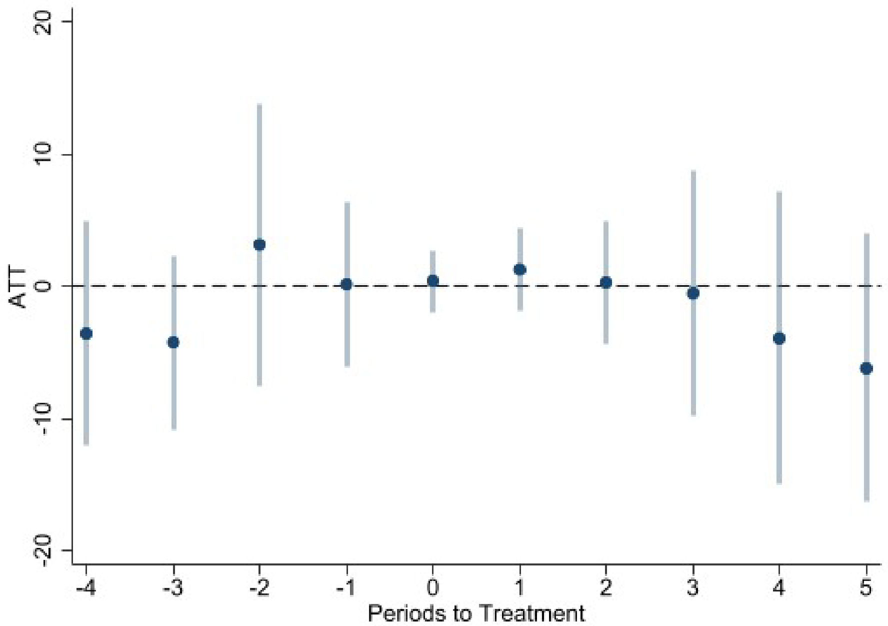
Note: The period t = 0 corresponds to the first year the firm is a two-way trader. The bars are 90% confidence intervals for each yearly estimated effect (dot).

Figure 11. ATT – The effect of IVA on intermediates gap



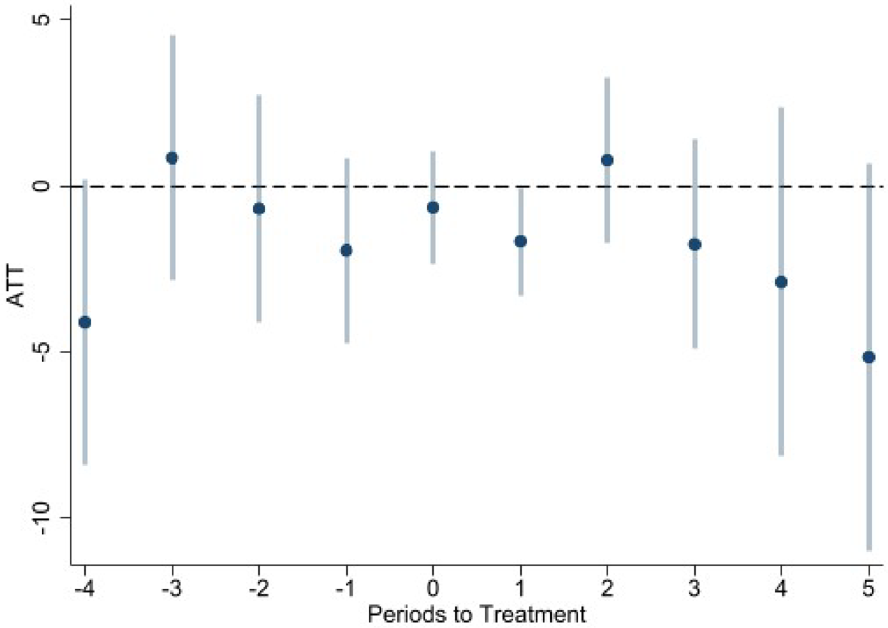
Note: The period t = 0 corresponds to the first year the firm has IVA. The bars are 90% confidence intervals for each yearly estimated effect (dot).

Figure 12. ATT – The effect of inward FDI on intermediates gap



Note: The period t = 0 corresponds to the first year the firm has inward FDI. The bars are 90% confidence intervals for each yearly estimated effect (dot).

Figure 13. ATT – The effect of outward FDI on intermediates gap



Note: The period t = 0 corresponds to the first year the firm has outward FDI. The bars are 90% confidence intervals for each yearly estimated effect (dot).

As a final counterpoint to address causality, we want to reinforce the arguments lying behind the role of GVCs on intermediates misallocation. In order to do so, we can think about a shock affecting GVC's functioning. This way, firms that were more exposed to GVCs prior to the shock, i.e., firms that were more engaged into GVC before the shock, should suffer more this shock, and thus this should be translated into the effect on the intermediates gap.

For GVC participation we can think about digitalisation and ICT as a positive shock. The use of information and communication technologies (ICT) is one of the factors behind the increase in trade activities (Añón Higón and Bonvin, 2022; Yushkova, 2014), and in particular they are associated to an increase in GVC participation. In fact, Baldwin (2016) already claimed that the ICT revolution is the technology breakthrough behind the international dispersion of activities within GVCs. Hence, the ICT use can be understood as a positive shock to GVCs, or in other words, it can be understood as a smoothing factor in the operation of GVCs.

Particularly, broadband applications are one of the communication technologies already allowing for more efficient communication within GVCs (De Backer and Flaig, 2017). The broadband service can be provided through multiple technologies. Traditionally, it has been provided over the xDSL technology family (usually over copper cable), but in general, its speed is not enough. That is why the European Digital Agenda considers fibre-based technology as key to meeting connectivity goals (Telefónica, 2021). According to the CNMC (the Spanish National Markets and Competition Commission) in 2010 more than 99% of the service lines in Spain used the xDSL technology. However, that year the first fibre optics deployments were carried out, and in 2013 fibre optics became the fastest growing technology in Spain. In fact, from 2013 to 2018 the fibre optics coverage had an average increase of 12.98% per year (Jesús-Azabal et al., 2021).

Hence, the deployment and explosion of the fibre optics can be understood as a positive shock to GVCs. This way, firms that were more exposed to GVCs before the expansion of the fibre optics should benefit more from this positive shock. Thus, these firms with a higher engagement in GVCs before the shock should decrease more the intermediates gap in comparison to those that were less exposed to the positive shock.

To assess the relationship of the fibre optics expansion and the misallocation of intermediates we rely on the following panel regression framework that consists on a DiD with continuous treatment intensity approach following Alpysbayeva and Vanormelingen (2022):

$$|G_{i,t}^{m}| = \beta_1 FVA_i + \beta_2 FIBRE\ OPTICS_t + \alpha\, FVA_i \times FIBRE\ OPTICS_t + \delta_s + \delta_t + \epsilon_{i,t} \quad (3)$$

Where FVA_i is the value of FVA in 2012 (the year before the expansion of the fibre optics) for firm i and $FIBRE\ OPTICS_t$ is a dummy indicating the period where the fibre optics was the fastest growing technology (2013-2017). α is the coefficient of interest, which indicates the impact of the fibre optics expansion depending on the pre-fibre optics FVA. A negative α means that the intermediates gap has decreased more after the expansion of the fibre optics for firms with an ex-ante higher FVA compared to the base group. Or in other words, post-expansion allocative efficiency of higher participants in GVCs has increased relative to lower participants in GVCs.

Furthermore, we change our specification to confirm the results. We chose to use the FVA in 2012 because it was the closest alternative to the year of expansion. However, we also use FVA in 2010 since that year was the arrival of the fibre optics. Finally, we check whether the effect of the fibre optics was also significant when it arrived to Spain (not only when it expanded). Thus, we also use the $FIBRE\ OPTICS_t$ to be the period from 2010-2017, and in that case we use the FVA in 2008 (prior to the arrival but avoiding the trade shock induced by the financial crisis in 2009). Table 9 shows these results.

Table 7. Intermediates misallocation – The effect of fibre optics.

	Absolute intermediates gap $\lvert G_{it}^m \rvert$		
	(1)	(2)	(3)
FVA_{2012} × FIBRE $OPTICS_{2013}$	-5.014** (2.279)		
FVA_{2010} × FIBRE $OPTICS_{2013}$		-5.272** (2.385)	
FVA_{2008} × FIBRE $OPTICS_{2010}$			-2.833† (1.821)
Constant	9.598*** (1.287)	8.973*** (1.212)	9.670*** (1.263)
Observations	15,401	16,194	15,429

Note: (i) Robust standard errors in parentheses (ii)*** p<0.01, ** p<0.05, † slightly above 0.1 (iii) Clustered by firm (iv) All regressions include FVA_i, $FIBRE\ OPTICS_t$, industry and year fixed effects.

In all of the specifications we confirm that after the fibre optics, firms with a higher FVA reduced more their intermediates gaps. However, the effect was stronger after the expansion of the fibre optics rather than after the introduction. This means that firms that had a higher engagement in GVCs benefited more with the expansion of the fibre optics, since it allowed them to have a more efficient communication within GVCs.

6. Robustness

To further check the validity of the results obtained, we will develop a series of robustness checks. In first place, given that the results from intermediates misallocation point out that being a two-way trader, or to a lesser extent having inward FDI, are the two types of GVC participation helping more reduce this misallocation, we focus on these two. For these two cases, we continue implementing the staggered DiD method with the same specification as before, but in this case using a balanced panel.[15] This allows us to rule out compositional confounds around the first treatment year. Nevertheless, it also implies the drawbacks of omitting young firms and of imposing survival after the treatment (Alfaro-Ureña et al. 2022).

Table 8 shows the results for the staggered DiD using a balanced panel for two-way trader and inward FDI. The negative effect of being a two-way trader on the intermediates gap confirms the impact of this type of GVC participation on intermediates misallocation. Moreover, Figure 14 displays its evolution, where it can be seen that the effect is present during the second and third year after starting its participation in GVCs. However, the non-significance of inward FDI finally shows that this GVC participation may not be relevant when dealing with intermediates misallocation.

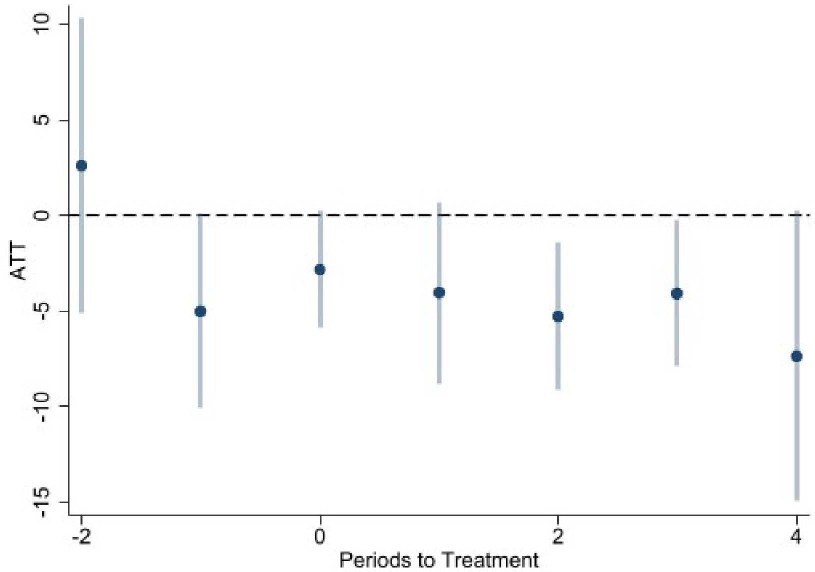
Table 8. Intermediates misallocation – Staggered DiD with balanced panel.

	Absolute intermediates gap $\|G_{it}^{m}\|$	
Two-way trader	-4.061***	
	(1.556)	
Inward FDI		-1.663
		(4.809)
Observations	6,976	19,089
Pretrend test	-1.202	10.161
	(2.453)	(13.865)

Notes: (i) Doubly robust inverse probability weighting method used for estimating standard errors (Sant'Anna & Zhao, 2020) (ii) *** p<0.01 (iii) The pretrend test tests if all the pre-treatment effects are all equal to 0. Thus, if we do not reject the null, we can confirm that there were parallel trends prior to the treatment.

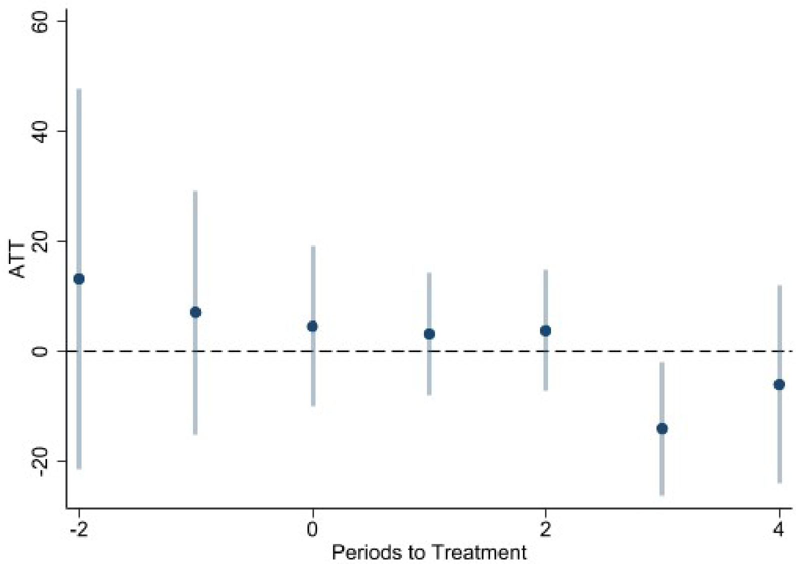
[15] We take firms that were present in the data 3 years prior to the treatment and 4 years after the treatment.

Figure 14. ATT – The effect of two-way trader on intermediates gap (balanced panel)



Note: The period t = 0 corresponds to the first year the firm is a two-way trader. The bars are 90% confidence intervals for each yearly estimated effect (dot).

Figure 15. ATT – The effect of inward FDI on intermediates gap (balanced panel)



Note: The period t = 0 corresponds to the first year the firm has inward FDI. The bars are 90% confidence intervals for each yearly estimated effect (dot).

Hence, since two-way trader seems to be the most important indicator of GVC participation when dealing with intermediates misallocation, it is convenient to disentangle its composition. Being a two-way trader means that the firm imports intermediates and exports. Thus, which is the effect on intermediates misallocation of importing intermediates and exporting, separately?

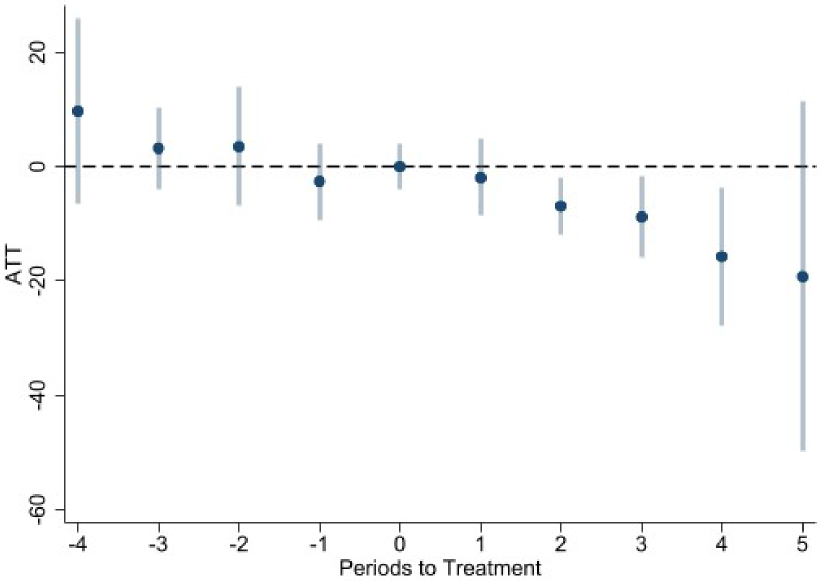
Table 9 shows the effect of importing intermediates, exporting and being a two-way trader, while Figures 16 and 17 display the effect over the years of importing intermediates and exporting, respectively. While exporting has not a significant effect, importing intermediates starts to indicate a negative effect on the intermediates gap. However, it is when both activities are combined, i.e. when firms engage in GVCs as two-way traders, that this effect on the misallocation of intermediaries becomes not only negative, but also very significant. This seems to imply that, although in isolation the activity of importing intermediate inputs is more relevant for the better allocation of this input than the activity of exporting, it is the confluence of both activities (a better indicator of participation in GVCs than the isolated ones) that is more relevant for reducing the misallocation of this factor of production.

Table 9. Intermediates misallocation – Staggered DiD disentangling two-way trader.

	Absolute intermediates gap $\lvert G_{it}^{m} \rvert$		
Only Import intermediates	-3.361† (2.262)		
Only Export		-0.184 (2.073)	
Two-way trader			-6.368*** (2.025)
Observations	8,487	5,205	9,586
Pretrend test	3.474 (3.690)	1.757 (2.306)	-1.030 (1.383)

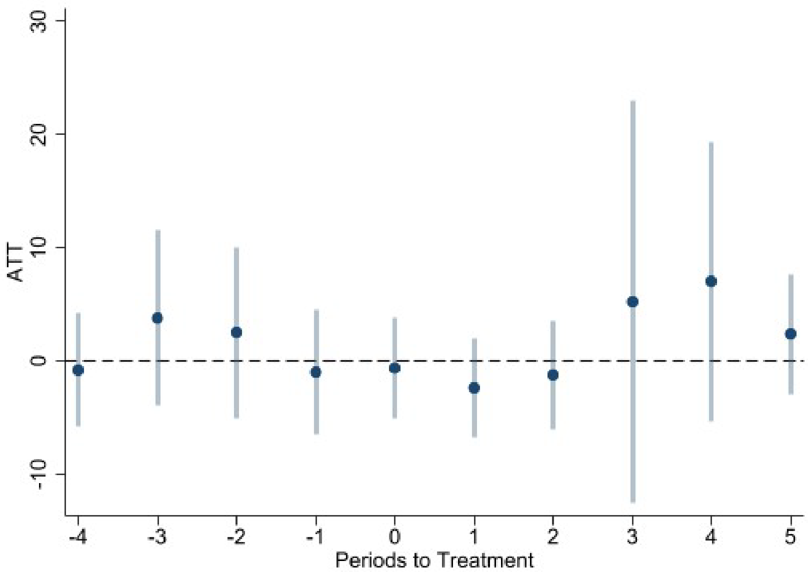
Notes: (i) Doubly robust inverse probability weighting method used for estimating standard errors (Sant'Anna & Zhao, 2020) (ii)*** p<0.01, † slightly above 0.1 (iii) Importing intermediates means that the firm only does this activity, but does not export. In the same way, exporting means that the firm only does this, but does not import intermediates. (iv) The result of two-way trader is the same as in Table 8, but we repeat it in here for convenience. (v) The pretrend test tests if all the pre-treatment effects are all equal to 0. Thus, if we do not reject the null, we can confirm that there were parallel trends prior to the treatment.

Figure 16. ATT – The effect of importing intermediates on intermediates gap



Note: The period t = 0 corresponds to the first year the firm imports intermediates. The bars are 90% confidence intervals for each yearly estimated effect (dot).

Figure 17. ATT – The effect of exporting on intermediates gap



Note: The period t = 0 corresponds to the first year the firm exports. The bars are 90% confidence intervals for each yearly estimated effect (dot).

7. Conclusion

This paper analyses how distortions in input markets are a source of factor misallocation with a particular focus on the misallocation of intermediate inputs and its relation to Global Value Chains (GVCs). We apply Petrin and Sivadasan (2013)'s methodology to study misallocation from a firm-level point of view.

Using a firm-level panel dataset for manufacturing firms provided by the Spanish Survey on Business Strategies (ESEE) for the period 1991-2017, we contribute to the literature on the study of misallocation adding several novelties. First, with respect to previous studies on this topic for the Spanish economy, we broaden the temporal scope of the analysis, as other papers focused mainly on misallocation in the period prior to the Great Recession. Second, and in contrast to the work for Spain and most of the work for other countries, we conducted the analysis from a firm-level perspective, while other papers had a more aggregated viewpoint. Third, in this paper we focus on the study of the misallocation of intermediate inputs, while previous papers focused on capital or labour. Fourth, our database allows us to use firm-level output and input deflators, while other papers use industry deflators, which may introduce a bias in the estimates of intermediate input elasticities in the production function. Finally, our paper combines descriptive and graphical tools, OLS and TWFE estimation methods, and, for the binary indicators of GVC participation, deepens causality with recent staggered DiD estimation methods (Callaway and Sant'Anna, 2021).

From the regression analysis in the paper, and as the major novelty from the paper, we find that participation in GVCs helps alleviate intermediates misallocation. We even confirmed the latter using the more demanding staggered DiD methodology for causal inference and a DiD with a continuous treatment intensity approach that exploits the emergence and expansion of fibre-optic based ICT technology that facilitates the operation of GVCs. Precisely, with the arrival of fibre optics in Spain, the improvement in the allocation of intermediates is more pronounced for those firms that before this technological shock participated more intensely in GVCs, which indicates that the fluidity and facilitation of operations within the chains generated by the arrival of this technological change was relevant for them.

Since the misallocation of factors of production affects not only the aggregate output of the economy, but also TFP growth, this paper can help policy makers to unravel the reasons behind it. Thus, studying the distortions underlying misallocation is of special interest. Particularly, unravelling the factors, i.e., GVC participation, behind the decrease in intermediates misallocation can contribute to understand the evolution of Spanish TFP and may be useful to boost it.

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APPENDIX

Table A1. Definition of variables used to construct the misallocation measures.

VARIABLE	DEFINITION
OUTPUT (q_{it})	Value (in euros) of the production of goods and services, deflated by a firm-specific price index of output. The price index is a Paasche-type one constructed starting from the percentage price changes on output reported by the firm.
LABOUR (l_{it})	Total number of hours worked.
CAPITAL (k_{it})	Capital at current replacement values K_{it} (in euros) is computed recursively from an initial estimate and data on current investments in equipment goods I_{it} (excluding buildings, land, and financial assets). The value of the past stock of capital is updated by means of the price index of investment P_{I_t} as $K_{it} = (1-\delta)\frac{P_{I_t}}{P_{I_{t-1}}}K_{it} + I_{it}$, where δ is an industry-specific estimate of the rate of depreciation. Capital in real terms is obtained by deflating capital at current replacement values by the price index of investment as $\widetilde{K}_{it} = \frac{K_{it}}{P_{I_t}}$. The price index of investment is obtained as the equipment goods component of the index of industry prices published by the Spanish National Institute of Statistics. This method has been already employed in other papers with the ESEE (see, for instance, Doraszelsky and Jaumandreu, 2013, Martín-Marcos and Moreno-Martín, 1991, and Martín-Marcos and Suárez, 1997).
INTERMEDIATE INPUTS (m_{it})	Value (in euros) of intermediate consumption deflated by a firm-specific price index of intermediate inputs. The price index is a Paasche-type one constructed starting from the percentage price changes on intermediates consumption reported by the firm.
WAGE PER UNIT OF LABOUR (w_{it})	Wage per hour, deflated by the index of industry prices published by the Spanish National Institute of Statistics.
COST PER UNIT OF CAPITAL (r_{it})	Cost per unit of capital defined as the cost of long-term debt, corrected by an industry-specific estimate of the rate of depreciation and deflated by the price index of investment obtained as the equipment goods component of the index of industry prices published by the Spanish National Institute of Statistics.
PRICE PER UNIT OF INTERMEDIATE INPUT (p_{it}^{m})	Price per unit of intermediate input expressed as the variation in the price of intermediates inputs.

Note: All variables come from the ESEE and are available for the whole time span (1991-2017).

TABLE A2. Input coefficients by sector

	Input coefficients		
	β_k	β_l	β_m
Meat products	0.132	0.11	0.565
Food and tobacco	0.127	0.144	0.636
Beverage	0.072	0.179	0.721
Textiles and clothing	0.107	0.33	0.412
Leather, fur and footwear	0.036	0.268	0.416
Timber	0.085	0.235	0.566
Paper	0.122	0.234	0.369
Printing (before Printing and Edition)	0.072	0.307	0.512
Chemicals and pharmaceuticals	0.135	0.117	0.685
Plastic and rubber products	0.148	0.249	0.475
Nonmetal mineral products	0.112	0.235	0.53
Basic metal products	0.166	0.067	0.441
Fabricated metal products	0.074	0.27	0.519
Machinery and equipment	0.126	0.171	0.504

Computer products, electronics and optical	0.084	0.259	0.427
Electric materials and accessories	0.118	0.283	0.466
Vehicles and accessories	0.077	0.134	0.527
Other transport equipment	0.106	0.148	0.661
Furniture	0.054	0.29	0.353
Other manufacturing	0.097	0.275	0.529
Overall	0.105	0.22	0.518