BGPE Discussion Paper

No. 151

Task trade and the employment pattern: the offshoring and onshoring of Brazilian firms

Philipp Ehrl

May 2014

ISSN 1863-5733

Editor: Prof. Regina T. Riphahn, Ph.D.
Friedrich-Alexander-University Erlangen-Nuremberg

BGPE Discussion Paper Series

Task trade and the employment pattern: the offshoring and onshoring of Brazilian firms

Philipp Ehrl*

University of Würzburg‡

May 2014

Abstract

This paper studies the effect of an expansion of imported intermediate inputs on establishments' average task intensities and employment size in a middle-income country. I use confidential matched employer-employee data and information on trade transactions for the universe of Brazilian firms. Propensity Score Matching indicates that import expansion leads to an overall employment growth, higher intensities in routine and non-routine manual tasks and an increased share of intermediates exports. Thus our findings point out that intermediates imports represent onshored instead of offshored tasks. This result remains unchanged regardless of whether imports from high- or low-wage countries are considered.

Keywords: task trade, offshoring, onshoring, Brazil

JEL Classification: F16, J24, O54

---

*First and foremost, I thank Bruno Oliveira Cruz, who made the realization of this research possible. I am grateful to Daniel Baumgarten, Massimiliano Bratti, Bohdan Kukharskyy, Lucas Ferreira Mattion, Rafael Moraes Pereira, Katariina Nilsson Hakkala, Aguinaldo Nogueira Maciente, Michael Pflüger, John Weche Gelübcke and participants at the University of Passau, the IPEA in Brasília, the AIEL/ITSG Conference in Padova, RIEF in Paris, EGIT in Munich and IAB/RCEA/ZEW in Nürnberg for fruitful discussions and comments. The author also acknowledges the hospitality of the IPEA, where most of the research was conducted, and the DAAD for financial support.

‡Faculty of Economics, Sanderring 2, 97070 Würzburg, Germany. *philipp.ehrl@uni-wuerzburg.de*

1 Introduction

The most distinctive feature between trade some 40 years ago and current trade is the fragmentation of the value chain.[1] Fostered by falling trade costs, lower tariffs and progress in computer and communication technology, intermediate inputs and services are increasingly exchanged across borders.[2] It turned out that whether a job is offshorable or not, is best characterized by the tasks a worker is actually performing. Tasks with low coordination requirement, high codifiability and a high degree of routinization are performed remotely at low cost and are thus are most easily relocated abroad (Autor *et al.* 2003; Grossman and Rossi-Hansberg 2012).[3] Ultimately, the question of the impact of offshoring on domestic jobs has received much attention in the scientific and political debate.[4]

Research about vertical specialization has some shortcomings that this paper addresses. With a few exceptions, e.g., Feenstra and Hanson (1997), the focus lies on high-wage countries where offshoring originates. In most models, a firm's decision is about the profitability of offshoring, but not about where exactly to locate the production. Because Brazil is a middle-income country, its firms may offshore to low-income countries or may onshore, i.e., receive offshored production steps from other countries. So in this study, imported intermediate inputs can represent offshoring from two perspectives. To distinguish between both possibilities, we examine the immediate consequences on the employment pattern in plants that receive new intermediate inputs from abroad. From this observation we deduce that firms mainly onshore medium-complex routine manual tasks in industrial production steps. Corresponding to the prediction from an extended Feenstra and Hanson (1996) model, the Brazilian economy is located in the middle of the global value-added chain.

Cross-border flows of intermediate inputs are a result of relocations and international production networks. However, in their presence, the empirical analysis of trade is more complex than "plain old trade in physical goods" (Krugman 2008: 135). Evaluating the factor content and value added of trade in each country requires information about the prior stages of processing. Otherwise, double-counting obscures the individual contribution and comparative advantages can not be verified. Using country-specific Input-Output matrices, Johnson and Noguera (2012) find that the ratio of value added to the gross value in exported manufactures is higher in more affluent countries. This suggests that those skill-abundant countries conduct production steps that involve more skilled labor in accordance with the classic Heckscher-Ohlin logic. To circumvent those accounting problems, our approach focuses directly on the type of labor employed in the production process. With confidential but not exclusive data on the universe of Brazilian firms, workers and trade transactions,

[1] This phenomenon is also labeled, among others, as vertical specialization or multi-stage production. Offshoring refers to the import of intermediate inputs from the point of view of the home country. It is thereby irrelevant whether the input was primarily produced domestically or whether the supplier is part of the firm.

[2] See Hummels *et al.* (2001), Yi (2003) and Amiti and Wei (2005). Hanson *et al.* (2005) examine further determinants of the volume of intermediate good trade flows, such as taxes and factor prices.

[3] Blinder (2009) stresses personal delivery as the most important determinant and argues that skill is entirely irrelevant.

[4] See Crinò (2009) or Feenstra (2010) for an ample review of the literature.

we examine which type of workers are hired or substituted after expanding intermediate input imports.

In this paper, offshoring and onshoring are viewed as discrete events, as are the closing or relocation of a production line. Muendler and Becker (2010) indeed find evidence that employment changes in multinationals are, above all, transmitted at the extensive margin. Our identification strategy relies mainly on Propensity Score Matching (PSM) which has been a useful tool to detect the effects of offshoring or FDI (Barba Navaretti *et al.* 2010; Hijzen *et al.* 2007). The majority of related papers report positive employment effects for the industrialized source countries. Moser *et al.* (2010) manage to disentangle the negative effect due to the restructuring inside the plant from an even larger positive productivity effect, which leads to an overall increase in plant size.[5] One reason why PSM is frequently used is that firms involved in international trade perform differently than the average domestic producer, see Bernard *et al.* (2007); Laplane and De Negri (2004). Hence, the identification of offshoring effects does not involve the entire population of plants but only those that perform similarly to the top-tier international companies. We use non-importers and importers without an increase in intermediates imports as control groups. With both groups and the usual comparison in levels as well as a difference-in-difference estimator, we find that plants grow by about 12 employees after an increase of their intermediate input imports.

Even from a theoretical point of view, it is difficult to make a proposition about the flow of intermediate inputs in a global perspective. In Grossman and Rossi-Hansberg (2008) vertical specialization is profitable if the offshoring cost is lower than the labor cost saving in the foreign location. Because most models are based on two countries, they do not discern if and which tasks will be performed in, e.g., China or Brazil. Empirical studies often merely make a distinction between high and low-income destinations to separate between vertical specialization (vertical FDI) and a duplication of production (horizontal FDI). Middle-income countries are not included separately in these considerations. These countries are an important object of study, given that their GDPs have been growing steadily and the 'South-South' and 'North-South' are beginning to overtake the trade flows between the industrial nations (Hanson 2012). An exception is Costinot *et al.* (2013) who study a continuum of countries that differ in their technical capabilities. Because production is sequential and subject to mistakes, countries with more advanced technology perform more complex and later production stages in their model.

Hanson (2012) emphasizes that the explanation of the surging North-South trade calls for theories with factor endowment differences. Brazil is well endowed with low-skilled labor, but still has a higher share of skilled labor than China or India.[6] While the automotive, aircraft and chemical industries have recently been expanded, the core of Brazil's economy remains the production of goods that require manual labor (De Negri 2005b). To have a solid theoretical guidline, we extend the model in Feenstra and Hanson (1996, 1997) to

[5] This productivity effect is discovered in the model by Grossman and Rossi-Hansberg (2008).

[6] According to data from the Barro and Lee (2013), the share of people with tertiary education is 6% Brazil compared to 31% in the US, 14% in Germany, 10% in France and 3% in China and India.

three countries. It is a Heckscher-Ohlin version where a final good is produced from a continuum of inputs. Its proposition is simple and suggests that a country should specialize in production stages whose complexity corresponds to the country's relative skill endowment. In fact, we see support for this prediction in the Brazilian data.

The question arises how does this pattern of vertical specialization emerge? Do Brazilian firms offshore unskilled jobs to low-wage countries, or do firms in high-wage countries offshore to Brazil? De Negri (2005a) identifies a number of innovative, highly productive and large domestic firms, which might be originators of offshoring. We rely on prior theoretical and empirical findings to distinguish both possibilities in the data. (1) As mentioned above, offshoring generates ambiguous employment effects, whereas onshoring should be clearly positive for suppliers in the target country. (2) According to our model, offshoring should decrease tasks at the lower end of the skill distribution, whereas onshoring implies gains in its middle. (3) Jobs that mainly involve routine tasks are most tradable.[7] Using a shift-share analysis and regressions on the wage bill share, Becker *et al.* (2013) confirm that offshoring increases the proportion of non-routine and interactive tasks in German multinationals.[8] According to these three predictions, we obtain evidence that Brazilian firms do indeed onshore tasks. The PSM shows that plants with an intermediates import expansion grow in size, conduct more routine manual tasks and export a higher share of intermediate inputs than plants in the control group. In particular, the employment gains are located in the middle of the skill distribution.

Another interesting firm-level study by Amiti and Cameron (2012) finds that the import of intermediate inputs decreases the demand for non-production relative to production workers in low-skill abundant Indonesia. They interpret this demand shift as being due to a substitution of in-house produced high-skill intensive inputs. In light of our results, their findings is also consistent with the notion that Indonesian firms perform onshored low-skill intensive production processes. We analyze created and destructed jobs separately and rule out that, in our case, the increase in plant's average routine manual task intensity is caused by a substitution of high-skilled workers.

Moreover, we distinguish plants by the origin of their intermediates imports because the origin may disclose different purposes and overlapped effects. On the one hand, inputs from high-wage countries are more likely to induce substitution effects. On the other hand, offshoring of Brazilian plants may only be visible in imports from low-wage countries. A number of studies find more negative employment effects when offshoring to low-wage destinations is considered separately (Barba Navaretti *et al.* 2010; Becker *et al.* 2013; Biscourp and Kramarz 2007; Moser *et al.* 2010). Notwithstanding, we observe the same pattern as before for both type of import sources. A reasonable explanation for this finding is that the origin of imports is only indicative of the production mode. In sequential

[7] Autor *et al.* (2003: 1280) define routine tasks as "a limited and well-defined set of cognitive and manual activities". These tasks are easily substituted by computers but also cause low coordination and monitoring costs.

[8] Goos *et al.* (2014) relate offshoring to employment changes within the entire country, whereas Firpo *et al.* (2011) and Baumgarten *et al.* (2013) study the associated wage changes. All three papers confirm the firm-level results.

production, the same input may first be processed in low-wage countries, then in Brazil, and then in other locations, while the complexity of the tasks and the value added in each stage rises, as in described in Costinot *et al.* (2013) and detected in Johnson and Noguera (2012). Moreover, independent components may be offshored, processed in Brazil and immediately returned to the originating high-wage country.[9]

The remainder of the paper is organized as follows. The next section analyzes Brazil's trade pattern of intermediate inputs from an empirical and theoretical point of view. Section 3 presents the data and the task classifications used. Section 4 describes the PSM approach. Section 5 contains the results and section 6 concludes the paper.

2 Brazil's trade pattern of intermediate inputs

This section presents aggregate trade statistics that document the growing importance of intermediate goods for Brazil. We then sketch a model that predicts which type of production steps should be conducted in middle-, high- and low-wage countries.

2.1 Stylized facts

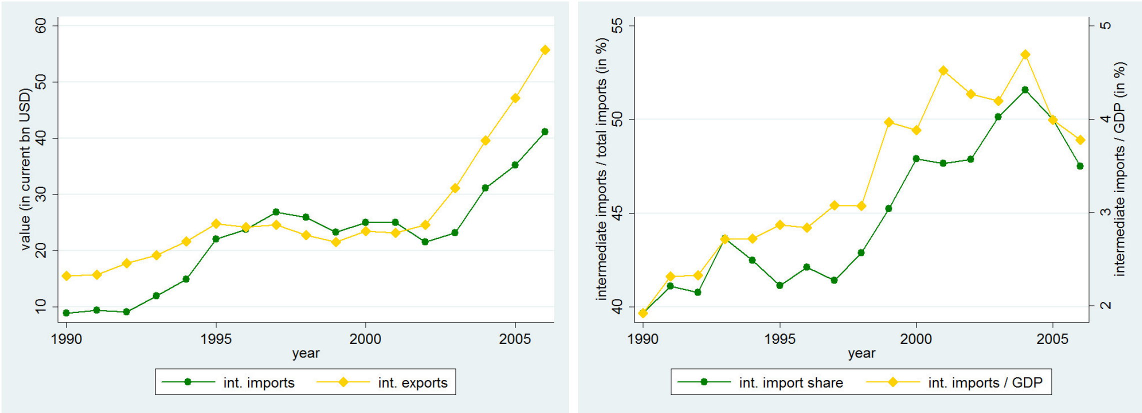
The steady increase in world trade over the last decades is well known. Driving forces for this development are the fragmentation of production and the intra-industry trade between industrial nations (Hummels *et al.* 2001; Yi 2003). A more recent aspect is that low- and middle-income countries are also increasingly involved in world trade (Hanson 2012). Figure 1 shows that Brazil's intermediate goods imports amount to US$ 41 billion and intermediates exports $ 56 billion in 2006. Since the 1990s both have grown by more than 350%.[10] Aggregate imports and exports show a very similar development. Hanson (2012) documents that Brazil is not the only developing country experiencing such a process. He also stresses that the gravity logic fails in these cases because the trade boost is disproportionate to the growth in GDP (which is nevertheless also remarkable). The growing importance of offshoring and the integration of developing countries in international production chains seem to offer a plausible explanation for this phenomenon. The right graph in figure 1 illustrates that Brazil's share of intermediates imports relative to GDP rises from 2% to 4% between 1990 and 2006. In one of these years, intermediates even accounted for more than half of total imports. Important triggers for Brazil's integration are, beyond doubt, its trade reform and the creation of the Mercosur in the early 1990s (Gonzaga *et al.* 2006).

Figure 2 displays how Brazil's intermediate goods trade is distributed over its major trading partners and how these shares change over time. Even though their stake declines, more

[9] See Baldwin and Venables (2013) for a theoretical analysis of trade patterns associated with these two production modes.

[10] The weak performance between 1995 and 2000 may be explained by the economic challenges after the monetary reform of 1994. Growth was low or negative, and prices for domestic products increased strongly, which harmed exporters and the trade balance (Ferreira and Tullio 2002).

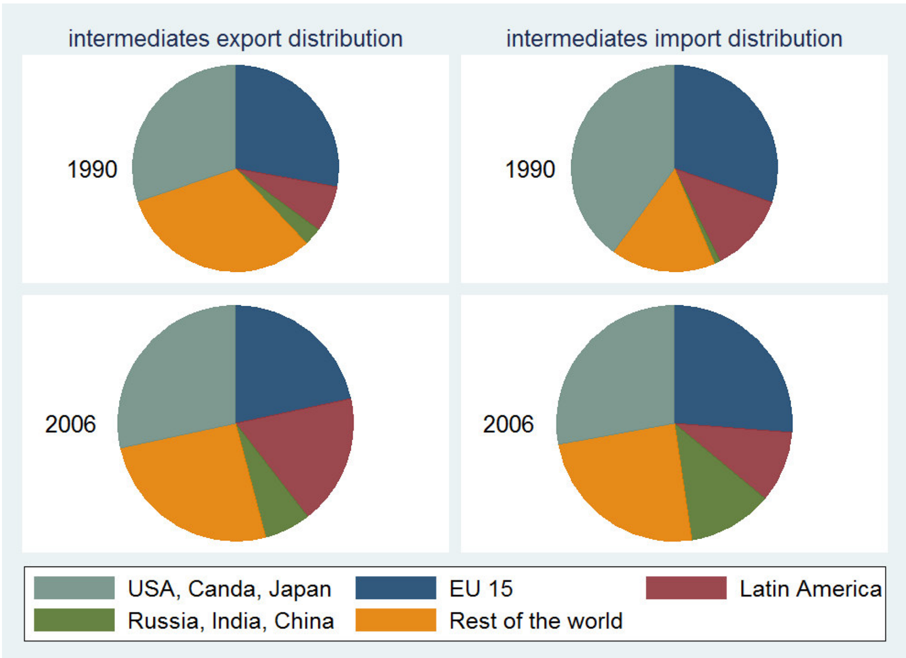
Figure 1: The growing importance of intermediate input imports



Source: UN Comtrade.

than half of the intermediates exports and imports still concentrate on a few high-wage countries, namely the EU, the US, Canada and Japan. Unsurprisingly, after the creation of the Mercosur, trade with other Latin American countries increased. However, these countries are more important as destinations for exports than as suppliers for intermediate inputs. The importance of China and India as trade partners also grows over time, whereas these countries are rather important as suppliers.

Figure 2: The distribution of Brazil's intermediate inputs trade across countries



Source: UN Comtrade.
Notes: The EU-15 comprises Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Sweden, Spain, Portugal, and the United Kingdom. Latin American countries comprise Argentina, Bolivia, Chile, Colombia, Ecuador, Guiana, Paraguay, Peru, Suriname, Uruguay and Venezuela.

2.2 A model

To derive a theoretical prediction about the location of intermediate inputs when the production of the final good is fragmented and mobile, we slightly modify the model in Feenstra and Hanson (1996, 1997) and extend it to a three-country framework. Note that we are only interested in a purely static description of the location of intermediate production stages.[11] There is a final good Y which is manufactured (free of cost) from a continuum of $z \in [0,1]$ differentiated inputs $x(z)$ subject to

$$\ln Y = \int_0^1 \alpha(z) \ln x(z)\, dz \quad \text{and} \quad \int_0^1 \alpha(z)\, dz = 1 \tag{1}$$

Producing one unit of $x(z)$ requires $a_L(z)$ of unskilled and $a_H(z)$ of skilled labor. The intermediate goods are ordered according to their complexity so that $a_H(z)/a_L(z)$ is strictly increasing in z. Assume that the relative skill endowments of the countries A, B and C are given by

$$\frac{H_A}{L_A} > \frac{H_B}{L_B} > \frac{H_C}{L_C} \tag{2}$$

These factor endowments are sufficiently different that factor prices are not equalized. Moreover, the countries differ in the factor neutral production efficiency. It follows that the skill-abundant country A has the lowest skilled wage ratio, i.e., $\frac{q_A}{w_A} > \frac{q_B}{w_B} > \frac{q_C}{w_C}$. The minimum cost function for the production of intermediate z in country i is given by

$$c_i(w_i, q_i, z) = \Omega_i \left[w_i a_L(z) + q_i a_H(z) \right] \tag{3}$$

where Ω_i is an inverse measure of the country's overall productivity. The relative slopes are determined for the three minimum cost curves and each pair of lines crosses at most once, when we assume that intermediate inputs are produced in all three countries (Feenstra and Hanson 1996). Given the assumptions about relative factor endowments in equation (2) the minimum cost curve c_B intersects c_C from above and c_A from below, cf. figure 3. These intersections define two marginal intermediates z_{CB} and z_{BA} for which the production cost is equal in the two countries. The production of each intermediate is located where its cost is minimized. Consequently, country C is the supplier of intermediates z in the range $[0, z_{CB}]$, country B supplies all $z \in [z_{CB}, z_{BA}]$, and country A the remaining inputs in the interval $[z_{BA}, 1]$. This pattern of fragmentation is shown in figure 3.

Due to equation (1), the share $\alpha(z)$ of world expenditure E is allocated to the production of each intermediate $x(z)$. Thus, the demand for $x(z)$ from country i is given by

$$x_i(z) = \frac{\alpha(z)E}{c_i(z)} \tag{4}$$

Factor demands in country i are derived from the derivative of the cost function with respect to the factor price and integrated over the production range of this country. For

[11] For this reason, including only two production factors into the model is sufficient.

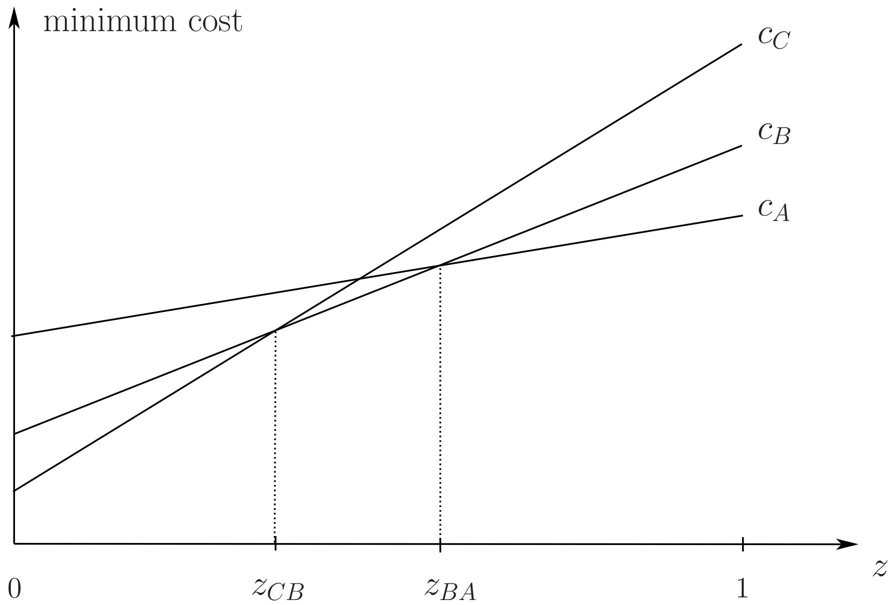
example, using equation (4) and (3) the low-skilled labor demand in B is given by

$$L_B = \int_{z_{CB}}^{z_{BA}} \left(\frac{a_L(z)\alpha(z)E}{w_B a_L(z) + q_B a_H(z)} \right) dz$$

Finally, the remaining five full employment conditions, the two equations that define the marginal intermediates and the definition of world expenditure $E = \sum(L_i w_i + H_i q_i)$, pin down the equilibrium of the nine endogenous variables in the model.

The ranking of relative endowments in equation (2) corresponds to the empirical facts if A is a high-wage country, such as the U.S., B represents Brazil and country C is a low wage country such as China.[12] According to figure 3, Brazil has a comparative advantage in producing intermediates of medium complexity. This is the main prediction that we will test in this paper.

Figure 3: International division of intermediate input production



3 Data

3.1 Employer-employee data

The backbone of this analysis is the linked employer-employee data set RAIS (Relação Anual de Informações Sociais) which comprises the universe of the formal Brazilian labor market.[13] On a yearly basis, all establishments are required to report to the Ministry of Labor about every worker registered throughout the calender year. The data is employment

[12] For example, according to data from Barro and Lee (2013), the ratio of persons with completed tertiary education relative to those with primary schooling or lower in 2005 amounts to 12 in the U.S., 0.13 in Brazil, 0.09 in China and 0.06 in India.

[13] Access to this data is confidential and was granted while the author visited the IPEA Institute in Brasília.

spell-specific and also contains basic information about the establishments activities. Since the information is extracted from official records, its quality is excellent. Furthermore, plants are fined for late- or non-submission and very few entries have missing values. Workers as well as plants are characterized by a unique identifier, so each can be tracked over the years. We extract the information yearly on December 31 and keep all plants with at least five employees. Multiple spells for workers, even in the same establishment, are distinguished and kept for the following analysis. Data constraints restrict the period of this investigation to the years 2003 to 2006. We focus on privately owned plants from the manufacturing industry, because international trade models are more relevant here. Still, there are around 6 million spells per year.

Throughout the paper we weight spell-specific information by the number of hours worked per week. Likewise, employment size is calculated as the total of hours worked in that plant relative to the grand mean of hours per job in the data. In addition, the annual mean wage, education and occupation of each worker are known. The latter is taken at the 5-digit level, where more than 2500 different jobs are recorded. Since occupations and their mapping to tasks are key variables in this paper, this most disaggregated level is kept throughout the analysis. Unfortunately, a severe break in the classification impedes the mapping before 2003 and thus limits the observation period in this study. Education is reported in 10 categories which we aggregate to four, corresponding to: (1) less than high school, (2) high school, (3) college and (4) higher education.

At the plant level we use the region[14], industry (IBGE subsectors 1-13)[15], legal form and an indicator, whether the plant is considered small from a fiscal point of view, i.e., its annual revenue is less than 1.2 million Reais. Because the affiliation of establishments is known, controlling for the overall firm size is possible. Apart from the disaggregated labor input, no more information about the production side is given. Nevertheless, we are confident that due to the way the outcome and offshoring variables are defined, this paper is able to provide robust and valuable insights about the effects of importing intermediates.

3.2 Trade data

This subsection describes our data about trade transactions and the construction of the offshoring/onshoring indicator. We also identify which variables are adequate controls for firms' performance in the absence of output and productivity.

For each establishment, the Ministry of Development, Industry and Foreign Trade (MDIC) records all commodity transactions at the level of product and countries.[16] This amounts to around 0.5 million observations per year. Via the unique plant identifier this information is merged into the RAIS.

[14] We found in the PSM procedure that the five Brazilian regions (North, North-East, Central-West, South-East and South) already capture most of the interstate heterogeneity, which obviously exists.

[15] Industries are aggregated to the 2-digit level. This IBGE (Brazilian Institute of Geography and Statistics) classification conforms roughly to the 2-digit ISIC (International Standard Industrial Classification) industries (Helpman *et al.* 2012). Those sectors are listed in figure 5, but we found no relevant differences between sectors, so a further discussion is of less importance.

[16] MDIC data was available until 2006, which has set the upper time bound in this study.

It is by now well known that firms involved in international trade are very distinct from purely domestic ones. Melitz (2003) and subsequent literature have placed exporters in the center of attention. In this paper, we only need to draw on the import dimension. Bernard *et al.* (2007) illuminate that importers are even more scarce than exporters. While both outperform plants that only serve the domestic market, importers have almost twice the total factor productivity of exporters.

A variety of papers show that indicators for the success on world markets are reasonable proxies for the productivity of the firm. Silva *et al.* (2012) report a positive relation between import volume and the hourly labor productivity in the Brazilian economy by employing Granger causality tests and a vector autoregressive model. Even in a model with plant fixed effects, Laplane and De Negri (2004) find positive relations between labor productivity and export and import volume. Bernard *et al.* (2010, 2011) demonstrate theoretically and empirically that the extensive margin of exporters is a good indicator for productivity. Using data from India, Goldberg *et al.* (2010) document that multi-product firms have superior performance in the developing world, as well.

In line with these studies, we employ the number of products, destinations and the total value for establishments' yearly imports and exports to control for the different performance of plants in the following propensity score matching. Summary statistics are displayed in table 1, where the the first four columns distinguish between importers and non-importers. Note that all the trade variables exhibit a huge heterogeneity across establishments. Our data support the previous findings on trade and performance. Importers are much larger and use a higher share of skilled labor in production than the average non-importer. Even the subgroup of only-exporters have a much smaller scope of products and destinations than firms which export and import. Finally, the latter's export value per product is higher by 156.000 Reais.

De Negri (2005a) divides Brazilian imports according to their technological content and country of origin. She finds that products from the EU or North America have a higher technological content, whereas the majority of imports from Asia and Latin America are labor and resource intensive. Furthermore, foreign firms are on average more productive than Brazilian firms, and they are more likely to import from the EU or North America.

This gives reason to believe that the purpose of imported intermediate goods is different depending on their country of origin. We pick up this differentiation for a detailed analysis after the pooled baseline results. Brazil's most important high-wage trading partners are the EU 15, the U.S., Canada and Japan. Their low-wage counterparts are Russia, India, China (RIC) and the countries in Latin America (LA). Imports from these countries account for more than 85% of all import transactions. For convenience, we denote the high income countries by 'EU' and the second trade bloc simply by 'LA'.

The final four columns in table 1 contain summary statistics according to whether more than 50% of a plant's total value of intermediates imports is from one of the two trading blocs. The findings from De Negri (2005a) are reflected in our data. EU-importers seem more productive as their export and import volumes are much higher. Even though they

Table 1: Summary statistics pooled for 2004 and 2005

	national		international		EU importers		LA importers	
	mean	std	mean	std	mean	std	mean	std
production								
size	22.9	87.3	208.6	371.0	207.1	348.1	209.9	412.1
Δsize	1.04	28.24	15.37	95.58	12.29	82.33	16.01	84.26
firm size	115	1028	672	2485	729	2670	552	1975
educ.sh.[1]	0.148	0.235	0.079	0.119	0.070	0.107	0.097	0.132
educ.sh.[2]	0.428	0.302	0.254	0.194	0.234	0.184	0.298	0.201
educ.sh.[3]	0.380	0.305	0.490	0.217	0.498	0.208	0.474	0.221
educ.sh.[4]	0.044	0.120	0.176	0.187	0.197	0.193	0.130	0.151
low revenue dummy	0.723	0.448	0.027	0.162	0.024	0.152	0.030	0.171
trade								
imp.countries	-	-	27.9	55.3	31.4	58.6	16.5	34.8
imp.products	-	-	19.8	28.7	22.8	31.0	11.9	18.3
imp.value	-	-	3.225	21.90	3.421	26.30	1.830	6.620
exp.value	1.865	18.10	6.350	32.30	6.295	35.00	4.858	25.30
exp.products	3.3	5.9	8.8	18.1	8.7	18.4	8.4	18.6
exp.countries	7.6	28.5	28.8	108.3	27.9	121.1	27.7	83.9
tasks								
analytical	9.301	0.363	9.489	0.346	9.534	0.340	9.406	0.340
r.cognitive	9.921	0.633	9.921	0.517	9.944	0.505	9.859	0.546
r.manual	10.37	0.662	10.32	0.538	10.32	0.539	10.36	0.530
non-r.cognitive	9.378	0.444	9.570	0.375	9.607	0.374	9.497	0.369
non-r.manual	10.19	0.603	10.11	0.440	10.11	0.441	10.14	0.446
offshorability	10.02	0.539	10.07	0.409	10.07	0.402	10.06	0.407
obs.	271427		2497		1528		599	
obs. (exporters)	8826		1678		1077		383	

Notes: The production and task specific variables (except for the low revenue dummy) are weighted by the number of hours worked by each employee. Column 1 and 2 refer to purely national firms, column 3 and 4 to all importers. The last 4 columns sub-divide importers into those that acquire more than 50% of the value of their imports from the EU, US, Canada or Japan (EU) and those plant which mainly import from Russia, India, China or Latin America (LA). Export and import values are in million Reais.

are not larger in terms of employment, their number of import products and destinations is more extensive. Finally, EU-importers are more likely to export.

As there is no direct information which states whether a plant has engaged in offshoring or onshoring, it is nontrivial to define an adequate indicator; however, the data is detailed enough to do so. The IBGE provides a mapping of the 5-digit product codes (NCM) in our MDIC data to the international BEC (Broad Economic Classification) classification. With the BEC the products can be divided according to their stage of production into: (i) primary products, (ii) intermediate goods and (iii) final goods (Calfat *et al.* 2008). The intermediate goods can be further divided into 'semi-finished goods' and 'parts and components'. Typically, the famous examples for offshoring from the automotive, aircraft or toy industry deal with the assembly of parts and components. Semi-finished goods are admittedly less dazzling, but we see no reason to restrict our definition of offshoring to the latter category. Most related studies either use all imports or do not discuss this distinction of intermediate goods at all. All following steps of our analysis were conducted for the entire intermediate goods classification and only for 'parts and components'. The results for the latter category were largely similar. Following Feenstra and Hanson (1999), we also check whether a restriction to imports within the same 2-digit sector (narrow offshoring) alters the results. Both cases are reported in the robustness checks section.

We now define the indicator for an increase in imports, which is of central importance for this paper. The indicator takes the value 1, when a plant imports a new intermediate good in a period t, subject to the following constraints. New products are products which the establishment has not purchased over the last two years and the product is at least purchased for three consecutive years or rather two years in case the import only begins in 2005. We thereby separate stable offshoring relations from one-off investments, fluctuations in productions, etc. However, the indicator for increased imports is not restricted to the number of products. Thus if a plant starts to import two or more new products in a given year, it would still be classified as an offshorer. Imports with an annual volume of less than 2000 Reais are regarded as being irrelevant and unlikely to cause any labor substitution. Finally, plants with an increase in two consecutive years and import newcomers are excluded from the analysis in order to obtain clean effects.[17]

Most prior studies have struggled with the definition of offshoring. In the absence of managers' direct responses, it is almost impossible to unequivocally determine from data whether or not a firm conducts offshoring. In the public perception, offshoring corresponds to a discrete event, like the closure and the relocation of a plant (or parts of it). Our indicator captures those events where a new and stable relationship to a foreign supplier begins. It also captures cases where the scope of production expands by using foreign intermediates, which would otherwise be produced or purchased domestically. Therefore, this variable is suitable to report offshoring as well as onshoring. In any case, the definition of such an indicator is novel. One of its advantages is that we can use it for the propensity score matching strategy, as in Moser *et al.* (2010). Comparing plants before and after the intermediate imports increase will show the immediate effect of the reorganization. Furthermore, purchases like machine parts or other capital assets are not included because we only consider parts that are repeatedly required for production. On the other hand, unlike working with the value of imported intermediates, our indicator does not address every plant with offshore relations. However, employment in offshore plants, as in Becker *et al.* (2013), or the share of imported intermediates in production, as in Hakkala and Huttunen (2010), bear another problematic aspect. A higher import volume from existing supplier relations is different from relocations and consequently only complementary workers and work processes are affected. In essence, our indicator is unaffected by undesired quantitative upward or downward fluctuations.

[17] For more than 90% of observations the increase in the number of products is synonymous with an increase in the total value of imports or the number of products. However, we prefer not to restrict the indicator to these cases, because the overall level of inputs could drop simultaneously. That is, a decrease in the total value of (intermediate) imports is not inconsistent with offshoring.

3.3 Tasks in Brazil

In the following we introduce six task measures by which we characterize employment changes. Unfortunately, there is no Brazilian workforce survey of tasks for a detailed classification of occupations but it is possible to rely on U.S. data from the O*NET (Occupational Information Network). Maciente (2013) conducted a mapping between the U.S. and Brazilian occupations at the 5-digit level.[18] The existence of different synonyms for many Brazilian and U.S. occupations (so called lay titles) facilitates the mapping. Moreover, Maciente (2013) compared the score distribution of the O*NET measures for matched occupations. In some cases where the mapping was ambiguous, the occupation is disregarded. The same is true for some occupations in which the O*NET categories appeared obviously inappropriate for the Brazilian job. Therefore, not all occupations could be matched with task measures.[19]

The O*NET survey asks workers to state the importance of various ability requirements and activities performed in their job. The advantage of using this data is that we may use the well known task measures introduced in the seminal article by Autor *et al.* (2003). Their definition is based on the DOT, the predecessor of O*NET, but Acemoglu and Autor (2011) reproduce the five task categories O*NET measures. These categories are: analytical, routine cognitive, routine manual, non-routine cognitive and non-routine manual. Acemoglu and Autor (2011) add one more category that should capture the offshorability of jobs.[20] Goos *et al.* (2010) provide different task definitions based on the O*NET, distinguishing only analytical, routine and service tasks. We performed our analysis with both definitions and found the categories used by David Autor to be more selective. One problem with the definition in Goos *et al.* (2010) is that in combination with the Brazilian occupations, service and abstract tasks are quite similar. Nevertheless, their routine category corresponds well with both routine categories in Acemoglu and Autor (2011) and we obtained similar results throughout.

To construct the task variables for each occupation, we first take the mean of the relevant O*NET measures and then standardize it to a mean of 10 and a standard deviation of 1. The standardization makes the six tasks measures comparable, independent of the differently scaled O*NET work activities. Once all occupations have positively defined task variables, it is more convenient to interpret changes in the employment pattern. To this end, we compute average task intensities of plants and weight worker's task values by their hours worked.

Figure 4 depicts the average task content of occupations along the *entire* wage distribution in all sectors used in this study with a lowess smoother for the year 2003. Since the task measures are standardized at the level of occupations, they do not have a mean of

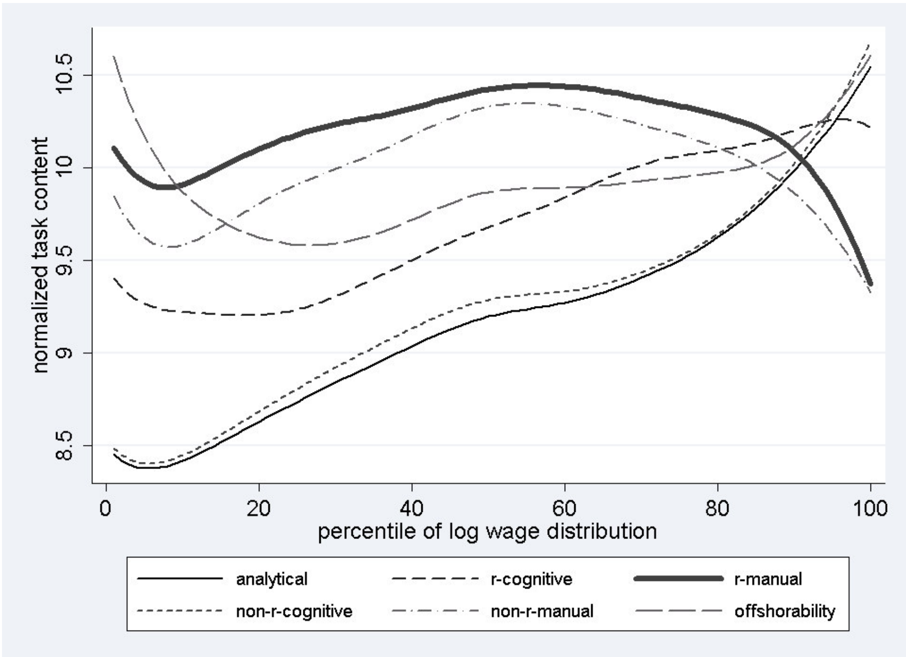
[18] The author is very grateful for the provision with this data.

[19] Consequently, we have some missing values when we calculate the average task content for each establishment. To avoid overly imprecise averages, all plants with more than one-third missing values are dropped. This amounts to 2% of observations.

[20] The exact same definitions are used here with one exception. The routine cognitive measure misses two O*NET work activities: 4.C.3.b.7 and 4.C.3.b.8.

10 anymore in this economy-wide representation. We see, for example, that only roughly 10% of workers have above average analytical or non-routine cognitive task content. Unsurprisingly, these jobs are located at the top of the wage distribution. The majority of the population is engaged in manual intensive occupations. Jobs in the middle of the wage distribution obviously require a certain amount of skill and are related to industrial activities. Occupations further to the left (around the 20^{th} percentile) are mostly either in the service sector or require less skill and more hard physical work. Accordingly, those jobs are unlikely to be offshored. Finally, the few remaining individuals at the lower end of the wage distribution are mainly handicraftsmen and agricultural workers. Their high offshorability is particularly explained by low scores regarding the interaction with colleagues and the public. The offshorability measure peaks again at the upper end due to scientists, editors and other creative workers that are not required to perform at a particular site.

Figure 4: Average task content of occupations along the wage distribution



Notes: Task intensities in each Brazilian occupation are plotted against their percentile in the wage distribution using a kernel weighted regression. The calculation of the wage distribution is based on the employment weighted mean wage of every occupation. Brazilian 6-digit occupations are mapped to US occupations according to the porcedure in Maciente (2013). Therefore, the task categories are defined as in Acemoglu and Autor (2011) by using the O*NET classification.

Comparable graphs for the U.S. and the German task classification are in Autor *et al.* (2008) and Dustmann *et al.* (2009), respectively. The main differences between these high-income economies is that the lower end of the wage distribution is marked by service rather than non-routine manual jobs in Brazil. Moreover, the segment of high-skilled and high-wage jobs is much smaller in Brazil. Notwithstanding, the task measures seem to make sense. Despite the precautionary measures with the mapping of occupations, as explained above, there is no certainty that Brazilian and U.S. occupations actually have the same task content. Because the U.S. is presumably the most technologically advanced nation in the world, if anything, the Brazilian occupations are likely to require more manual and less analytic operations.

As will be made clear in the next section, the identification strategy requires information from the period before and after the increase in imports. Essentially the increase can occur either in 2004 or in 2005. Table 1 shows the complete summary statistics for the variables described in this chapter pooled for the periods 2004/5. The first four columns contain the mean and the standard deviation, depending on whether the plant is an importer or not. The last four columns subdivide the group of importing plants into those that purchase more than 50% from the EU, the U.S., Canada or Japan. The label 'LA importers' refers to those plants with more than 50% of total value of intermediates imports coming from Latin America, Russia, India and China.

4 Empirical strategy

The purpose of this paper is to investigate the employment effects on establishments due to an increase in the extensive margin of intermediate goods imports. To start, we need to verify if offshoring or onshoring is more present in the data. Observing which tasks are increasingly or less often performed, we may infer Brazil's comparative advantage and where these traded intermediates range in the global value added chain. Ideally, we would like to observe the same establishment in two situations, where the only exogenous difference is the increase in imports. Since this is impossible, the propensity score matching (PSM) approach serves to construct a comparable counterfactual situation. If the assumptions of the PSM are satisfied, we estimate the causal effect on the outcome Y. The role of the researcher is to evaluate and implement these assumptions as accurately as possible. This strategy and its advantages over a simple regression analysis are explained in the following section.

There are two distinct groups of establishments in our sample: those that have expanded their import product range ($D = 1$) in period t and those without an expansion ($D = 0$), according to the indicator described above. In analogy to the program evaluation literature, we refer to the expansion of imports as *treatment*. Besides its treatment status D, an establishment is characterized by observable characteristics X. Following Heckman *et al.* (1998b) two conditions have to be satisfied for the matching approach to be valid. Conditional on X, the expected outcome without treatment Y^0 has to be the same for establishments in both groups. More formally, this is

$$E(Y^0|D = 1,\ X) = E(Y^0|D = 0,\ X) \tag{5}$$

The RHS refers to the actual observation for the untreated establishments, whereas the LHS refers to the hypothetical outcome of a treated establishment in case it would not have increased its imports. Clearly, this requirement is impossible to verify and has to hold by assumption. To satisfy this assumption, we require establishments in both groups to be as similar as possible in X. This is the heart of the identification strategy: establishments with $D = 1$ are paired one at a time with untreated establishments if they are sufficiently similar regarding their pre-treatment characteristics X. Conditional on being matched, the difference in the observed outcome between both groups is the treatment effect we are interested in.[21]

The employment size and the average task intensities are analyzed as outcome variable Y. The response in the latter variables is straightforward and easily explained. Since all task intensities are positively defined, an increase in their plant average means that either workers are hired with a task intensity above average, or alternatively, that workers with a task intensity below average are dismissed. Thus, it is irrelevant in the first place, whether the total employment rises or falls.

Rosenbaum and Rubin (1983) establish that instead of comparing firms along all variables X, a single statistic $P(X)$ suffices. $P(X)$, the so called propensity score, is defined as the probability of receiving the treatment conditional on X. Here, we estimate $P(X)$ in a Probit model, where X are values from period $t-1$. The pre-treatment value of the outcome variable is also included in X, to obtain similar values of Y_{t-1} in the treatment and control group as well.

The second requirement in the procedure is that $0 < P(X) < 1$. This is a practical matter that guarantees that all establishments can theoretically be matched. Therefore, the predicting power in the probit estimation should not be too high. Otherwise, it is difficult to find pairs with the same $P(X)$ from treatment and control group, which is of course especially true for perfectly predicted treatment statuses $P(X) = 1$ and $P(X) = 0$. We follow the previous literature and restrict the matching to a common set of $P(X)$-values in both groups (Heckman *et al.* 1998b). In the present application, we are not worried that this common support restriction may confine the representativeness of our findings. Quite the contrary. It is well known that firms involved in international trade, especially importers, are inherently different from national firms (Bernard *et al.* 2007). Therefore, the largest multinationals and the smallest domestic firms do not represent comparable matching partners and should be disregarded. One might still be worried that responses in the outcome are influenced by the participation in international trade. For this reason, we have excluded import newcomers in the definition of the treatment dummy and we work with two distinct control groups. One group is composed of non-importing firms and the group other are only importers which did not increase their imports. Matching with the second control group allows trade related characteristics to be included into X. The different performances between importers and non-importers are extensively discussed in subsection 3.2.

Then the PSM approach proceeds to choose the pairs of firms. To satisfy equation 5, the assignment to treatment conditional on the propensity score must be random. Not only the distribution of $P(X)$ and Y_{t-1} but also of each variable in X should now be alike in

[21] Matching also requires the stable unit treatment value assumption. In the setting here, it means that a firm's import decision has no impact on the employment pattern of other firms. Even though the matching is performed on regions and sectors, their definition is ample. Furthermore the number of importers is rather low, thus there is no reason to suspect that importers employment changes have an effect on local labor markets in the short run.

both groups. These are conditions that can and will be tested. It turns out that the best balance of all variables between treatment and control group is achieved with a simple 1:1 nearest neighbor matching without replacement, where we additionally restrict the maximum distance between observations of a possible pair. Consequently the distributions of $P(X)|D = 1$ and $P(X)|D = 0$ are limited to the common support plus/minus this maximum distance. Firms that remain unmatched are discarded in the following analysis, leading to the satisfaction of the second requirement. Note that the main findings in this paper are not critical to the matching algorithm. Using a k-nearest neighbor matching with $k = 10$ yields similar effects. However, the number of establishments in the control group is much lower and the balance of covariates in matched sample is less exact than in our 1:1 matching.

Once treated and untreated firms are accurately matched on the relevant characteristics, the conditional mean independence in equation (5) implies that the *observed* difference in outcomes between treated and control group $E(Y_t^1|D = 1, P(X)) - E(Y_t^0|D = 0, P(X))$ reveals the effect of an increase in imports we are interested in.

$$E(Y_t^1 - Y_t^0|D = 1, P(X)) \quad . \tag{6}$$

A potential problem for the identification are unobservable factors that affect the decision to increase imports. In this case, equation (5) does not hold with equality and the estimation is biased. We additionally construct the conditional difference-in-difference (DID) estimator proposed by Heckman *et al.* (1998a) that eliminates biases that are constant over time, which implies a relaxation of the requirement in equation (5).

$$E(Y_t^1 - Y_{t-1}^1|D = 1, P(X)) - E(Y_t^0 - Y_{t-1}^0|D = 0, P(X)) \tag{7}$$

Alternatively, it is possible to compare changes in Y^1 and Y^0 between $t + 1$ and $t - 1$. This would be reasonable if restructurings take more than one year to occur. We report both DID_t and DID_{t+1} in the following. However, a preliminary look at the data showed that for the treatment group the largest change in employment (in absolute values) occurs between t and $(t - 1)$, in each case the firms' characteristics are recorded at the end of a year.

Ultimately, we want to emphasize some benefits of propensity score matching over regression analysis. The PSM does not include all firms, but only similar candidates, for the calculation of the treatment effect. In the context of trade, this exclusion is certainly important, as few nationals perform like international companies. Furthermore, PSM equalizes the pre-treatment mean of the outcome variable in both groups. Thereby, differences in Y in later periods mirror the causal effect of the treatment, contrary to a linear regression on the treatment dummy. The downside of the PSM is that some information is lost due to unmatched establishments. Given that we use the universe of Brazilian firms, this does not impede obtainment of significant results.

5 Results

5.1 Propensity Score Matching

This section presents the estimation of the propensity scores (PS), balance properties and finally presents the treatment effects. The PS is estimated in a Probit model, where the dependent variable is the indicator for an increase in imported intermediates in period t.

We perform two specifications to fortify the robustness of the results. In version 1, the control group contains plants that do not have any imports in t and $t-1$. In version 2, the control firms are importers that do not increase the extensive margin of their purchases from abroad. The variables on which the PS is conditioned also differ in both versions. Obviously, the number of different import products, import products multiplied by their destinations and their value appear exclusively in version 2. As discussed in subsection 3.2, these variables are proxies for a plant's productivity. Having a much higher dispersion in plant size in version 1, we obtain a satisfactory balance between treated and control group, with a quadratic in log plant employment size and the overall log size of the entire firm. In the other sample, we obtain better results with dummies for employment size ranges. Moreover, both versions contain employment shares for workers whp have completed high school, college and higher education. The omitted reference group is the share of workers without a high school degree. These variables absorb differences in the production technology. Finally, both estimations contain region fixed effects, an indicator for less than 1.2 million Reais annual revenue and a quadratic in the outcome variable.

For each outcome variable a different Probit estimation and matching is conducted to balance the latter as much as possible. Coefficients are very similar across the models, thus to save on space, appendix table A.5 exemplarily shows the results with the routine manual task index. All coefficients except for the trade related variables are significant predictors for the increase in imported intermediates for both groups of plants. Only after the estimation of the PS, we condition plants to be in the same 2-digit sector and observations years to be equal.[22] The low pseudo R^2 in the Probit estimation for version 2 is not necessarily bad news. It means that, given the available variables, it is difficult to predict which *importer* will increase its foreign activities. Either the data set is not rich enough, selection into treatment is based on unobservables and the treatment effect can not be interpreted as causal, or the low pseudo R^2 is a sign that the conditional independence assumption in equation (5) is likely to hold. Recall that all firms are already importers, and thus an additional increase in the next period is difficult to predict ex ante.

Because matching conditions can never be undoubtedly verified, the following checks suggest that the procedure is stable and provides reliable results. In any case, this paper is interested in the direction of task intensity changes rather than an exact number. Therefore, even in case of small biases, PSM is informative.

[22] Given the caliper matching, the forcing of exact matches is done by adding 10∗year and 100000∗sector to the predicted PS, cf. Ebner (2012). The maximum distance between the PS in matched pairs is equal to 0.005 in version 1 and 0.1 in version 2. A larger distance is allowed in the version with only importers, because the firms are more similar and there are much less possible matching partners available.

Balancing properties of both versions are again reported exemplarily for the case where the outcome variable is the routine manual task intensity in appendix tables A.6 and A.7, respectively. The matching yields reasonable bias reductions and the difference in means is insignificant for most of the covariates. While Rosenbaum and Rubin (1985) consider a bias of 20% as large, we remain well below 5% for most of the variables. Most importantly, the plant's task content, i.e. the outcome variables in the pre-treatment period, are also well-balanced in treatment and control group. Their PS distributions confirm this impression, compare panel (a) and (b) in appendix figure 9. We also observe that after conditioning on the common support, the remaining overlap of $P(X)$ is quite large. Finally, note that neither the matching algorithm (as mentioned above), nor the choice of covariates is critical to obtain the results in this paper. Matching on less variables X deteriorates the balance between importer and control group while most outcome effects have the same sign and similar magnitude.

The following two tables contain the effects for all variables and also repeat the pre-treatment differences. Table 2 and 3 are created with the non-importer and the importer control group, respectively. The first column shows the difference in means between treated and control plants, while the second and third column refer to the difference-in-difference estimators. The comparable treatment effects, across estimators and across the two control groups confirm that matching is accurate.

Table 2: PSM results - national control group

	treatment effect			pre-treatment	
	level	DID_t	DID_{t+1}	difference	obs
analytical	-0.005	-0.004	0.003	-0.001	2213
	[0.623]	[0.453]	[0.634]	[0.821]	
r.cognitive	-0.060	-0.010	-0.002	-0.050	2226
	[0.000]	[0.191]	[0.866]	[0.002]	
r.manual	0.052	0.025	0.027	0.027	2183
	[0.002]	[0.002]	[0.003]	[0.131]	
non-r.cognitive	-0.004	-0.017	-0.009	0.012	2225
	[0.722]	[0.011]	[0.267]	[0.323]	
non-r.manual	0.030	0.013	0.004	0.017	2189
	[0.056]	[0.035]	[0.634]	[0.249]	
offshorability	-0.046	-0.017	-0.013	-0.030	2185
	[0.001]	[0.008]	[0.110]	[0.038]	
exp.sh.int	0.110	0.084	0.073	0.025	1971
	[0.000]	[0.000]	[0.000]	[0.075]	
size	12.03	12.28	11.10	-0.24	2183
	[0.056]	[0.000]	[0.001]	[0.980]	

Notes: The control group are purely national plants, and the treatment group are plants with an increase in intermediate imports. P-values in parenthesis are based on bootstrapped standard errors with 100 replications. The last column quotes the number of treated plants.

For the average task contents of a plant, reported in the first six rows, we obtain significant results for routine and non-routine manual tasks. An increase in intermediate imports raises the intensity of manual tasks in production. The associated mirror-image is the

Table 3: PSM results - importer control group

	treatment effect			pre-treatment	
	level	DID_t	DID_{t+1}	difference	obs
analytical	-0.009	-0.008	0.002	-0.002	2315
	[0.241]	[0.108]	[0.688]	[0.849]	
r.cognitive	-0.023	-0.007	-0.012	-0.016	2310
	[0.116]	[0.257]	[0.177]	[0.280]	
r.manual	0.017	0.022	0.018	-0.005	2311
	[0.249]	[0.002]	[0.043]	[0.762]	
non-r.cognitive	-0.013	-0.013	-0.010	-0.001	2314
	[0.126]	[0.014]	[0.130]	[0.955]	
non-r.manual	0.007	0.011	0.007	-0.004	2320
	[0.531]	[0.061]	[0.288]	[0.761]	
offshorability	-0.002	-0.007	-0.004	0.005	2316
	[0.840]	[0.172]	[0.615]	[0.696]	
exp.sh.int	0.032	0.027	0.036	0.005	2304
	[0.002]	[0.001]	[0.000]	[0.716]	
size	36.32	14.66	20.2	21.65	2311
	[0.000]	[0.000]	[0.000]	[0.024]	

Notes: The control group are importers with out an increase in intermediates imports plants, and the treatment group are plants with such an increase. P-values in parenthesis are based on bootstrapped standard errors with 100 replications. The last column quotes the number of treated plants.

reduction of the non-routine cognitive task intensity. Moreover, routine cognitive tasks do not seem to be much affected by trade in intermediate products. In line with Becker *et al.* (2013), routine manual tasks are among the most tradable. The novelty is that non-routine manual tasks are apparently also affected and, what is more, an increase of their intensity is observed, instead of a reduction.[23] This finding is consistent with the overall predominance of manual tasks in the Brazilian economy (De Negri 2005b). Table 2 also shows that the increase in intermediate imports implies a clear increase in employment by about 12 workers on average, and a higher share of intermediate goods exports. This paints the following picture: On average, establishments process the imported intermediates using manual tasks intensively and then proceed to export them. In other words, onshoring seems to be prevalent in the Brazilian economy. The random assignment to treatment is much easier to sustain in the case of onshoring. In this case, the Brazilian establishment is not necessarily the one who initiates the relocation but the one who accepts an additional order from a foreign buyer or affiliate.

Even though the change in *average* task intensities may seem small given the large spread between occupations, the shifts inside the plants must be substantial given that establishment sizes are quite large. Consider a stylized example to exemplify the size of the treatment effects. Table A.6 shows that the average size of matched plants is 163 in period

[23] Treated importers appear to conduct tasks with an offshorability score below average. This might be explained by the fact that the construction of this task measure is aimed at personal or public interactions. The onshored manufacturing activities require little of those interactions and therefore naturally decrease the average of offshorability task measure.

$t-1$. The average value of routine manual tasks is 10.32 for the treated firms and 10.29 for the control group. For simplicity, we assume that the plants' characteristics in the control group remain constant. Consequently, after the treatment, the task value for the treated firms increased to 10.345. If we assume that these firms keep all previous employees, the 12 additional workers have an average task score of 10.68. To elucidate the routine manual scale, we select a few comprehensive examples of the 2511 occupations: weaver (11.02), maintenance technician (10.74), machine assembler (10.57), production supervisor (10.27), truck driver (10.22), automotive engineer (9.47); Therefore, the new jobs must be considerably routine manual intensive.

As argued in section 3.3, in case of possible inaccuracies, the Brazilian occupations are without much doubt more manual and less analytic than their U.S. counterparts. In this case, we expect the additionally employed workers to attain even higher scores in the manual task categories. So, the good news is that the PSM estimates, if anything, represent lower bounds. One might also be worried that due to the definition of our treatment variable, we principally capture new innovations. In this case, the increase in the size of the plant would come about naturally. Colantone and Crinò (2012) show that new imported intermediates foster the development of new final products. However, their definition of new products is much more stringent because 'new'refers to latest technological innovations. In addition, the fact that the share of exported intermediates also rises, makes us confident that the evidence is consistent with onshoring, rather than with the effects of adopting new technologies from abroad.

5.2 Won and lost jobs

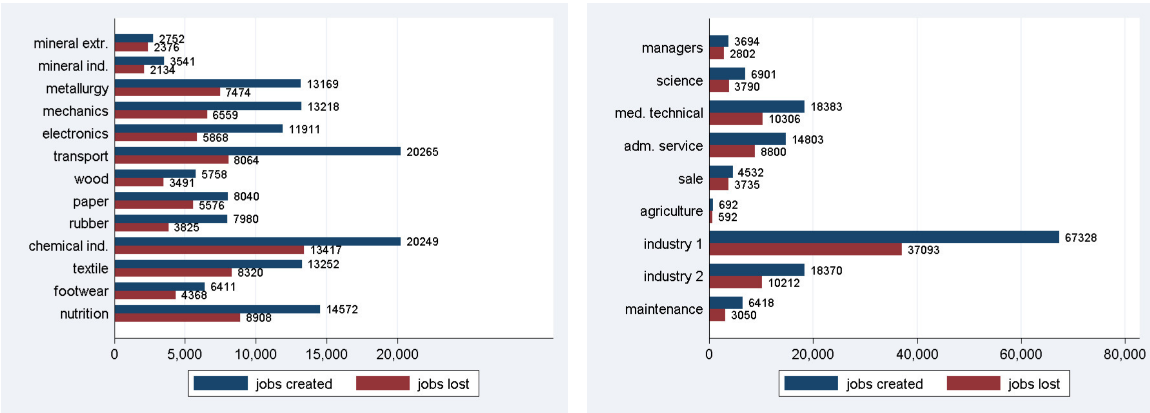
The primary goal of this subsection is to identify Brazil's comparative advantage in the globally fragmented production process. To this end, we characterize the jobs that are created and destructed when establishments expand their extensive margin of foreign intermediate inputs. This also provides a closer examination of the results from the PSM. So far it is not definitely evident whether average task content changes are caused by an increase in manual tasks or whether jobs are lost which use manual labor un-intensively. In conjunction with the prior impression, our expectation is that onshoring creates routine manual jobs, whereas offshoring leads to a loss of routine tasks and to possible gains in non-routine tasks due to the productivity effect.

In the following, only those plants are regarded that experienced an expansion in imports in period t, according to our indicator.[24] First, we count the number of employees (weighted by hours worked) in each plant for each of the 5-digit occupations. Then, we calculate the change in the stock of workers between t and $t-1$. The left graph in figure 5 plots these changes aggregated by sector. It is striking that in all of the 13 industries more jobs are created than lost. The same picture emerges from the aggregation by 1-digit occupation

[24] A few plants are excluded from the analysis that report large increases or decreases in a certain occupation, whereupon this change is almost reversed in the following period. We suppose that these dismissals are merely intended to bypass certain consequences of labor legislation.

groups in the right graph of figure 5. The vast majority of churning occurs in industrial and technical jobs. On average, the import of intermediate goods has positive employment effects for the involved establishments. Even occupations (like sales or administrative services) and sectors (like textile or footwear) where offshoring would normally be expected, do not shrink.

Figure 5: Distribution of won and lost jobs



(a) by sector (b) by occupational group

Notes: These aggregate employment changes by sectors and occupation groups occur in those establishments with an increase in intermediate input imports during the period of the increase.

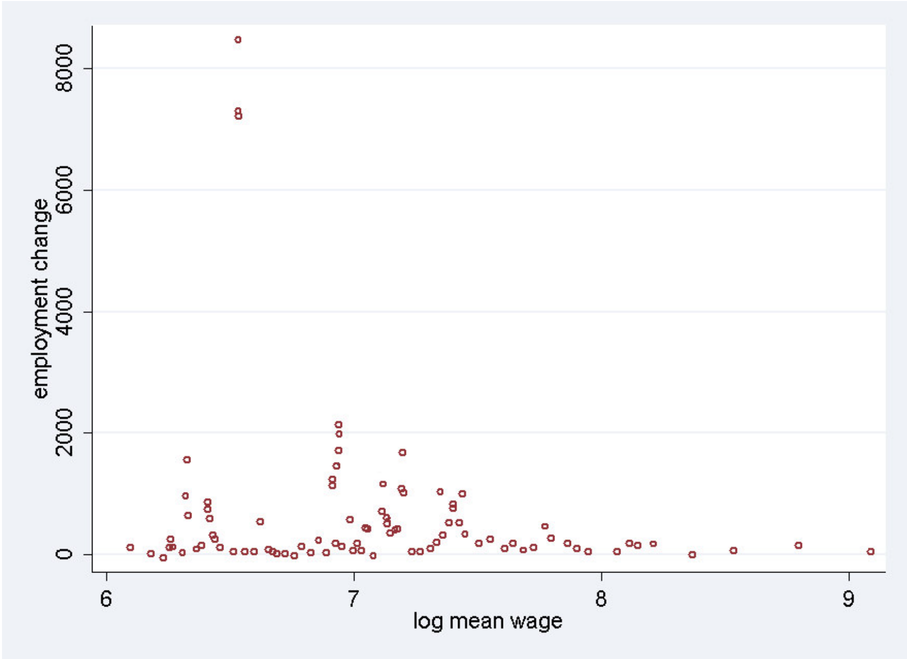
To examine the quality and the skill content of those affected jobs, we show the net employment change in each percentile the wage distribution in figure 6. Some employment gains are located at the lower end of the distribution. In accordance with the theoretical considerations in subsection 2.2, a main part of the increases are located around the $50th$ percentile. In the highly paid jobs, only very small total gains are visible in figure 6.

In the next consideration, the task contents of affected jobs are analyzed. Moreover, we are still interested in determining whether some similar jobs show systematical employment losses that have been overlapped in the graphs considered so far. Therefore, all 5-digit occupations are now considered separately. Figure 7 plots the task contents of occupations against the amount of their net employment change by using a kernel-weighted local polynomial regression.[25] The task contents of occupations with small employment changes are close to their original mean of 10. Further to the edges, the manual task intensity increases steadily, while the analytical intensity decreases. The curve for the routine cognitive intensity shows no clear direction and stays close to its mean. Most astonishing is that the task contents of occupations with the largest absolute change are almost equal. The fact that the maximum value of employment changes is much larger for created than for destructed occupations reflects the overall employment gains. Using the variables in our data set we were not able to find a meaningful distinction between those positively and negatively affected occupations.[26] In the following subsection we explore if differences

[25] For the ease of exposition, only four of the six task measure are depicted here. Non-routine cognitive were quite alike the analytical tasks in this diagram, as was the case in figure 4. The offshorablity measure is omitted, because its change was insignificant before.

[26] We have ruled out that changes in the classifications of some occupations or similar statistical artifacts

Figure 6: Aggregate changes in the wage distribution



Notes: The figure shows the aggregate employment change between period t and $t-1$ in those establishments with an increase in intermediate input imports in period t for each percentile of the wage distribution.

between plants are responsible for this finding.

In summary, an expansion in intermediate imports along the extensive margin induces the creation of jobs. These gains are not restricted to particular sectors but concentrate in routine manual intensive and industry related jobs that are mainly located in the middle of the wage distribution. Because routine manual tasks are easily traded, the picture is consistent with the notion that Brazil is executing tasks that have been offshored from other countries. This suggests that the description of these jobs corresponds to Brazil's comparative advantage in the fragmented production chain.

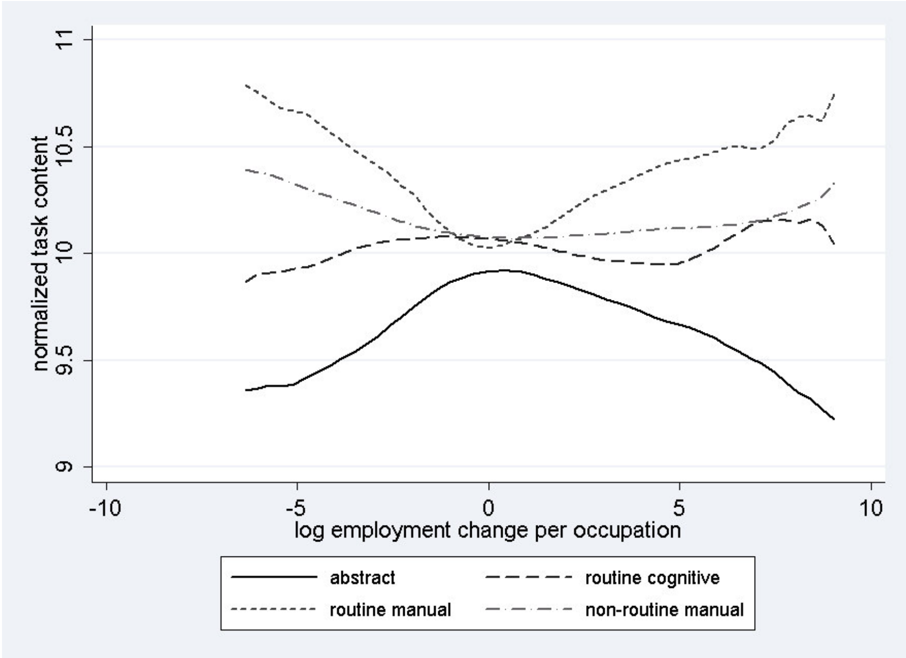
5.3 Imports from high- and low-wage countries

What could be the reason for the almost symmetric change at the level of occupations? Notwithstanding, we are still confident that the task classification is appropriate, given that the routine manual index shows the largest dispersion and seems to be most associated with the tradability of jobs. One possibility is that the origin of imports reflects different intentions and renders different effects, which are overlaid in the pooled sample. As the basic intention of offshoring is to save labor costs, our working hypothesis is: Intermediates imports from high-wage countries are onshored tasks, while imports coming from developing countries represent tasks that have been offshored by Brazilian plants.

The distinction between high- and low-wage countries is frequently made in the context of FDI. Concerning imports, e.g., Becker *et al.* (2013) found that interrelations with low-wage

are responsible for the nature of figure 7. Constructing the graph with the 4-digit or 6-digit classification yields a very similar picture.

Figure 7: Task content and the employment change by occupation



Notes: The employment change is calculated as the net change of employees in each 5-digit occupation between t and $t-1$ considering all establishments with an increase in intermediates imports. The absolute value of this net change is transformed in logs. Employment losses are multiplied by -1 and consequently displayed on the negative part of the x-axis. The vertical axis shows the average task content in 5-digit occupations using a Kernel-weighted local polynomial regression.

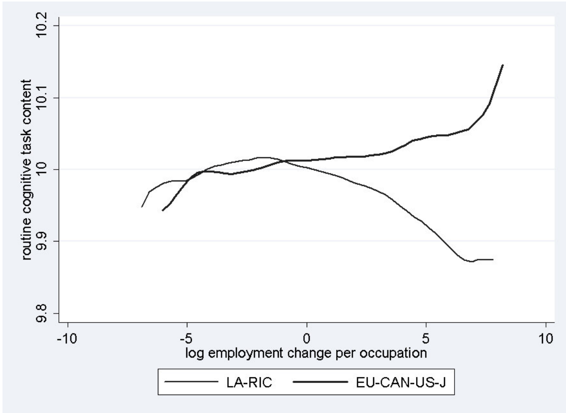
countries generate larger effects. We focus on Brazil's main trading partners and classify the EU, Canada, Japan and the U.S. (labeled EU) as high-wage countries and Russia, India, China and Latin American countries (labeled LA) as low-wage countries. We repeat the PSM and the analysis of created and destructed jobs, but this time we split the group of treated plants into these two groups.

Figure 8 shows the task contents and the net employment change per occupation. The bold lines refer to importers from high-wage plants. For the two categories analytical and non-routine cognitive in panels (a) and (d), a level difference in the entire employment change distribution emerges. This observation is consistent with the summary statistics in table 1 and the view in De Negri (2005a) which states that high-wage country importers are technologically advanced.

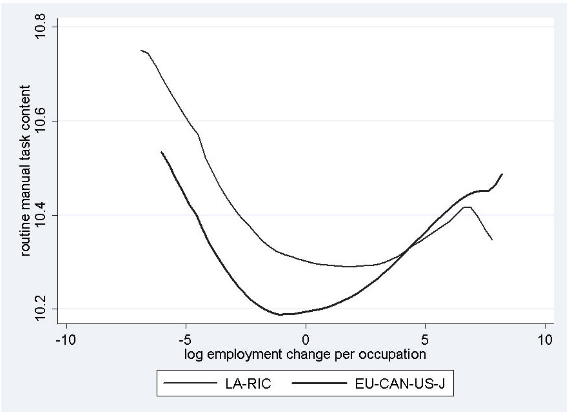
Regarding the routine manual, routine cognitive and offshorability task measures, we observe systematic differences in the two dimensions lost vs. won employment and EU vs. LA imports, that support the working hypothesis. Displaced workers in LA importers show a higher value of offshorability and routine manual intensity than destructed jobs in EU importers. This pattern is reversed for created jobs. In essence, EU importers shift their employment towards routine tasks, whereas the low-wage country importers reduce those tasks. To complete the picture, LA importers seem to shift away from non-routine manual tasks, whereas the direction for the EU importers is ambiguous, given the information in the graph.

Figure 8: Task content and the employment change by occupation - EU and LA imports

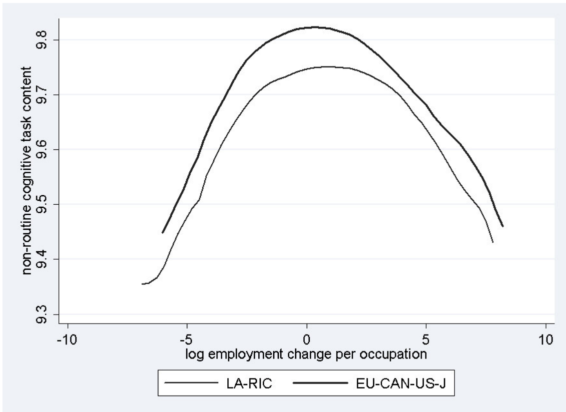
(a) analytical



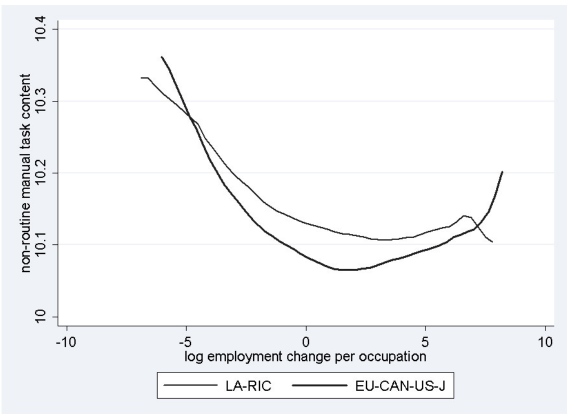
(b) routine cognitive



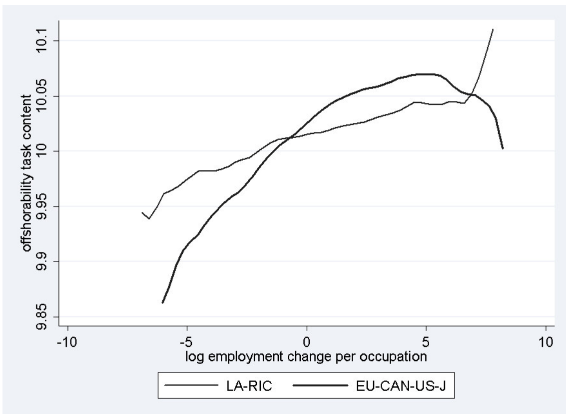
(c) routine manual



(d) non-routine cognitive



(e) non-routine manual



(f) offshorability

Notes: The construction of these graphs is as in figure 7, except that employment changes in plants with intermediate input imports from high- and low-wage countries are considered separately.

Our interpretation of these patters is the following: Some inherent differences between importers are due to a technological edge. Jobs created as a result of more imported intermediates from the EU, U.S., Canada and Japan are more tradable and routine intensive. On the other hand, reduced tasks in plants with imports from low-wage countries are also easier to offshore and more routine manual intensive than those tasks reduced by EU importers. All in all, this is consistent with EU importers performing onshored work, whereas

LA imports look more like offshored tasks.

An advantage of this graphical assessment is that one has an overview of all occupations and of the entire employment change distribution. The downside is that we do not control for differences other than the origin of imports. We provide some regressions at the occupation-establishment level in appendix table A.8 to mitigate that concern. As expected, only large differences along the entire axis of positive or negative employment changes turn out to be significant. That is, LA importers reduce tasks which are significantly less abstract and more routine manual intensive. EU importers increase routine cognitive intensive tasks which may be due to their technological edge and is in line with the prior findings.

The last piece of evidence stems from Propensity Score Matching. Again, we separate the treated importers according to the origin of their foreign intermediates and compare both groups to non-importers.[27] Table 4 shows those outcome variables with significant results and an acceptably low pre-treatment difference. The effects of low-wage country imports in panel B do not provide any evidence for the expected offshoring. We do not observe that treated plants reduce their routine and manual intensive tasks. In fact, the results in both panels in table 4 look much the same and reproduce the prior results in tables 2 and 3. Treated plants grow faster on average than their counterparts and they use routine manual tasks more intensively. EU importers only show more significant results, which is possibly due to the larger number of observations, and they have a larger increase in the export share of intermediates. In both cases it seems that the imported intermediate goods are passed on to a different production site abroad. After all, it seems to make no difference where the imported inputs are coming from.

Baldwin and Venables (2013) argue convincingly that technical characteristics determine the method of production and how the production may be fragmented. They provide some examples for the presence of two different international production processes. One involves the back and forth trade of single components to distinct locations and is thus called "spider". The other is called "snake" because intermediates need to be processed in a certain sequence.[28] No matter if the production is sequential or not, the three-country framework described in subsection 2.2 implies that Brazil performs tasks and production stages with medium complexity, i.e., those in the middle of the value added chain.[29] The detected empirical pattern confirms this and is at the same time consistent with the existence of both the spider and the snake production. Intermediate imports that come from low-wage countries to Brazil thus need not necessarily represent offshoring when the production process is sequential. On the other hand, the imports from high-wage countries conform to a spider type production and the usual perspective of offshoring from

[27] The reason why we prefer the non-importer control group is that most importers source from a variety of different countries and, unlike the import increase, it is less clear to assign importers to either the EU or LA group. Moreover, our baseline results showed that both control groups yield comparable results. Hence the PSM procedure is just like before in version 1. Probit results and balancing properties are similar to the prior ones and are thus omitted for brevity.

[28] Hanson (2012) denotes the two types of production models according to the strategies of the computer companies Dell (spider) and Intel (snake).

[29] Costinot *et al.* (2013) provide a model with technical differences between countries and sequential production. It yields the same prediction if Brazil's technology is assumed to be mediocre.

Table 4: PSM results - EU and LA imports

	A) EU imports			*B) LA imports*		
	level	DID_t	pre-tr.-diff.	level	DID_t	pre-tr.-diff.
r.manual	0.070	0.033	0.038	0.030	0.032	-0.006
	[0.002]	[0.001]	[0.088]	[0.326]	[0.048]	[0.865]
non-r.manual	0.030	0.013	0.016	0.001	0.018	-0.025
	[0.089]	[0.127]	[0.419]	[0.960]	[0.238]	[0.420]
offshorability	-0.040	-0.017	-0.013	-0.008	-0.023	0.019
	[0.032]	[0.059]	[0.493]	[0.792]	[0.122]	[0.493]
exp.sh.int	0.127	0.095	0.032	0.092	0.052	0.048
	[0.000]	[0.000]	[0.085]	[0.000]	[0.000]	[0.076]
size	34.09	9.867	24.23	23.32	10.42	12.91
	[0.000]	[0.000]	[0.024]	[.094]	[0.011]	[0.631]

Notes: The label 'EU' pertains jobs in establishments that acquire more than 50% of the value of their increased imports from the EU, U.S., Canada or Japan. Accordingly, 'LA' marks jobs in plant which mainly import from Russia, India, China or Latin America. The number of observations oscillates around 2750 in panel A and 1090 in panel B. Both have the purely national plants as control group and matching is performed analogous to version 1 before.

developed countries. Since this paper has focused on shifts in the task compositions and less on the actual flow of intermediates, this conclusion should be seen as a preliminary indication. We leave these questions about the organizational structure and the affiliation to global production networks for future research.

5.4 Robustness checks

The main evidence from PSM was complemented by a finer division of treated importers and by the perspective of won and lost occupations. It was mentioned earlier that the classification of tasks, the choice of the control group, the timing of the effects either in t or $t+1$ and the matching algorithm do not change the conclusions obtained so far. One of the crucial variables in the entire paper has not been examined more closely: the increase in imported intermediates. This section briefly shows that the findings remain robust to variations in the definition of this treatment indicator.

Recall that the definition was based on the purchase of any new intermediate good(s) from abroad, subject to some constraints which ensure that the relation is stable and economically important. As a first robustness check, we follow Feenstra and Hanson (1999) and restrict the indicator to cases, where the expanded imports correspond to the importing plant's 2-digit industry class. This narrow definition is intended to separate imports, which the plant could potentially produce itself, from other inputs which are less related to its core competences. The robustness check also lends itself to onshoring, because it can reduce the concern that the observed pattern is merely caused by so-called carry-along trade or by supplementary material for new innovations. That is to say, maybe imported inputs are not even processed, because they do not belong to the plant's core business activity. Appendix table A.9 shows that the responses with the narrow intermediates measure are a little stronger than before. Again, only outcome variables which were most affected so far are displayed. While the sample size is reduced by about one half, our estimators in levels and differences are positive and highly significant for routine manual tasks, the share of exported intermediates and employment size.

For a second robustness check, imports of semi-finished products are disregarded and we focus only on ‘parts and components’. Obviously, the latter category is closely linked to industrial manufacturing activities.[30] Except for a decrease in the significance of the effect on the routine manual task intensity, the results in appendix table A.10 are similar to the previous ones. The drop in significance indicates that even the processing of semi-finished products requires intensive use of routine manual tasks. Therefore, both robustness exercises confirm that Brazilian firms seem to perform stages of medium complexity in a globally fragmented production chain.

6 Conclusion

Falling trade and communication costs enabled the fragmentation of the production process. Firms respond to cost differentials and distribute parts of their production around the globe. This paper examines changes in employment and task composition of plants that increase the extensive margin of imported intermediate inputs. From this pattern, we infer that this middle-income country has a comparative advantage in production steps that require medium-complex routine manual tasks.

In contrast to high-wage countries, the import of intermediate inputs may reflect two different activities. Either tasks were offshored to countries with lower production costs, or to take the reversed perspective, those inputs were offshored from a high-wage country. From the Brazilian point of view, the latter is called onshoring. To distinguish between both activities, we examine the consequences in the aftermath of an expansion in intermediates imports along the extensive margin. Propensity Score Matching shows that the affected plants grow in size, perform a higher intensity of routine manual tasks and also have a higher share of exported intermediates than their counterparts. Because routine manual tasks are most tradable, this picture is consistent with the notion that Brazilian firms are engaged in onshoring. Even the distinction of the origin of intermediate imports into high and low-wage countries could not identify which plants, if at all, conduct offshoring. This result is compatible with the existence of two distinct global production methods, as argued by Baldwin and Venables (2013). (1) The back-and-forth trade of single components and (2) the sequential production in a variety of countries, whereby the complexity of production steps is gradually increasing.

Furthermore, we examine the characteristics of created and destructed jobs in plants with an increase in intermediate imports more closely. Created jobs are principally industrial and technical occupations that comprise routine manual tasks. The aggregate employment

[30] Plotting the distribution of won and lost jobs, analogous to figure 5, confirms this. However, the seven industries displayed in the lower part of the figure are considerably affected as well. Just as before, not a single industry experiences overall employment losses due to the expansion of imports.

change is positive, evenly distributed over all sectors and is located in the middle of the wage distribution. This evidence suggests that those medium-complex routine manual tasks represent Brazil's comparative advantage within the global production chain. Brazil's relative factor endowments and the developed extension of the model in Feenstra and Hanson (1996) are in line with our findings.

While the overall impact for the importing plants is positive, the generated jobs do not promote substantial qualitative advances along the value chain. Nevertheless, the increase of industrial employment might be one explanation for the observed reduction of wage inequality (Cruz and Naticchioni 2012). A profound investigation of the wage effects, the actual flow of intermediate inputs and the effects on the entire economy constitute logical extensions of this research.

References

Acemoglu, D. and Autor, D. H. (2011). Skills, tasks and technologies: Implications for employment and earnings. In O. Ashenfelter and D. Card (eds.), *Handbook of Labor Economics*, vol. 4, Amsterdam: Elsevier-North Holland, pp. 1043–1171.

Amiti, M. and Cameron, L. (2012). Trade liberalization and the wage skill premium: Evidence from Indonesia. *Journal of International Economics*, **87** (2), 277–287.

— and Wei, S. J. (2005). Fear of service outsourcing: Is it justified? *Economic Policy*, **20** (4), 307–347.

Autor, D. H., Katz, L. F. and Kearney, M. S. (2008). Trends in US wage inequality: Revising the revisionists. *Review of Economics and Statistics*, **90** (2), 300–323.

—, Levy, F. and Murnane, R. J. (2003). The skill content of recent technological change: An empirical investigation. *Quarterly Journal of Economics*, **118** (4), 1279–1333.

Baldwin, R. and Venables, A. J. (2013). Spiders and snakes: offshoring and agglomeration in the global economy. *Journal of International Economics*, **90** (2), 245–254.

Barba Navaretti, G., Castellani, D. and Disdier, A. C. (2010). How does investing in cheap labour countries affect performance at home? Firm-level evidence from France and Italy. *Oxford Economic Papers*, **62** (2), 234–260.

Barro, R. J. and Lee, J. W. (2013). A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics*, **104**, 184–198.

Baumgarten, D., Geishecker, I. and Görg, H. (2013). Offshoring, tasks, and the skill-wage pattern. *European Economic Review*, **61**, 132–152.

Becker, S. O., Ekholm, K. and Muendler, M. A. (2013). Offshoring and the onshore composition of tasks and skills. *Journal of International Economics*, **90** (1), 91–106.

Bernard, A. B., Jensen, J. B., Redding, S. J. and Schott, P. K. (2007). Firms in international trade. *Journal of Economic Perspectives*, **21** (3), 105–130.

—, Redding, S. J. and Schott, P. K. (2010). Multiple-product firms and product switching. *American Economic Review*, **100** (1), 70–97.

—, — and — (2011). Multiproduct firms and trade liberalization. *Quarterly Journal of Economics*, **126** (3), 1271–1318.

Biscourp, P. and Kramarz, F. (2007). Employment, skill structure and international trade: Firm-level evidence for France. *Journal of International Economics*, **72** (1), 22–51.

Blinder, A. S. (2009). How many US jobs might be offshorable? *World Economics*, **10** (2), 41–78.

Calfat, G., Cassimon, D., Flôres, R. G. and Rivas, A. (2008). Far from champions, close to midgets–international production sharing in central and south america. *IOB Working Papers No. 2008-01.*

Colantone, I. and Crinò, R. (2012). New imported inputs, new domestic products, mimeo.

Costinot, A., Vogel, J. and Wang, S. (2013). An elementary theory of global supply chains. *Review of Economic Studies*, **80**, 109–144.

Crinò, R. (2009). Offshoring, multinationals and labor market: A review of the empirical literature. *Journal of Economic Surveys*, **23** (2), 197–249.

Cruz, B. and Naticchioni, P. (2012). Falling urban wage premium and inequality trends: evidence for Brazil. *Investigaciones Regionales*, **24**, 91–115.

De Negri, F. D. (2005a). Conteúdo tecnológico do comércio exterior brasileiro: O papel das empresas estrangeiras. *IPEA Texto para discussão No. 1074*.

— (2005b). Padrões tecnológicos e de comércio exterior das firmas brasileiras. In J. De Negri and M. Salerno (eds.), *Inovações, padrões tecnológicos e desempenho das firmas industriais brasileiras*, IPEA Brasília.

Dustmann, C., Ludsteck, J. and Schönberg, U. (2009). Revisiting the German wage structure. *Quarterly Journal of Economics*, **124** (2), 843.

Ebner, S. (2012). *Essays on the economics of mergers & acquisitions*. Ph.D. thesis, University of Passau.

Feenstra, R. C. (2010). *Offshoring in the global economy: microeconomic structure and macroeconomic implications*. Cambridge University Press.

— and Hanson, G. H. (1996). Foreign investment, outsourcing and relative wages. In R. C. Feenstra, G. M. Grossman and D. A. Irvin (eds.), *The political economy of trade policy: papers in honor of Jagdish Bhagwati*, Cambridge, MA: MIT Press.

— and — (1997). Foreign direct investment and relative wages: Evidence from Mexico's maquiladoras. *Journal of International Economics*, **42** (3-4), 371–393.

— and — (1999). The impact of outsourcing and high-technology capital on wages: estimates for the United States, 1979–1990. *Quarterly Journal of Economics*, **114** (3), 907–940.

Ferreira, A. and Tullio, G. (2002). The brazilian exchange rate crisis of january 1999. *Journal of Latin American Studies*, **34** (1), 143–164.

Firpo, S., Fortin, N. M. and Lemieux, T. (2011). Occupational tasks and changes in the wage structure. *IZA Discussion Paper No. 5542*.

Goldberg, P. K., Khandelwal, A. K., Pavcnik, N. and Topalova, P. (2010). Multiproduct firms and product turnover in the developing world: Evidence from india. *Review of Economics and Statistics*, **92** (4), 1042–1049.

Gonzaga, G., Menezes Filho, N. and Terra, C. (2006). Trade liberalization and the evolution of skill earnings differentials in Brazil. *Journal of International Economics*, **68** (2), 345–367.

Goos, M., Manning, A. and Salomons, A. (2010). Explaining job polarization in europe: the roles of technology, globalization and institutions. *CEP Discussion Paper No. 1026*.

—, — and — (2014). Explaining job polarization: Routine-biased technological change and offshoring. *American Economic Review*, **Forthcoming**.

Grossman, G. M. and Rossi-Hansberg, E. (2008). Trading tasks: A simple theory of offshoring. *American Economic Review*, **98** (5), 1978–97.

— and — (2012). Task trade between similar countries. *Econometrica*, **80** (2), 593–629.

Hakkala, K. and Huttunen, K. (2010). Offshored job tasks and displaced workers, mimeo.

Hanson, G. H. (2012). The rise of middle kingdoms: Emerging economies in global trade. *Journal of Economic Perspectives*, **26** (2), 41–63.

—, Mataloni Jr, R. J. and Slaughter, M. J. (2005). Vertical production networks in multinational firms. *Review of Economics and Statistics*, **87** (4), 664–678.

Heckman, J., Ichimura, H., Smith, J. and Todd, P. (1998a). Characterizing selection bias using experimental data. *Econometrica*, **66** (5), 1017–1098.

—, — and Todd, P. (1998b). Matching as an econometric evaluation estimator. *Review of Economic Studies*, **65** (2), 261–294.

Helpman, E., Itskhoki, O., Muendler, M. A. and Redding, S. J. (2012). Trade and inequality: From theory to estimation. *NBER Working Paper No. 17991*.

HIJZEN, A., TOMOHIKO, I. and TODO, Y. (2007). The effects of multinational production on domestic performance: Evidence from Japanese firms. *RIETI Discussion Paper Series No. 07-E-006.*

HUMMELS, D., ISHII, J. and YI, K.-M. (2001). The nature and growth of vertical specialization in world trade. *Journal of International Economics*, **54** (1), 75–96.

JOHNSON, R. C. and NOGUERA, G. (2012). Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics*, **86** (2), 224–236.

KRUGMAN, P. R. (2008). Trade and wages, reconsidered. *Brookings Papers on Economic Activity*, **39** (1), 103–154.

LAPLANE, M. F. and DE NEGRI, F. (2004). Impactos das empresas estrangeiras sobre o comércio exterior brasileiro: evidências da década de 90. *Revista de Economia*, **30** (1), 31–48.

MACIENTE, A. N. (2013). *The determinants of agglomeration in Brazil.* Ph.D. thesis, University of Illinois at Urbana.

MELITZ, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, **71** (6), 1695–1725.

MOSER, C., URBAN, D. M. and WEDER DI MAURO, B. (2010). Offshoring, firm performance and establishment-level employment: Identifying productivity and downsizing effects, mimeo.

MUENDLER, M.-A. and BECKER, S. O. (2010). Margins of multinational labor substitution. *American Economic Review*, **100** (5), 1999–2030.

ROSENBAUM, P. R. and RUBIN, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, **70** (1), 41–55.

— and — (1985). Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. *The American Statistician*, **39** (1), 33–38.

SILVA, I. . M., BEZERRA, J. F. and LIMA, R. C. (2012). Análise da relação entre importações e produtividade. *Revista de Economia Contemporânea*, **16**, 62 – 87.

YI, K.-M. (2003). Can vertical specialization explain the growth of world trade? *Journal of Political Economy*, **111** (1), 52–102.

Appendix

A Tables and figures

Table A.5: PSM Probit estimation

	all plants [1]		importers only [2]	
	coef.	std. error	coef.	std. error
$educ.share[2]_{t-1}$	0.50	0.08***	0.20	0.12*
$educ.share[3]_{t-1}$	1.50	0.07***	0.54	0.10***
$educ.share[4]_{t-1}$	2.83	0.09***	0.70	0.12***
$\ln(size_{t-1})$	0.28	0.03***		
$(\ln(size_{t-1}))^2$	0.03	0.00***		
$\ln(firmsize_{t-1})$	-0.13	0.01***		
$small_{t-1}$	-1.21	0.04***	-0.25	0.07***
$imp.\text{-}countries_{t-1}$			9.8e-04	9.9e-04
$imp.\text{-}products_{t-1}$			1.9e-03	1.7e-03
$imp.\text{-}value_{t-1}$			1.2e-03	9.8e-04
$r\text{-}manual_{t-1}$	8.65	0.53***	1.52	0.67***
$(r\text{-}manual_{t-1})^2$	-0.41	0.03***	-0.07	0.03***
$constant$	-48.82	2.70***	-9.47	3.42***
size dummies	✗		✓	
region FE	✓		✓	
observations	273780		14203	
pseudo R^2	0.383		0.021	

Notes: The dependent variable is the indicator for an increase in imports. * significance at ten, ** five, *** one percent. This table is exemplarily and corresponds to the version where the outcome variable is the mean routine manual task intensity.

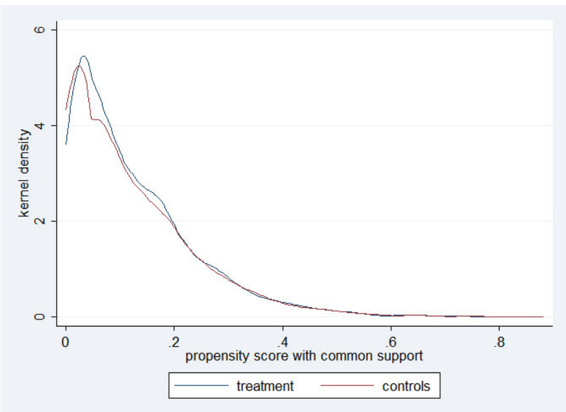
Table A.6: Balance of covariates in matched sample - national control group

		Mean			%reduct.		
Variable	Sample	Treated	Control	%bias	|bias|	t-value	p>|t|
$educ.share[1]_{t-1}$	Unmatched	0.090	0.158	-34.7		-13.4	0.000
	Matched	0.093	0.083	5.0	85.5	2.35	0.019
$educ.share[2]_{t-1}$	Unmatched	0.274	0.442	-64.3		-26.4	0.000
	Matched	0.282	0.279	1.3	98.0	0.51	0.610
$educ.share[3]_{t-1}$	Unmatched	0.465	0.358	40.5		17.0	0.000
	Matched	0.458	0.458	0.4	99.1	0.13	0.895
$educ.share[4]_{t-1}$	Unmatched	0.171	0.042	81.5		51.7	0.000
	Matched	0.166	0.180	-9.0	88.9	-2.06	0.039
$size_{t-1}$	Unmatched	199.0	21.89	70.4		99.1	0.000
	Matched	162.9	163.1	-0.1	99.9	-0.03	0.980
$firmsize_{t-1}$	Unmatched	641.6	107.9	30.1		27.0	0.000
	Matched	527.4	633.4	-6.0	80.1	-1.56	0.118
$r\text{-}manual_{t-1}$	Unmatched	10.33	10.37	-8.2		-3.61	0.000
	Matched	10.32	10.29	4.4	46.1	1.51	0.131
$region_{t-1}$	Unmatched	3.986	3.907	8.1		3.78	0.000
	Matched	3.993	4.022	-3.0	63.2	-1.07	0.284

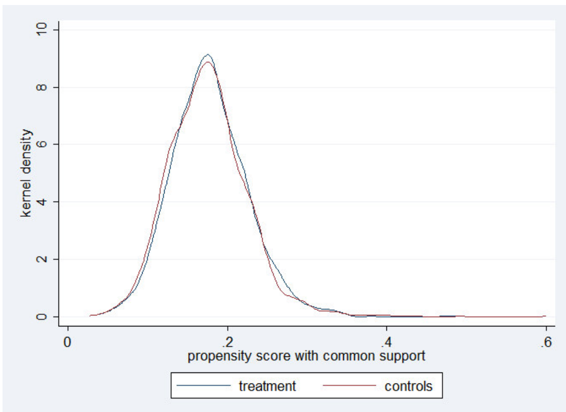
Table A.7: Balance of covariates in matched sample - importer control group

Variable	Sample	Mean Treated	Mean Control	%bias	%reduct. |bias|	t-value	p>|t|
$educ.share[1]_{t-1}$	Unmatched	0.090	0.110	-14.1		-6.0	0.000
	Matched	0.091	0.087	3.3	76.5	1.24	0.214
$educ.share[2]_{t-1}$	Unmatched	0.274	0.308	-16.4		-7.1	0.000
	Matched	0.278	0.279	-0.9	94.5	-0.31	0.758
$educ.share[3]_{t-1}$	Unmatched	0.465	0.432	14.9		6.6	0.000
	Matched	0.463	0.471	-3.8	74.7	-1.28	0.200
$educ.share[4]_{t-1}$	Unmatched	0.171	0.150	11.7		5.3	0.000
	Matched	0.168	0.163	3.0	74.7	0.99	0.322
$size_{t-1}$	Unmatched	199.0	157.6	12.4		5.6	0.000
	Matched	192.5	170.8	6.5	47.7	2.27	0.024
$firmsize_{t-1}$	Unmatched	641.6	601.1	1.7		0.8	0.449
	Matched	605.5	587.4	0.8	55.3	0.29	0.774
$r\text{-}manual_{t-1}$	Unmatched	10.33	10.31	2.3		1.02	0.308
	Matched	10.32	10.33	-0.9	61.7	-0.3	0.762
$region_{t-1}$	Unmatched	3.986	4.043	-6.1		-2.76	0.006
	Matched	3.996	3.985	1.2	81.0	0.4	0.693
$imp.countries_{t-1}$	Unmatched	20.92	13.44	20.0		10.2	0.000
	Matched	17.95	16.12	4.9	75.6	1.92	0.055
$imp.products_{t-1}$	Unmatched	14.86	10.23	21.9		10.6	0.000
	Matched	13.31	12.08	5.8	73.4	2.09	0.037
$imp.value_{t-1}$	Unmatched	2.4	1.6	4.4		1.99	0.047
	Matched	2.0e+6	1.6e+6	2.7	38.2	1.19	0.234

Figure 9: Distribution of matched propensity scores



(a) national control group



(b) importer control group

Notes: ...

Table A.8: Task content of won and lost jobs - EU and LA importers

	analytical	r.cognitive	r.manual	non-r.cognitive	non-r.manual	offshorability
A) won jobs						
LA imports	-0.043	-0.175	0.005	-0.029	-0.008	-0.004
	[0.260]	[0.000]	[0.919]	[0.354]	[0.854]	[0.938]
R^2	0.05	0.06	0.04	0.05	0.06	0.04
B) lost jobs						
LA imports	-0.081	0.058	0.122	-0.017	0.069	-0.012
	[0.009]	[0.400]	[0.034]	[0.720]	[0.119]	[0.788]
R^2	0.09	0.04	0.06	0.11	0.09	0.07

Notes: Each column pertains to a regression where the dependent variable is the task content of either won or lost occupations in establishments with an increase in intermediates imports. The variable of interest is a dummy for firms with imports from low-wage countries. Regressions control for sector, region and size class dummies and whether the plant has annual revenue below 1.2 Mio. Reais and are weighted by the number of workers in each occupation. Panel A has 26990 observations, panel B has 12120. Standard errors are clustered at the establishment level and p-values are reported in parenthesis.

Table A.9: PSM robustness - narrow intermediate imports

	treatment effect			pre-treatment	
	level	DID_t	DID_{t+1}	difference	obs
r.manual	0.086	0.032	0.037	0.053	1164
	[0.000]	[0.003]	[0.007]	[0.037]	
non-r.manual	0.026	0.013	0.019	0.012	1161
	[0.194]	[0.129]	[0.087]	[0.534]	
exp.sh.int	0.123	0.102	0.115	0.021	1048
	[0.000]	[0.000]	[0.000]	[0.299]	
size	42.03	16.63	11.21	33.55	1204
	[0.007]	[0.000]	[0.086]	[0.033]	

Notes: The control group are purely national plants. In contrast to table 2, the indicator variable has the value 1 if the increased imported intermediate inputs correspond to the 2-digit sector of the importing plant.

Table A.10: PSM robustness - parts and components imports

	treatment effect			pre-treatment	
	level	DID_t	DID_{t+1}	difference	obs
r.manual	0.043	0.020	0.006	0.022	1015
	[0.087]	[0.062]	[0.698]	[0.401]	
non-r.manual	0.013	0.004	0.013	0.009	1007
	[0.521]	[0.677]	[0.315]	[0.670]	
exp.sh.int	0.130	0.088	0.082	0.042	898
	[0.000]	[0.000]	[0.000]	[0.051]	
size	39.18	15.26	19.47	23.92	1015
	[0.007]	[0.000]	[0.002]	[0.069]	

Notes: The control group are purely national plants. In contrast to table 2, the indicator variable has the value 1 if the increased imported intermediate inputs correspond to the sub-group 'parts and components'.