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A firm level perspective on migration

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Abstract

We address the role of migrant workers from extra-EU countries in Italian manufacturing production at the firm-level. Cross price and demand elasticities confirm the complementarity found in previous studies between migrants and natives, which holds when native workers are split into white and blue collars. However, when measuring how the ratio of domestic to migrant (migrant to domestic) workers changes in response to a change in the migrant (domestic) wage - Morishima Elasticity of Substitution - we find that the two labour inputs are substitutes. We further analyse the effect of the use of foreign labour in manufacturing firms on the industry composition. We find that, *ceteris paribus*, had migrant labour not grown in our sample period, the weight of *Low Skill intensive* sectors would have been approximately 2% lower and the white to blue collars ratio would have been slightly higher than observed, even accounting for the complementarity between natives and migrants.

JEL Class.: F22, D22, J61, L60
Keywords: Migrant workers, manufacturing production technology, elasticity of substitution

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1 Introduction

Immigration, and specifically workers' mobility, is a wide and complex phenomenon that has long since drawn the attention of social sciences. Moreover, it represents a controversial issue in the ongoing political debate everywhere in the world, across the members of the European Union, but also in the United States, Canada and Australia. Large inflows of immigrants, mainly from developing countries, have raised doubts on the absorbing capacity of developed economies. Public opinion is often concerned that immigrants take jobs away from native workers, and burden on developed countries' welfare systems already fighting with population aging and birth rates decline.

The current economic downturn could easily strengthen these fears and an anti-immigrant attitude with dangerous consequences in terms of social integration, notably in the most recent immigration countries.

Even if a consensus has not been reached yet in the economic literature as far as immigration impact on host countries' wages and employment is concerned, there is quite a volume of empirical studies that finds only modest evidence of detrimental effects, or even no evidence at all (Card, 2001;

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Ottaviano and Peri, 2006). The crucial point in this context is whether immigrant workforce could substitute or complement the native one in terms of skill levels.

A mechanism of labour market segmentation might be at work, since immigrant workers acquire some degree of specialisation in jobs that are typically manual and low-skill intensive, while native workers prefer high-skill intensive jobs, or simply occupations requiring different levels of ability in terms of language and communication tasks. Moreover, it could be the case that the production structure directly react to immigration flows. Thanks to the increased availability of low-skilled workers, production might shift towards low-skill intensive sectors and technologies, and the consequent reallocation of resources may cushion the original impact on wages and employment rates (Lewis, 2011).

Although factor complementarity and substitutability actually depict firm's decision over production techniques, very little firm-level evidence exists on the role of immigrant labour inside the production process. The vast majority of the studies investigates the effects of immigration for native workers by means of Census or Labour Force Survey data[1].

Making use of the 9^{th} wave of the Survey on Manufacturing Firms (*Indagine sulle imprese manifatturiere*) carried out by Capitalia in 2004 (with information on the period 2001-2003), our contribution is meant to add to the existing evidence in two respects. On one hand, we investigate how immigrant workers directly contribute to the production process of Italian firms. On the other hand, we try to shed light on the type of relationship (complementarity/substitutability) existing between immigrant labour and the other inputs in the production process, especially native labour. Several measures of substitutability are employed trying to focus on the relationship between

[1]To cite a few works, Card (2001), Borjas (2003), Ottaviano and Peri (2006), Borjas, Grogger, and Hanson (2008) and Peri (2009) are on the based on U.S. Census or Labour Force Survey and find mixed evidence on the effect of migrants on natives'employment and wage rates. For Europe there is some evidence of a small decrease in natives' wages in France (Hunt, 1992), while no significant impact emerges for Germany (Pischke and Velling, 1997; D'Amuri, Ottaviano, and Peri, 2008). Hijzen and Wright (2010), using the GNP function approach find that an increase in the number of unskilled immigrants slightly reduces the wages of unskilled domestic workers and that unskilled immigrants and imports are substitutes in production. For Italy Gavosto, Venturini, and Villosio (1999) use administrative data and find a positive impact of immigration on the wages of natives. Immigrant workers seem to do those jobs that native workers do not will to accept anymore and in Northern Italy, where most immigrants are settled, the probability of finding a job is either positively affected or not affected at all by the share of immigrants in the region (Venturini and Villosio, 2006). As a consequence, no wage or employment assimilation emerges (Venturini and Villosio, 2008).

manufacturing specialisation, production techniques and the presence of migrants.

Firstly, from the estimation of a production function we retrieve the partial price elasticities which measure how the shadow price of each factor responds to the availability of migrant labour. This will let us answer the question on how, at the firm level, an increase in the availability of migrants affects natives' wages.

Secondly, from the estimation of a cost function we will derive the partial demand elasticities which measure how demanded quantities of inputs respond to changes in other input prices. These elasticities give insights on whether firms hire more migrants to respond to an increase in the natives' wage.

However, with a multi-input technology, the traditional Allen-Uzawa elasticity of substitution, on which demand elasticities are based, is no longer informative on the real ease of substitutability between any two inputs (Blackorby and Russell, 1989; Chambers, 1988). This is why we will also refer to the Morishima elasticity of substitution, *MES*, to evaluate the type of relationship involving two inputs: MES measures the percentage change in the ratio of domestic to foreign (foreign to domestic) labour when only the price of foreign (domestic) labour varies and all other prices are constant. In this respect, MES offers a real measure of how production techniques adjust to a change in a factor price and specifically addresses the question on whether production techniques tend to become more migrant labour intensive as far as domestic labour becomes more expensive. If this was the case we could think of a general downgrading of the production technology that might obviously represent a critical issue for the growth prospects of a country.

For Italy in particular, the analysis of migrants in production is quite important since the country has experienced in recent years rapidly growing inflows of foreign labour from developing countries. Additionally, the effect of migration on the Italian labour market may also be interesting since its production structure is specialised in "traditional" sectors. On one hand, despite the labour market evidence of complementarity between migrants and natives (Gavosto, Venturini, and Villosio, 1999) and the fact that most of the migrants are employed in construction and services (Istat, 2009), many Italian workers, especially low-skilled, complain about migrants stealing jobs within the manufacturing sector. On the other hand, there is an ongoing debate on the declining manufacturing productivity and some scholars address the lack of innovation and technological advances as the major limits of Italian manufacturing. In this stagnant context it is interesting to investigate which role migrants can have in modeling and affecting the future prospects of manufacturing and, in general, of its production specialisation.

In this respect, an inflow of low skilled migrants might stimulate the adoption of less skill intensive techniques and a further contraction of innovation and technological upgrading (Lewis, 2011). Consequently, shedding light on how and to what extent migrants actually take part into production is very important to understand their role in the expansion of manufacturing firms and in the shaping of production specialisation. Our work is organized as follows: Section 2 offers a review of the main contributions on the topic. The data and the empirical model are presented respectively in Sections 3 and 4. Results from the estimates are discussed in Section 5 while Section 6 concludes.

2 The literature

As already suggested in the introduction, one possible explanation for the fact that many studies fail to find a significant impact of immigration inflows on either employment or wages of native workers is strictly related to the structure of the production sector. An increased availability of low-skilled workers could generate a reallocation of resources in different directions: toward sectors where production is low-skilled labour intensive; inside sectors, towards firms that use low-skill intensive technology; or even inside firms, towards goods of such a kind.

Card and Lewis (2005) and Lewis (2011) show that, while a change in the national industry composition is not supported by empirical evidence, inside different U.S. production sectors low qualified Mexican immigration has been absorbed mainly by the firms that were already using low-skill intensive technologies. An opposite effect (*i.e.* a shift towards more skill intensive firms) was sorted out in Israel because of the high-skilled immigrants coming from Russia (Gandal, Hanson, and Slaughter, 2004).

At the firm level, again Lewis (2011) analyses the relationship between the use of automation technologies and immigration in U.S. metropolitan areas and finds that the latter has a negative causal impact on the former. This means that an increase in the supply of low-skilled workers induces firms to downgrade the technology they are using in the production process, moving from capital-intensive to labour-intensive techniques.

A different perspective is adopted in Malchow-Mller, Munch, and Skaksen (2009). If labour markets are not fully competitive, the aggregate supply side approach is not able to capture the fact that an increased use of immigrants could influence wage formation at the firm level due to bargaining effects or efficiency wages. What matters is that immigrants, and typically those from less developed countries, have much worse outside options compared to native workers. By setting up an efficiency wage model with linked employer-employee data on Denmark, they test the empirical hypothesis that a higher share of immigrants from less developed countries hired in the firm reduces the firm-specific wages of native workers. Estimates show that this is indeed the case and that high-skilled and low-skilled natives are almost equally affected by the use of immigrant workers.

Campos-Vazquez (2008) instead analyses short and longer run displacement effects of an increased use of immigrant workers in German firms after 1989. By using both an instrumental variable and the propensity score matching approach, it is shown that the displacement effect for native workers is significant but modest in magnitude; most of the effect is anyway concentrated in the short run. Firms which increase foreign-born employment do not increase native employment as much as the rest of the firms. Moreover, an increase in immigrant employment comes together with a 2% reduction in the average immigrant wage at the firm level, with no corresponding effect to the average wage of native workers.

The impact of immigration to Italy on firm-level strategies is analysed in Accetturro, Bugamelli, and Lamorgese (2009), who consider investment decisions and hence adjustments in capital intensity as an endogenous response to the increase in the relative abundance of low-skilled workers due to immigration. They find that in a sample of Italian manufacturing firms over the period 1996-2006, a larger inflow of low-skilled immigrants has on average a positive impact on firms' investment rate in machinery. In particular, results are stronger for small firms and less technologically intensive industries.

Barba Navaretti, Bertola, and Sembenelli (2008) look at the relationship between the use of foreign labour and offshoring strategies, albeit from the opposite perspective, showing that Italian firms that offshore are usually less likely to employ immigrant workforce. Anyway, these findings do not exclude the opposite nexus, and leave room also for the possibility of a reduction in imports of inputs due to the availability of migrant work, that could substitute for foreign workers' activity abroad.

Summing up, the mentioned evidence shows that at the firm-level migration in some cases may result in a technology downgrading and in the direct substitution of native labour, while in other cases it seems to foster investment rates especially in small and less skill intensive firms. Within this framework, we mean to adopt a structural approach to evaluate the contribution of migrants to Italian manufacturing production and to assess how migrants interact with native labour and with the remaining factors of production both from a technological and an economic point of view. The estimation of a technology relationship on different sub-samples of firms according to their economic activity will allow us to assess if and how migrants contribute to the differences in the performance of manufacturing firms.

3 Data and descriptive evidence

The data used in the following analysis are retrieved from the 9^{th} wave of the Capitalia Survey, containing plenty of information on Italian manufacturing firms' characteristics and their activities for the period 2001-2003. The dataset includes all firms with more than 500 employees, while for firms with less than 500 employees a rotating sample is created stratifying by industry, size class and geographical area. Information concern firms' output, inputs, investments, innovation activities, internationalisation strategies and, more importantly for our aims, firms are asked about Extra European Community (EC)[2] employees hired in each year. From now on we will indifferently refer to these workers as migrant or foreign workers.

After a cleaning procedure[3], we end up with a sample of 3,264 firms for a total of 9,314 firm-year observations in the period 2001-2003; 1,403 firms have employed migrant workers at least in one year of the period 2001-2003 summing up to 3,822 firm-year observations.

Despite the short time dimension, we can notice an increase in the number of Italian manufacturing firms hiring immigrant workers, from 39.23% in 2001 to 42.89% in 2003. The use of foreign employees in the manufacturing sector has increased in the last decades due to the higher availability of migrant workers but also to the tougher competitive pressure from developing countries that may have pushed Italian firms to use cheaper labour. Thus, the increased availability of low-wage unskilled employees may have affected firms' decisions about their workforce, and also their choices about production processes and techniques. It is important to stress that the use of foreign labour does not affect only the employment of native workers, but also the use of capital and other inputs inside firms. The presence in the market of cheap labour, in our case foreign labour, may for example stimulate firms to abandon capital intensive techniques and adopt labour intensive ones (Peri, 2009). For these reasons in our analysis we try to understand which are the substitution and complementarity linkages among the different production inputs.

[2]The period of the analysis is prior to the Eastern EU enlargement so Extra European Community workers include also citizens from New Members.

[3]We drop observations with missing data for our variables of interest (output, value added, employment, capital, services materials, and labour costs), or with implausible negative values. We also delete firms which are considered as outliers for at least one year in the sample period. We consider as outliers observations from the bottom and top 1 percent of distribution of the ratios va/labour and capital/va.

About 43% of Italian manufacturing firms in the sample was employing immigrant workers in 2003, even if the average share of migrants on the total employment of those firms using foreign labour was low (9.33%).

Table 1 shows the distribution of firms employing foreign workers across sectors[4], size classes[5] and geographical areas[6]. The share of firms employing foreign labour ($MIGR$), the average share of foreign employees on the total employment for all firms (shL^M) and for firms making use of immigrants in their production process ($shL^M_{MIGR=1}$) are reported.

Table 1: Firms using immigrants by sector, size and area, %

	$MIGR$	shL_M	$shL_{M\ MIGR=1}$
Sector:			
High Skill intensive	40.98	3.72	9.07
Low Skill intensive	41.16	3.97	9.66
Size:			
SMEs	41.37	4.09	9.88
Large Firms	38.21	1.48	3.88
Area:			
North	48.46	4.65	9.60
Centre-South	25.59	2.12	8.27

Focusing on the technological level, we cannot detect any strong pattern even if *High Skill intensive* sectors seem to be less likely to employ foreign workers and display a lower share of foreign employees. The use of foreign labour is more widespread in Northern regions (see also Istat (2009)), where the presence of immigrants is larger thanks to better job opportunities. Concerning firm's size, the smaller the firm, the higher the share of migrant

[4]Sectors are classified as Low Skill intensive if they belong to the Traditional activities from the Pavitt's taxonomy. these Activities are characterised by a lower skill ratio if compared with Non Traditional Sectors (Science-based, Scale-intensive and Specialised Suppliers) and their ratio is below the median value.

[5]SMEs are firms with less than 250 employees and include 90% of the sample.

[6]Italy is divided into 20 administrative regions which are commonly grouped into four different areas characterised by similar geographic and economic conditions. The four areas and North-West, North-East, Center and South even if for convenience here we group the Northern regions against the Center and Southern once. The latter also inlcudes the two islands, Sardinia and Sicily. The North represents 68% of pur sample.

workers in total employment. When crossing sector and firm size in Table 2, a lower share of migrant workers in large firms emerges as a general feature although in more traditional sectors it is twice as large as in *High Skill intensive* sectors.

Table 2: Migrant Labour by Sector and Firm Size, %

Sector/Size	Large Firms	SME
High Skill Intensive	1.1	4.0
Low Skill Intensive	2.2	4.1

Additionally to consider labour as a unique homogeneous factor, we also try to expand the investigation splitting the firm employment into white and blue collars. The Capitalia database provides information on the total number of white (directors and clerical workers) and blue (manual workers) collars, although it does not distinguish according to their nationality. However, we can use a different data source to have information on the skill composition of the immigrant workforce employed in Italy. The WHIP[7] dataset shows that foreign-born workers account for 10.76% of the total employment in the Italian manufacturing sector in the period 2001-2003. 9.76% is represented by extra-EU immigrants[8], and the remaining 1% by EU-15 citizens. The share of blue collars is definitely higher among extra-EU immigrants: on average, 94% of them is employed in low-skilled jobs between 2001 and 2003[9]. Given this piece of evidence, and since migrant workers in our sample are all extra EU citizens, we assume that they are all employed as blue collars and, consequently, white collar jobs are performed only by natives.

Table 3 shows the distribution of the workforce between domestic white collars, domestic blue collars and migrant blue collars for the whole sample of firms and across different groups.

As expected, *High Skill intensive* sectors present a higher share of white collars, while the use of native blue collars is more widespread in *Low Skill intensive* sectors. The use of foreign-born labour instead is pretty similar across sectors. SMEs employ a higher number of blue collars compared to large firms, but it is worth to notice that in our sample the difference does

[7]WHIP, "Work History Italian Panel", is a database of individual working histories, based on the INPS (National Institute of Social Security) administrative archives and consists in a representative sample of Italian employment.

[8]In our sample extra-EU migrants are about 7% of the overall manufacturing employment.

[9]On the other hand, only 60% of EU-15 immigrants are blue collars thus representing about 0.6% of the overall employees.

Table 3: Workforce Distribution, %

	Domestic WC	Domestic BC	Foreign BC
Sector:			
High Skill intensive	34.23	62.05	3.72
Low Skill intensive	30.31	65.71	3.97
Size:			
SMEs	32.22	63.69	4.09
Large Firms	35.07	63.45	1.48
Area:			
North	34.16	61.19	4.65
Centre-South	29.04	68.85	2.12
All Sample	32.50	63.67	3.83

WC: White Collars. BC: Blue-Collars

not rest on the share of domestic blue collars, but on the use of migrant labour (4.09% in SMEs, against 1.48% in large firms). Another interesting fact concerns regional differences: firms in Northern regions are more skill-intensive, use a larger share of migrant blue collars and a smaller share of domestic unskilled workers.

Table 4: Migrant versus only-natives employers

	y	lp	l	sk	ky	c	p_L	$\frac{p_{L_{DW}}}{p_{L_{DB}}}$
$MIGR$	-0.032**	-0.060***	0.251***	-0.055***	0.063***	-0.038**	-0.080***	-0.110***
	[0.016]	[0.009]	[0.024]	[0.004]	[0.022]	[0.017]	[0.008]	[0.020]
Obs	9,298	9,298	9,298	9,298	9,298	9,179	9,179	9,104
R^2	0.689	0.079	0.038	0.107	0.1	0.675	0.153	0.101

y: log of output; lp: log of labour productivity; l:log of number of employees; sk: skill ratio; ky: log of capital over output; c: log of total cost; p_L: log of average wage; $p_{L_{DW}}/p_{L_{DB}}$: log native white to blue collars ratio. All regressions include sector, size, area dummies, the regional unemployment rate and a regional proxy for the shadow economy.

In the present analysis, besides the firm's production function we also estimate its dual cost function which requires the use of input prices. Since we have no firm level prices for production factors at our disposal, we make use of sectoral level prices. Material, capital and services price indices have been retrieved from EU-KLEMS Database and are defined at NACE rev. 1.1 level. Concerning wages, from the Capitalia sample we are only able

Table 5: Average Output and Input Evolution, 2001-2003

Sector	Δy	ΔL	ΔL_D	ΔL_{DW}	ΔL_{DB}	ΔL_M	ΔK	ΔIM	ΔIS
High skilled	0.67%	1.22%	1.21%	1.97%	1.25%	2.95%	0.51%	1.28%	0.00%
Low skilled	-3.19%	0.36%	0.16%	2.12%	-0.15%	3.84%	-2.28%	-5.18%	-3.00%

y: log of output; L_D: log of labour; L_D: log of native labour; L_{DW}: log of native white collars; L_{DB}: log of native blue collars; L_M: log of migrants; K: log of capital; IM: log of materials; IS: log services.

to compute an average wage regardless of workers' nationality[10]. Therefore, we compute the average wages for both native and immigrant workers by region and NACE division from the WHIP database. In order to check the reliability of these external data, we tried to recalculate the labour share in total cost for the two categories of workers. The correlation between the total wage bill calculated using WHIP average weekly wages for domestic and migrant workers and the wage bill from balance sheet information available in Capitalia dataset is 96% and turns to 93% for firms employing migrants. Figure 1 in the Appendix compares the distribution of the logs of the different wage bills and shows that the two measures are fairly similar in the time interval, even when only firms employing immigrants are considered.

To sum up and extend the above information, Table 4 shows that, once accounted for sector, area, size class, regional unemployment rate and the shadow economy, firms employing foreigners have on average lower output, productivity, skill intensity, total costs; they also pay lower wages and display a lower high to low skilled wage ratio. On the other hand, they are larger in terms of number of employees and more capital intensive. A higher capital intensity, together with a lower skill intensity for firms using migrant labour may be supportive of the evidence that extra-EU workers are mainly blue collars performing unskilled tasks that possibly complement the use of machineries, as also suggested by the findings by Accetturro, Bugamelli, and Lamorgese (2009).

Finally, Table 5 shows the evolution of output and factor inputs over the period 2001-2003. Output, materials, services and capital decline for firms in *Low Skill intensive* sectors while skilled and migrant labour intensity especially tend to grow. On the other hand, the average growth of inputs and output in *High Skill intensive* sectors is positive. The growth in migrant employment is higher in the former group of firms where the production then becomes more labour intensive.

[10]The average wage is obtained as the ratio between the firm total labour cost from balance sheet and the number of employees.

4 The empirical model

The substitutability/complementarity among factors of production can be assessed by the estimates of the technology parameters retrieved from a production function or its dual cost function. Our interest on the substitutability among factors and the availability of firm-level information on production inputs and output led us to choose a translog production function which imposes no *a priori* restrictions on the relationships among factor inputs. The function is specified as follows

$$lnY_f = \alpha_0 + \sum_i \alpha_i lnX_{fi} + \frac{1}{2} * \sum_i \alpha_{ii} lnX_{fi} lnX_{fi} + \sum_{i=} \sum_{j \neq i} \alpha_{ij} lnX_{fi} lnX_{fj} \quad (1)$$

For each firm f in our sample, lnY measures the logarithm of real output while lnX_i represents the log of the quantity of input i used in production. The index i respectively refers to materials (IM), services (IS), capital (K), domestic labour (L_D) and foreign labour (L_M). To improve estimation efficiency, the production function is usually augmented with the input share equations obtained as its first derivatives:

$$S_{fi} = \alpha_i + \alpha_{ii} lnX_{fi} + \sum_{j \neq i} \alpha_{ij} lnX_{fj} \quad (2)$$

Under the hypothesis of constant returns to scale and profit maximization S_i represents the share of input i in total output/cost:

$$\frac{\partial lnY}{\partial lnX_i} = \frac{\partial Y}{\partial X_i} * \frac{X_i}{Y} = S_i \quad (3)$$

To overcome the lack of information on the share of labour costs attributable to foreign workers, we follow Yasar and Morrison Paul (2008) and we express the share of the two inputs as a sum, then we include the share of overall labour which is something we actually observe:

$$\begin{aligned} S_{fL} = \; & S_{fL_D} + S_{fL_M} = (\alpha_{L_D} + \alpha_{L_M}) + (\alpha_{L_D L_D} + \alpha_{L_{L_M} L_D}) * ln(L_D) + \\ & + (\alpha_{L_M L_M} + \alpha_{L_M L_D}) * ln(L_M) + (\alpha_{L_D K} + \alpha_{L_M K}) * ln(K_f) + \\ & + (\alpha_{L_D IM} + \alpha_{L_M IM}) * ln(IM_f) + (\alpha_{L_D IS} + \alpha_{L_M IS}) * ln(IS_f) \end{aligned} \quad (4)$$

From the parameter estimates of the above system it is then possible to infer the substitutability/complementarity relationship among factors of production.

Making use of the predicted shares for each input, it is straightforward to calculate the elasticity of complementarity c_{ij} among input i and j, which, *ceteris paribus*, measures a percentage change in the price ratio p_i/p_j with respect to a change in the input ratio X_i/X_j (Hamermesh, 1993). From this, the partial price elasticity $\epsilon_{p_i x_j}$ can be obtained as

$$\epsilon_{p_i x_j} = c_{ij} * S_j = \frac{\alpha_{ij} + S_i * S_j}{S_i} \tag{5}$$

and describes the response of the price of input i to an increase of 1% in the availability of input j. If an increase in the availability of input j raises/reduces the return to input i the two factors are defined as *q-complements/substitutes.*

Partial price elasticities are particularly interesting in our case since they could tell us whether the increase in the availability of immigrants actually lowers the wage of native workers. Furthermore, they also show the complementarity/substitutability relationship between foreign and native labour and the remaining inputs in production.

However, another part of the story might be hidden in the response of the demand for foreign labour to an increase in the wage of domestic workers. In this respect, one could observe a null or positive response of the domestic wage to the increased availability of foreign workers while an increase in the wage of domestic workers could actually foster their substitution with immigrant workers. If an increase in the price of input j raises/lowers the demand of input i the two factors are classified as *p-substitutes/complements.* This piece of information is contained in the partial demand elasticities which are based on the estimates of the Allen elasticities of substitution (AES), σ. The dual approach represents the most natural way to compute the AES (and consequently the partial demand elasticities) from the estimates of a cost function of the same form as the production function above (eq. 1) with prices substituting for inputs and the log of the cost substituting for the log of output. So, we proceed estimating a translog short-run cost function of the following form:

$$\begin{aligned} lnC_f = \; & \beta_0 + \textstyle\sum_i \beta_i lnP_{fi} + \frac{1}{2} * \sum_i \beta_{ii} lnP_{fi} lnP_{fi} + \\ & + \textstyle\sum_{i=} \sum_{j \neq i} \beta_{ij} lnP_{fi} lnP_{fj} + \gamma_k lnK + \sum_i \gamma_{ki} lnK lnP_{fi} + \\ & + \gamma_y lnY + \textstyle\sum_i \gamma_{yi} lnY lnP_{fi} + \gamma_{yk} lnY lnK \end{aligned} \tag{6}$$

We use sector level prices of material and services and average wages for domestic and foreign labour at the region-sector level, keeping capital fixed. The cost function is estimated jointly with the cost shares of inputs and we adopt the strategy already mentioned to overcome the lack of information on the exact firm-level measure of the shares of domestic and foreign labour.

The partial demand elasticity of factor i with respect to factor j's price is calculated as follows:

$$\eta_{x_i p_j} = \sigma_{ij} * S_j = \frac{\beta_{ij} + S_i * S_j}{S_i} \tag{7}$$

It represents the percentage response of the demand of input i to an increase of 1% in the price of input j.

From the coefficient estimates of the cost function we can, then, recover the demand elasticities and use them to calculate a further measure of substitutability, the Morishima elasticity of substitution (*MES*), obtained as follows:

$$MES_{ij} = \eta_{x_i p_j} - \eta_{x_j p_j} = \frac{\partial ln(X_i/X_j)}{\partial ln P_j} \tag{8}$$

Whereas cross-price elasticities are absolute measures of substitution, the *MES* represents a relative substitution elasticity and measures the percentage change in the ratio of input i to j when only p_j varies and all other prices are constant. Two factors i and j are termed *MES-substitutes* if $MES_{ij} > 0$ and *MES-complements* if $MES_{ij} < 0$. In other words, one might observe that although an increase in natives' wages decreases the demand for both native and migrant labour, the latter declines less, thus causing production techniques to become more migrant labour intensive. In this sense two factors can be considered as substitutes even if, when dealing with absolute demand elasticities, they have been classified as complements. The issue has been widely discussed in the literature (Blackorby and Russell, 1989; Chambers, 1988; Nguyen and Streitwieser, 1997; Frondel, 2004) which points at MES as being the right informative elasticities to assess the curvature of an isoquant when the production technology employs more than two factors. As a matter of fact, in this case the traditional Allen-Uzawa elasticity of substitution is only imperfectly measuring how the ratio of factor quantities changes when their price ratio changes, i.e. is not informative on the curvature of the isoquant.

In the following, we employ the Maximum Likelihood Zellner-efficient estimator to estimate the system of the production function (cost function) and revenue (cost) share equations. From the parameter estimates elasticities are obtained, their respective standard errors being calculated by means of the delta method. Unfortunately, we are not really able to correct for the endogeneity of the right hand side variables. The use of the GMM estimator, which is usually adopted in this framework, is prevented by the short time dimension in our data and by the lack of valid instruments, other than lags of the variables, at the firm level. A larger and longer data set might help in the future to overcome these estimation constraints.

5 Results

Migrants usually have lower reservation wages compared to domestic workers (Malchow-Mller, Munch, and Skaksen, 2009). In addition, skilled migrants are likely to be employed in low skilled jobs thus providing a higher productivity level at a lower cost. Therefore, one could expect that an increase in the availability of low-cost foreign labour might reduce the wage of the natives because domestic workers have to face with a tougher competition. At the same time, when we assume an exogenous increase in native wages firms may respond with a higher demand for migrants, thus revealing a substitutability linkage between the two types of labour.

Nevertheless, migrants may actually perform those activities that native workers are not willing to perform anymore, and in this case one would observe complementarity between foreign and domestic labour (Ottaviano and Peri, 2006). This might be the case if migrants perform mostly blue collar activities while domestic workers are engaged in more skilled tasks, as the evidence from WHIP data would suggest for Italy.

The type of relationship existing between foreign and domestic labour and the degree of their complementarity or substitutability is likely to differ across firms and the type of economic activity performed may actually affect the nature of the linkages among inputs. In the following we will present the results for the whole sample of firms and for the two subsamples of *High* and *Low Skill intensive* sectors[11] (Tables 8-7).

Estimates of the production function and the partial price elasticities are presented first, followed by the estimates of the cost function, the partial demand elasticities and, finally, the *MES*. As illustrated in Section 3, we assume that all migrant workers in our sample are employed as blue collars and, consequently, only natives perform white collar jobs. For this reason, each Table presents two sets of results: the first one always refers to a technology with five inputs - native and migrant labour, L_D and L_M respectively, materials, IM, services, IS and capital, K; the second set of results refers to a technology with six inputs due to the split of domestic labour into white

[11] We also investigated heterogeneity in parameter and elasticity estimates across other dimensions - firms' size, location and international exposure - but no significant differences resulted from what found on the overall sample or on one of the two subsamples of *High* and *Low Skill intensive* sectors.

collars, L_{DW}, and blue collars, L_{DB}.

Homogeneity of degree one has been imposed both on the production and cost function[12] and all specifications include time, sector, area and firm size dummies together with the regional unemployment rate and the regional share of the shadow economy[13] in order to capture local economic conditions. Since taking the log of migrant workers leads to miss those observations where this input is equal to zero, we restrict the sample to the firms using foreign labour. We control for sample selection including the inverse Mill's ratio from a probit model[14] of the probability to hire migrant workers in the estimation of the production inputs' coefficients.

Before moving to the detailed description of the results it is worth to mention how our empirical models satisfy the regularity conditions of monotonicity and quasi-concavity required by the theory of production. Monotonicity entails non-negative estimated share equations and Table 8 shows the shares computed from balance sheet data, S_i, and their predicted values, $\hat{S}_i$, as obtained from the estimation of the production function and cost function, respectively with five and six inputs. The two sets are pretty similar confirming the goodness of the estimation. To verify the reliability of our predicted shares, we made use of the average wages from WHIP, calculated the shares of migrant and domestic workers in total output and compared them to the average of their prediction from the estimates of the empirical model. The total % of violation of monotonicity, i.e. the number of negative predictions, is fairly low in general and slightly higher for the predicted share of migrants from the cost function. However, comparing the predicted and "actual" shares of foreign and domestic workers in total output and in total cost we find that, although not exactly equal, the prediction reflects our calculations (a little worse performance is shown for domestic labour

[12]Homogeneity and symmetry are imposed through the following restrictions: $\sum_i \alpha_i = \lambda$, $\sum_j \alpha_{ij} = 0$ and $\alpha_{ij} = \alpha_{ji}$ in the case of the production function and $\sum_i \beta_i = \lambda$, $\sum_j \beta_{ij} = 0$ and $\beta_{ij} = \beta_{ji}$ in the case of the cost function. For the linear homogeneity $\lambda = 1$. We estimated the production and cost function both for the λ homogeneity and linear homogeneity cases and results do not change substantially so we simply present the results for the constant returns to scale production technology. The remaining set of results is readily available from the authors upon request.

[13]Both the regional unemployment rate and the regional share of the shadow economy are from the National Institute of Statistics (Istat). We also added two dummy variables to account respectively for product and process innovation and results did not show any relevant change.

[14]The probit model includes labour productivity, capital intensity, the firm's age and size with their squared value and several other firms' characteristics: dummies for investors, innovators, offshoring, import and export status and intensity, a dummy for the destination of offshoring and for the type of activity offshored, sector and area of activity. Results are not shown for the sake of brevity.

shares, especially white collar, from the cost function). Sample averages and the average predictions for material, services and capital are very similar too. In order to proceed with the estimations, the observations that violate monotonicity have been dropped from the sample.

Turning to the second order conditions, sufficient condition for quasi-concavity is that the bordered Hessian is negative semi-definite and this is validated both at the mean and the median of the sample. The elements on the main diagonal of the matrix, i.e. the own partial price elasticities f_{ii}, need therefore to be non positive and Table 9 shows that this is the case for our sample. The columns respectively report the sample mean and median elasticities[15] computed according to formulas 5 and 7, and the elasticities evaluated at the mean of the prediction of the shares and at the mean of the shares calculated using WHIP wages. The four sets of elasticities are negative and bear consistent insights, in particular the own price and demand elasticities are often very similar.

The average of the predicted own price elasticity is surprisingly positive for services and domestic white collars, but since we are going to work with elasticities calculated at the mean of the predicted shares this will not represent a problem in the analysis. Finally, the last column displays the share of observations with positive estimated elasticities: a few violations occur for some observation, especially in the case of the production function, however they do not affect the results shown below[16].

5.1 Production function, output elasticities and partial price elasticities

We turn now to the description of results for the production function estimation and the relative elasticities.

The left side of Table 10 shows the production function coefficient estimates with five inputs respectively for the overall sample, for *High Skill intensive* and *Low Skill intensive* sectors.

Output elasticities for each input are reported in the bottom part of the Table. In the whole sample (column 1) the doubling of migrant labour would correspond to an increase of only 1.4% in the output of Italian manufacturing, while the contribution of natives would be ten times larger and capital contribution nearly three times larger. The largest elasticities are displayed

[15]In this case we calculated the elasticity for each observation in the sample and then took respectively the average and the median together with the average and the median significance level.

[16]Wales (1977) discusses how the rejection of either monotonicity or concavity does not necessarily imply that the elasticity estimates are incorrect.

for materials and services. The output elasticities are pretty similar among the sub-groups of firms, however it is worth to notice that a slightly higher contribution of foreign labour is shown for *Low Skill intensive* sectors. The same is true for the output elasticity of capital, while the contribution of domestic labour is slightly higher for firms in *High Skill intensive* sectors[17].

From these elasticities it is possible to assess how, *ceteris paribus*, the observed change in the employment of migrant labour may affect the distribution of economic activity between High and Low skill intensive sectors. The percentage growth in output explained by migrant workers can be obtained by simply multiplying the estimated elasticities by the effective average growth in the use of migrant labour.

Table 6 reports the observed percentage increase in the employment of migrant workers ($dlnL_M$) for the estimation sample, which turns into a contribution of around 0.05% to the average growth in manufacturing output (0.03% and 0.07%, respectively, for High and Low skill intensive sectors). This implies that the observed growth in migrant labour could explain 0.02% of the output increase of a low skill intensive firm with respect to the average manufacturing firm, and the relative decrease in the output of a high skill intensive firm by the same percentage. If the estimated elasticities are applied to each firm in our sample according to the sector it belongs to, the overall effect would approximately correspond to an increase of 2% of the weight of *Low Skill intensive* sectors in the aggregate of manufacturing. In other words, *ceteris paribus* the observed increase in migrant labour could explain by itself an increase by approximately 2% in the weight of *Low Skill intensive* sectors.

When domestic labour is split into white and blue collars, the right side of Table 10 confirms the above results of a lower contribution of foreign labour to production when compared to native skilled and unskilled labour, and its relatively higher importance in *Low Skill intensive* sectors. As expected, the contribution of white collars is instead higher in *High Skill intensive* sectors.

Partial price elasticities, which measure the degree of q-substitutability between each pair of inputs, are presented in the left part of Table 12[18].

A general message from the elasticities of a five-input production function is that domestic and foreign labour are $q - complements$: an increase in the

[17] Output elatsicities for domestic labour, capital and material are close to the ones found by Yasar and Morrison Paul (2008) for Turkey, even if their set of production inputs is slightly different from ours.

[18] For the sake of brevity, we only show the estimated elasticities for the domestic and foreign labour with respect to each other and to the remaining inputs; by symmetry, their signs also tell the kind of relationship of the remaining inputs with respect to domestic and foreign labour.

Table 6: Observed growth in labour input quantities and prices

	All	High Skill intensive	Low Skill intensive
$dln\bar{L}_D$	0.59%	1.05%	0.01%
$dln\bar{P}_D$	3.28%	3.19%	3.40%
$dln\bar{L}_M$	3.34%	2.95%	3.84%
$dln\bar{P}_M$	4.67%	4.32%	5.11%
$dln\bar{L}_{DW}$	2.13%	2.13%	2.12%
$dln\bar{P}_{DW}$	4.52%	2.82%	6.88%
$dln\bar{L}_{DB}$	0.34%	0.97%	-0.45%
$dln\bar{P}_{DB}$	2.15%	2.52%	1.67%

availability of one of the two types of workers does not threaten the earnings of the other, but is positively related to its wage. This result confirms the evidence provided by Gavosto, Venturini, and Villosio (1999). Domestic and foreign workers may perform different tasks in the firm production process without competing against each other. The highest elasticity of domestic wage with respect to foreign workers is registered in *Low Skill intensive* sectors. Taking into account the figures in Table 6, the higher availability of migrant workers might explain on average about 5.6% of the growth in natives' wages. The share increases up to 8% when *Low Skill intensive* sectors are considered[19]. Our results therefore echo other empirical evidence according to which the fears - in advanced countries - for the great inflows of migrants from developing countries in terms of wage reductions seem to be groundless. Quite surprisingly, this turns to be even more evident for domestic workers of low-tech sectors, which might be considered the most exposed to the detrimental effects of immigration.

Migrants' wages are instead more sensitive to changes in the domestic labour inputs: on average, the observed increase in native labour may explain about 7% of the observed increase in migrants' pay. In *High skill intensive* sectors, the larger increase in native labour explains a large share of the more modest increase in the price of migrant labour (15%). On the contrary, in *Low Skill intensive* sectors where the very small growth in domestic labour only explains 0.11% of the overall migrants' wage increase.

When we split domestic workers into white and blue collars (Table 12) *q-complementarity* is particularly strong between migrant workers and native blue collars while the relationship between the former and native white collars is found significant only in *High Skill intensive* sectors. This seems to suggest once again that the two categories of blue-collar workers do not

[19]The calculations are as follows: for the whole sample $\epsilon_{p_{L_D} x_{L_M}} * (dlnL_M/dlnP_{L_D}) = 0.055*(3.34/3.28) = 0.056$ and for the *Low Skill intensive* sectors $0.071*(3.84/3.40) = 0.08$.

represent a homogeneous factor of production and possibly perform different tasks. Even if natives are employed as blue collars, they may be involved in more specialised tasks, while firms may hire immigrant workers for manual and routine jobs with the lowest skill content. In other words, migrants could fill jobs not performed by domestic workers as already suggested by Gavosto, Venturini, and Villosio (1999) to justify their result that the stock of immigrants had a positive impact on natives' wages, with an elasticity equal to 0.01.

The own price elasticities are generally higher for the "weaker" group of foreign workers and this supports the evidence on segmented labour markets provided by Hamermesh (1993) which also corroborates the finding of an estimated own elasticity of natives around 0.23 in absolute value.

Turning to the relationship between labour and other inputs, we find that while domestic labour is *q-complement* with respect to the remaining factors of production, price elasticities of foreign labour bear sometimes a non-significant relationship with other inputs, especially as far as services are concerned.

When we split white and blue collars, *q-complementarity* holds between services and white collar natives, while domestic blue collars result being *q-substitutes* with respect to services. Hence, a different ease of substitution characterizes the two types of domestic labour with respect to services. Anyway, focusing on the skill-content of sectors, it is clear that an increase in the availability of services is related to a reduction of the wage of domestic blue collars only in *Low Skill intensive* sectors. On the other hand, no difference is detected for the relationship between native white collars and services across sector groups.

It is worth to notice that a negative cross price elasticity, although non significant, is found also between material and domestic blue collars in *Low Skill intensive* sectors. These findings might actually hint at the general process of outsourcing which is recently characterizing the restructuring of manufacturing, especially in *Low Skill intensive* sectors.

An interesting difference emerges between the two types of sectors also for what concerns the cross price elasticity of unskilled labour and capital: complementarity is higher between migrants and machineries in the *High Skill intensive* sectors and between domestic blue collars and machineries in *Low Skill intensive*. This may be due to the different tasks that domestic and migrant blue collars perform in the two sets of activities.

Summing up this evidence, an increase in migrant labour is *ceteris paribus* associated with an expansion in the relative output (and weight) of *Low Skill intensive* firms. Italian manufacturing production is characterised by the *q-complementarity* between domestic and foreign labour, and between the two types of employment and other inputs and this is true regardless of the type of native workers, blue or white collars. Finally, in general, the price of migrant labour is much more sensitive to the changes in the availability of remaining factors than the prices of other inputs to the availability of migrant labour.

5.2 Cost function, partial demand elasticities and MES

The previous section has shown the elasticities obtained from a production function estimates, under the hypothesis of factor quantities and prices being respectively the exogenous and endogenous variables. However, in a short time-span it may well be the case that a single manufacturing firm takes prices as given and faces the problem to minimize costs for a given level of output to produce. A dual representation of the technology may then appear more realistic and allows for the investigation of what happens to factor demands when prices change. Table 11 displays the estimated coefficients of the cost function from which we can compute the partial demand elasticities. Also in the case of demand elasticities, foreign labour displays a higher sensitivity with respect to the prices of the other factors of production (right side of Table 12). The estimated own elasticity for domestic labour is -0.73 for the whole sample, in line with the wide evidence gathered and reported by Hamermesh (1993)[20].

Complementarity between domestic and foreign labour is confirmed. The negative sign on the elasticity of the demand of domestic (foreign) labour with respect to the wage of migrant (domestic) workers implies that the two factors are $p-complements$ and the firm demand for the two types of labour behave similarly when one of the two prices changes. However, the elasticity turns to be non significant for firms in *Low Skill intensive* sectors. The elasticity of the demand of migrant workers with respect to the wage of domestic labour is shown to be higher than the elasticity of domestic labour with respect to the wage of foreign workers. From this, the change in migrant employment that is explained by the observed variation in the price of native labour represents the 80% of the total migrant employment change and is bigger than the change in the use of domestic labour explained by a variation in migrants' wage (40%)[21].

[20] See Table 3.4 for small firms and Table 3.5 for firm-plant level studies in Hamermesh (1993), chapter 3. Also the figures we got for the elasticity of labour with respect to materials are similar to what reported in Table 3.6 in Hamermesh (1993), chapter 3.

[21] From Table 6 $dln\hat{L}_D = |\eta_{x_{L_D}p_{L_M}}| * dlnP_{L_M}/dlnL_D = 0.0497 * 4.67/0.59 = 0.40$ and $dlnL_M = dln\hat{L}_M = |\eta_{x_{L_M}p_{L_D}}| * dlnP_{L_D}/dlnL_M = 0.805 * 3.28/3.34 = 0.80$.

When turning to the five-input cost function (Table 12), both types of domestic labour appear as *p-complements* with respect to foreign labour, especially for blue collar natives in *Low Skill intensive* Sectors. The complementarity with respect to high skilled workers is only significant for *High skill intensive* firms, as previously found for price elasticities. In *Low skill intensive* sectors, instead, the estimated demand elasticity of white collars with respect to migrants' wage is positive, although not significant, hinting at a possible substitutability relationship between the two factors. This would add to the positive estimated elasticities $\eta_{x_{L_{DW}}p_{L_{DB}}}$ and $\eta_{x_{L_{DB}}p_{L_{DW}}}$ which show that in this category of firms white and blue collar natives are *p-substitutable*.

According to our calculations, both types of labour are *p-substitutes* with respect to materials while this is not the case with respect to service inputs, especially as far as foreign labour is considered. A 1% increase in the price of materials raises the demand for domestic labour of 0.59% and for migrant labour of 2.68%, then firms especially tend to substitute migrant labour for material inputs. This different effect, in terms of magnitude, on the demand for foreign and native workforce is particularly evident in *Low Skill intensive* sectors and it could reflect the different skill composition of the domestic and foreign labour force in these sectors.

The distinction between white and blue collar natives reveals that the substitutability of domestic labour with respect to materials mainly concerns domestic blue collars (which in *High Skill intensive* sectors substitute for services too). The evidence might highlight a potential firm vertical integration process in response to the growing material costs. Thus, firms may decide to concentrate the upstream phases of the production process inside their boundaries. In this integration process migrants' labour is likely to play a central role, especially for low-tech activities which may be performed by unskilled workers. This could partially recall the finding by Barba Navaretti, Bertola, and Sembenelli (2008) on Italian offshorers as less likely to employ immigrant workforce.

Firms seem to substitute domestic labour for services too, even if this is not confirmed for firms in *Low Skill intensive* sectors. However, when native labour is split into white and blue collars the substitutability with respect to services concerns domestic high skilled workers (who also are substitutes for materials in *High Skill intensive* sectors). On the contrary, migrant labour appears as a *p-complement* with respect to service inputs, the only exception being firms in *High Skill intensive* sectors, for which the elasticity, although negative, is not significant. Anyway, it is difficult to deepen these findings about the linkages between services and labour without any description of the kind of services we are dealing with. The different impact of the changes in the price of services on foreign and domestic labour demand might well be related to the different high-tech or high-quality content of the services purchased by firms.

The positive estimated coefficients γ_{KL_D} and γ_{KL_M} in the left part of Table 11 show that an increase in the fixed asset is associated with an increase in the demand of both types of labour. Also, the calculated elasticities - obtained dividing the coefficient for the respective factor share shown in Table 8 - imply that a 1% increase in the availability of capital assets is associated with an increase of 0.14% in domestic labour and of 0.3% in migrant labour. This finding again points at migrant labour as being more sensitive to changes in the technology than native labour.

The elasticity of migrant labour with respect to capital however is not statistically different from zero when the sample is split into *High* and *Low Skill intensive* sectors. Within the two categories, larger capital assets do not significantly affect the demand for migrants, while moving from a *High* to a *Low Skill intensive* sector implies a higher demand for migrant labour. These results are confirmed when domestic workers are split into white and blue collars. On the overall sample, an increase in the capital intensity of production affects the demand of native skilled labour more than the demand for native blue collars, even if the difference in the elasticities shrinks for firms in *Low Skill intensive* sectors.

The different linkages that have been displayed for migrants, blue-collar natives and white-collar natives with other inputs support the hypothesis that each group of workers is dealing with a different kind of tasks. As a consequence, it would be interesting to combine data on the type of performed tasks by workers with their nationality and qualification[22].

However, even if domestic and foreign labour are complements according to the traditional definitions of complementarity that have usually been addressed in the literature, it may well happen that factor price variations, through changes in the absolute demands, may induce significant changes in the production techniques adopted at the firm-level, in terms of relative use of inputs. For this reason we proceed with the discussion on the *MES* that are obtained according to formula 8.

The left side of Table 13, where MES are displayed, shows that domestic and foreign labour are *MES-substitutes* since an increase in the wage of migrants increases the natives/migrants ratio; this happens because for each 1% increase in the price of migrant labour the demand of migrants decreases

[22]The split between white and blue collars may be ambiguous and may hide important differences in performed tasks. It could be the case that tasks involved in some blue-collar jobs may require more specialised skills than tasks of white collars.

more than the demand of natives. Anyway, it is interesting to highlight that an increase of the wage of natives does not show any significant relationship with the change in the migrants/natives ratio. Although coefficients are never significant here, in the case of *Low Skill intensive* sectors the sign of the *MES* is positive thus hinting at the fact that the labour techniques may become more migrant labour intensive as domestic wages increase. This set of estimates then hints at MES-substitutability of the two types of labour in the production techniques. As a matter of fact, when we split domestic labour into white and blue collars, only in *Low Skill intensive* sectors the ratio of migrant to domestic white collars increases when domestic skilled wage rises. In opposite in all sectors, the growing of migrants' pay is positively related with both the ratio of white-collar natives to migrants and the one of blu-collar natives to migrant.

Turning to the remaining *MES*, from the whole sample estimates in the first column, it is interesting to notice that a 1% increase in the price of materials increases the migrants/materials ratio of 5.18% while in the reverse case a 1% increase in the wage of migrants increases the materials/migrants ratio of 1.11%. The findings might point again at the vertical integration process that firms may undertake as a cost-saving strategy when material suppliers apply higher prices. In general, the *MES* with respect to services and materials are higher for foreign than for domestic labour thus reflecting their higher substitutability in production and this is true in all of the cases except for *High Skill intensive* sectors. To conclude, the *MES* elasticities of services with respect to labour are similar, in terms of magnitude, to elasticities of materials. These results are confirmed with the six input technology in the right side of the Table.

Finally, an interesting point is to assess how the white-collar/blue-collar ratio, $SR = \frac{L_{DW}}{(L_{DB}+L_M)}$, changes in response to a 1% change in the availability of migrants. From the derivation of the skill ratio with respect to the price of migrant labour we have:

$$\frac{dlnSR}{dlnP_{L_M}} = \eta_{L_{DW}L_M} - \eta_{L_{DB}L_M} * \frac{L_{DB}}{(L_{DB}+L_M)} - \eta_{L_M L_M} * \frac{L_M}{(L_{DB}+L_M)} \quad (9)$$

from which follows

$$\frac{dlnSR}{dlnL_M} = \frac{\eta_{L_{DW}L_M}}{\eta_{L_M L_M}} - \frac{\eta_{L_{DB}L_M}}{\eta_{L_M L_M}} * \frac{L_{DB}}{(L_{DB}+L_M)} - \frac{L_M}{(L_{DB}+L_M)} \quad (10)$$

Table 7 shows, following an increase by 1% in the migrant labour, a reduction of 0.16% in the skill ratio for the overall sample, and of 0.24 for

Table 7: Changes in the Skill ratio explained by observed migration changes

	All	High Skill int. sectors	Low Skill int. sectors
$\frac{dlnSR}{dlnL_M}$	-0.156**	-0.123	-0.239***
	[0.0683]	[0.106]	[0.0690]
$\frac{dlnSR}{dlnL_M} * dln\bar{L}_M$	-0.520**	-0.364	-0.919***
	[0.228]	[0.313]	[0.265]

$\frac{dlnSR}{dlnL_M}$ is computed as in equation 10

Low Skill intensive sectors (for *High Skill intensive* sectors the coefficient turns to be non significant). When we take into account the observed average yearly growth in the availability of migrant blue collars in the second row of the Table, it turns that, *ceteris paribus*, migrant labour growth is actually associated to a decline in the skill ratio around 0.5%, mainly driven by the result on *Low Skill intensive* sectors. Had the availability of migrants not increased in these sectors, the growth in the skill ratio could have been 0.92 percentage points higher. Given that the skill ratio has increased on average by 3.2%, this means that its growth could have been around 4%. Considering that the average skill ratio in the *Low Skill intensive* sectors is about 38%, this roughly would correspond to a higher ratio by about 0.3 percentage points.

Summing up the evidence from the dual approach, the higher elasticities of the demand of migrant labour with respect to its own and other input prices reveal once again that this factor may be considered an element of flexibility in the process of manufacturing production. In particular, foreign labour is shown to be *p-substitute* with respect to materials and *p-complement* with respect to services. When turning to the relationship with domestic labour, the two types of employment are *p-complements*, but they are *MES-substitutes* at the same time. As a matter of fact, migrant wage increases seem to affect domestic labour less than migrant labour itself and this causes production to become less migrant labour intensive. This, however, implies that, if migrants are ready to accept a lower pay, the ratio of domestic to foreign labour might decrease. Finally, from our estimates, migrants contribute to reduce the skill intensity of production in only *Low Skill intensive* sectors even if their role is not as large as one might expect.

6 Conclusion

With this paper we contribute to the existing firm-level evidence on the use of foreign labour in manufacturing production. Exploiting the information on the migrant work-force hired in Italian manufacturing firms we have modeled a flexible functional form for the firm-level technology with five inputs: domestic labour, foreign labour, materials, services and capital. In a second stance, native labour has also been split according to the skill contents of the job into white and blue collars. From the coefficients of the estimated production and cost function we have retrieved the partial price and demand elasticities and the Morishima elasticity of substitution among the inputs trying to highlight the role of migrant labour in the Italian manufacturing. We have focused on both its contribution to the overall production and its interplay with respect to the remaining factors of production, especially native labour.

We have shown that each 1% increase in migrant labour contributes for about 0.14% of the overall manufacturing output growth with a higher contribution recorded in *Low Skill intensive* sectors. *Ceteris paribus*, the observed increase in the adoption of foreign labour is associated to a 2% growth in the weight of *Low Skill intensive* sectors in manufacturing.

When turning to the evidence on the complementarity/substitutability nexus between foreign labour and the other production factors, we show that migrants are both *q-* and *p-complements* with respect to blue collar natives and, in *High Skill intensive* sectors, they are also complements with respect to high skilled native labour. Although an increase in the availability of material inputs is associated with an increase in the price of migrant workers, when output is held fixed and prices are the exogenous variables, migrants are substitutes for materials and an increase in the capital intensity of production is associated with an increase in the use of migrant labour.

In general, foreign labour seems to represent an element of flexibility in technology and production: its own and cross estimated elasticities are much higher than the ones estimated for native labour and it is also more responsive to what happens to non-labour variable factors such as materials and services.

Native labour in *High skill intensive* sectors substitutes for materials and services while the evidence shows that white and blue collar natives are p-substitutes in *Low Skill intensive* sectors. Then, if any kind of substitution exists in the traditional way substitution has been interpreted, this only involves substitution among natives, between different skill groups.

When we investigate the Morishima elasticities of substitution, the migrants/natives ratio in production only increases if migrants are ready to accept lower wages, while it never changes in response to an increase in the wage of native workers. However, when splitting domestic labour into high and low skilled workers, white collars are *MES-substitutes* for blue collars (both native and migrant) and vice-versa. This suggests that, when the price of skilled labour increases, firms in these sectors tend to downgrade their production techniques towards less skill intensive techniques. Turning to the effect of an increase in the availability of blue collar migrants on the ratio of white to blue collar workers, we have found that, *ceteris paribus*, an increase by 1% in the availability of migrants reduces the ratio by about 0.2% in *Low Skill intensive* sectors only.

From the above evidence it emerges that, although in our sample period migrants account for a small share of labour in Italian manufacturing production and they seem not to represent a direct threat for native employment in manufacturing, a sharp increase in their availability might foster production in less skill intensive sectors and push firms towards the use of less skill intensive techniques.

National data show that in 2006 only 9% of the whole foreign employment was represented by skilled workers. In 2008 this share decreased to 8%. Unfortunately our data have a short time coverage that represent a serious limit to analyse structural issues. However, were detailed information available, further work could investigate the relationship between innovative activity and the increased availability of low skilled migrants and evaluate their contribution to the growth of total factor productivity. If innovative activity goes hand in hand with production skill intensity, the implications from our results would suggest that innovation activity could be discouraged by the availability of cheaper low skilled migrant labour, and could also hide the specialisation of firms in less sophisticated and skill intensive goods, within the same sector.

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Figure 1: Wage Bill - Comparison WHIP Balance sheet

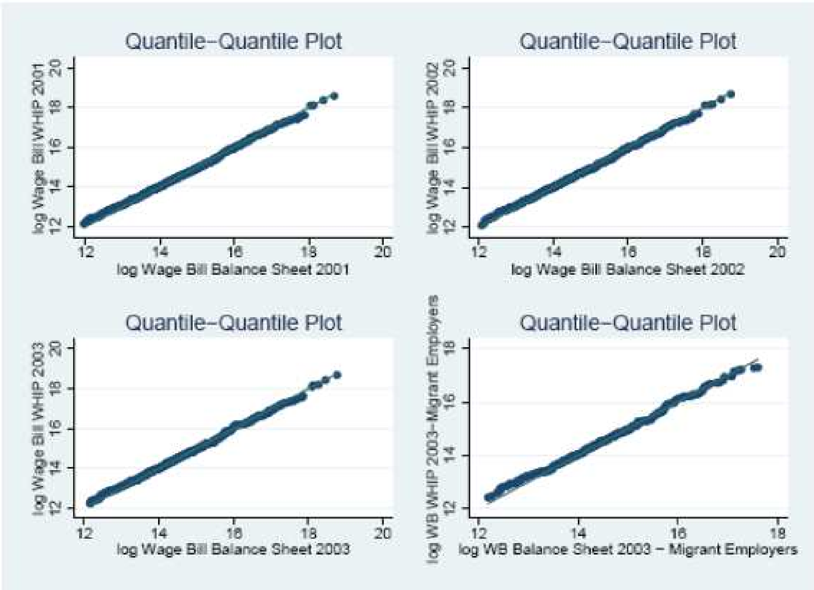

Table 8: Regularity Conditions - Monotonicity

	$Y = F(L_D, L_M, K, IM, IS)$				$Y = F(L_{DW}, L_{DB}, L_M, K, IM, IS)$			
	Production Function		Cost Function		Production Function		Cost Function	
Share	Mean	%Viol.	Mean	%Viol.	Mean	%Viol.	Mean	%Viol.
S_L	0.185		0.213		0.19		0.21	
$\hat{S}_L$	0.186	1.00%	0.215	0.80%	0.19		0.22	
S_{L_D}	0.147		0.148					
$\hat{S}_{L_D}$	0.144	1.47%	0.202	0.59%				
$S_{L_{DW}}$					0.05		0.05	
$\hat{S}_{L_{DW}}$					0.06	2.11%	0.03	18.18%
$S_{L_{DB}}$					0.08		0.09	
$\hat{S}_{L_{DB}}$					0.08	1.01%	0.08	0.63%
S_{L_M}	0.011		0.013		0.01		0.01	
$\hat{S}_{L_M}$	0.014	2.77%	0.013	24.01%	0.02	3.41%	0.01	11.71%
S_{IM}	0.468		0.503		0.47		0.50	
$\hat{S}_{IM}$	0.520	0.41%	0.501	0.00%	0.52	0.39%	0.50	0.00%
S_{IS}	0.249		0.284		0.25		0.28	
$\hat{S}_{IS}$	0.283	0.65%	0.284	0.00%	0.28	0.68%	0.28	0.00%
S_K	0.033				0.03			
$\hat{S}_K$	0.039	1.74%			0.04	1.13%		

The columns "Mean" contain the computed (S) and estimated ($\hat{S}$) revenue share and cost shares of inputs respectively for the production and cost function estimations. The columns $\%Viol.$ contain the percentage of observations violating the monotonicity condition.

Table 9: Regularity Conditions - Own Partial Price and Demand elasticities

	Production Function: $Y = F(L_D, L_M, K, IM, IS)$				
	$\epsilon_{p_i x_j}$ based on:				
	mean η_{ij} **across** i	**median** η_{ij} **across** i	**estimated shares**	**calculated shares**	**Violations**
$\epsilon_{p_{L_D} x_{L_D}}$	-0.12	-0.31	-0.27	-0.28	16.84%
$\epsilon_{p_{L_M} x_{L_M}}$	-0.67	-0.79	-0.90	-0.89	0.12%
$\epsilon_{p_K x_K}$	-0.30	-0.55	-0.50	-0.45	2.62%
$\epsilon_{p_{IM} x_{IM}}$	-0.04	-0.09	-0.09	-0.10	10.39%
$\epsilon_{p_{IS} x_{IS}}$	0.00	-0.13	-0.11	-0.06	18.88%
	Cost Function: $C = F(p_{L_D}, p_{L_M}, K, p_{IM}, p_{IS})$				
	$\eta_{x_i p_j}$ based on:				
	mean η_{ij} **across** i	**median** η_{ij} **across** i	**estimated shares**	**calculated shares**	**Violations**
$\epsilon_{p_{L_D} x_{L_D}}$	-0.71	-0.72	-0.73	-0.76	0.00%
$\epsilon_{p_{L_M} x_{L_M}}$	-1.16	-1.04	-1.04	-1.04	0.00%
$\epsilon_{p_{IM} x_{IM}}$	-2.57	-2.54	-2.50	-2.48	0.00%
$\epsilon_{p_{IS} x_{IS}}$	-4.05	-3.94	-3.97	-3.98	0.00%
	Production Function: $Y = F(L_{DW}, L_{DB}, L_M, K, IM, IS)$				
	$\epsilon_{p_i x_j}$ based on:				
	mean η_{ij} **across** i	**median** η_{ij} **across** i	**estimated shares**	**calculated shares**	**Violations**
$\epsilon_{p_{L_{DW}} x_{L_{DW}}}$	0.02	-0.59	-0.59	-0.49	3.81%
$\epsilon_{p_{L_{DB}} x_{L_{DB}}}$	-0.62	-0.67	-0.54	-0.52	0.53%
$\epsilon_{p_{L_M} x_{L_M}}$	-0.79	-0.89	-0.92	-0.86	0.00%
$\epsilon_{p_K x_K}$	-0.69	-0.73	-0.73	-0.68	0.53%
$\epsilon_{p_{IM} x_{IM}}$	-0.03	-0.1	-0.09	-0.1	10.12%
$\epsilon_{p_{IS} x_{IS}}$	0.13	-0.15	-0.11	-0.07	18.03%
	Cost Function: $C = F(p_{L_DW}, p_{L_DB}, p_{L_M}, K, p_{IM}, p_{IS})$				
	$\eta_{x_i p_j}$ based on:				
	mean η_{ij} **across** i	**median** η_{ij} **across** i	**estimated shares**	**calculated shares**	**Violations**
$\eta p_{L_{DW}} x_{L_{DW}}$	-0.10	-0.70	-0.71	-0.79	0.00%
$\eta p_{L_{DB}} x_{L_{DB}}$	-0.96	-0.78	-0.77	-0.79	1.60%
$\eta p_{L_M} x_{L_M}$	-1.26	-1.14	-1.13	-1.15	0.00%
$\eta p_{IM} x_{IM}$	-2.64	-2.58	-2.56	-2.55	0.00%
$\eta p_{IS} x_{IS}$	-4.15	-4.04	-4.07	-4.07	0.00%

ϵ and η are respectively the Partial Price and Demand elasticities computed as in equation 5 and 7

Table 10: Production Function Estimates

	$Y = F(L_D, L_M, K, IM, IS)$			$Y = F(L_{DW}, L_{DB}, L_M, K, IM, IS)$		
	All	High Skill intensive	Low Skill intensive	All	High Skill intensive	Low Skill intensive
	[1]	[2]	[3]	[4]	[5]	[6]
α_{L_D}	0.527***	0.553***	0.504***			
	[0.006]	[0.009]	[0.009]			
$\alpha_{L_{DW}}$				0.260***	0.265***	0.244***
				[0.009]	[0.011]	[0.014]
$\alpha_{L_{DB}}$				0.314***	0.305***	0.313***
				[0.008]	[0.010]	[0.012]
α_{L_M}	0.056***	0.049***	0.060***	0.076***	0.066***	0.080***
	[0.004]	[0.005]	[0.007]	[0.005]	[0.007]	[0.008]
α_{IM}	0.124***	0.103***	0.130***	0.058***	0.045***	0.074***
	[0.004]	[0.006]	[0.006]	[0.006]	[0.008]	[0.008]
α_K	0.089***	0.091***	0.094***	0.112***	0.135***	0.106***
	[0.004]	[0.006]	[0.005]	[0.006]	[0.008]	[0.008]
α_{IS}	0.204***	0.204***	0.212***	0.179***	0.185***	0.183***
	[0.005]	[0.006]	[0.007]	[0.006]	[0.008]	[0.010]
$\alpha_{L_D L_D}$	0.080***	0.087***	0.073***			
	[0.002]	[0.002]	[0.002]			
$\alpha_{L_{DW} L_{DW}}$				0.022***	0.017***	0.032***
				[0.002]	[0.002]	[0.003]
$\alpha_{L_{DB} L_{DB}}$				0.020***	0.022***	0.024***
				[0.002]	[0.002]	[0.003]
$\alpha_{L_M L_M}$	0.002***	0.003***	0.001	0.002**	0.002**	0.002
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
α_{IMIM}	0.192***	0.197***	0.191***	0.195***	0.200***	0.192***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
α_{KK}	0.012***	0.014***	0.011***	0.009***	0.010***	0.009***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
α_{ISIS}	0.160***	0.165***	0.154***	0.160***	0.165***	0.155***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.002]
α_{IML_D}	-0.058***	-0.062***	-0.056***			
	[0.001]	[0.001]	[0.001]			
$\alpha_{IML_{DW}}$				-0.028***	-0.031***	-0.024***
				[0.001]	[0.001]	[0.001]
$\alpha_{IML_{DB}}$				-0.030***	-0.029***	-0.030***
				[0.001]	[0.001]	[0.001]
α_{IML_M}	-0.007***	-0.006***	-0.007***	-0.008***	-0.007***	-0.009***
	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]
α_{IMK}	-0.012***	-0.013***	-0.013***	-0.014***	-0.015***	-0.014***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
α_{IMIS}	-0.115***	-0.116***	-0.114***	-0.115***	-0.117***	-0.114***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
α_{KL_D}	0.006***	0.007***	0.005***			
	[0.001]	[0.001]	[0.001]			
$\alpha_{KL_{DW}}$				0.002*	0.008***	-0.001
				[0.001]	[0.001]	[0.002]
$\alpha_{KL_{DB}}$				0.009***	0.006***	0.010***
				[0.001]	[0.001]	[0.001]
α_{KL_M}	0.002***	0.002**	0.003***	0.002***	0.002**	0.002**
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
α_{KIS}	-0.008***	-0.010***	-0.005***	-0.008***	-0.011***	-0.006***
	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]	[0.001]
α_{ISL_D}	-0.034***	-0.036***	-0.030***			
	[0.001]	[0.001]	[0.001]			
$\alpha_{ISL_{DW}}$				-0.011***	-0.014***	-0.009***
				[0.001]	[0.001]	[0.001]
$\alpha_{ISL_{DB}}$				-0.021***	-0.019***	-0.021***

				[0.001]	[0.001]	[0.001]
α_{ISL_M}	-0.004***	-0.003***	-0.005***	-0.004***	-0.003***	-0.005***
	[0.001]	[0.001]	[0.001]	[0.000]	[0.001]	[0.001]
$\alpha_{L_D L_M}$	0.006***	0.004***	0.008***			
	[0.001]	[0.001]	[0.001]			
$\alpha_{L_{DW} L_M}$				0.001	0.003***	-0.002*
				[0.001]	[0.001]	[0.001]
$\alpha_{L_{DB} L_M}$				0.008***	0.004***	0.012***
				[0.001]	[0.001]	[0.001]
$\alpha_{L_{DW} L_{DB}}$				0.014***	0.016***	0.005**
				[0.001]	[0.001]	[0.002]
Observations	3391	1865	1526	3368	1850	1518
R-squared	0.993	0.993	0.993	0.993	0.993	0.993
Output Elasticities						
K	0.039***	0.038***	0.042***	0.042***	0.043***	0.045***
	[0.001]	[0.002]	[0.002]	[0.001]	[0.002]	[0.002]
L_D	0.144***	0.160***	0.131***			
	[0.002]	[0.003]	[0.003]			
L_{DW}				0.062***	0.069***	0.053***
				[0.002]	[0.003]	[0.003]
L_{DB}				0.081***	0.080***	0.081***
				[0.002]	[0.003]	[0.003]
L_M	0.014***	0.011***	0.017***	0.019***	0.015***	0.022***
	[0.001]	[0.001]	[0.002]	[0.001]	[0.002]	[0.002]
IM	0.520***	0.502***	0.534***	0.515***	0.504***	0.524***
	[0.001]	[0.002]	[0.002]	[0.001]	[0.002]	[0.002]
IS	0.283***	0.288***	0.276***	0.281***	0.289***	0.275***
	[0.002]	[0.002]	[0.002]	[0.002]	[0.002]	[0.003]

*** p<0.01, ** p<0.05, * p<0.1. Robust S.E. in brackets.

Regressions are run on the sample of only migrant employers. To correct for selection bias we include the Mill's ratio computed from the probit of the probability to use foreign workers.

All specifications also include area, time and sector dummies together with controls for regional unemployment rate and shadow economy.

Table 11: Cost Function Estimates

	$C = F(p_{L_D}, p_{L_M}, K, p_{IM}, p_{IS})$			$C = F(p_{L_{DW}}, p_{L_{DB}}, p_{L_M}, K, p_{IM}, p_{IS})$		
	All	High Skill intensive	Low Skill intensive	All	High Skill intensive	Low Skill intensive
	[1]	[2]	[3]	[4]	[5]	[6]
β_{L_D}	0.788***	0.907***	0.791***			
	[0.028]	[0.049]	[0.038]			
$\beta_{L_{DW}}$				0.233***	0.285***	0.266***
				[0.0206]	[0.0427]	[0.0452]
$\beta_{L_{DB}}$				0.556***	0.556***	0.662***
				[0.0259]	[0.0642]	[0.0710]
β_{L_M}	0.135***	0.199***	0.071***	0.106***	0.292***	0.119***
	[0.013]	[0.022]	[0.019]	[0.0203]	[0.0328]	[0.0349]
β_{IM}	-0.541***	-0.773***	-0.498***	-0.484***	-0.802***	-1.142***
	[0.057]	[0.099]	[0.080]	[0.0488]	[0.160]	[0.176]
β_{IS}	0.618***	0.667***	0.635***	0.589***	0.669***	1.095***
	[0.050]	[0.085]	[0.071]	[0.0432]	[0.133]	[0.154]
$\beta_{L_D L_D}$	0.014**	-0.006	0.021**			
	[0.007]	[0.012]	[0.010]			
$\beta_{L_{DW} L_{DW}}$				0.00818**	0.0221***	-0.0146**
				[0.00408]	[0.00563]	[0.00633]
$\beta_{L_{DB} L_{DB}}$				0.0104*	0.0290***	-0.0126
				[0.00539]	[0.00727]	[0.00836]
$\beta_{L_M L_M}$	-0.001	0.003	-0.005**	-0.00197	0.00442	-0.00636*
	[0.002]	[0.004]	[0.003]	[0.00240]	[0.00347]	[0.00331]
$\beta_{L_D L_M}$	-0.013***	-0.024***	-0.002			
	[0.002]	[0.004]	[0.003]			
$\beta_{L_{DW} L_M}$				-0.00288	-0.00727**	0.00294
				[0.00209]	[0.00291]	[0.00317]
$\beta_{L_{DW} L_{DB}}$				-0.00901**	-0.0216***	0.0116*
				[0.00379]	[0.00518]	[0.00596]
$\beta_{L_{DB} L_M}$				-0.0103***	-0.0157***	-0.00744**
				[0.00238]	[0.00330]	[0.00346]
β_{IMIM}	-1.003***	-0.435**	-1.213***	-1.033***	-0.664***	-1.188***
	[0.075]	[0.183]	[0.099]	[0.0737]	[0.122]	[0.0974]
β_{ISIS}	-0.924***	-0.301	-1.068***	-0.947***	-0.616***	-1.017***
	[0.078]	[0.191]	[0.104]	[0.0748]	[0.122]	[0.102]
β_{IML_D}	0.018	0.052**	0.037*			
	[0.014]	[0.024]	[0.020]			
$\beta_{IML_{DW}}$				-0.0105**	-0.00319	-0.0129*
				[0.00504]	[0.00695]	[0.00738]
$\beta_{IML_{DB}}$				0.0385***	0.0175	0.0727***
				[0.00864]	[0.0110]	[0.0140]
β_{IML_M}	0.027***	0.040***	0.030***	0.0289***	0.0266***	0.0353***
	[0.003]	[0.005]	[0.005]	[0.00280]	[0.00360]	[0.00444]
β_{IMIS}	0.958***	0.343*	1.147***	0.976***	0.623***	1.093***
	[0.075]	[0.186]	[0.099]	[0.0732]	[0.121]	[0.0974]
β_{ISL_D}	-0.019	-0.022	-0.056***			
	[0.012]	[0.020]	[0.018]			
$\beta_{ISL_{DW}}$				0.0142***	0.00995*	0.0130**
				[0.00424]	[0.00579]	[0.00623]
$\beta_{ISL_{DB}}$				-0.0296***	-0.00921	-0.0643***
				[0.00730]	[0.00913]	[0.0122]
β_{ISL_M}	-0.014***	-0.019***	-0.023***	-0.0138***	-0.00800***	-0.0244***
	[0.002]	[0.004]	[0.004]	[0.00235]	[0.00297]	[0.00379]
γ_K	-0.152***	-0.153***	-0.157***	-0.0704***	-0.256***	-0.249***
	[0.010]	[0.018]	[0.013]	[0.0159]	[0.0273]	[0.0267]
γ_{KL_D}	0.021***	0.021***	0.023***			
	[0.002]	[0.004]	[0.003]			
$\gamma_{KL_{DW}}$				0.0111***	0.0140***	0.00833***

				[0.00214]	[0.00305]	[0.00313]
$\gamma_{KL_{DB}}$				0.0124***	0.00958***	0.0158***
				[0.00250]	[0.00347]	[0.00365]
γ_{KL_M}	0.004***	0.003	0.002	0.00269*	0.00218	0.00213
	[0.001]	[0.003]	[0.002]	[0.00161]	[0.00237]	[0.00221]
γ_{KIS}	0.005**	-0.002	0.012***	0.00669***	0.00376	0.0114***
	[0.002]	[0.004]	[0.003]	[0.00219]	[0.00295]	[0.00327]
γ_{KIM}	-0.036***	-0.028***	-0.043***	-0.0382***	-0.0349***	-0.0429***
	[0.003]	[0.005]	[0.004]	[0.00284]	[0.00388]	[0.00419]
γ_Y	1.281***	1.286***	1.288***	1.158***	1.962***	2.004***
	[0.010]	[0.020]	[0.014]	[0.0215]	[0.0422]	[0.0391]
γ_{YL_D}	-0.101***	-0.099***	-0.108***			
	[0.003]	[0.005]	[0.004]			
$\gamma_{YL_{DW}}$				-0.0328***	-0.0374***	-0.0314***
				[0.00294]	[0.00421]	[0.00417]
$\gamma_{YL_{DB}}$				-0.0741***	-0.0684***	-0.0800***
				[0.00368]	[0.00516]	[0.00524]
γ_{YL_M}	-0.013***	-0.014***	-0.008***	-0.0104***	-0.00874***	-0.00904***
	[0.002]	[0.004]	[0.003]	[0.00225]	[0.00327]	[0.00314]
γ_{YIM}	0.143***	0.136***	0.144***	0.156***	0.149***	0.160***
	[0.004]	[0.008]	[0.006]	[0.00420]	[0.00576]	[0.00616]
γ_{YIS}	-0.036***	-0.030***	-0.035***	-0.0439***	-0.0399***	-0.0449***
	[0.003]	[0.006]	[0.005]	[0.00341]	[0.00462]	[0.00504]
γ_{YK}	0.006***	0.006***	0.007***	0.00537***	0.00539***	0.00511***
	[0.001]	[0.002]	[0.001]	[0.00105]	[0.00152]	[0.00146]
Observations	3369	1060	1520	3338	1831	1507
R-squared	0.995	0.995	0.995	0.993	0.994	0.993

*** p<0.01, ** p<0.05, * p<0.1. Robust S.E. in brackets.

All the specifications include area, time and sector dummies together with controls for regional unemployment rate and shadow economy.

Table 12: Partial Price and Demand Elasticities: Direct Estimates From the Production and Cost Functions

	Partial Price Elasticities from the Production Function				**Partial Demand Elasticities from the Cost Function**		
	All	High Skill intensive	Low Skill intensive		All	High Skill intensive	Low Skill intensive
	[1]	[2]	[3]		[4]	[5]	[6]
	$Y = F(L_D, L_M, K, IM, IS)$				$C = F(p_{L_D}, p_{L_M}, K, p_{IM}, p_{IS})$		
$\epsilon_{p_{L_D} x_{L_D}}$	-0.229***	-0.242***	-0.214***	$\eta_{x_{L_D} p_{L_D}}$	-0.729***	-0.834***	-0.698***
	[0.011]	[0.014]	[0.017]		[0.035]	[0.063]	[0.050]
$\epsilon_{p_{L_D} x_{L_M}}$	0.055***	0.045***	0.071***	$\eta_{x_{L_D} p_{L_M}}$	-0.050***	-0.098***	-0.001
	[0.006]	[0.007]	[0.010]		[0.012]	[0.022]	[0.016]
$\epsilon_{p_{L_D} x_K}$	0.086***	0.069***	0.101***				
	[0.006]	[0.008]	[0.009]				
$\epsilon_{p_{L_D} x_{IM}}$	0.072***	0.086***	0.051***	$\eta_{x_{L_D} p_{IM}}$	0.590***	0.759***	0.689***
	[0.005]	[0.007]	[0.009]		[0.068]	[0.122]	[0.103]
$\epsilon_{p_{L_D} x_{IS}}$	0.016***	0.043***	-0.009	$\eta_{x_{L_D} p_{IS}}$	0.189***	0.173*	0.009
	[0.006]	[0.007]	[0.010]		[0.060]	[0.104]	[0.092]
$\epsilon_{p_{L_M} x_{L_M}}$	-0.894***	-0.800***	-0.938***	$\eta_{x_{L_M} p_{L_M}}$	-1.040***	-0.842***	-1.717***
	[0.049]	[0.076]	[0.067]		[0.163]	[0.139]	[0.361]
$\epsilon_{p_{L_M} x_{L_D}}$	0.550***	0.639***	0.560***	$\eta_{x_{L_M} p_{L_D}}$	-0.805***	-0.740***	-0.028
	[0.058]	[0.096]	[0.075]		[0.190]	[0.164]	[0.432]
$\epsilon_{p_{L_M} x_K}$	0.220***	0.283***	0.195***				
	[0.041]	[0.067]	[0.054]				
$\epsilon_{p_{L_M} x_{IM}}$	0.119***	-0.073	0.179***	$\eta_{x_{L_M} p_{IM}}$	2.677***	2.045***	4.454***
	[0.034]	[0.056]	[0.044]		[0.230]	[0.198]	[0.601]
$\epsilon_{p_{L_M} x_{IS}}$	0.005	-0.049	0.004	$\eta_{x_{L_M} p_{IS}}$	-0.833***	-0.464***	-2.708***
	[0.032]	[0.052]	[0.045]		[0.196]	[0.165]	[0.518]
	$Y = F(L_{DW}, L_{DB}, L_M, K, IM, IS)$				$C = F(p_{L_DW}, p_{L_DB}, p_{L_M}, K, p_{IM}, p_{IS})$		
$\epsilon_{p_{L_{DW}} x_{L_{DW}}}$	-0.592***	-0.729***	-0.336***	$\eta_{x_{L_{DW}} p_{L_{DW}}}$	-0.705***	-0.465***	-1.393***
	[0.029]	[0.029]	[0.057]		[0.131]	[0.125]	[0.185]
$\epsilon_{p_{L_{DW}} x_{L_{DB}}}$	0.394***	0.403***	0.289***	$\eta_{x_{L_{DW}} p_{L_{DB}}}$	-0.209*	-0.384***	0.409**
	[0.024]	[0.023]	[0.047]		[0.122]	[0.115]	[0.175]
$\epsilon_{p_{L_{DW}} x_{L_M}}$	0.016	0.043***	-0.034	$\eta_{x_{L_{DW}} p_{L_M}}$	-0.079	-0.144**	0.096
	[0.013]	[0.013]	[0.027]		[0.067]	[0.065]	[0.093]
$\epsilon_{p_{L_{DW}} x_K}$	0.0422***	0.159***	-0.029				
	[0.016]	[0.010]	[0.031]				
$\epsilon_{p_{L_{DW}} x_{IM}}$	0.072***	0.063***	0.054**	$\eta_{x_{L_{DW}} p_{IM}}$	0.164	0.417***	0.125
	[0.014]	[0.016]	[0.024]		[0.162]	[0.154]	[0.216]
$\epsilon_{p_{L_{DW}} x_{IS}}$	0.067***	0.061***	0.057**	$\eta_{x_{L_{DW}} p_{IS}}$	0.739***	0.504***	0.667***
	[0.013]	[0.015]	[0.026]		[0.137]	[0.128]	[0.183]
$\epsilon_{p_{L_{DB}} x_{L_{DB}}}$	-0.535***	-0.641***	-0.437***	$\eta_{x_{L_{DB}} p_{L_{DB}}}$	-0.791***	-0.598***	-1.109***
	[0.025]	[0.025]	[0.043]		[0.066]	[0.077]	[0.119]
$\epsilon_{p_{L_{DB}} x_{L_{DW}}}$	0.299***	0.349***	0.190***	$\eta_{x_{L_{DB}} p_{L_{DW}}}$	-0.079*	-0.183***	0.199**
	[0.019]	[0.020]	[0.031]		[0.046]	[0.055]	[0.085]
$\epsilon_{p_{L_{DB}} x_{L_M}}$	0.104***	0.090***	0.140***	$\eta_{x_{L_{DB}} p_{L_M}}$	-0.113***	-0.149***	-0.096*
	[0.010]	[0.013]	[0.018]		[0.029]	[0.035]	[0.049]
$\epsilon_{p_{L_{DB}} x_K}$	0.161***	0.091***	0.223***				
	[0.013]	[0.018]	[0.021]				
$\epsilon_{p_{L_{DB}} x_{IM}}$	0.031***	0.086***	-0.008	$\eta_{x_{L_{DB}} p_{IM}}$	0.975***	0.673***	1.539***
	[0.011]	[0.014]	[0.016]		[0.106]	[0.117]	[0.199]
$\epsilon_{p_{L_{DB}} x_{IS}}$	-0.059***	0.025**	-0.107***	$\eta_{x_{L_{DB}} p_{IS}}$	-0.081	0.185*	-0.629***
	[0.010]	[0.013]	[0.017]		[0.090]	[0.097]	[0.174]
$\epsilon_{p_{L_M} x_{L_M}}$	-0.916***	-0.913***	-0.873***	$\eta_{x_{L_M} p_{L_M}}$	-1.132***	-0.733***	-1.636***
	[0.037]	[0.055]	[0.061]		[0.177]	[0.196]	[0.336]
$\epsilon_{p_{L_M} x_{L_{DW}}}$	0.052	0.198***	-0.084	$\eta_{x_{L_M} p_{L_{DW}}}$	-0.181	-0.364**	0.333
	[0.041]	[0.062]	[0.066]		[0.154]	[0.164]	[0.322]
$\epsilon_{p_{L_M} x_{L_{DB}}}$	0.440***	0.480***	0.519***	$\eta_{x_{L_M} p_{L_{DB}}}$	-0.680***	-0.791***	-0.686*
	[0.043]	[0.067]	[0.066]		[0.176]	[0.186]	[0.352]
$\epsilon_{p_{L_M} x_K}$	0.155***	0.152***	0.099**				
	[0.032]	[0.050]	[0.048]				
$\epsilon_{p_{L_M} x_{IM}}$	0.188***	0.032	0.260***	$\eta_{x_{L_M} p_{IM}}$	2.637***	1.984***	4.086***
	[0.026]	[0.043]	[0.038]		[0.207]	[0.203]	[0.451]
$\epsilon_{p_{L_M} x_{IS}}$	0.081***	0.051	0.080**	$\eta_{x_{L_M} p_{IS}}$	-0.734***	-0.168	-2.193***
	[0.025]	[0.039]	[0.038]		[0.173]	[0.167]	[0.385]

*** p<0.01, ** p<0.05, * p<0.1. S.E. in brackets.

Table 13: Morishima Elasticities of Substitution, $\frac{\partial ln(X_i/X_j)}{\partial lnp_j}$

	All	High Skill intensive	Low Skill intensive		All	High Skill intensive	Low Skill intensive
	[1]	[2]	[3]		[4]	[5]	[6]
	$C = F(p_{L_D}, p_{L_M}, K, p_{IM}, p_{IS})$			$C = F(p_{L_{DW}}, p_{L_{DB}}, p_{L_M}, K, p_{IM}, p_{IS})$			
		$\frac{\partial ln(L_D/X_j)}{\partial lnp_j}$				$\frac{\partial ln(L_{DW}/X_j)}{\partial lnp_j}$	
$mes_{L_D L_M}$	0.990***	0.744***	1.716***	$mes_{L_{DW} L_{DB}}$	0.582***	0.214	1.519***
	[0.172]	[0.156]	[0.373]		[0.164]	[0.166]	[0.257]
$mes_{L_D IM}$	3.089***	2.150***	3.599***	$mes_{L_{DW} L_M}$	1.053***	0.590**	1.732***
	[0.169]	[0.391]	[0.231]		[0.217]	[0.235]	[0.389]
$mes_{L_D IS}$	4.159***	1.937***	4.385***	$mes_{L_{DW} IM}$	2.721***	2.290***	2.989***
	[0.298]	[0.704]	[0.399]		[0.230]	[0.306]	[0.309]
				$mes_{L_{DW} IS}$	4.808***	3.398***	4.920***
					[0.318]	[0.467]	[0.426]
						$\frac{\partial ln(L_{DB}/X_j)}{\partial lnp_j}$	
				$mes_{L_{DB} L_{DW}}$	0.626***	0.282*	1.593***
					[0.165]	[0.165]	[0.252]
				$mes_{L_{DB} L_M}$	1.019***	0.585***	1.540***
					[0.194]	[0.217]	[0.360]
				$mes_{L_{DB} IM}$	3.531***	2.546***	4.403***
					[0.191]	[0.293]	[0.289]
				$mes_{L_{DB} IS}$	3.989***	3.080***	3.624***
					[0.296]	[0.450]	[0.440]
		$\frac{\partial ln(L_M/X_j)}{\partial lnp_j}$				$\frac{\partial ln(L_M/X_j)}{\partial lnp_j}$	
$mes_{L_M L_D}$	-0.0765	0.0948	0.669	$mes_{L_M L_{DW}}$	0.524**	0.101	1.726***
	[0.192]	[0.173]	[0.431]		[0.240]	[0.243]	[0.433]
				$mes_{L_M L_{DB}}$	0.111	-0.193	0.424
					[0.211]	[0.231]	[0.399]
$mes_{L_M IM}$	5.177***	3.436***	7.363***	$mes_{L_M IM}$	5.194***	3.857***	6.950***
	[0.282]	[0.425]	[0.641]		[0.262]	[0.341]	[0.498]
$mes_{L_M IS}$	3.138***	1.300*	1.667**	$mes_{L_M IS}$	3.335***	2.727***	2.060***
	[0.365]	[0.713]	[0.699]		[0.336]	[0.466]	[0.579]
		$\frac{\partial ln(L_{IM}/X_j)}{\partial lnp_j}$				$\frac{\partial ln(L_{IM}/X_j)}{\partial lnp_j}$	
$mes_{IM L_D}$	0.967***	1.135***	0.970***	$mes_{IM L_{DW}}$	0.716***	0.504***	1.402***
	[0.054]	[0.096]	[0.077]		[0.134]	[0.128]	[0.188]
				$mes_{IM L_{DB}}$	0.949***	0.728***	1.324***
					[0.073]	[0.087]	[0.131]
$mes_{IM L_M}$	1.106***	0.949***	1.783***	$mes_{IM L_M}$	1.203***	0.806***	1.716***
	[0.163]	[0.140]	[0.362]		[0.178]	[0.196]	[0.337]
		$\frac{\partial ln(L_{IS}/X_j)}{\partial lnp_j}$				$\frac{\partial ln(L_{IS}/X_j)}{\partial lnp_j}$	
$mes_{IS L_D}$	0.863***	0.952***	0.704***	$mes_{IS L_{DW}}$	0.787***	0.545***	1.473***
	[0.057]	[0.096]	[0.083]		[0.132]	[0.126]	[0.186]
				$mes_{IS L_{DB}}$	0.768***	0.660***	0.956***
					[0.071]	[0.083]	[0.127]
$mes_{IS L_M}$	1.003***	0.800***	1.647***	$mes_{IS L_M}$	1.096***	0.723***	1.561***
	[0.163]	[0.139]	[0.361]		[0.177]	[0.196]	[0.336]

*** p<0.01, ** p<0.05, * p<0.1. S.E. in brackets.