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Job Creation and Trade in Manufactures: Industry Level Analysis Across Countries

Admasu Shiferaw
The College of William and Mary

Degol Hailu
United Nations Development Program (UNDP)

College of William and Mary
Department of Economics
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Abstract

This paper examines industry level responses of manufacturing employment in the context of globalization using a large sample of developed, developing and transition economies. We find that developing countries need atypically high rates of value added growth (about 10%) to increase manufacturing employment appreciably (about 4%). The employment benefits of export-orientation are also modest even in "comparative advantage" industries of developing countries. However, diversifying the export basket contributes significantly to employment growth, particularly in the medium- and high-technology industries. Import-competition does not undermine employment growth in low-technology industries of developing countries while it displaces jobs in the same industries in OECD and transition economies. For developing countries, import-induced job losses are higher in the more capital-intensive medium-technology industries. Jobs in high-technology industries are less sensitive to imports with positive relationships observed in the OECD. Investment also complements job creation in low-technology industries of developing countries that have yet to industrialize.

JEL Classification: J21, L60, O14, O25
Keywords: Labor Demand; Employment Elasticity; Manufacturing; Export Orientation; Import Competition

Admasu Shiferaw
Economics Department
The College of William and Mary, Williamsburg, USA
PO Box 8795, Williamsburg, VA 23187
Email: ashiferaw@wm.edu

Degol Hailu
United Nations Development Program (UNDP)
New York, USA

1. Introduction

Economic development and poverty reduction in developing countries depend critically on access to gainful job opportunities. The World Bank's 2013 *World Development Report* highlighted the broader socioeconomic significance of jobs that transcend the private returns to employment (World Bank, 2012). Employment in formal sector manufacturing, the focus of this paper, receives special attention from policymakers and researchers partly because it provides relatively stable and better paying jobs. Such desirable attributes of jobs deserve emphasis as the bulk of employment opportunities in developing countries are created by small firms in the unregistered sector where earnings are typically unsteady and job related benefits are nonexistent (World Bank, 2012; Goldberg and Pavcnik, 2003).

While a number of studies underscore the critical role of industrial progress and diversification for economic growth (Hausmann, Hwang and Rodrik, 2007; Jones and Olken, 2005; Imbs and Wacziarg, 2003), the labor market implications of industrialization and diversification are not entirely clear partly because such processes are taking place in the context of increasingly globalized economies. Uncertainty about employment prospects also arises from recent episodes of 'job-less' economic growth experienced by both developed and developing countries at least in the short to medium runs (Caballero and Hammour, 1997; Kapsos, 2005). In fact, many developing countries grapple with persistently high unemployment rates, especially in urban areas, in spite of more open and growing economies. Overcoming constraints to economic growth and exports therefore does not seem to guarantee satisfactory labor market outcomes. A recent review of empirical studies from semi-industrialized developing countries by Goldberg and Pavcnik (2007) shows that trade liberalization has been accompanied by rising wage inequality contrary to the expectation of more favorable outcomes for low-skilled workers. Evidence is still lacking on the more pressing issue of unemployment and global integration particularly in developing countries. The limited empirical literature coming mainly from developed countries provides a mixed picture on the employment effects of trade liberalization as discussed later in this paper.

Labor economists assert that strict labor market regulations are among the main culprits for slow employment growth (Botero et al., 2004). The assumption is that employers respond to restrictive hiring and firing regulations with lackluster job creation, investing instead on productivity enhancing activities (Caballero and Hammour, 1997). However, Freeman (2010) and World Bank (2012) report only modest, if any, impacts of labor market regulations in developing countries partly because of weak enforcement of regulations.[1] Concurrent with trade liberalization, most developing countries have also been relaxing labor laws during the 1990s (Goldberg and Pavcnik, 2007) further attenuating the potential explanatory power of labor market institutions.

Over the last decade or so, economists began to explore firm heterogeneity in size, productivity and export-orientation to better understand the mechanisms through which trade openness may affect labor market outcomes. More recent trade theories extend the Meltitz (2003) model with heterogeneous firms by introducing labor market imperfections arising not as such from hiring and firing regulations but from search frictions, efficiency wages or firm specific wage bargaining. Leading contributions in this regard include Egger and Kreickemeier (2009); Helpman, Itskhoki, and Redding (2010); Felbermayr, Prat, and Schmerer (2011a); and Davis and Harrigan (2011). These new models highlight the conditions under which trade openness could increase wage inequality and the unemployment rate. This marks a significant improvement over comparative advantage and intra-industry trade models whose implications often do not match observed labor market outcomes.

While the above-mentioned theoretical contributions inspire the empirical analysis in this paper, some of their restrictive features need to be addressed. For instance, potential differences in the labor market effects of trade for developed and developing countries are often ignored mainly because of the focus on intra-industry trade among countries with

[1] While Fallon and Lucas (1993) find that job security laws in India and Zimbabwe reduce labor demand, this claim has been disputed by subsequent studies on Indian labor markets (Bhalotra, 1998).

similar economic structures.[2] Similarly, variation in industry level responses to trade reforms cannot be inferred directly from the latest trade models given their emphasis on equilibrium unemployment rate and wage inequality. However, the controversies surrounding trade liberalization arise primarily from divergences in economic structure and patterns of specialization across countries. The empirical approach in this paper therefore addresses such differences by using industry level analysis of employment for countries with dissimilar economic structures. As compared to the large empirical literature on the productivity and wage inequality effects of globalization, studies that address its employment effects are rare and differ remarkably on a number of dimensions. These include differences in response variables, levels of aggregation, measures of trade openness, and data sources and quality, which complicate meaningful comparison of the existing evidence and the lessons to be drawn.

This paper contributes to this literature by estimating a labor demand model for a large sample of developing, transition and developed countries observed over the period 1990-2009. The model examines industry level responses of manufacturing employment to changes in market demand, factor prices, trade openness as well as investment and export basket diversification. We use four-digit ISIC industries that are matched with trade flows from 72 countries. The analysis allows model parameters to vary across regional labor markets and industry categories at different level of technological advancement. We also use country and industry specific instrumental variables to address endogeneity problems that often undermine estimation of labor demand models.

As a preview of our results, we find a negative wage elasticity of labor demand that tends to decline in industries with relatively high labor share of output. Growth in demand increases manufacturing employment although the elasticity is far less proportionate such that developing countries may need to achieve atypically high rates of value added growth (about 10%) to increase employment by about 4%. While demand and own-price elasticities of labor-demand are remarkably similar across all countries and industries, systematic

[2] Felbermayr et al. (2011a) mention that their model does not address the labor market implications of trade between structurally different countries.

regional differences emerge in the labor market implications of trade openness. The employment response to trade openness also depends crucially on the technological composition of industries. Export-orientation has at best modest employment benefits even in "comparative-advantage" industries of developing countries, while it tends to slowdown job destruction in low-technology industries of OECD countries. However, we did not find employment reducing effects of exports as implied by recent trade theories. Import-penetration does not reduce employment growth in low-technology industries of developing countries while it leads to substantial job displacement in the same industries in the OECD. For developing countries, import-induced job losses are relatively high in the more capital-intensive medium-technology industries. Diversification of the export basket boosts job creation particularly in skill-intensive industries of both developed and developing countries. For countries that have yet to industrialize and become accomplished exporters of manufactures, investment has a strong complementary effect on employment.

The rest of the paper is organized as follows: Section two outlines the theoretical perspectives that inspire our labor demand model and provides a review of existing empirical evidence. Section three discusses the datasets and describes the distribution of key variables as well as the industrial composition of employment and trade. Estimation issues are addressed in section four while section five discusses the results. Section six concludes the paper with some policy implications.

2. Theoretical Framework

We draw both on theories of labor demand and international trade to assess manufacturing employment in the context of globalization.

Derived demand for labor:

Following Hamermesh (1993), the own-price elasticity of labor demand holding output constant can be expressed as:

$$\eta_{LL} = \frac{\partial \ln L}{\partial \ln w} = -\left[1 - s_L\right]\sigma \qquad (1)$$

where L is labor and w is wage rate, σ is the elasticity of substitution between labor and other inputs and s_L is the revenue share of labor. Since wage shocks affect product prices, the resulting adjustment in the scale of production will also affect labor demand. Hamermesh (1993) shows this effect to depend on the price elasticity of consumer demand η. Therefore, the total own-price elasticity of labor demand can be expressed as:

$$\eta_{LL} = -\left[1 - s_L\right]\sigma - s_L\eta \qquad (2)$$

Eq. (2) shows a negative wage elasticity of labor demand with two components: the "substitution effect" represented by $\left[1 - s_L\right]\sigma$ and the "scale effect" represented by $s_L\eta$ (Slaughter, 2001). In an industry with low labor share, wage spikes affect labor demand primarily through the factor substitution effect while the scale effect dominates in industries with relatively high labor share.

Our basic labor demand function, following Hamermesh's log-linear specification can thus be expressed as:

$$\ln\left(L_{jt}\right) = \delta + \beta\ln\left(V_{jt}\right) + \alpha\ln\left(w_{jt}\right) + \varepsilon_{jt} \qquad (3)$$

where L stands for units of labor, V is value added, w is wage rate , j indexes industry and t indexes time.

In assessing the effect of trade openness on labor demand, Rodrik (1997) argues that imports not only push the price index down but also raise the price elasticity of demand (η) as access to a wide variety of consumer goods increases. The own-price elasticity of labor demand will thus increase in import competing industries. He also underscores that better access to imported intermediate inputs and parts may give domestic firms further flexibility in organizing production which implies an increase in σ and thus higher wage elasticity of labor demand following a reduction in import restrictions. Slaughter (2001) provides further details on these mechanisms.

To better understand the net effect in a given industry with a known labor-share, Eq. (2) can be rearranged as: $\eta_{LL} = -\sigma - s_L(\eta - \sigma)$. Therefore, in industries where $\eta > \sigma$, the own-price elasticity of labor demand increases with s_L. Since the price elasticity of product demand is equivalent to the elasticity of substitutions between final goods (Slaughter, 2001), an increase in η_{LL} with the labor-share of output implies that consumers' elasticity of substitution between products is greater than firms' elasticity of substitution between inputs. Trade liberalization can intensify this by increasing consumers' choices more than the input choices for domestic firms. However, if consumer demand is relatively price inelastic and imports primarily increases σ, then the total price elasticity of labor demand will be lower for industries with relatively high labor share.

Trade theories and labor demand:

Recent trade theories with heterogeneous firms highlight labor market effects of trade openness other than through greater own-price elasticity of labor demand. The basis for this argument is the recognition that firms participating in export markets are typically larger and more efficient than firms producing only for domestic markets (Bernard et al. 2003; Bernard and Jensen, 1999). Formalizing these observations, the Melitz (2003) trade model shows that the selection of exporters from the upper end of the firm size and productivity distributions intensifies the reallocation of jobs toward more productive firms. Such job churning, however, leaves equilibrium wages and unemployment intact because of the assumption of perfectly competitive labor markets in the Melitz (2003) model. The innovation of recent trade theories is thus to introduce labor market imperfection in Melitz-type models to assess trade related wage inequality and unemployment.

Helpman, Itskhoki and Redding (2010) propose a trade model with heterogeneous firms and search frictions. Firms in this model screen workers for their abilities and large firms have economies of scale in screening allowing them to hire workers with above average abilities. Opening trade increases profits for large firms entering export markets and raises their incentive to screen workers ever more strictly. Since workers with superior abilities are difficult to replace, wages in export firms will be higher on average as compared to wages in

non-exporting firms who screen less – hence increasing wage inequality after trade liberalization. Stricter screening of workers in the Helpman et al. (2010) model also reduces the hiring rate among export firms, which can increase the equilibrium unemployment rate if the vacancy-to-unemployment ratio is low.

Felbermayr, Prat and Schmerer (2011a) propose a similar model with search frictions where trade reduces the unemployment rate as long as it leads to average productivity growth. These authors argue that the value of a new job for an employer increases with average firm productivity (hence increasing the job creation rate), but productivity growth requires a reduction in variable trade costs or an increase in the number of trading partners.[3]

A trade model by Egger and Kreckmeire (2009) relies on workers' preference for a "fair" wage, which is tied to firm performance. Trade openness under this assumption leads to wage inequality as wages rise significantly in highly productive firms that enter into export markets. Non-export firms face stiff competition from imported final goods while experiencing pressure to keep up with high wages in export firms. Unemployment in the Egger and Kreckmeire (2009) model increases because the combined effect reduces profit margins of non-export firms forcing them to either cut jobs or exit the market. Davis and Harringa (2011) add an efficiency wage argument to a Meltiz-type model where large firms pay higher than the market-clearing wage to elicit effort from their workers as it is particularly harder to monitor effort in large firms. While Davis and Harringa (2011) predict a rise in unemployment rate following trade openness, it is expected to be moderate as compared to the volume of job reallocation across firms.

[3] Davidson, Matusz and Shevchenko (2008) propose another trade model with search frictions. While they do not examine unemployment per se, they model firm level productivity as endogenous (rather than a random draw as in most Melitz-type models) to firms' choice of technology. They argue that firms that choose advanced technology hire highly skilled workers (because of the complementarity) and become more productive. Such firms engage in export activities once trade is opened up. Low-technology firms hire relatively less skilled workers and achieve productivity levels that allow them to serve only the domestic market. Wage differences across firms reflect underlying choices of technology and skill composition of workers and this inequality increases after the removal of trade restrictions. Underemployment can happen in the Davidson et al. (2008) model if high skill workers are matched with low-technology firms.

Overall, the above-mentioned trade models with imperfect labor markets suggest that free trade could have undesirable consequences in terms of inequality and/or unemployment despite clear welfare benefits. These predictions are quite different from both the traditional Heckscher-Ohlin-Samuelson model and the intra-industry trade models, and they seem to be more consistent with actual data and public opinion on trade. In the comparative advantage trade models, for instance, trade openness would lead to inter-industry reallocation of labor (from import competing industries to export oriented ones) and reduces unemployment in a labor-abundant country. In the intra-industry trade models, countries with similar endowments can gain from trade without job reallocation across firms, as they assume no firm heterogeneity.

The preceding discussion suggests that a labor demand model needs to account for export orientation and import competition. An increase in the revenue share of export firms could reduce employment growth as in the Helpman et al. (2010) and Davis and Harringa (2011) models or it may lead to employment growth as in Felbermayr et al. (2011a). Since the risk of firm exit declines with firm size and productivity (Bernard and Jensen, 1999), one would also expect jobs in exporter firms to be relatively more stable. It is therefore possible that as an industry gets increasingly export-oriented, employment becomes more secure while job creation rates may slowdown. Although trade theories with heterogeneous firms typically assume firm productivity to be a random draw from a Pareto-distribution, in practice exporter firms would engage in long-term productivity enhancing activities such as innovation, training of workers and investment in latest machinery and equipment – interventions that are more frequent among large firms (Revenga, 1997). The resulting productivity gains, including those from learning-through-exporting, may allow exporters to increase output with limited job creation. The effect on net employment thus becomes an empirical question.

Import competition, apart from reducing workers' bargaining power (Rodrik, 1997), may lead to job destruction as in Egger and Kreckmeier (2009). However, the employment effect arguably varies across industries within a country depending on sources of competitiveness. If access to intermediate inputs is a major constraint for domestic firms,

reducing import restrictions may increase average productivity. Competitive pressure could also lead to productivity growth by reducing either *x*-inefficiency or firm/worker rents (Revenga, 1992). Productivity growth may thus allow domestic firms to compete effectively with imports and avoid rapid job destruction. Similar to the effects of exports on labor demand, the actual employment response to import competition is ultimately an empirical question.

The labor demand model with export-orientation and import-penetration at the industry level can be expressed as:

$$\ln\left(L_{jt}\right) = \delta + \beta \ln\left(V_{jt}\right) + \alpha \ln\left(w_{jt}\right) + \phi\left(\frac{X}{Y}\right)_{jt} + \varphi\left(\frac{M}{M+Y}\right)_{jt} + \varepsilon_{jt} \qquad (4)$$

where X stands for exports, Y is output and M is imports.

A detailed discussion of estimation issues will be picked up in section four, while we now turn to a review of related empirical studies.

Existing Empirical Evidence

The multiplicity of new trade models with different assumptions and labor market implications suggests that the unemployment effects of trade need to be assessed empirically. The empirical literature unsurprisingly shows mixed results. For a sample of industrialized countries in the OECD, Felbermayr, Prat and Schmerer (2011b) find that trade openness, measured as the trade share of GDP, reduces the long-run unemployment rate significantly. Using a large sample of developed and developing countries, Dutt, Mitra and Ranjan (2009) also find that trade liberalization reduces the national unemployment rate in the long-run although unemployment may increase in the short-run. While these papers assess national unemployment rates, they say very little about industry specific effects, which can be important given the across-country differences in industry structure.

Studies that examine industry-level employment and trade often use data from a single country and provide interesting results. Earlier studies by Greenaway et al. (1999) for the UK, Revenga (1992) and Sachs et al. (1994) for the US, and Revenga (1997) for Mexico all

find employment reducing effects of trade openness.[4] More recently, Hasan, Mitra and Ramaswamy (2007) investigate the effects of India's 1991 trade reform on industry-level labor demand. They find significant post-reform increases in the own-price elasticity of labor demand, which tend to be higher for Indian states with flexible labor markets. However, the coefficients on indicators of trade policy shifts are by and large insignificant. Also using industry and state level data from India, Hasan et al. (2012) find that trade protection increases unemployment in states with flexible labor markets particularly in urban areas with export-oriented industries.

The evidence from Latin American countries is not as encouraging. According to Attanasio, Goldberg and Pavcnik (2004), trade liberalization in Colombia during the late 1980s and early 1990s significantly increased wage inequality and the likelihood of informal sector employment where wages and benefits are minimal. The argument is that formal sector firms exposed to increased import competition cut permanent employment positions and outsource some activities to low-wage workers in the informal sector. In Brazil, Menezes-Filho and Muendler (2011) find large transitions of workers out of the labor force and into unemployment following trade liberalization. The authors argue that reallocation of labor to exporters and comparative-advantage sectors are not enough to accommodate import-induced job displacements from the formal sector. Both Attanasio et al. (2004) and Menezes-Filho and Muendler (2011) use household surveys to match workers with their industrial affiliation, and it will be interesting to examine the evidence based on actual industry-level data as we do latter in this paper. There is now a large literature on the productivity effects of trade liberalization in developing countries. [5]

[4] Based on four-digit ISIC industries from UK manufacturing during the 1980s, Greenway et al. (1996) find that both imports and exports reduce domestic employment significantly. Revenga (1992) also finds a negative employment effect of reduction in import prices for US manufacturing industries during 1977-87 while Sachs et al. (1994) substantial employment reduction especially in low-wage sectors. Examining Mexico's trade liberalization in the late 1980, Revenga (1997) shows a downward shift in labor demand.

[5] A firm level study by Pavcnik (2002) for Chilean manufacturing and industry specific studies by Schor (2004) and Iscan (1998) for Brazil and Mexico, respectively, find significant productivity improvements in the manufacturing industries after trade liberalization but did not analyze labor market outcomes. Also see Kim (2000) for productivity enhancing effects of trade in South Korean industries.

Studies on African countries are rather scarce and focus on South Africa. Using industry level data, Jenkins (2008) shows that both imports and exports have negative effects on labor demand in South African manufacturing while Johnson and Subramanian (2001) show that tariff reductions increase productivity growth. Firm-level evidence by Söderbom and Teal (2000) show that exporter firms in Africa are larger, more productive and capital intensive on average than firms supplying only to domestic markets.

The empirical evidence on unemployment effects of trade liberalization is thus quite mixed although the weight of evidence leans slightly toward the unemployment increasing effect. Such mixed results are unsurprising given the wide variation across studies in terms of dependent variables, indicators of trade openness, model specification, estimation methods and time horizon. Some studies use national unemployment rates while other use state- and industry-level data. Trade measures also include indices of trade volume as well as actual trade policy changes. How much of the disparity in the existing empirical evidence reflects differences in data and methodologies is quite unknown. One of the contributions this paper is thus to provide a consistent set of empirical evidence on the employment-trade relationship using the same data sources, level of disaggregation, model specification and estimation method for a large sample of developing, transition and developed countries over a comparable time horizon. The analysis also takes into account potential differences in the employment response to trade openness based on the technological advancement of manufacturing industries. This approach allows a better comparison of performances across countries while addressing differences in industry structure and degree of trade integration.

3. Data and Descriptive Statistics

Data

The paper combines two datasets on manufacturing industries. The first one is UNIDO's Industrial Statistics database (INDSTAT4) that provides disaggregated data on industrial activities at the four-digit ISIC level. INDSTAT4 reports, among other variables, the number of workers (L) and current US dollar values of total output (Y), value added (V), the wage bill (W) and investment (I) in an industry. The other data source is the United Nations

Commodity Trade database (COMTRADE), which provides highly disaggregated data on exports (X) and imports (M) at the level of 6-digit Harmonized System trade classification codes (HS codes). The trade data is restricted to manufacturing industries. The two datasets are combined at the four-digit ISIC level using a concordance provided by the UN statistics division.

The response variable of interest, $\ln(L_{ijt})$, is the logarithm of total number of workers in country i , industry j at time t . The wage rate (w) in an industry represents the average wage per worker obtained by dividing the total wage bill by the total number of workers. Partial labor productivity (v) is calculated as value added per worker in a 4-digit ISIC industry. Constant price values of output, value added and wages are calculated using producer price indices (PPI) for 2-digit ISIC industries from INDSTAT2 database. This database provides industry-level indices of volume of output from which we were able to recover the underlying producer price index. For industries with missing values of PPI, we use the manufacturing sector PPI.

The export share of output (X/Y) and import penetration rates [$M/(M+Y)$] are calculated by using trade data from COMTRADE and total output from INDSTAT4. The number of export items (HS) refers to the number of 6-digit products in a 4-digit ISIC industry for which a country has non-zero exports. The number of competing countries (CX) is the number of exporting countries around the world for each HS code a country is an active exporter.

We have data on the above mentioned variables for 72 countries: eight from Sub-Saharan Africa (SSA), eleven from Asia and the Pacific (ASIA), ten from Latin American and the Caribbean (LAC), eight from Middle East and North Africa (MENA), sixteen from Central and East Europe (CEE) and nineteen from the OECD. The sample period extends from 1990 to 2009 with unbalanced panel at the industry level. See Appendix 1 for list of countries.

Growth rates

Table 1 provides summary statistics on manufacturing output and employment by region. Real manufacturing value added grew at about 3% per annum during 1990-2008[6] for the entire sample with growth rates in developing countries exceeding that of OECD countries. At about 3% per annum, SSA and MENA are the only regions with relatively strong employment growth during the sample period. To put growth rates in perspective, it should be recognized that SSA and MENA regions started from a very low manufacturing base. Employment in semi-industrialized ASIA and LAC regions grew rather slowly at 1.6% and 0.6%, respectively. The more advanced CEE and OECD countries, however, experienced absolute contraction of employment at 1% and 1.3%, respectively. The regional averages suggest that growth in manufacturing employment tends to wane with the maturity and technological advancement of the sector.

Real wage rates in our sample grew on average by about 2% per annum during 1990-2008. Real wages in MENA and CEE increased by 3.3% and 5.1%, respectively, mirroring the above average value added growth rates in these regions shown in Table 1. In ASIA and OECD countries, real wages grew modestly just above one percent while they literally stagnated in LAC and SSA.[7] This suggests that the increase in manufacturing wage bills in LAC and SSA is driven predominantly, if not entirely, by employment growth as shown in Table 1. This contrast with CEE and OECD countries where the wage bill grew entirely because of wage rates as employment declined. Not surprisingly, labor productivity and wage rates are highest in the OECD and lowest in SSA countries.

The regional aggregates in Table 1 conceal important nuances at lower levels of aggregation, which are unraveled in Table 2. For the sake of this analysis, we classify the food, beverage, tobacco, textile, garments, leather and wood industries as "Low-Technology" industries. These are industries that typically require standardized technologies and rely mainly on unskilled labor justifying why they have often been considered as

[6] The 2009 data is excluded from the summery statistics to avoid the effects of a sharp drop in manufacturing performance at the beginning of the recent global financial crisis.

[7] Kapsos (2005) makes similar observation using employment data for entire economies including manufacturing.

"comparative-advantage" industries for developing countries. The printing and paper, chemical and plastic, non-metal, and metal industries are considered to be "Medium-Technology" industries that are often capital-intensive and may require semi-skilled labor. The machinery, transport equipment, electronics, semi-conductor and precision instruments industries are classified as "High-Technology" industries. Competitiveness in the latter often requires continuous upgrading of technologies and a critical mass of skilled labor, hence giving developed countries an edge over developing countries.[8]

Table 2 shows that employment in ASIA's high-technology (HT) manufacturing industries expanded at 4% and 7% in the 1990s and 2000s, respectively, revealing that the slow employment growth in this region (Table 1) is due to weak job creation in low-technology (LT) industries. LT industries, on the other hand, drive employment growth in SSA while medium-technology (MT) industries have been critical in MENA countries (mainly in the petro-chemical industry).[9] None of the industries in LAC show strong employment performance. Not surprisingly, the main source of decline in manufacturing employment in the OECD has been sustained job losses in LT industries. Employment in MT industries in the OECD suffered only minor contractions while HT industries actually gained employment since 2000. Therefore, Table 2 indicates an underlying job reallocation process across manufacturing industries within a region especially in ASIA and OECD countries. It also shows a rather persistent division of labor among regions that may keep the technological gap from closing.

Structural change

To give further insight into structural features of manufacturing, we juxtapose the employment and output compositions of industries in Figure 1a at five-year intervals. It is clear that the employment shares of LT industries have been increasing steadily in SSA,

[8] There is obviously some arbitrariness in this classification as some "low-technology" industries presumably involve advanced technologies just as some "high-technology" industries may not necessarily require highly skilled labor. However, this classification is broadly consistent with the expected technological requirements of industries (Lall, 2001) and would allow us to identify broader patterns of structural change and their implications on manufacturing employment.

[9] Employment in high-technology industries also grew faster in SSA and MENA although this is a rather narrow experience restricted to the transport equipment industry, which emerged only recently.

LAC and MENA regions while they declined in ASIA, CEE and OECD countries. This pattern is reversed in MT industries whose employment shares declined in SSA, LAC and MENA countries while they increased in ASIA, CEE and OECD countries (the trend reversing a bit in SSA during 2005-09). While no clear trend is detectable in HT industries, the employment shares are clearly higher in ASIA, CEE and OECD countries. Since trade openness increased during the sample period, Figure 1a suggest that international trade reinforces existing differences in industrial structure between developed and developing countries. This is quite different from Wacziarg and Wallack (2004) who find insignificant effects of trade on job reallocation across industries for emerging countries but quite consistent with Menezes-Filho and Muendler (2011) for Brazil.

The industrial distribution of manufacturing employment, however, does not always coincide with the distribution of output. Figure 1b shows that the output shares of LT industries in SSA, LAC and MENA are far less than their respective employment shares. Most importantly, the output shares of LT industries are not rising with the increasing employment shares in these regions suggesting a decline in labor productivity in this sector. In ASIA, CEE and OECD countries, however, there has been a decline in the output shares of LT industries consistent with the declining trend in their employment shares. Strikingly, the output shares of MT industries are far greater than their employment shares across all regions with little variation over time underscoring their capital-intensive technologies. MT industries also dominate manufacturing output in the developing world with output shares more than twice that of LT industries. The output shares of HT industries show a steady increase over time only in ASIA, CEE and OECD countries.

A few remarks can be made based on Figures 1a and 1b: (i) that LT industries are clearly labor intensive while MT industries tend to be capital-intensive, with HT industries standing somewhere in between; (ii) that except for ASIA, there is less dynamics in the technological composition of manufacturing output in developing countries while employment is shifting away from MT to LT industries. Employment and output in ASIA are both shifting toward MT and HT industries similar to the pattern in CEE and OECD countries; (iii) that the employment and output shares of industries in the OECD and CEE are rather balanced

indicating equivalence of labor productivity (output per person) in LT, MT and HT industries. Unlike developed countries, there is stark cross-industry variation in labor productivity in developing countries suggesting ample room for reallocation of resources within the manufacturing sector.

Trade in manufactures

Turning to international trade, Table 3 shows that about a quarter of manufactured output in a 4-digit industry is exported during 1990-2008 with noticeable differences across regions. OECD countries have the highest export-orientation at 31% while SSA countries have the lowest rate at less than 7%. This is consistent with the expected positive correlation between exports and productivity. Export orientation of manufacturing has increased steadily from about 14% of output during 1990-94 to about 29% during 2005-09 for the entire sample. At the same time, import penetration rate also increased from 14% to 25% suggesting greater trade openness. Within the developing world, LAC has the highest import penetration rate (24%), which is at par with that of OECD countries.

Figure 2a shows export orientations that often do not reflect the underlying employment structure. Low-technology industries in ASIA, CEE and OECD countries have become increasingly export-oriented although the employment and output shares of LT industries have been declining steadily in these regions. For the rest of the developing world, export-orientation of LT industries either remained well below 10% (as in SSA and MENA) or declined over time (as in LAC) in direct contrasts with the increasing employment share of this sub-sector in these regions. While medium-technology industries account for the majority of manufactured output around the world, this is by far the least export-oriented sector especially in developing countries including ASIA. The export ratio of high-technology industries is also not impressive with that of LAC and ASIA closely following OECD countries. The HT industries in the OECD are the only sector where there is a clear co-movement between export-output ratio and employment share.

Low-technology industries across all regions face higher import-penetration rates in comparison with MT and HT industries. Strikingly, LT industries in developing countries are experiencing increasingly higher rates of import-penetration rate than their counterparts in OECD countries. Also increasing is import-penetration in MT industries in developing countries, exceeding that of OECD countries since 2000. Import penetration in LAC countries is larger than any other region across all industries.

4. Econometric Approach

Given the industry-level panel data for a large sample of countries, the econometric model we estimate takes the following form:

$$\ln(L)_{ijt} = \delta + \beta \ln(V)_{ij,t-1} + \alpha \ln(w)_{ij,t-1} + \phi\left(\frac{X}{Y}\right)_{ij,t-1} + \varphi\left(\frac{M}{M+Y}\right)_{ij,t-1} + \psi \ln(w)_{ij,t-1} * s_{ij,t-1} + ij + u_t + \varepsilon_{ijt} \quad (5)$$

where L is labor, V is real value added, w is real wage rate, $\frac{X}{Y}$ is export-to-output ratio, $\frac{M}{M+Y}$ is import-penetration rate, s is the labor share of output, and the subscripts *i* and *j* index respectively countries and 4-digit industries while *t* indexes year. The term *ij* is a country-industry fixed effect, u_t stands for time fixed effects and ε_{ijt} represents time varying equation errors. Eq. (5) is estimated using panel data that uniquely identify a 4-digit industry for each sample country. The garments industry in Bangladesh is thus uniquely identified from the garments industry in India.

The interaction term between the labor share of output and wage rate emanates from our discussion in section two, where Eq. (2) is expressed as $\eta_{LL} = -\sigma - s_L(\eta - \sigma)$. Here the labor share of output acts as a weight for the net effect of the elasticities of substitution of inputs and final goods on η_{LL}. Therefore, ψ in Eq. (5) captures the differential own-price

elasticity of labor demand for industries with higher share of labor.[10] For instance, if ψ is positive and significant, it implies that the wage elasticity of labor demand declines with the labor share of output and that $\sigma > \eta$. Identification of the own-price elasticity of labor demand is based on the assumption that labor supply is perfectly elastic. While this may seem to be a strong assumption, the level of disaggregation in our analysis at 4-digits is reasonably small such that it is not an egregious misrepresentation (Slaughter, 2001). For developing countries with high unemployment rates and small share of manufacturing in total employment, this assumption is rather reasonable. If that is not the case, our model may overstate the wage elasticity of labor demand.

The decision to use the intensity of exports and imports to capture the employment effects of trade integration is partly data driven. The majority of developing countries in our sample implemented major trade liberalizations during the second half of the 1980s and at the beginning of the 1990s. The fact that our data begins in 1990 or later for some countries, excludes trade policy shifts as control variables. It is also common practice to use trade flows in the growth and trade literature as they show real exposure to international trade.[11]

While we assume exogenous demand for manufactures from domestic and export markets, potential endogeneity of explanatory variables arise partly because of simultaneous determination of employment, output, exports and intermediate imports. We address this problem to an extent by taking one-year lags of all explanatory variables. We also use the panel fixed effects estimator to account for unobserved technical and market characteristics that are industry specific and time invariant. This estimator will also address the influence of country fixed effects. The time fixed effects will capture variations over time in interest rates and other macroeconomic shocks that are common to all industries. Since sample

[10] The average labor share of output in our sample does not have a clear trend over time suggesting that *s* in Eq. (5) is a shift variable for industry level differences within a country. This was discovered by running cross-sectional and panel fixed effects regressions of labor share on a time variable which show statistically insignificant coefficients with or without controls for trade. The only exception is SSA where there has been 3 percentage points reduction in labor share and OECD countries with a fifth of a percentage point increase in labor share.

[11] The time span of our data also has an advantage in the sense that the countries in our sample have relatively less divergent trade policy stances than would have been the case before 1990. This allows us to focus on the labor market effects of actual exposure to trade and underlying differences in economic structure.

countries are at different stages of industrialization and success in one industry could have spillover effects on related industries, it is unrealistic to assume independence of ε_{ijt} across industries within a country. Robust standard errors will thus be used throughout the analysis.

Despite these safeguards, the panel fixed effects model is unlikely to address all the endogeneity problems satisfactorily. Job losses in specific manufacturing industries may trigger selective trade protection measures that reduce imports, while increased female labor force participation and/or migration may fuel export competitiveness. Therefore, we use instrumental variables to account for problems of reverse causation and time varying un-observables and obtain exogenous variation in import-penetration rate, export orientation as well as real wages and real value added.

The instruments we construct are country and industry specific and vary over time. One of our instruments for import-penetration rate is a weighted average exchange rate index of major import supplier countries to a particular industry of a given country. Since the US Dollar is the currency of choice for most international transaction, we use US Dollar exchange rates of import partner countries. Exchange rate indices from the IMF Financial Statistics database are weighted by the source country's share in total imports of a country in a given industry using trade flows from the COMTRADE database. We also construct an average implicit GDP deflator of import supplier countries weighted in a similar fashion as an additional instrument for import-penetration rate. The assumption is that exchange rates and price indices of key import supplier countries are exogenous to economic conditions in a specific industry of the importing country while affecting import costs.

The instruments for import-penetration rate can be expressed as:

$$EXI_{ijt} = \sum_{k} \left(\frac{M_{ijkt}}{\sum_{k} M_{ijkt}} \right) EX_{kt}^{US} \qquad 6$$

$$PPI_{ijt} = \sum_{k} \left(\frac{M_{ijkt}}{\sum_{k} M_{ijkt}} \right) PPI_{kt} \qquad 7$$

where EXI_{ijt} is a weighted average exchange rate index of import supplier countries, M_{ijkt} represents import by country *i* from supplier country *k* in industry *j* at time *t,* EX_{kt}^{US} is US Dollar exchange rates of import supplier countries. PPI_{kt} represents implicit GDP deflators of source countries as a proxy for their producer price indices while PPI_{ijt} is a weighted average industry specific index of import source countries.

In constructing the instruments for import penetration, we allow the composition of partner countries to vary across industries and over time, which together with the annual data on exchange rates and GDP deflators provide us with industry specific instruments for each sample country. We use a 2.5% import share as a cutoff point to determine the set of import partner countries. The selected source countries account on average for 89% of industry level imports in our sample. As much as data allow, we take three data points *each* for the 1990s and 2000s to allow changes in the composition of import source countries. In a few cases, data limitations restrict us to only two sets of partner countries, i.e., one set for the 1990s and another set for the 2000s.

To instrument the export-output ratio, we construct industry specific weighted average real exchange rate index for exporting countries. We use the official US dollar exchange rate index adjusted for industry specific price indices. The producer price indices of major export destination countries are weighted by their respective export shares from a given industry using trade flows from COMTRADE. The official exchange rate is assumed to be exogenous to firms in a four-digit ISIC industry and so also are producer prices in the export destination countries. In addition to this we also use a weighted GDP index of export destination countries to capture demand shocks in partner countries using the export shares as weights. To be included in the calculation of the real exchange rate index and the GDP index, a destination country should account for at least 2.5% of an industry's exports from a

sample country. The selected destination countries account on average for 90% of industry level exports from our sample.

The instruments for export-output ratio can be expressed as:

$$REXI_{ijt}^{US} = EX_{it}^{US}\left(\frac{PPI_{ijt}}{\sum_{k'}\left(\frac{X_{ijk't}}{\sum_{k'}X_{ijk't}}\right)PPI_{k't}}\right) \qquad 8$$

$$GDPI_{ijt} = \sum_{k'}\left(\frac{X_{ijk't}}{\sum_{k'}X_{ijk't}}\right)GDPI_{k't} \qquad 9$$

where $REXI_{ijt}^{US}$ is weighted average real exchange rate index for export destination countries, $X_{ijk't}$ is total export from industry *j* of country *i* to destination country k' at time *t,* EX_{it}^{US} is the official exchange rate of exporting country *i*, PPI_{ijt} is industry level producer price index (from INDSTAT2) of exporting country, $PPI_{k't}$ is implicit GDP deflator of an export destination country. $GDPI_{k't}$ is the GDP index of an export destination country while $GDPI_{ijt}$ is the aggregate GDP index of export destination countries applicable to industry *j* of an exporting country.[12]

Assuming that workers in a four-digit industry will consider the average wage in the respective two-digit industry as an alternative wage, we use the latter to instrument real wage rates at the four-digit level. The fact that we are using real wages already takes into account the two-digit producer price index in that industry. Real value added of each four-digit industry is instrumented by the real GDP of the same country to capture demand shocks from the entire domestic economy.

[12] For developing countries where export earnings are driven by primary commodity exports, the nominal exchange rate itself is expected to be exogenous for four-digit manufacturing industries.

Following the discussion in section three, the labor demand model will be estimated separately for the six regions. By creating sub-samples of countries with comparable geographic, historical and institutional backgrounds, we hope to further mitigate the effects of time varying country level heterogeneity that our model does not control for. These include differences in technological capabilities, human capital, and institutional qualities that could affect the employment response to exogenous shocks in our covariates. The vast regional difference in industrial structure and dynamics shown earlier in section three seem to support this strategy rather than imposing the same coefficient for all developed and developing countries.

Within each region, the employment model will also be estimated for the entire manufacturing sector as well as for High-, Medium- and Low-technology industries. The idea is to allow for heterogeneous employment responses to exogenous shock in our covariates across groups of industries which may arise from unobserved technological and market characteristics. The observed structural differences in section three support this classification of industries, which hopefully enhances the statistical precision and policy relevance of the econometric analysis.

5. Estimation Results

Table 4 presents estimates of the labor demand model for groups of developing, transition and developed countries. As would be expected, we find a negative and statistically significant own-price elasticity of labor demand across all regions. In developing countries the coefficient on real wage ranges from 0.44 in MENA to 0.54 in SSA with an average of 0.48. Interestingly, Table 4 shows positive and statistically significant coefficients on the interaction term between real wages and the labor share of output for all regions. This suggests that the elasticity of employment with respect to real wages declines as the labor share of output increases. At average values of labor share, which is about 42% in developing countries, the results indicate about 5% reduction in the own-price elasticity of labor demand. This is consistent with the neoclassical factor demand theory where the rate

of factor substitution declines as firms use more of one input keeping output constant. The sign of the interaction term also suggest that the elasticity of substitution of inputs for manufacturing firms is greater than consumers' elasticity of substitution between final products, although in theory the latter has no upper bound (Slaughter, 2001).

Demand for manufactured goods has the expected positive and statistically significant effect on labor demand. Across the developing world, the average demand elasticity of employment is about 0.43, i.e., a one percent growth in real value added leads to a 0.43 percent increase in employment. Given the small standard errors of these coefficients, it is fair to say that employment elasticities in SSA and MENA are below the average for developing countries while that of ASIA and OECD are above average. While total manufacturing employment contracted in the OECD, the positive demand elasticity indicates the reallocation of jobs from the declining LT industries toward better performing MT and HT industries. A much weaker employment response to value added growth in CEE countries reflects the massive reductions in manufacturing employment during the 1990s (See Figure A in the Appendix).

The coefficients on real value added in Table 4 suggest that the employment benefits of industrialization in developing countries are rather moderate than what policymakers may wish for. A developing country needs to maintain about 10% growth in real value added to achieve a 4.3% annual growth in manufacturing employment. However, performance indicators in Tables 1 and 2 suggest that such spectacular rates of value added growth are rather infrequent. In countries where population and labor force continue to grow at 2-3% per annum, increasing the employment share of manufacturing may require even higher rates of industrial expansion.

While demand and wage elasticities of labor demand are remarkably similar across developing regions in terms of coefficient size and significance, there are striking differences in the employment response to participation in international trade. LAC and MENA are the only developing regions where import-penetration significantly dampens domestic labor demand. This is not surprising in the case of LAC given its high import-

penetration rate relative to other developing regions. This finding is also consistent with existing empirical studies on individual Latin American countries discussed earlier (Revenga, 1997; Attanasio et al., 2004; Menezes-Filho and Muendler, 2007). Import-penetration causes no adverse employment effects in ASIA, while it significantly increases employment growth in SSA. The latter is likely the result of better access to imported intermediate inputs that more than offset the negative employment effects of competition with imported final products. While import competition has statistically significant job destruction effects in CEE and OECD countries, the employment effect in the OECD is rather marginal as compared to CEE.

Large regional differences also emerge in the employment effects of export-orientation. Other things being equal, growth in manufactured exports increases labor demand significantly in LAC and ASIA. Positive albeit weaker employment effects of exports are also observed in CEE and OECD countries. Owing partly to their limited participation in export markets, employment in SSA and MENA does not vary with the export-output ratio of an industry. Overall, the evidence does not support the negative relationship between employment and export growth predicted by some of the new trade theories with heterogeneous firms. But our findings are more consistent with Felbermayr et al. (2011a) where export-orientation increases job creation. Nonetheless, the coefficients on the export ratio are typically small even when they are statistically significant. Such unimpressive employment benefits suggest that the size and productivity advantages of export firms may also be playing a role in allowing them to increase exports with limited adjustment of labor.

The results in Table 4 reflect average employment responses across all manufacturing industries ignoring potential heterogeneity across groups of industries. By estimating the labor demand model for technology-based groups of industries, we allow employment responses to vary within each region. Table 5 examines employment in low-technology industries while Tables 6 and 7 report the results for medium- and high-technology industries, respectively. Because of limited number of observations for the SSA sample, Table 6 combines the MT and HT industries in Africa.

Table 5 indicates that for most countries, the elasticity of employment with respect to value added growth in LT industries is (about 10 percentage points) larger than the manufacturing sector averages reported in Table 4 (that of MENA and CEE are close to the average). The demand elasticity of employment in MT industries in Table 6 is, however, typically below the respective regional average in Table 4 across all regions. These results are consistent with the descriptive statistics that LT industries are typically labor-intensive while MT industries tend to be capital-intensive. The employment intensity of value added growth in

HT industries (Table 7) is often better than MT industries but less than LT industries. LAC and CEE are exceptions where demand elasticities of employment in HT industries are stronger relative to LT industries. As discussed earlier, the only industries that exhibited employment growth in CEE and OECD countries are HT industries and the estimated model captures this reality in Table 7. Another noteworthy point in Table 5 is that for developing countries the coefficients on the interaction term *ln(w)*s* in LT industries are larger in magnitude as compared to the manufacturing sector averages in Table 4 as well as those in Tables 6 and 7 for MT and HT industries.

Although import-penetration rates in LT industries are higher than other industries, this does not seem to induce significant reduction in labor demand in developing countries (Table 5). The only exception is the resource rich MENA region where the coefficient on import-penetration is large, negative and statistically significant. As developing countries have become the main sources of LT exports (accounting for about 2/3 of total LT exports for countries in our sample), the absence of a strong adverse employment effect of imports in this sector could be the result of trade among developing countries. For developed and transition economies, however, LT imports cause significant displacement of low-skill jobs. This indicates the relative competitiveness of developing countries in LT industries and our findings support the view that trade with developing countries reduce jobs in high-income countries.

As shown in Table 6, jobs in medium-technology industries are particularly susceptible to import competition across all regions except SSA. Unlike the LT industries, the employment reducing effects of import competition in MT industries are much stronger for developing countries as compared to the employment effects in CEE and OECD countries. Until very recently, more than 50% of world exports in MT industries are supplied by OECD countries showing their competitive advantage. MT industries in Africa seem to benefits from increased import penetration, which could be explained by better access to intermediate inputs. Jobs in high-technology industries are by far the least sensitive to import competition relative to LT and MT industries. The only exception is Latin America where statistically significant employment contraction occurs as a result of import-penetration. On the flip side, the two regions that dominate world exports in HT industries, i.e. OECD and ASIA, have positive employment elasticities with respect to import-penetration, although the coefficient for ASIA is not statistically significant. This suggests that greater trade openness in high-technology industries is beneficial for most countries.

Not all developing countries benefit from export-oriented low-technology manufacturing. Table 5 shows that only MENA and ASIA have statistically significant employment benefits from LT exports. Interestingly, the coefficient on export-output ratio is positive and significant for LT industries of the OECD suggesting that export-orientation helps slowdown the rate of job destruction in this sector. This is consistent with the declining employment share and increasing export ratio of this sector in the OECD (Figure 2). Export-orientation in MT industries has employment benefits only in ASIA and OECD regions suggesting these are the dominant exporters in this industry.

High-technology exports are not important sources of employment gain with the exception of LAC where the coefficient is positive and significant. The size of the coefficient on export ratio is quite low even when statistically significant reaffirming the limited contribution of export-oriented manufacturing for job creation. Once again, the fact that exporters are relatively large and productive seems to allow them to increase exports with limited job creation. Equally important is the observation that export orientation is not costing existing jobs as some of the latest trade theories predicted.

Summing up, low-technology industries still seem to have significant employment potentials for developing countries. A shift toward MT manufacturing may increase productivity and value added growth in developing countries, as shown earlier in Figure 2, but such a transition is less likely to generate more employment because of the capital-intensive nature of the sector and its limited export orientation. From an employment perspective, a structural change that favors HT over MT industries may serve developing countries better as human capital and per capita income keep rising. This is partly because the output share of HT industries in total manufacturing is still very low in developing countries and employment in this sector is far less susceptible to import competition. The latter is perhaps an indication of the role of intermediate inputs as well as growing FDI flows in this sector from OECD to developing countries.

Extended Model

In this section we extend the labor demand model by considering additional dimensions of export activities. Countries and industries with comparable export-output ratios may differ in the range of export items, i.e., the extensive margin. Hausmann et al. (2007) argue that the discovery of new export items is bound to be sub-optimal because of sunk-costs that are private and the public-good nature of successful new export products. The authors also show diversification as an important predictor of both the level and future growth rate of per capita income. In a related literature, Bernard et al. (2010) and Goldberg et al. (2010) find that multiproduct firms are significantly larger, more productive and more export oriented than single product firms. Whether diversification affects employment opportunities, holding export-ratios constant, is thus worth exploring.

Our conjecture is that the employment benefits of adding a new export item may depend on the current diversity of the export basket. For a developed country with a broad range of manufactured export items, adding one more product may not have a noticeable employment effect as compared to a developing country with only a few export items. We attempt to explore this relationship by including in the labor demand model the total number of six-digit export items (*HS* codes) within a four-digit ISIC industry and compare the outcome for developed and developing countries.

Once a new export item is introduced, subsequent employment growth will be driven by the intensive margin, which in turn depends partly on the competitiveness of the global market in that particular industry. Products with relatively low discovery costs are likely to be exported by firms from multiple countries. With fewer buyers and many suppliers, importers may exercise market power and use the threat of switching supplier countries/firms to dictate the terms of exchange in their advantage. The resulting uncertainty of demand and contract terms may reduce exporters' incentive and ability to create and retain jobs. To capture this effect the extended labor demand model includes a measure of the number of active exporter countries (*CX*) for each four-digit industry.

Finally, constraints to job creation may arise from inadequate investments in machinery and equipment. Since Eq. (5) already controls for value added, the focus here is on the role of investment on labor productivity of domestic firms facing competitive pressure. One example is the reduction in maintenance cost and down time by replacing old machines by new ones. The productivity effect could also be associated with the increase in the scale of production as investment intensifies. We expect such complementary employment effects to be important for countries at early stages of industrialization. For others, high investment rates may dampen labor demand as production becomes more capital-intensive. The extended model includes the investment rate as one of the explanatory variables and it is calculated as the percentage of manufactured output dedicated for investment purposes. The extended model is expressed as follows:

$$\ln(L)_{ijt} = \delta + \beta \ln(V)_{ij,t-1} + \alpha \ln(w)_{ij,t-1} + \phi\left(\frac{X}{Y}\right)_{ij,t-1} + \varphi\left(\frac{M}{M+Y}\right)_{ij,t-1} + \psi \ln(w)_{ij,t-1} * s_{ij,t-1} + \gamma \ln(HS)_{ij,t-1} + \pi \ln(CX)_{ij,t-1} + ij + u_t + \varepsilon_{ijt} \quad (10)$$

The results from the extended model are presented in Table 8. Because of the substantial reduction in the number of observations due to missing values for the new variables, the extended model is first estimated for the entire manufacturing sector without delving into technology-based industry categories. The coefficients on previously discussed covariates

remain similar to those in Table 4 with minor differences in magnitude and a few losses of precision due to sample size reduction. Therefore, the remaining discussion focuses on the new variables in the extended model.

A key observation is the positive and statistically significant coefficient on the number of export items (*HS*) for developing countries. This is particularly true in SSA and LAC countries and to a certain extent in MENA too. This suggests that after controlling for export-output ratio, adding new export items has significant employment benefits for countries that have yet to become accomplished exporters of manufactures. No such employment benefits accompany export diversification in ASIA and OECD countries, which currently dominate world exports of manufactures. The marginal employment benefits from product adding seem to decline with the scale of export activities. This appears to resonate with the findings of Imbs and Wacziarg (2003) that as countries develop, their economies become increasingly less (more) concentrated (diversified) until a threshold level of per capita income is reached, beyond which specialization kicks in.

Participating in export markets in which there are a large number of competitors does not have any noticeable employment effects. Nonetheless, there is some evidence that exporting what most other countries export increases job opportunities in SSA. This suggests that countries with limited technological capabilities can get a foothold in international markets by exporting items with low discovery costs. Similarly, the fact that the coefficient on *CX* is negative for the Asian sample, despite lacking precision, suggests that the region is approaching a point where industrial expansion and job creation through low-technology exports may no longer be a viable option. This opportunity is about to avail itself to low-cost countries in Africa. The other interesting result in Table 8 is the positive and significant relationship between investment and employment in developing countries as a group with the exception of LAC. It is striking that the employment effects of investment are larger and highly significant for manufacturing industries in SSA.

In Table 9 we allow the coefficients of the new variables to vary across technology-based industry categories. Medium- and high-technology industries for developing countries are

merged together to economize on observations. The results show that labor demand in developing countries increases significantly as new export items (*HS*) are added to both LT and the combined MT/HT industries. However, the employment benefits are substantially larger in the MT/HT industries reflecting perhaps greater possibilities for diversification in more advanced industries. This is consistent with Hausmann et al. (2007) where growth in per capita income increases with the introduction of new products in technologically advanced industries. Product adding also helps developed countries create manufacturing jobs but only in the HT industries; even then the coefficient on *HS* is barely significant. The coefficient on *CX* that proxies the competitiveness of export markets at the industry level is negative for the most part as would be expected but statistically insignificant. For LT industries in developing countries, however, an increase in the number of competing countries seems to increase employment.

While investment increases job creation in developing countries as shown in Table 8, only in LT industries does this complementarity turn out to be statistically significant. This seems to be consistent with the observed increase in the employment share of LT industries in the developing world except for ASIA (Figure 1a). On the other hand, investment in OECD manufacturing complements job creation only in HT industries while it tends to be negatively related with employment in both LT and MT industries. Capital flows from OECD countries to LT industries of developing countries could thus lead to a win-win situation.

6. Conclusions

This paper provides industry level analysis of manufacturing employment using panel data from a large sample of developing, transition and developed countries. The labor demand model is inspired by the literature in labor economics as well as recent developments in trade theory with heterogeneous firms. We allow the elasticities of labor demand to vary across regions as well as groups of industries at different levels of technological advancement. By using the same data sources, estimation model/method and level of

disaggregation for a large sample of countries, the paper provides a better understanding of the state of manufacturing employment in an increasingly integrated global economy.

While industrial expansion generates employment opportunities in developing countries, we find the elasticity of employment with respect to value added growth to be far less than proportional suggesting that developing countries may need to sustain atypically higher rates of real value added growth (above 10%) to increase manufacturing employment by about 4% on average. In fact, the cross-country comparison of employment growth suggests that job creation in manufacturing tends to slowdown with the maturity and technological advancement of the sector. For developed countries, for instance, value added growth and exports at best reduce the rate of job destruction in manufacturing.

While the own-price elasticity of labor demand is negative across all regions, the degree of responsiveness declines as the labor share of output increases which is consistent with the neoclassical factor demand model. The employment effect will thus be larger for developing regions experiencing relatively faster growth rates in real wages such as ASIA countries.

In low-technology industries where developing countries have comparative advantage, the adverse employment effects of import-competition are rather insignificant – the resource rich MENA region being an outlier. For developed and transition economies, however, import-penetration in LT industries reduces domestic labor demand significantly. Developing countries experience substantial employment contractions due to import competition in the more capital-intensive medium-technology industries. The only exception to the latter is SSA where import penetration and employment are positively related. Jobs in the emerging high-technology industries in developing countries, excluding LAC, are not susceptible to import-penetration presumably because of the associated flows of technologies and intermediate inputs. HT industries in OECD countries gain employment as imports intensify testifying to the region's competitive advantage in this sector.

The export intensity of manufacturing does not seem to have substantial employment benefits for developing countries. Cases where export-orientation contributes to

employment growth include LT and MT industries in ASIA, and HT industries in LAC. However, we do not find any employment reducing effects of exports as implied by some of the recent trade theories with imperfect labor markets. In fact, for OECD countries, exports seem to slowdown the rate of job destruction in LT industries. On the other hand, diversifying the export basket by adding new products contributes significantly to employment growth in developing countries particularly in the MT and HT industries. Product adding also helps create jobs in OECD countries but only in the HT industries.

The paper also underscores the importance of allowing for regional differences in understanding the dynamics of manufacturing employment. A few generalizations can be made in this regard. Latin American and Caribbean countries have the highest import-penetration rate in the developing world and suffer most from import-induced job losses in their MT and HT industries with only marginal employment gains from HT exports. To make matters worse, value added growth in the labor-intensive LT industries has started to slowdown in LAC since the year 2000. On the bright side, employment in this region is strongly responsive to diversification of export items.

Although manufacturing employment in Sub-Saharan Africa does not seem to suffer from growing imports and may even benefit from it, few of its industries are export-oriented. Domestic demand for manufactures will likely set the growth path of manufacturing in this region and its employment contributions in the foreseeable future. Luckily, African manufacturing is responding favorably to the addition of new export items and to investment in machinery and equipment. Obviously more FDI can address simultaneously the investment and export diversification efforts in this region.

Among developing regions, Asian countries have by far the most promising outlook in terms of manufacturing employment. Although declining over time, LT industries still account for about a third of manufacturing employment in this region while MT and HT industries are rising to fill this gap. Export orientation in the LT and MT industries also contribute to manufacturing employment as already indicated. A challenge for the region is strengthening the competitiveness of MT industries where imports tend to curb domestic

labor demand. Given rising real wages in the region, improving labor productivity is imperative to sustain competitiveness.

Middle East and North African countries are doing better than SSA with growing participation in the export of manufactures. The dominance of capital-intensive medium-technology industries may suppress employment growth in MENA together with susceptibility to import competition. On the other hand, MENA has the highest investment rate in manufacturing than any other region and this seems to have significant contributions to job creation.

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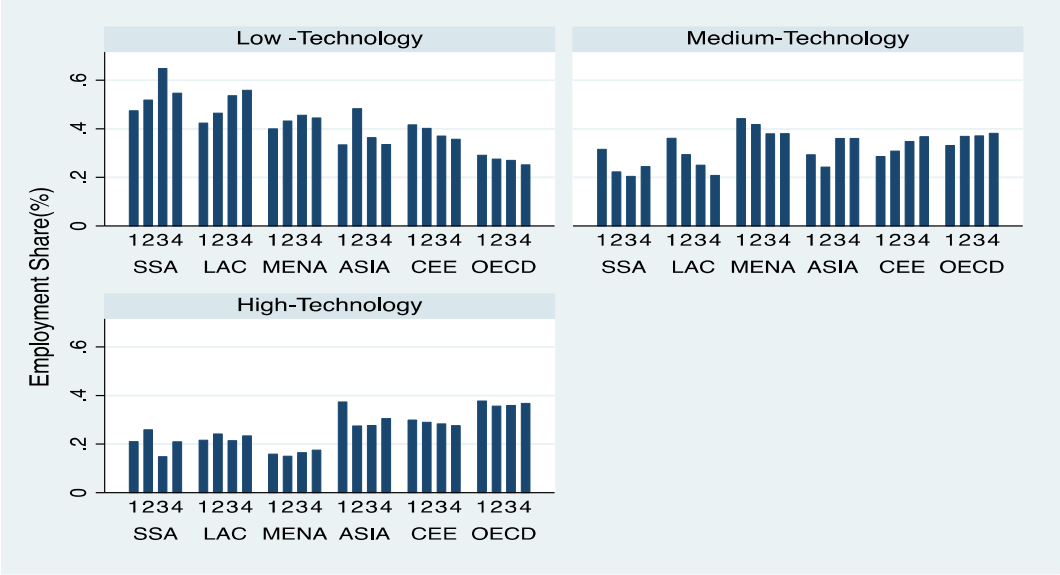


Figure 1a: Employment Share of Industries by Level of Technology and Region.

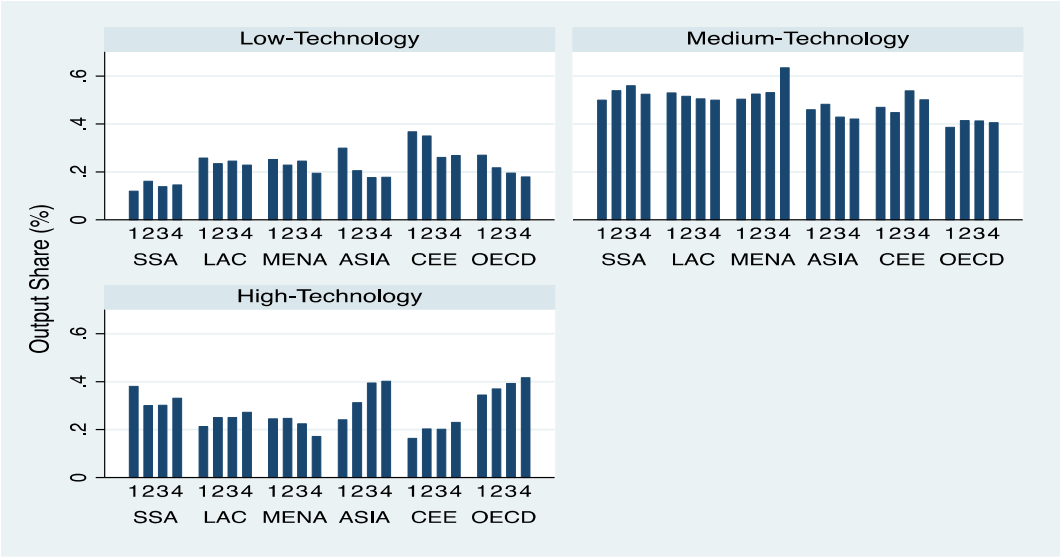


Figure 1b: Output Share of Industries by Level of Technology and Region.
Note: Numbers 1 to 4 in both panels refer to five-year intervals for 1990-94, 1995-99, 2000-04 and 2005-09, respectively.

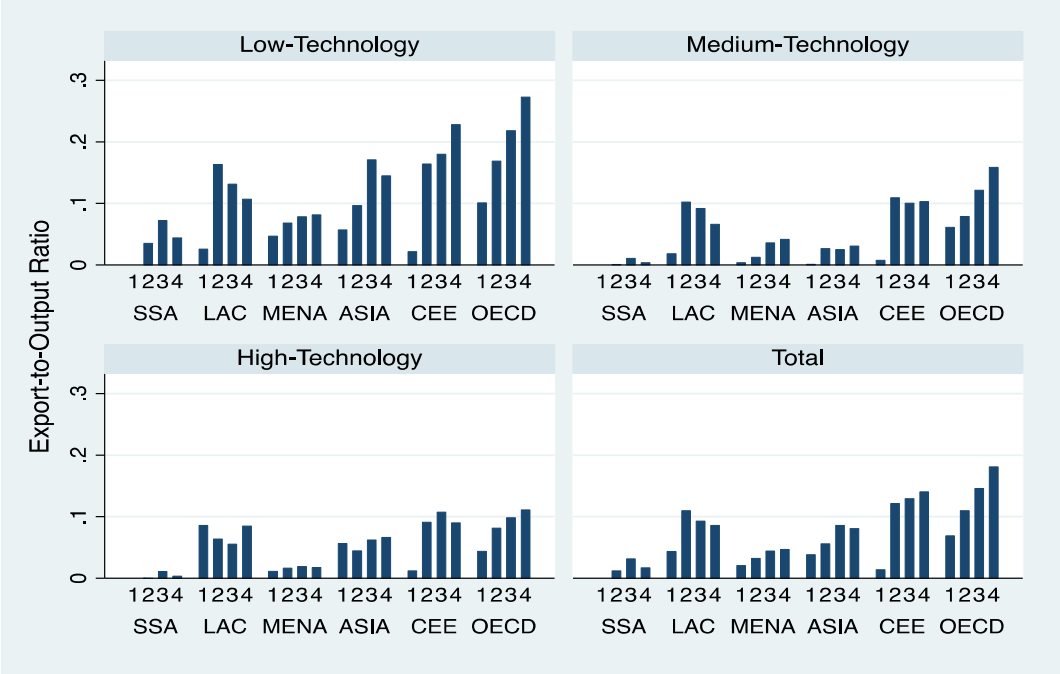


Figure 2a: Export-to-Output Ratio by Industry and Region

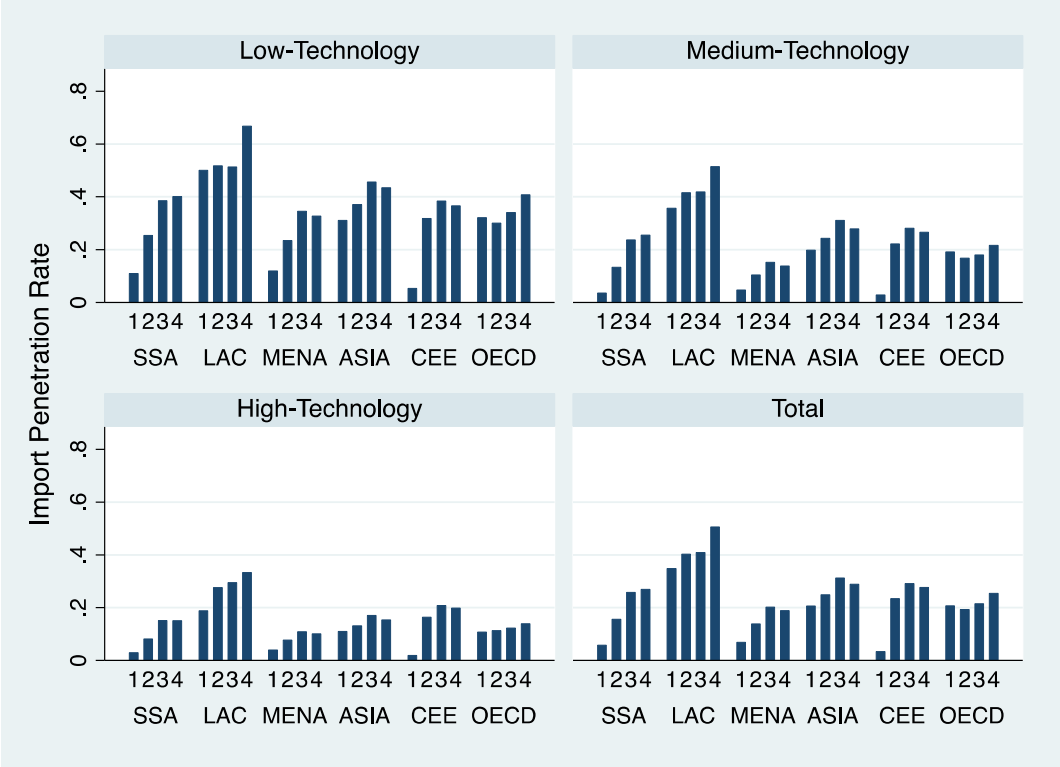


Figure 2b: Import-penetration Rate by Industry and Region.
Note: Numbers 1 to 4 in both panels refer to five-year intervals for 1990-94, 1995-99, 2000-04 and 2005-09, respectively.

Table 1: Performance of Manufacturing by Region (growth rates in percent) 1990-2008

	ΔY/Y	*ΔV/V*	*ΔL/L*	*ΔW/W*	*Δw/w*	*Δv/v*	*ln(w)*	*ln(v)*	*I/Y*
LAC	2.50	3.26	0.61	0.79	-0.09	2.39	8.60	10.16	0.06
SSA	4.94	2.98	3.27	2.99	0.00	-0.01	7.10	8.48	0.08
MENA	6.44	5.70	3.11	5.74	3.32	3.28	8.40	9.59	0.21
ASIA	3.49	2.27	1.61	1.66	1.14	1.75	8.69	10.07	0.17
CEE	5.69	6.36	-0.96	4.19	5.07	7.24	8.09	9.04	0.17
OECD	1.21	0.63	-1.31	0.17	1.33	1.79	10.28	11.08	0.05
Total	3.19	2.91	-0.05	1.88	2.11	3.14	9.13	10.17	0.10

Source: UNIDO INDSTAT4.
Note: All variables are in real values. *Y*– output, *V* – value added; *L* – employment; *W* – wage bill; *w* - wage per worker; *v* - value added per worker; *I/Y* – investment to output ratio; *Δ* – difference.

Table 2: Employment and Value Added Growth Rates by Industry and Region

	Low-Technology		**Medium-Technology**		**High-Technology**	
	1990-99	2000-08	1990-99	2000-08	1990-99	2000-08
LAC	-0.46	0.56	1.10	1.64	0.17	0.85
	1.42	*3.20*	*-0.54*	*4.29*	*-2.56*	*8.19*
SSA	2.40	2.89	-1.75	5.18	28.53	8.56
	6.87	*3.64*	*4.91*	*0.65*	*-3.76*	*1.54*
MENA	2.18	0.70	5.88	3.72	16.33	9.27
	2.16	*4.99*	*-0.49*	*8.25*	*3.24*	*7.47*
ASIA	-3.99	0.65	0.63	4.26	4.06	7.24
	3.50	*0.64*	*6.26*	*1.69*	*14.81*	*2.66*
CEE	-2.55	-2.94	-2.59	1.24	-5.42	2.96
	-4.87	*6.35*	*-1.00*	*10.34*	*-8.90*	*7.09*
OECD	-2.36	-2.83	-0.33	-0.75	0.11	1.90
	0.13	*-1.59*	*4.46*	*0.62*	*5.16*	*2.53*

Source: UNIDO INDSTAT4

Note: The top number in each cell is employment growth rate while the bottom number in italics is value added growth rates

Table 3: Trade in Manufactures by Region (growth rates in percent) 1990-2008

Region	SSA	LAC	MENA	Asia	CEE	OECD	Total
ln*(X)*	7.74	14.61	11.29	16.52	14.29	17.34	15.31
ΔX/X	14.74	13.19	16.61	12.34	14.63	5.45	10.41
X/Y	0.07	0.19	0.12	0.22	0.28	0.31	0.25
ln *(HS)*	6.18	7.30	6.01	6.34	6.67	6.92	6.75
ln*(CX)*	4.61	4.03	4.62	4.46	4.36	4.27	4.32
ln*(M)*	13.77	16.39	14.73	17.21	16.05	18.22	16.93
ΔM/M	11.84	9.78	12.38	11.09	15.71	5.39	9.74
M/(M+Y)	0.16	0.24	0.15	0.14	0.29	0.24	0.23

Source: UN COMTRADE.
X- export earnings; *X/Y* – export to output ratio; *HS* – number of 6 digit *HS* export items in a 4-digit industry; *CX*- number of countries exporting the same *HS* code; *M* – value of imports; *M/(M+Y)* – import penetration ratio; Δ – difference

Table 4: Estimated Labor Demand Model by Region: IV-Panel Fixed Effects

	SSA	MENA	LAC	ASIA	DVPG	CEE	OECD
Ln*(V)*	0.3597***	0.3724***	0.3935***	0.4614***	0.4337***	0.2770***	0.6402***
	(0.0336)	(0.0206)	(0.0227)	(0.0149)	(0.0096)	(0.0109)	(0.0082)
M/(M+Y)	0.2437**	-0.3097***	-0.3961***	0.0214	0.0679	-0.3188***	-0.0600**
	(0.0967)	(0.0922)	(0.0836)	(0.0987)	(0.0443)	(0.0688)	(0.0251)
X/Y	-0.0382	-0.0045	0.0355***	0.0212***	0.0268***	0.0172*	0.0141***
	(0.0305)	(0.0358)	(0.0082)	(0.0079)	(0.0061)	(0.0096)	(0.0037)
Ln*(w)*	-0.5421***	-0.4406***	-0.4635***	-0.4785***	-0.4804***	-0.3649***	-0.6440***
	(0.0214)	(0.0136)	(0.0172)	(0.0117)	(0.0071)	(0.0092)	(0.0062)
Ln*(w)*s*	0.0743***	0.0337***	0.1215***	0.0823***	0.0577***	0.0020***	0.0674***
	(0.0068)	(0.0029)	(0.0065)	(0.0045)	(0.0021)	(0.0002)	(0.0016)
Constant	5.3675***	4.7048***	4.7174***	4.0743***	4.2927***	5.8563***	2.0429***
	(0.4848)	(0.3097)	(0.3828)	(0.2517)	(0.1581)	(0.1741)	(0.1382)
Observations	1367	3619	2789	5235	13010	7950	16258
Number of Industries	162	397	449	448	1456	1068	1501

Note: All variables are lagged by one period. *V* is real value added, w is real wage, *s* is the share of labor in output, *X/Y* is the export share of output, and *M/(M+Y)* is import- penetration rate. Robust standard errors indicated in parentheses.*,** and *** represent statistical significance at 10%, 5% and 1%, respectively. DVPG refers to developing countries.

Table 5: Estimated Labor Demand Model for Low-Technology Industries by Region: IV-Panel Fixed Effects

	SSA	MENA	LAC	Asia	DVPG	CEE	OECD
Ln*(V)*	0.4403***	0.5452***	0.3779***	0.6026***	0.5489***	0.2782***	0.7516***
	(0.0480)	(0.0345)	(0.0408)	(0.0241)	(0.0159)	(0.0168)	(0.0141)
M/(M+Y)	-0.0290	-0.5260***	-0.0830	0.1866	-0.0586	-0.6591***	-0.2830***
	(0.1435)	(0.1187)	(0.1897)	(0.1470)	(0.0660)	(0.1084)	(0.0442)
X/Y	-0.0193	0.1211***	-0.0163	0.0401**	0.0346**	0.0128	0.1343***
	(0.0299)	(0.0425)	(0.0452)	(0.0157)	(0.0135)	(0.0176)	(0.0096)
Ln*(w)*	-0.4931***	-0.5793***	-0.4370***	-0.6230***	-0.5629***	-0.3172***	-0.7399***
	(0.0342)	(0.0275)	(0.0288)	(0.0215)	(0.0134)	(0.0157)	(0.0111)
Ln*(w)*s*	0.1110***	0.0775***	0.1401***	0.1784***	0.1284***	0.0013***	0.0507***
	(0.0138)	(0.0100)	(0.0124)	(0.0090)	(0.0054)	(0.0002)	(0.0021)
Constant	3.8088***	2.9508***	4.8977***	2.3120***	2.7883***	5.6677***	0.9704***
	(0.6850)	(0.4734)	(0.7177)	(0.3922)	(0.2464)	(0.2737)	(0.2545)
Observations	671	1143	944	1610	4368	2683	4692
Number of Industries	80	127	145	139	491	347	435

Note: See notes under Table 4

Table 6: Estimated Labor Demand Model for Medium-Technology Industries by Region: IV-Panel Fixed Effects

	SSA	MENA	LAC	Asia	DVPG	CEE	OECD
Ln*(V)*	0.3261***	0.3141***	0.3973***	0.2838***	0.3607***	0.4240***	0.5806***
	(0.0511)	(0.0365)	(0.0444)	(0.0292)	(0.0176)	(0.0215)	(0.0166)
M/(M+Y)	0.3232**	-0.5156**	-0.5473***	-0.4580**	0.1886**	-0.2788**	-0.2495***
	(0.1323)	(0.2418)	(0.1523)	(0.1977)	(0.0757)	(0.1288)	(0.0626)
X/Y	-0.0092	-0.0226	0.0353	0.0351***	0.0233**	0.0144	0.0761***
	(0.1455)	(0.0766)	(0.0773)	(0.0113)	(0.0117)	(0.0109)	(0.0232)
Ln*(w)*	-0.5740***	-0.3979***	-0.4930***	-0.3936***	-0.4630***	-0.4886***	-0.5816***
	(0.0302)	(0.0214)	(0.0311)	(0.0213)	(0.0117)	(0.0180)	(0.0119)
Ln*(w)*s*	0.0646***	0.0345***	0.1546***	0.0732***	0.0548***	0.0519***	0.0809***
	(0.0081)	(0.0051)	(0.0130)	(0.0092)	(0.0035)	(0.0031)	(0.0034)
Constant	5.9938***	5.4613***	4.9503***	6.9532***	5.4960***	4.3036***	2.5997***
	(0.7348)	(0.5998)	(0.7560)	(0.5174)	(0.3044)	(0.3289)	(0.2906)
Observations	696	1380	893	1600	4437	2539	5366
Number of Industries	82	149	143	137	491	346	497

Note: See notes under Table 4

Table 7: Estimated Labor Demand Model for High-Technology Industries by Region: IV-Panel Fixed Effects

	MENA	LAC	ASIA	DVPG	CEE	OECD
Ln*(V)*	0.3715***	0.4394***	0.3771***	0.4335***	0.4098***	0.6365***
	(0.0506)	(0.0361)	(0.0315)	(0.0209)	(0.0243)	(0.0144)
M/(M+Y)	-0.1984	-0.4408**	0.1953	-0.0517	-0.1176	0.1222**
	(0.1926)	(0.1821)	(0.1734)	(0.1059)	(0.1241)	(0.0505)
X/Y	-0.1101	0.0480***	-0.0059	0.0294***	0.0160	-0.0020
	(0.0974)	(0.0078)	(0.0148)	(0.0089)	(0.0318)	(0.0043)
Ln*(w)*	-0.5269***	-0.5007***	-0.4396***	-0.5072***	-0.5031***	-0.6869***
	(0.0302)	(0.0323)	(0.0195)	(0.0138)	(0.0182)	(0.0111)
Ln*(w)*s*	0.0953***	0.0831***	0.0457***	0.0717***	0.0232***	0.0953***
	(0.0110)	(0.0095)	(0.0069)	(0.0049)	(0.0017)	(0.0036)
Constant	5.0214***	4.1416***	5.4001***	4.4400***	4.4876***	2.3626***
	(0.7198)	(0.5628)	(0.5494)	(0.3390)	(0.3540)	(0.2277)
Observations	983	870	1821	3797	2449	5527
Number of Industries	107	144	155	424	337	506

Note: See notes under Table 4

Table 8: Extended Labor Demand Model by Region: IV-Panel Fixed Effects

	SSA	**MENA**	**LAC**	**ASIA**	**DVPG**	**CEE**	**OECD**
Ln*(V)*	0.3352***	0.3631***	0.2503***	0.4066***	0.3084***	0.3115***	0.6764***
	(0.0502)	(0.0350)	(0.0335)	(0.0286)	(0.0158)	(0.0220)	(0.0139)
M/(M+Y)	0.0784	-0.6395***	-0.6473***	-0.2628**	-0.3702***	-0.4983***	0.0200
	(0.1441)	(0.1099)	(0.1161)	(0.1159)	(0.0599)	(0.0836)	(0.0494)
X/Y	0.0002	0.0338	0.0430***	-0.0012	0.0188***	0.0068	0.0126***
	(0.0308)	(0.0335)	(0.0088)	(0.0084)	(0.0060)	(0.0102)	(0.0033)
Ln*(w)*	-0.4880***	-0.4128***	-0.3239***	-0.4079***	-0.3674***	-0.2919***	-0.6771***
	(0.0344)	(0.0240)	(0.0253)	(0.0245)	(0.0124)	(0.0194)	(0.0122)
Ln*(w)*s*	0.0731***	0.0209***	0.0747***	0.1174***	0.0378***	0.0203***	0.0989***
	(0.0107)	(0.0033)	(0.0087)	(0.0102)	(0.0027)	(0.0017)	(0.0032)
Ln*(HS)*	1.0269***	0.1124[d]	2.2233***	0.2012	0.2922***	0.7878***	0.1813[c]
	(0.2831)	(0.0762)	(0.4782)	(0.3500)	(0.0565)	(0.1338)	(0.1194)
Ln*(CX)*	0.4071[a]	0.0289	0.1368	-0.1497	0.0705	0.1752	0.0307
	(0.2527)	(0.1928)	(0.1635)	(0.1641)	(0.0964)	(0.1902)	(0.0542)
I/Y	0.4089**	0.0925**	-0.0805	0.0234	0.0315[b]	-0.0067	0.0810[d]
	(0.1927)	(0.0418)	(0.0641)	(0.0246)	(0.0201)	(0.0189)	(0.0547)
Constant	-2.9992	4.1023***	-10.0472***	4.0980*	3.5978***	-1.3813	0.1106
	(2.1329)	(1.1365)	(3.3685)	(2.3353)	(0.6381)	(1.3317)	(0.9039)
Observations	534	1104	1322	1551	4511	2211	6357
Number of Industries	57	131	201	148	537	352	716

Note: See notes under Table 4. *HS* is the number of six-digit export items in a 4-digit industry, *CX* is the number of competing countries, and *I/Y* is the investment rate. Superscripts *a, b, c* and *d* represent statistical significance at 11%, 12%, 13% and 14%, respectively.

Table 9: Extended Labor Demand Model by Region and Industry Group: IV-Panel Fixed Effects

	Developing Countries		**OECD Countries**		
	Low-Tech	Med/High-Tech	Low-Tech	Med-Tech	High-Tech
Ln(*V*)	0.4288***	0.2261***	0.7620***	0.6067***	0.5924***
	(0.0214)	(0.0247)	(0.0208)	(0.0237)	(0.0426)
M/(M+Y)	-0.2558***	-0.4861***	-0.3644***	-0.4502***	0.2714***
	(0.0811)	(0.0859)	(0.0877)	(0.1002)	(0.0898)
X/Y	0.0347***	0.0172**	0.1199***	0.1186***	-0.0025
	(0.0132)	(0.0069)	(0.0102)	(0.0225)	(0.0044)
Ln(*w*)	-0.4815***	-0.3286***	-0.7149***	-0.6477***	-0.6969***
	(0.0181)	(0.0178)	(0.0200)	(0.0214)	(0.0322)
Ln(*w*)*s	0.1161***	0.0231***	0.1374***	0.0945***	0.0772***
	(0.0066)	(0.0031)	(0.0061)	(0.0053)	(0.0074)
Ln(*HS*)	0.1911***	0.3515***	0.0403	-0.1885	0.6140*a*
	(0.0720)	(0.0864)	(0.1689)	(0.1675)	(0.3980)
Ln(*CX*)	0.2196*	-0.1575	-0.0085	0.0970	-0.1306
	(0.1235)	(0.1465)	(0.1118)	(0.0679)	(0.1206)
I/Y	0.0433*	0.0297	-0.0684	-0.1055	0.2332**
	(0.0249)	(0.0317)	(0.1273)	(0.0831)	(0.0995)
Constant	2.1329***	5.4557***	-0.1446	3.7549***	-0.5908
	(0.8238)	(0.9565)	(1.3057)	(1.2790)	(3.0254)
Observations	2430	2081	2811	2234	994
Number of Industries	287	250	314	254	114

Note: See notes under Table 4. *HS* is the number of six-digit export items in a 4-digit industry, *CX* is the number of competing countries, and *I/Y* is the investment rate. Superscripts *a, b, c* and *d* represent. Superscripts *a* represents statistical significant at 13%.

Appendix 1: List of Sample Countries by Region

Asia and Pacific	Central and Eastern Europe	Middle East and North Africa	Sub-Saharan Africa	Latin America and Caribbean	OECD
China	Albania	Egypt	Botswana	Argentina	Australia
Fiji	Azerbaijan	Iran	Eritrea	Bahamas	Austria
Hong Kong	Belarus	Jordan	Ethiopia	Bolivia	Belgium
Indonesia	Bulgaria	Kuwait	Madagascar	Brazil	Denmark
South Korea	Cyprus	Morocco	Malawi	Chile	Finland
Macao, China	Estonia	Oman	Mauritius	Colombia	Germany
Malaysia	Georgia	Qatar	Senegal	Ecuador	Greece
Mongolia	Kyrgyz Republic	Israel	South Africa	Mexico	Hungary
Philippines	Latvia			Paraguay	Ireland
Singapore	Lithuania			Peru	Japan
Sri Lanka	Moldova				Luxembourg
	Poland				Malta
	Romania				Netherlands
	Russian Federation				New Zealand
	Slovak Republic				Portugal
	Slovenia				Spain
					Sweden