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INDUSTRY DYNAMICS AND COMPETITION FROM LOW-WAGE COUNTRIES: EVIDENCE ON ITALY

by Stefano Federico*

Abstract

This paper analyses the effect of competition from low-wage countries on domestic activity, using data on 230 Italian manufacturing sectors between 1995 and 2007. It finds that low-wage import penetration is negatively related to employment and other measures of activity. The effect is significantly smaller in more skill, capital and R&D-intensive sectors and in more vertically differentiated sectors. There is also evidence of significant effects of low-wage competition through inter-industry linkages: employment is negatively related to low-wage import penetration in downstream sectors but positively related to low-wage import penetration in upstream sectors.

JEL Classification: F16, F14, L60, D57.
Keywords: import penetration, low-wage country competition, factor proportions, inter-industry linkages.

Contents

* Bank of Italy, Economic Research and International Relations.

1 Introduction[1]

The integration of low-wage countries into the world trading system has been among the most important economic developments of recent decades. It has involved a massive increase in the number of workers producing for international markets, with far-reaching implications for the rest of the world, including advanced countries. Low-wage countries' market share of world exports of goods has correspondingly expanded, with China's share, for instance, rising from less than 3 percent in 1995 to 9 percent in 2008 (United Nations, 2009). These developments have led many observers to identify low-wage competition as a major threat to employment and wages in the manufacturing sector in advanced countries.

The employment and wage effects of import penetration have long been studied. The initial evidence, pointing to a weak impact of trade on domestic developments (Grossman, 1982; Krugman and Lawrence, 1993), has been reconsidered afterwards (Freeman and Katz, 1991; Revenga, 1992; Sachs and Shatz, 1994; Krugman, 2008; Bernard et al., 2002 2006; Baldwin and Lileeva, 2008; White, 2008; Khandelwal, 2010). This was due in part to improved methodologies and in part to significant changes in trade patterns: not only has trade integration increased markedly since the mid-1990s, but the differences across trading countries in terms of factor abundance have become larger. Specifically, the set of developing countries contributing to

[1]I am grateful to two anonymous referees, Matteo Bugamelli, Gilles Duranton, Roberto Tedeschi and seminar participants at the Rimini Conference in Economics and Finance, the EPI Conference in Parma, the European Trade Study Group in Lausanne and the Demography of Firms and Industries Conference at Paris Est Créteil University. The views expressed in this paper are those of the author and do not necessarily reflect those of the Bank of Italy.

a significant fraction of the increase in trade has lower wages (relative to wages in advanced countries) than the set of developing countries that was studied in the literature in the 1980s and early 1990s (Krugman 2008). Trade between countries with markedly different factor intensities may have in fact a stronger impact on reallocation across sectors than trade between similar countries, as is suggested, for instance, by the Heckscher-Ohlin model.

This paper analyses the effects of competition from low-wage countries on employment and other measures of sector activity in Italy. Using a panel of 230 manufacturing sectors over the years 1995-2007, it employs variation in import penetration across industries and over time in order to estimate its effect on employment. It also uses instrumental variable (IV) methods to control for the endogeneity of imports, which are clearly influenced by demand and supply conditions in the domestic country. Specifically, this work tackles the following questions. Does employment decrease in sectors more exposed to low-wage import penetration, and, if so, by how much? Does employment decrease less in capital or skill-intensive sectors, as one would expect from factor proportions theory? Does import penetration also have an impact on employment in upstream and downstream sectors?

The contribution of this paper to the literature is twofold. First, it extends the analysis of the employment effects of low-wage country competition to a new country, supplementing the available evidence, which is largely restricted to the United States. With its relatively large and open manufacturing industry, Italy provides a suitable setting for such an analysis. Italy's specialization in low-technology manufacturing sectors makes it particularly exposed to competition from low-wage countries. Several studies using

data for Italy have already found evidence of significant effects of Chinese competition on sectoral productivity (Bugamelli and Rosolia, 2006) and on firm-level prices (Bugamelli et al., 2010).

Second, this paper explores the effects of low-wage country competition through inter-industry linkages. The usual approach typically relates employment outcomes in one sector to import penetration in the same sector, thus ruling out the possibility that sector-specific shocks spill over to other sectors. However, as suggested by Long and Plosser (1983) and Shea (2002), supply or demand shocks to a given sector can be propagated to other sectors through input-output linkages. We therefore innovate by linking employment outcomes in one sector to import penetration in upstream and downstream sectors, finding that this transmission channel is far from negligible.

We find that an increase in import penetration from low-wage countries is associated with a decrease in employment, output, the wage bill and the number of firms. The decrease in industry activity is smaller in more skill, capital, R&D-intensive and vertically differentiated sectors. We also find evidence of significant inter-industry linkages: import penetration in downstream sectors is negatively related to employment, as it lowers the demand for domestically produced inputs, while import penetration in upstream sectors is positively related to employment, presumably thanks to the benefits from using cheaper inputs.

The rest of the paper is structured as follows. Section 2 provides a description of the theoretical framework, the estimation model, identification issues and data. Section 3 reports the main empirical results, while Sections 4 and 5 focus on heterogeneous effects across sectors and inter-industry linkages

respectively. Section 6 concludes.

2 Methodology and data

2.1 Theoretical framework

This section outlines a simple theoretical model, based on Pindyck and Rotemberg (1987), which will guide our empirical analysis. For a competitive domestic industry, supply and demand are given by the following equations:

$$S_t = s_0 + s_1 a_t + s_2 P_t + \epsilon_{st} \tag{1}$$

$$D_t = d_0 + d_1 b_t + d_2 P_t + \epsilon_{dt} \tag{2}$$

where P_t is price, a_t is a supply shift parameter (technological progress, labour costs, etc.), b_t is a demand shifter (income level, tastes, etc.) and ϵ_{st} and ϵ_{dt} are unobserved supply and demand shocks, respectively. Equilibrium is given by the following equation, which relates domestic demand in a given sector to the sum of domestic supply and imports:

$$D_t = S_t + (M_t^{LW} + M_t^{OT}) \tag{3}$$

where M_t^{LW} represents imports from low-wage countries and M_t^{OT} imports from other countries. The import supply curve is assumed to be upward sloping, depending on P_t and a shift parameter c_t (which reflects foreign supply and demand conditions):

$$M_t^k = m_0^k + m_1^k c_t^k + m_2^k P_t + \epsilon_{mt}^k \qquad \forall k = LW, OT \tag{4}$$

It is then assumed that Y_t (a measure of activity in the domestic industry: employment, wage bill, output, profits, etc.) is a function of domestic supply and of the shift parameter a_t:

$$Y_t = i_0 + i_1 a_t + i_2 S_t + \epsilon_{it} \tag{5}$$

Using (1), (2), (3) and (5), Y_t can be written as a function of demand and supply shift variables, imports from low-wage countries, imports from the rest of the world and an error term:

$$Y_t = \psi + \alpha a_t + \beta b_t + \delta M_t^{LW} + \gamma M_t^{OT} + \epsilon_t \tag{6}$$

where ϵ_t is a combination of the error terms in the supply and demand equations (ϵ_{st} and ϵ_{dt}) and of ϵ_{it}. This extremely simple model states that domestic employment in a given sector will be negatively affected by outward shifts of the foreign supply curve.[2]

Further insights can be derived from the Heckscher-Ohlin model with two additional important assumptions. First, we assume that countries have different factor endowments: labour is relatively more abundant in low-wage countries, capital (including human capital) is relatively more abundant in advanced economies. Second, we assume that sectors have

[2]Autor, Dorn and Hanson (2011) present a simple model based on Eaton and Kortum (2002) where a reduction in trade costs or an exogenous increase in productivity in China increases the toughness of competition and reduces the demand for goods produced by a region, thus reducing the region's output.

different factor intensities: machinery and transport equipment are usually more capital intensive, textiles and apparel are usually more labour-intensive. The model then predicts that each country exports the good that makes intensive use of the input that is abundant in that country (factor proportions theory). Thus, capital-abundant countries export capital-intensive goods while labour-abundant countries export labour-intensive goods.

This framework can also be used to explore the implications of a decrease in the price of the labour-intensive good. This could derive, for instance, from the removal of trade barriers in that sector, from an increase in the overall output capacity of low-wage countries, etc. The decrease in the price of the labour-intensive product lowers the price of labour relative to capital. This determines an expansion of the labour-intensive sector in the labour-abundant country, while the opposite takes place in the capital-abundant country, with a reallocation of output and employment away from the labour-intensive sector towards the capital-intensive sector. For some factor endowments, the capital-abundant country will even completely cease producing the labour-intensive good, thus moving to a situation of complete specialization in the capital-intensive good.[3]

2.2 Estimation model

The estimated specification is the following:

$$\ln L_{jt} = \alpha_j + \beta_t + \delta LWPEN_{jt} + \gamma OTPEN_{jt} + \epsilon_t \tag{7}$$

[3]Using an assignment model with a continuum of goods and workers, Costinot and Vogel (2010) also show that, when the skill-abundant country opens to trade, the employment share in skill-intensive tasks will increase.

where L_{jt} is the level of employment in industry j at time t, α_j is an industry fixed effect, β_t is a time fixed effect, $LWPEN_{jt}$ and $OTPEN_{jt}$ measure low-wage countries' import penetration and other countries' import penetration, respectively. A similar specification is used by Khandelwal (2010) and, with firm-level data, by Bernard et al. (2006). The estimating equation is a transformation of equation (6) to a panel of sectors, where the measure of activity Y_t is given by the employment level and imports are scaled by apparent consumption. Comparing equation (7) with equation (6), one may notice that the supply and demand shifters, a_t and b_t, are assumed to be captured by the set of industry and time fixed effects. These controls might not be sufficient if there is skill-biased technological change, which causes advanced countries to move away from unskilled industries independently of import competition. In this case low-wage import penetration would simply be filling a gap in unskilled production determined by a long-term technological trend. To control for skill-biased technological change, we will include the interaction between two-digit sector and year dummies in all the main specifications. The effect of import penetration is then identified using only on the basis of variation among four-digit sectors within a given two-digit sector.

The import penetration variables require detailed discussion. First, there is a general question of how to measure foreign competition properly, whether using import prices (Grossman, 1982; Revenga, 1992) or import quantities (values or volumes of imports, normally scaled on domestic consumption or output: Freeman and Katz, 1991; Bernard et al., 2006; Khandelwal, 2010). The use of import prices is problematic for a number of reasons. First,

it is well known that import prices derived from unit values suffer from a composition bias, as the bundle of products imported in a given industry may change over time. Second, import prices derived from direct surveys are not available for some countries (including Italy), and even when they are available they are much less disaggregated by product or partner than import quantities; this is particularly important for our purposes, as this work looks at differences between low-wage countries and other countries. Finally, if products are differentiated an increase in the variety of imports would not be reflected in conventional price indices, while it would correctly show up in import quantities (Feenstra, 1994, 1995 pp. 1587-88).

These reasons lead us to build our measure of import penetration as the share of imports in domestic consumption of the goods produced by an industry (where domestic consumption is the sum of imports and domestic production minus exports), as in Bernard et al. (2006) and Khandelwal (2010):

$$LWPEN_{jt} = \frac{M_{jt}^{LW}}{\overline{M}_j + \overline{Q}_j - \overline{X}_j} \tag{8}$$

$$OTPEN_{jt} = \frac{M_{jt}^{OT}}{\overline{M}_j + \overline{Q}_j - \overline{X}_j} \tag{9}$$

where M_{jt}^{LW} is imports from low-wage countries in Italy's sector j at time t, M_{jt}^{OT} is imports from other countries (imports from all countries minus imports from low-wage countries), $\overline{M}_j$ is sector j's imports from all countries, $\overline{Q}_j$ is sector j's domestic production and $\overline{X}_j$ is sector j's exports. All variables are in value terms. As in Auer and Fischer (2010), the denominator (imports

from all countries plus domestic output minus exports) is averaged over 1995-2006, in order to reduce the correlation between domestic production (included in the denominator of (8) and (9)) and domestic employment (dependent variable in (7)). Our measure of low-wage import penetration equals 0.10 if imports from low-wage countries account for 10 percent of average domestic consumption in the sector in question.

A country is classified as low-wage if its GDP per capita in current U.S. dollars is less than 10 percent of U.S. GDP per capita in 2006. As in the previous literature, we use non-PPP-adjusted data, which are available for a wider number of countries than PPP-adjusted data. Our threshold is in between the 5 percent used by Bernard et al. (2006) and Khandelwal (2010) and the 20 percent threshold used by Auer and Fischer (2010).[4] We choose a fixed cut-off, based on GDP per capita ratios in the final year of our sample, rather than a time-varying cut-off, in order to avoid noisy fluctuations due to countries crossing the threshold in either direction over the years. We also believe that since our measure is based on imports from all countries below a given threshold, it is preferable to one based on imports from just one country, such as China. The latter would be biased, for instance, if imports from China are only replacing imports from other low-wage countries. The list of low-wage countries is presented in the Appendix.

A final remark on the import penetration variables concerns their dynamics. Domestic employment is likely to react to foreign competition with a certain lag. We will therefore estimate employment at time t as a

[4]Since Italy's GDP per capita was 72 percent of U.S. GDP per capita in 2006, the low-wage cutoff corresponds to 14 percent (= 10/72 percent) of Italy's GDP per capita. We will control the sensitivity of our results to alternative cutoffs.

function of import penetration at time $t-2$ (as in Bugamelli and Rosolia, 2006). The results are robust to different lag structures.

2.3 Identification

Equation (7) can be estimated consistently with ordinary least squares, provided that the explanatory variables are not correlated with ϵ_t (which is a combination of ϵ_{st} and ϵ_{dt}). There are several reasons why this condition may not hold true in the case of import penetration variables. For instance, an unobserved positive demand shock will raise prices and therefore will also raise imports, determining a correlation between ϵ_t and import penetration. A similar line of reasoning holds for unobserved supply shocks, such as an increase in labour costs or a decrease in productivity. As Pindyck and Rotemberg (1987) point out, this issue becomes even more problematic when imports are highly price-elastic, because in this case they will respond more strongly to domestic shocks having an impact on prices. Ideally, one needs an instrument which is correlated with imports but not with unobserved domestic supply and demand shocks.

As argued by Auer and Fischer (2010), although integration of low-wage countries into the world trading system has been relatively speedy, its cumulative impact cannot be evaluated with an event-study approach based on trade liberalizations or sudden tariff reductions. Each of the various IV methods suggested in previous studies has its own strengths and weaknesses, and since the exclusion restrictions are usually not testable, it is important to compare results across different IV methods. We therefore report the results

obtained with three alternative IV approaches.

As our first set of instruments, we compute $LWPEN$ and $OTPEN$ using four-digit industry data for the United States ($LWPEN_{US}$ and $OTPEN_{US}$). These instruments, which are strongly correlated with the instrumented variables, are unlikely to be correlated with supply shocks in Italy, given the large differences between the two countries in terms of labour markets, legal institutions, monetary policy, etc. They are also unlikely to be correlated with demand shocks: Italy accounts for a very small fraction of U.S. imports (around 3 percent); the U.S. takes only 7 percent of Italy's exports and accounts for less than 3 percent of Italy's total sales by manufacturing firms.[5] A similar approach, where imports from China to the U.S. are instrumented with imports from China to other high-income countries, is used by Autor et al. (2011).

The second set of instruments draws on Auer and Fischer (2010), who start by noticing that, according to factor proportions theory, low-wage countries should increase their exports more in labour-intensive or low-skill intensive sectors as their output capacity grows. They therefore suggest interacting industrial production in low-wage countries (which measures their overall output capacity) with an industry-specific indicator of labour intensity. This gives rise to a time and industry-varying instrument, where the time variation derives from the industrial production index and the industry variation derives from the labour intensity indicator. In a similar way, we collect data on industrial production for the main low-wage countries

[5]Italy's market share in U.S. imports tends to be small for the vast majority of sectors. Excluding sectors with a market share larger than 10 or 20 percent of U.S. imports does not have any effect on our results.

in our dataset (China, India and Indonesia, using the 10 percent GDP per capita threshold) and for a group of advanced economies. Industry-level measures of labour intensity computed on data for Italy or other countries might be endogenously influenced by import penetration. We therefore prefer to interact low-wage industrial production with an industry-level indicator of routine or manual tasks intensity ($IP_{LW} * ROUTINE$), derived from O*Net database (Acemoglu and Autor, 2010). We also instrument import penetration from the rest of the world, by interacting advanced economies' industrial production with an industry-level indicator of non-routine or creative tasks intensity ($IP_{OT} * NONROUTINE$), also from the O*Net database. In other words, we expect that a given increase in industrial production in low-wage countries will increase their exports to Italy relatively more in sectors that are more intensive in routine or manual tasks. Conversely, we expect that a given increase in industrial production in high-wage countries will increase their exports to Italy relatively more in sectors that are more intensive in non-routine or creative tasks.

The third and final approach is based on Bernard et al. (2006) and Khandelwal (2010), who instrument import penetration with industry-year measures of transport costs, tariffs and exchange rates. The idea behind this approach is that these variables shift the import supply curve, while being largely exogenous to demand or supply shocks in the domestic industry. Exchange rate movements mainly reflect macroeconomic conditions in the exporting countries. As in Revenga (1992), we compute an industry-weighted geometric average of nominal exchange rates ($EXCH_{LW}$, $EXCH_{OT}$). Transport costs ($TRANSPORT_{LW}$, $TRANSPORT_{OT}$) and

tariffs ($TARIFF_{LW}$, $TARIFF_{OT}$) are computed using data on duties and freight costs for U.S. imports, in order to reduce endogeneity concerns (for instance, tariffs may be raised in order to protect domestic industries from large increases in import penetration). All variables are separately computed for low-wage countries and for the rest of the world.

2.4 Data description

Our data come from two main sources: Structural Business Statistics (SBS) and External Trade Statistics (COMEXT). Both sources are based on information supplied by EU Member States' national statistical institutes (Istat, for Italy) and publicly released by Eurostat, the Statistical Office of the European Union.

From SBS we take data on employment and other structural variables for each Italian four-digit manufacturing sector. The industry classification corresponds to NACE revision 1. SBS data are available for Italy on an annual basis for the years 1995-2007. Data are collected by Istat using two firm-level surveys: the system of economic accounts in enterprises, which includes firms with 100 or more workers, and the sample survey on small and medium-sized enterprises for firms with up to 99 workers. Survey data are then integrated with administrative data (balance sheets) and statistical techniques for treatment of non-response units and extrapolation to the universe (Istat, 2009). There are some conceptual differences between SBS data and national accounts data: in particular, SBS data are usually not adjusted for informal businesses (OECD, 2006). Overall, SBS data in our

sample represent on average more than 90 percent of both manufacturing employment and value added in national accounts data (Table 1).

From the COMEXT dataset we obtain annual values of Italy's imports and exports by partner country and product code, for the years 1988-2006. Products are defined according to the Combined nomenclature, which is based on the Harmonized system (HS) classification and includes about 10,000 eight-digit codes. Product-level data were then aggregated to the four-digit Classification of products by activity (CPA) level, using concordance tables available on the Eurostat website. Since there is a one-to-one correspondence between CPA and NACE, trade data can be easily linked to employment data at the four-digit level. Using data on GDP per capita from the IMF World Economic Outlook database, one can then distinguish between imports from low-wage countries and imports from other countries. Table 2 reports summary statistics. Sources and definitions for all variables are presented in the Appendix.

3 Main empirical findings

3.1 Preliminary evidence

Figure 1 plots the 1996-2007 changes in employment against the 1995-2006 changes in low-wage import penetration for 211 Italian manufacturing sectors, using unweighted data (left panel) and employment-weighted data (right panel). Several observations can be made. First, low-wage import penetration increased in the vast majority of sectors. Its increase did not

exceed 5 percentage points in most cases, although there are larger increases (up to 30 percentage points) in a few sectors.

Second, there is a wide variability across sectors in terms of employment changes, even if we ignore outliers, which generally correspond to very small sectors. Overall, 98 sectors recorded employment expansion and 113 sectors employment contraction.

Third, there is a negative relationship between changes in low-wage penetration and changes in employment. Simple OLS regressions of employment changes on low-wage import penetration changes yield negative coefficients, which are statistically significant and have a similar slope. The R-squared equals .137 using unweighted data, but rises to .319 using weighted data. As a first approximation, these results suggest a potentially significant effect of low-wage import penetration on employment decline at the industry level.

An alternative way to look at the extent of competition from low-wage countries is the following. Sectors in which low-wage import penetration was greater than 10 percent accounted for less than 2 percent of Italy's total manufacturing employment in 1995 but almost 20 percent in 2006. This suggests that low-wage competition was not confined to a few small industries. Italy's specialization structure, with a relatively large share of low-technology sectors, may explain this pattern: in 1995 the textiles, apparel and leather sector still accounted for about 20 percent of manufacturing employment, a much larger share than in other advanced economies.

3.2 OLS estimates

Table 3 reports OLS estimates of equation (7). All estimates are weighted using average employment in each sector. The reason is that SBS data are based on sampling techniques, which estimate large sectors with more precision than small sectors. Moreover, this procedure attenuates the impact on our results of extreme changes in employment in very small sectors. Columns (1)-(2) are estimated using fixed effects (FE), while columns (3)-(4) are estimated in first difference (FD) and columns (5)-(6) are estimated in long difference (i.e. changes between 1996 and 2007, LD).

Starting with column (1), the coefficient on low-wage import penetration ($LWPEN$) is negative (-1.766) and statistically significant at the one percent level. The coefficient on other countries' penetration ($OTPEN$) is instead not different from zero. These results are in line with the notion that trade has a larger effect on domestic developments when it takes place between countries with very different factor endowments than between countries with similar factor endowments. The fit of the regression is good, as shown by the within R-squared equal to .143.[6]

Column (2) includes two-digit sector-year pair fixed effects, as in Khandelwal (2010). This is an additional control that captures time-varying demand or supply shocks common to all four-digit sectors within the same two-digit sector. This specification thus exploits variation in employment and import penetration within two-digit sectors. While its magnitude now equals -.580, the coefficient on $LWPEN$ is still significant at the one percent

[6]The coefficient on $LWPEN$ remains almost unchanged if $OTPEN$ is excluded from the regression. Notice that the two variables are only weakly correlated (.199).

level. $OTPEN$ is again not different from zero. Since it controls for a large set of supply and demand shocks, this is our preferred OLS specification.

The alternative specifications in first difference and long difference (columns (3)-(6)) further support the findings of a negative relation between employment and low-wage import penetration and no relation between employment and other countries' import penetration. Only in column (4), where the first difference specification includes two-digit sector-year fixed effects, does $LWPEN$ turn out to be not significantly different from zero. We do not see this as a serious issue, since first-difference estimates mainly capture very short-run movements while our predictions are more likely to hold in a longer-run framework. In fact, long-difference estimates show larger and significant coefficients for $LWPEN$, while the coefficients for $OTPEN$ are again not different from zero.[7]

To evaluate the quantitative impact, a one standard deviation increase in low-wage import penetration in a four-digit sector (which corresponds to an increase of about 7 percentage points) is associated with a 4 percent annual decline in the employment of the same sector, according to our preferred specification in column (2). Our results are in line with previous evidence. Khandelwal (2010) finds that a ten-percentage-point increase in low-wage import penetration (which corresponds to almost one and a half standard deviations in our sample) decreases employment by 6 percent on average.[8]

[7]In the LD specification import penetration variables are one-year lagged (1995-2006 change, compared to 1996-2007 change in employment), rather than two-year lagged as in the other specifications.

[8]Bernard et al. (2006) find that a one standard deviation increase in low-wage import penetration is associated with a 2-percentage-point decrease in annual employment growth for surviving plants and a 2.2-percentage-point increase in the probability of plant closure. Their findings are based on plant-level data and therefore cannot be easily compared to

These figures should not be interpreted as a measure of the overall effect of trade on employment, since they take into account only import competition but not the increased opportunities for exports toforeign markets or the gains from a larger variety of imports. Complete welfare calculations are beyond the scope of this paper but could fruitfully follow the approach recently suggested by Arkolakis et al. (2012), which makes use of a very parsimonious set of sufficient statistics.

3.3 IV estimates

OLS estimation of equation (7) might be biased if import penetration variables are correlated with unobserved demand or supply shocks in the domestic economy. We now report the results of the three IV methods presented in Section 2.3, starting with the first-stage results (Tables 4 and 5 for $LWPEN$ and $OTPEN$, respectively).

Looking at columns (1)-(2) in both tables, instruments based on import penetration in the U.S. turn out to be very closely correlated with our endogenous variables. Despite a lower goodness of fit, the results using the Auer and Fischer (2010) IV method are also quite satisfactory (columns (3)-(4)). Low-wage import penetration is positively correlated with the interaction between low-wage countries' industrial production and routine tasks intensity and negatively correlated with advanced countries' industrial production interacted with non-routine tasks intensity (Table 4, column (3)), while the opposite holds for import penetration from the rest of the world (Table 5, column (3)). The correlation becomes very weak instead once we

ours.

include the interaction between two-digit sector and year dummies in column (4); this reflects the fact that the variation in our measures of routine and non-routine tasks intensity is mainly across rather than within two-digit sectors. The third IV method (columns (5)-(6)), where we use tariffs, transport costs and exchange rates as instruments, is the least powerful, although the F statistics are in line with other studies using a similar approach (Khandelwal 2010). This is explained by their low variability across time and sectors, especially when we control for the interaction between two-digit sector and year dummies.

Table 6 reports the second-stage results for each of the three IV methods. Overall, the coefficient on low-wage import penetration is always negative and significant except in the last specification (where the power of the third set of instruments is very low after controlling for the interaction of two-digit sector and year dummies). Its magnitude is always larger than the OLS coefficient. This is consistent with evidence reported by Bernard et al. (2006) and Khandelwal (2010), and might be explained by non-classical measurement error in the endogenous variable (Kane et al., 1999). While there is some variability in the point estimates, the results are qualitatively similar using three very different IV approaches and are almost always robust to the inclusion of the set of two-digit sector and year interacted dummies. The coefficient on import penetration from the other countries is generally not different from zero. Overall, the evidence based on various IV approaches is consistent with the evidence based on OLS.

3.4 Robustness

For robustness analysis, we run specifications of equation (7) with alternative measures of aggregate activity in a sector: value added, sales, wage bill and number of firms (Table 7). We use our baseline OLS specification in column (2) of Table 3, where we control for the interaction of two-digit sector and year dummies.[9] The coefficient on $LWPEN$ is always negative and significant. The coefficient on $OTPEN$ is not significant, except when the dependent variable is the number of firms. A first interesting result is that low-wage penetration turns out to have a smaller effect on the number of firms than on employment. This implies that the scale of firms (measured by average employment per firm) actually does not increase in response to low-wage competition, contrary to predictions based on Lawrence and Spiller (1983).

A second interesting result is that the fall in sales and value added derived from low-wage import penetration is larger than the fall in employment, as also found by Khandelwal (2010). This implies a negative effect of low-wage import penetration on various measures of labour productivity (although the effect is only significant for value added per employee). This finding is not consistent with the implications of a Melitz (2003) model, where average productivity in a sector rises after trade liberalization due to output reallocation from less efficient to more efficient producers. A possible explanation is related to the rigidity of labour markets and to the existence of adjustment costs in quickly reducing the workforce after a negative demand shock.

[9]We check the sensitivity of our results to IV estimates, using our first approach based on U.S. measures of import penetration, and find that the results are very similar.

We also check the sensitivity of our results to two additional assumptions. One is the lag structure with which low-wage import penetration is assumed to influence employment levels. The other is related to the definition of low-wage countries. The first three columns of Table 8 report the results of our baseline specification in which both import penetration variables have been included at either a one-year, three-year or four-year lag. The results do not depend on the choice of a specific lag structure. The second assumption is the definition of low-wage countries as countries whose GDP per capita was less than 10 percent of U.S. GDP per capita in the final year of our sample. We compute low-wage import penetration (and other countries' import penetration) changing the GDP per capita threshold to either 5, 20 or 30 percent. The last three columns of Table 8 show again that $LWPEN$ is always negatively and significantly related to employment, while the coefficient on $OTPEN$ is never significantly different from zero.

4 Heterogeneous effects across sectors

4.1 Factor intensity and quality ladder

We then analyse whether the employment effects of competition from low-wage countries are heterogeneous across sectors. Our hypothesis is that the impact of low-wage competition should be smaller in sectors that are intensive in inputs which are scarcer in low-wage countries. This follows from the factor proportions theory, according to which each country produces goods that are intensive in inputs that are relatively abundant in that

country: the opening to trade with low-wage countries should therefore push advanced countries' specialization towards sectors that make intensive use of relatively abundant factors such as capital, skilled labour and R&D.

We also consider quality ladders, which measure the degree of vertical differentiation in a given sector. Khandelwal (2010) shows that the employment effects of low-wage competition are smaller in sectors with a longer quality ladder. Its model assumes that products are not only horizontally differentiated (as is usually assumed in monopolistic competition models) but also vertically differentiated (low-quality vs. high-quality goods). In long-ladder sectors, firms in the advanced countries can use their comparative advantage factors in order to specialize atop the quality ladder, while in short-ladder sectors the scope for competition on quality is reduced.

We modify regression (7), including the interaction between $LWPEN$ and capital, skill, R&D intensity and a measure of quality ladder length. Capital intensity is proxied by gross tangible investments divided by the sum of gross tangible investments and the wage bill. Skill intensity is measured by the number of non-production workers divided by the number of production and non-production workers. R&D intensity is equal to the ratio of R&D expenditures to sales. Ladder lengths are taken from Khandelwal (2010) and adapted to our more aggregate industry classification. To avoid endogeneity, we fix these variables at their initial values. Further details on these variables are presented in the Appendix.

We include the interaction variables in the baseline OLS specification from column (2) of Table 3, where we control for the interaction between two-digit sector and year dummies. The interaction variables are included one by one

in columns (1)-(4) of Table 9 and simultaneously in column (5). As expected, their sign is positive and they are always significant (except for capital intensity), suggesting that the employment effects of low-wage penetration are smaller for skill and R&D-intensive sectors and for sectors with a longer quality ladder. These results are consistent with factor proportions theory, Italy being relatively more intensive in such inputs than low-wage countries. They are also in line with the idea that in long-ladder markets firms are less exposed to low-wage competition than in short-ladder markets.

The lower panel of Table 9 reports the effect of low-wage import penetration on employment at selected values of the factor intensity variable (the mean minus one standard deviation and the mean plus one standard deviation). In industries with low skill, capital and R&D intensity or a short quality ladder, the effect of low-wage import penetration is strongly negative and significant. Conversely, in industries with high endowments of these factors or long quality ladder, there is usually no significant effect of competition from low-wage countries.

4.2 Quality ladder and export unit values

The quality ladder hypothesis suggests that the effect of low-wage competition is smaller in sectors with a greater scope for vertical differentiation. In this case firms in advanced countries are able to increase the quality of their products in order to protect themselves from foreign competition. We provide further evidence on this hypothesis, looking at the relation between low-wage competition and export unit values. Export unit

values can be considered to some extent a good proxy of quality and have been used as such, for instance, by Schott (2004, 2008) and Fontagné et al. (2008).

We look at the relation between low-wage import penetration and Italy's export unit values, relative to low-wage countries' unit values. This allows us to determine whether the response to low-wage competition includes a process of quality upgrading, with firms in the advanced country improving the quality of their products. The quality ladder hypothesis predicts that Italy's export unit values, relative to low-wage countries' unit values, should increase in sectors that are more exposed to competition from low-wage countries and that this increase should be concentrated in sectors with a long quality ladder.

To this end, we use the BACI dataset provided by Cepii (Gaulier and Zignago, 2010), which reports harmonized trade data on values and quantities (in tons) at the HS six-digit level for a large sample of countries. We regress relative export unit values (Italy's unit values relative to low-wage countries' unit values) in a given HS six-digit product on low-wage import penetration and import penetration from other countries in the corresponding NACE four-digit sector. We also include the interaction between import penetration variables and quality ladder. The results are reported in Table 10. We always control for the interaction between two-digit sector and year dummies. We also control for four-digit sector fixed effects in columns (1)-(2) and for six-digit product fixed effects in columns (3)-(4), in order to take into account sector or product-specific trends in relative unit values.

The results in columns (1) and (3) show that, when we look at an

average-ladder industry, there is no significant relation between changes in relative unit values and changes in competition from low-wage countries or from the rest of the world. When we introduce the interaction between import penetration and ladder length in columns (2) and (4), however, we find that relative export unit values increase more in sectors that are more exposed to low-wage country competition and that have a long quality ladder, as shown by the positive and significant coefficient of the interaction term between low-wage import penetration and quality ladder. No such effect is found instead for competition from other countries, as the interaction term is not significantly different from zero. These findings are consistent with the quality ladder hypothesis, suggesting that quality upgrading may be a way to respond to competition from low-wage countries, especially in sectors with a greater scope for vertical differentiation. Evidence along similar lines is provided by Bloom et al. (2011), who show that firms tend to innovate more if they are exposed to competition from China.

5 Inter-industry linkages

5.1 Motivation

Thus far it has been assumed that import penetration in one sector may have effects only on employment in the same sector. However, there are reasons to believe that this assumption might be too restrictive. The main reason derives from inter-industry linkages. Firms in one sector may purchase inputs from other sectors (upstream sectors) and sell their own goods as inputs

to other sectors (downstream sectors). They could therefore be affected by import penetration in upstream or downstream sectors. One could expect, for instance, that higher import penetration in downstream sectors may reduce the demand for domestically produced inputs used by those sectors (Pindyck and Rotemberg, 1987). Import penetration in upstream sectors could instead have a positive impact, if it increases firms' efficiency through the availability of cheaper inputs (Altomonte et al., 2008). More generally, a theoretical justification is provided by Long and Plosser (1983) and Shea (2002) with a multi-sector model in which sector-specific supply or demand shocks are propagated to the other sectors by input-output linkages.

A second reason is that firms usually produce several products, which do not necessarily belong to a single sector. Multi-product firms are classified in SBS data according to the sector of their largest product. Thus, if 51 percent of a firm's production is in one sector and 49 percent in a different one, the firm (together with all its employees) will be classified by SBS data in the former sector, although in reality it will be affected by foreign competition in both sectors. In this context, an analysis at a more aggregate industry level may capture competition effects that do not appear at a more disaggregate level for measurement issues.

5.2 Methodology

To address these issues, we first aggregate our data from the four-digit level to the two-digit level (21 sectors) and re-estimate equation (7). We then build the following two indicators of low-wage import penetration in upstream

sectors and downstream sectors:

$$UPLWPEN_{jt} = \sum_{i \neq j} \alpha_{ij} LWPEN_{it} \tag{10}$$

$$DOWNLWPEN_{jt} = \sum_{k \neq j} \beta_{jk} LWPEN_{kt} \tag{11}$$

where α_{ij} is the share of inputs purchased by sector j from sector i in total manufacturing inputs purchased by sector j and β_{kj} is the share of output purchased by sector k from sector j in total manufacturing output sold by sector j (similarly to Smarzynska Javorcik, 2004). $UPLWPEN$ is therefore a weighted average of low-wage import penetration in upstream sectors, while $DOWNLWPEN$ is a weighted average of low-wage import penetration in downstream sectors. To control for the potential endogeneity of the input-output matrix to changes in import penetration, we use Germany's input-output matrix instead of Italy's. We also fix input-output coefficients at their value in the year 2000 rather than using time-varying coefficients. Input-output coefficients are strongly correlated both over time and across countries, and our results are robust to several specifications.

5.3 Results

We start by reporting OLS results in Table 11. We always control for two-digit sector fixed effects and year dummies. Columns (2), (4) and (6) also include controls for the interaction between macro-sector and year dummies, where macro-sectors are aggregations of two-digit sectors based on NACE

letters or groups of letters (examples of such groups of sectors are "textiles, wearing apparel and leather" or "coke and petroleum products, chemicals and chemical products, rubber and plastic products"). This aims at controlling for domestic supply and demand shocks, as in the previous section with four-digit level data.[10] $LWPEN$ has a negative and significant effect on employment at the two-digit sector level in every specification. $OTPEN$ is also negative and significant in almost all specifications, although its coefficient is once again much smaller.

Using the most conservative estimate in column (2), where we control for the interaction between macro-sector and year dummies, a one standard deviation increase in low-wage import penetration in a two-digit sector (which corresponds to an increase of 3.5 percentage points) is associated with an annual decline in the employment of the same sector of 3.6 percent. This is very much in line with the results based on four-digit sectors (where the implied fall in employment was estimated to be 4 percent).[11]

We then include our measures of low-wage import penetration in downstream and upstream sectors (columns (3)-(4)). Employment in a given sector is negatively associated with low-wage import penetration in downstream sectors. This could be explained by a "competition" effect, where import penetration in downstream sectors reduces the demand for

[10] Admittedly sector aggregations might be too broad to capture all relevant supply and demand shocks.

[11] This could be explained by two different effects that offset each other. On one hand, two-digit level estimates could be higher than four-digit level estimates if they pick up competition effects that are not restricted to four-digit sectors (for instance, if there is some product substitutability across different four-level sectors). On the other hand, two-digit level estimates could be lower than four-digit level estimates if firms react to foreign competition by moving into other four-digit sectors within the same two-digit class.

domestically produced inputs. In other words, imports do not only displace domestic producers in the same sector, but also displace domestic suppliers that used to sell their output to that sector.

Employment is instead positively related to import penetration in upstream sectors. A potential explanation is a "productivity" effect, where firms are able to buy cheaper inputs from their domestic suppliers thanks to the latter's access to imports from low-wage countries. A similar mechanism has been studied by a recent literature in the context of trade liberalization and imported inputs. (Amiti and Konings, 2007, Amiti and Davis, 2008, Topalova and Khandelwal, 2011). These studies show that trade liberalization has an effect on firms' activity not only throught lower output tariffs but also through lower input tariffs. Specifically, the fall in input tariffs seems to be associated with an increase in firm-level productivity or wages, especially for importing firms. The intuition behind this result is that lower input tariffs allow firms to have access to cheaper, higher quality or more varied inputs which were not available before trade liberalization. Our study points to an analogous process where firms are able to expand their activity as their inputs become cheaper thanks to the increase in imports from low-wage countries.

The results are generally robust to the inclusion of other countries' import penetration in upstream or downstream sectors, whose coefficients are small or not significant (columns (5)-(6)).

Table 12 reports IV estimates, where $LWPEN$ and $OTPEN$, as well as all their upstream and downstream measures, are instrumented using the corresponding values for the United States. We are not able to apply

the second approach, since we would have more endogenous variables than instruments, while the third approach does not have a good explanatory power in the first stage. The results are quite similar to the OLS estimates.

Overall, these results suggest that low-wage import penetration has significant effects through inter-industry linkages: employment is negatively related to higher penetration in downstream sectors, which reduces the demand for domestically produced inputs, while it is positively related to higher penetration in upstream sectors, presumably through a productivity channel.

Finally, it might be interesting to look at a few concrete examples. Figure 2 plots the employment change (the residual from regressing the change in employment over the years 1995-2007 on the change in $LWPEN$ and $OTPEN$) versus the change in $LWPEN$ in downstream sectors (left panel) or the change in $LWPEN$ in upstream sectors (right panel). The slope is negative in the former case but positive in the latter, consistently with our estimates. An example of the negative relationship between employment change and import penetration in downstream sectors is given by the textiles sector (17), which sells one third of its output (excluding the output sold to itself and final demand) to the apparel sector. Low-wage imports strongly increased in the apparel sector, which explains the very large increase in $LWPEN$ in downstream sectors for the textiles sector. Stronger competition from low-wage countries in the wearing apparel reduced demand for the intermediate inputs usually provided to that sector by domestic textiles firms. A similar story can be told for the wood and wood products sector (20): one of its main customers is the furniture, toys and other manufacturing products

sector (sector 36), where low-wage imports have grown very fast.

An example of the positive relation between employment and low-wage competition in upstream sectors is given by the fabricated metal products sector (28), which gets inputs mainly from basic metals sector (27). A strong increase in $LWPEN$ in basic metals might have provided advantages, in terms of cheaper inputs, to the fabricated metal products sector, which was therefore able to expand significantly.

6 Concluding remarks

This paper starts by noticing the growing competition from China and other low-wage countries, as suggested by their increasing market share of world exports. The high level of their exports, together with their factor endowments, heavily unbalanced in favour of labour, suggests that low-wage competition may have significant implications on industry dynamics in advanced economies. This paper provides an empirical analysis of this hypothesis, using a panel of 230 Italian manufacturing sectors over the years 1995-2007.

The main findings can be summarized as follows. First, an increase in low-wage import penetration is associated with a decrease in employment, output, the wage bill and the number of firms. According to our most conservative estimate, a one standard deviation increase in low-wage import penetration in a given sector is associated with an annual decrease in employment of 4 percent in the same sector; by contrast, import penetration from richer countries does not seem to be significantly related to employment.

While the sign of this result is not particularly surprising, it was important in our view to measure the quantitative effect of low-wage competition on employment and on the other industry variables and to assess its sensitivity to IV methods.

Second, the decrease in employment tends to be smaller in more skill, capital and R&D-intensive sectors. This is consistent with factor proportions theory, which predicts that trade leads each country to specialize in those sectors which are intensive in factors that are relatively abundant in that country. We also find that competition from low-wage countries has a smaller effect on more vertically differentiated sectors, and that in those sectors export unit values, which are a proxy for the quality of products, have increased, in line with a quality upgrading hypothesis.

Third, there is evidence of significant inter-industry effects of import penetration through upstream and downstream channels. Employment is negatively related to higher penetration in downstream sectors, which reduces the demand for domestically produced inputs, while it is positively related to higher penetration in upstream sectors, probably reflecting productivity gains due to cheaper inputs. This result is in line with recent studies showing that trade liberalization does not only affect demand for firms' output but also firms' access to imported inputs. It also suggests that studies looking at the consequences of low-wage competition on specific industries or firms may offer only a partial view of the overall developments in the economy. The analysis of multi-sector models in an open economy could provide interesting insights in this regard.

Our work should not be interpreted as a full assessment of costs and

benefits of trade, which are only partially discussed here. Such an assessment would require considering the gains from new markets available for exports, those from importing new varieties of goods and so forth. It would also require a more general-equilibrium approach in which one would ideally observe the movement of workers away from sectors exposed to low-wage competition towards other sectors, including service sectors, or their going through spells of unemployment or leaving the labour force. Alternatively, the approach based on sufficient statistics proposed by Arkolakis et al. (2012) could be followed. The point of this paper is simply to show that the effects of trade with low-wage countries can be highly significant in specific industries, and that the corresponding changes in the structure of the economy are consistent with factor proportions theory.

A limitation of this work is that it does not address within-industry changes. Firms belonging to the same sector may be differently affected, given the marked firm heterogeneity that characterizes many sectors. Different types of workers may also be differently affected, with low-skilled workers typically expected to lose more than high-skilled workers from trade with low-wage countries. Finally, the effects of import penetration may be particularly significant in some regions, where there is a larger concentration of sectors exposed to foreign competition (Autor et al., 2011, Kandilov, 2009). Clearly, further research is needed on these issues.

Appendix

Classification of low-wage countries. A country is classified as low-wage if its GDP per capita in 2006 is less than 10 percent of U.S. GDP per capita (the cut-off corresponds to 14 percent of Italy's GDP per capita). GDP per capita is non-PPP adjusted, at current prices and in U.S. dollars. Data are taken from the IMF World Economic Outlook database, April 2009 release. List of low-wage countries: Afghanistan; Albania; Algeria; Angola; Armenia; Azerbaijan; Bangladesh; Belarus; Belize; Benin; Bhutan; Bolivia; Bosnia and Herzegovina; Bulgaria; Burkina Faso; Burundi; Cambodia; Cameroon; Cape Verde; Central African Republic; Chad; China; Colombia; Comoros; Congo, Democratic Republic of; Congo, Republic of; Cote d'Ivoire; Djibouti; Dominican Republic; Ecuador; Egypt; El Salvador; Eritrea; Ethiopia; Fiji; Gambia; Georgia; Ghana; Guatemala; Guinea; Guinea-Bissau; Guyana; Haiti; Honduras; India; Indonesia; Iran; Iraq; Jamaica; Jordan; Kenya; Kiribati; Kyrgyz Republic; Lao People's Democratic Republic; Lesotho; Liberia; Macedonia, Former Yugoslav Republic of; Madagascar; Malawi; Maldives; Mali; Mauritania; Moldova; Mongolia; Morocco; Mozambique; Myanmar; Namibia; Nepal; Nicaragua; Niger; Nigeria; Pakistan; Papua New Guinea; Paraguay; Peru; Philippines; Rwanda; Samoa; Senegal; Serbia; Sierra Leone; Solomon Islands; Sri Lanka; Sudan; Suriname; Swaziland; Syrian Arab Republic; Sao Tome and Principe; Tajikistan; Tanzania; Thailand; Timor-Leste, Dem. Rep. of; Togo; Tonga; Tunisia; Turkmenistan; Uganda; Ukraine; Uzbekistan; Vanuatu; Vietnam; Yemen, Republic of; Zambia; Zimbabwe.

Employment and other industry variables. Italy's employment and other industry variables are taken from the Eurostat SBS database. Data are at the four-digit level of NACE rev.1 classification and cover the years 1995-2007. Data are consistent over time, although sampling techniques of the surveys changed in 1998. In addition, since 1999 administrative data on balance sheets and the number of employees have also been used. In 2005, the coverage rate was 49.6 percent for the survey of firms with at least 100 workers (61.4 percent in terms of employees and 66.2 percent in terms of value added) and 3.9 percent for the survey of firms with up to 99 workers (Istat, 2009). The wage bill, value added and sales are deflated by producer prices (also taken from Eurostat). CAP is equal to gross tangible investments divided by the sum of gross tangible investments and the wage bill over the years 1995-2007. $SKILL$ is equal to the number of non-production workers divided by the number of production and non-production workers in 1998 (Istat data). $R\&D$ is the ratio of R&D expenditure to sales over the years 1997-1999.

Quality ladders. Quality ladders are taken from Khandelwal (2010). Starting from quality ladder measures at the ten-digit HS level, we first compute weighted averages of quality ladders at the six-digit HS level. The initial period total real value of the HS code is used as a weight. Using a concordance table taken from Eurostat, we then compute weighted averages of quality ladders at the four-digit CPA level. If a six-digit HS code was matched with two or more four-digit CPA codes, its value was assumed to be equally split across the CPA codes. No suitable match was found for a group of HS codes amounting to about 15 percent of total value in Khandelwal (2010)'s dataset (LAD).

Imports and exports. Italy's imports and exports at current values by year, partner and product (Combined Nomenclature) over the years 1988-2006 are taken from the Eurostat COMEXT database. Data are then aggregated to the four-digit level of CPA classification using concordance tables available on the Eurostat website.

U.S. import penetration. U.S. trade data by year, partner and six-digit NAICS product are taken from Schott's website. U.S. industry sales data at the six-digit NAICS level are taken from the NBER productivity database. Data are then converted to the four-digit NACE rev.1 level, using a concordance table published by the Bureau of Economic Analysis and used to compute $LWPEN_{US}$ and $OTPEN_{US}$.

Industrial production. Industrial production is taken from the IMF International Financial Statistics (for advanced economies and China) and from the OECD Main Economic Indicators (for other low-wage countries). Industrial production refers to the industrial sector for China and to the manufacturing sector for all the other countries. Low-wage industrial production is interacted with an industry-level measure of routine and manual tasks intensity ($IP_{LW} * ROUTINE$). Industrial production in other countries is interacted with an industry-level measure of non-routine and creative tasks intensity ($IP_{OT} * NONROUTINE$). Routine and manual tasks intensity is obtained as a composite of the following O*Net tasks: 4.C.3.d.3 Pace determined by speed of equipment; 4.A.3.a.3 Controlling machines and processes; 4.C.2.d.1.i Spend time making repetitive motions; 4.C.3.b.7 Importance of repeating the same tasks; 4.C.2.d.1.g Spend time using hands to handle, control or feel objects, tools or controls. Non-routine and creative tasks intensity is obtained as a composite of the following O*Net tasks: 4.A.2.a.4 Analyzing data/information; 4.A.2.b.2 Thinking creatively; 4.A.4.a.1 Interpreting information for others. The O*Net database reports information on tasks by occupational profile. For each six-digit NAICS sector, a weighted average of each task is computed using the share of each occupational profile in the sector's total employment. Data are then aggregated at the four-digit NAICS sector and converted to the four-digit NACE rev.1 level. The composite measure, obtained as the sum of the various task measures, is then standardized to a variable with zero mean and standard deviation equal to one.

Transport costs. Transport costs are computed as the ratio between freight costs and CIF imports for each US six-digit NAICS sector and country group (using data available from Schott's website). Data are then converted to the four-digit NACE rev.1 level, using a concordance table published by the Bureau of Economic Analysis. We compute transport costs separately for low-wage countries ($TRANSPORT_{LW}$) and for the other countries ($TRANSPORT_{OT}$).

Tariffs. Tariffs are computed as the ratio between duties and CIF imports for each U.S. six-digit NAICS sector and country group (using data available from Schott's website). Data are then converted to the four-digit NACE rev.1 level, using a concordance table published by the Bureau of Economic Analysis. We compute tariffs separately for low-wage countries ($TARIFF_{LW}$) and for the other countries ($TARIFF_{OT}$).

Exchange rates. Nominal exchange rates (annual averages) are taken from the Bank of Italy. The exchange rate index is defined as a geometric average of foreign countries' nominal exchange rates. The weights are the share of each foreign country's goods in Italy's total imports in 1997. Weighted exchange rates are computed separately for low-wage countries ($EXCH_{LW}$) and for the rest of the world ($EXCH_{OT}$).

Relative export unit values. Export unit values are computed using the BACI trade database available from Cepii (Gaulier and Zignago 2010). The database reports harmonized trade values (in dollars) and quantities (in tons), by reporting country, partner

country, HS six-digit product and year between 1995 and 2007. Data are converted to four-digit NACE rev. 1 classification using a concordance table provided by Eurostat. Unit values are computed as values divided by quantities. Relative export unit values are the log of Italy's export unit values minus low-wage countries' unit values, where low-wage countries are defined as in the rest of the paper.

Input-output coefficients. Input-output coefficients for the upstream and downstream sectors are computed using the symmetric activity-by-activity table for Germany's total production in the year 2000 (source: Eurostat).

Two-digit sector codes. 15 Food and beverages. 17 Textiles. 18 Wearing apparel. 19 Leather products. 20 Wood and wood products. 21 Pulp, paper and printing. 22 Publishing and printing. 23 Coke and petroleum products. 24 Chemicals and chemical products. 25 Rubber and plastic products. 26 Non-metallic mineral products. 27 Basic metals. 28 Fabricated metal products. 29 Machinery and equipment. 31 Electrical machinery. 32 Radio, television and communication machinery. 33 Medical, precision and optical instruments. 34 Motor vehicles. 35 Other transport equipment. 36 Furniture, toys and other manufacturing products.

Macro sector aggregations. Textiles, Wearing apparel and Leather products (17, 18, 19). Food and beverages, Wood and wood products, Pulp, paper and printing, Publishing and printing, Non-metallic mineral products, Furniture, toys and other manufacturing products (15, 20, 21, 22, 26, 36). Coke and petroleum products, Chemicals and chemical products, Rubber and plastic products (23, 24, 25). Basic metals, Fabricated metal products, Machinery and equipment, Motor vehicles, Other transport equipment (27, 28, 29, 34, 35). Electrical machinery, Radio, television and communication machinery, Medical, precision and optical instruments (31, 32, 33).

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Table 1: **SBS and national accounts data**

	Employment			Value added		
	SBS	NA	%	SBS	NA	%
1995	4771	5065	94.2	164	190	86.5
1996	4866	5005	97.2	186	197	94.2
1997	4807	4985	96.4	185	204	90.6
1998	4852	5071	95.7	191	205	93.2
1999	4774	5033	94.9	186	206	90.3
2000	4809	5005	96.1	204	216	94.3
2001	4820	4994	96.5	202	220	91.8
2002	4766	5034	94.7	202	222	91.0
2003	4749	5072	93.6	201	221	90.8
2004	4647	5026	92.5	206	227	90.6
2005	4569	4990	91.6	207	227	90.9
2006	4550	5034	90.4	217	237	91.8
2007	4576	5069	90.3	232	251	92.2
Average	4735	5030	94.2	199	217	91.4

Data for Italy's manufacturing sector. Employment is in thousands of persons, value added (at factor costs) in EUR billions at current prices.

Table 2: **Summary statistics**

	Mean	Std. Dev.	Min.	Max.	N
LWPEN	0.03	0.07	0	1.47	2454
OTPEN	0.25	0.24	0	1.45	2454
Employment (persons)	21133	28976	10	206838	2454
Number of firms (units)	2408	5059	3	39676	2454
Value added (EUR mln)	908	1091	0	9353	2454
Sales (EUR mln)	3626	4976	0	65115	2447
Wage bill (EUR mln)	379	466	0	3841	2454
Skill intensity (%)	29.3	12.9	14.1	58.9	2454
Capital intensity (%)	23.1	7.5	8.6	51.8	2454
R&D intensity (%)	0.5	1.6	0	15.9	2435
Ladder length (log)	2.0	0.8	-0.1	4.6	1899

Table 3: **OLS estimates**

	(1)	(2)	(3)	(4)	(5)	(6)
$LWPEN_{t-2}$	-1.766***	-0.580***	-0.434***	0.028	-2.121***	-1.243***
	(0.251)	(0.200)	(0.163)	(0.116)	(0.403)	(0.390)
$OTPEN_{t-2}$	-0.005	0.026	-0.028	-0.065	0.157	0.225
	(0.086)	(0.079)	(0.063)	(0.069)	(0.219)	(0.222)
Estimation	Fixed effects	Fixed effects	First diff.	First diff.	Long diff.	Long diff.
4d sector FE	Yes	Yes	-	-	-	-
2d sector FE	-	-	-	-	-	Yes
2d sector*year	No	Yes	No	Yes	No	No
Year	Yes	Yes	Yes	Yes	No	No
R^2	0.143	0.366	0.033	0.210	0.226	0.503
Observations	2454	2454	2214	2214	217	217
Sectors	227	227	227	227	217	217

OLS regressions. The dependent variable is log employment in a four-digit sector. $LWPEN_{t-2}$ is low-wage import penetration, $OTPEN_{t-2}$ is import penetration from the rest of the world. Columns (1)-(2) are estimated with four-digit sector fixed effects, columns (3)-(4) are estimated with first differences, columns (5)-(6) are estimated with long difference (changes between 1996 and 2007). Columns (1)-(4) include year fixed effects. Columns (2) and (4) include the interactions between two-digit sector dummies and year dummies. Column (6) includes two-digit sector dummies. Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Table 4: **IV estimates: first-stage (LWPEN)**

Instrument	US		IP*tasks		Trade costs	
	(1)	(2)	(3)	(4)	(5)	(6)
$LWPEN_{US}$	0.393***	0.377***				
	(0.026)	(0.035)				
$OTPEN_{US}$	-0.018	-0.021**				
	(0.012)	(0.010)				
$IP_{LW} * ROUTINE$			0.008*	-0.007		
			(0.005)	(0.009)		
$IP_{OT} * NONROUTINE$			-0.124***	-0.026		
			(0.019)	(0.023)		
$TARIFF_{LW}$					-0.083	0.274**
					(0.139)	(0.111)
$TARIFF_{OT}$					-0.557***	-0.014
					(0.135)	(0.088)
$TRANSPORT_{LW}$					-0.137***	-0.045*
					(0.038)	(0.027)
$TRANSPORT_{OT}$					0.064	-0.020
					(0.092)	(0.080)
$EXCH_{LW}$					-0.001	-0.001
					(0.001)	(0.001)
$EXCH_{OT}$					0.092***	0.022
					(0.017)	(0.019)
F	113.2	58.2	26.2	2.6	9.8	1.9
4d sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
2d sector*year FE	No	Yes	No	Yes	No	Yes
Observations	2224	2224	2339	2339	2120	2120
Sectors	205	205	216	216	196	196

First-stage results of IV regressions for the endogenous variable $LWPEN_{t-2}$. The instruments are: the corresponding import penetration measures for the U.S. ($LWPEN_{US}$ and $OTPEN_{US}$) in columns (1)-(2); the interaction between industrial production in low-wage countries and routine tasks intensity ($IP_{LW} * ROUTINE$) and the interaction between industrial production in advanced countries and non-routine tasks intensity ($IP_{OT} * NONROUTINE$) in columns (3)-(4); tariffs, transport costs and exchange rates ($TARIFF_{LW}$, $TARIFF_{OT}$, $TRANSPORT_{LW}$, $TRANSPORT_{OT}$, $EXCH_{LW}$, $EXCH_{OT}$) in columns (5)-(6). All columns include year and four-digit sector fixed effects. Columns (2), (4) and (6) include the interactions between two-digit sector dummies and year dummies. Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Table 5: **IV estimates: first-stage (OTPEN)**

Instrument	US		IP*tasks		Trade costs	
	(1)	(2)	(3)	(4)	(5)	(6)
$LWPEN_{US}$	-0.051	0.105				
	(0.061)	(0.072)				
$OTPEN_{US}$	0.380***	0.299***				
	(0.056)	(0.036)				
$IP_{LW} * ROUTINE$			-0.023	-0.033*		
			(0.015)	(0.019)		
$IP_{OT} * NONROUTINE$			0.061	0.147***		
			(0.054)	(0.052)		
$TARIFF_{LW}$					0.128	0.095
					(0.367)	(0.333)
$TARIFF_{OT}$					-0.048	0.450**
					(0.301)	(0.190)
$TRANSPORT_{LW}$					-0.335**	-0.232*
					(0.141)	(0.119)
$TRANSPORT_{OT}$					-0.922***	-0.185
					(0.289)	(0.196)
$EXCH_{LW}$					-0.010**	0.001
					(0.004)	(0.004)
$EXCH_{OT}$					-0.122**	0.016
					(0.059)	(0.038)
F	23.1	36.9	3.5	1.4	5.6	2.7
4d sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
2d sector*year FE	No	Yes	No	Yes	No	Yes
Observations	2224	2224	2339	2339	2120	2120
Sectors	205	205	216	216	196	196

First-stage results of IV regressions for the endogenous variable $OTWPEN_{t-2}$. The instruments are: the corresponding import penetration measures for the U.S. ($LWPEN_{US}$ and $OTPEN_{US}$) in columns (1)-(2); the interaction between industrial production in low-wage countries and routine tasks intensity ($IP_{LW} * ROUTINE$) and the interaction between industrial production in advanced countries and non-routine tasks intensity ($IP_{OT} * NONROUTINE$) in columns (3)-(4); tariffs, transport costs and exchange rates ($TARIFF_{LW}$, $TARIFF_{OT}$, $TRANSPORT_{LW}$, $TRANSPORT_{OT}$, $EXCH_{LW}$, $EXCH_{OT}$) in columns (5)-(6). All columns include year and four-digit sector fixed effects. Columns (2), (4) and (6) include the interactions between two-digit sector dummies and year dummies. Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Table 6: **IV estimates: second-stage**

Instrument	US		IP*tasks		Trade costs	
	(1)	(2)	(3)	(4)	(5)	(6)
$LWPEN_{t-2}$	-2.914***	-1.886***	-4.218***	-8.004*	-4.878***	-3.538
	(0.283)	(0.306)	(1.443)	(4.745)	(0.635)	(2.805)
$OTPEN_{t-2}$	-0.030	-0.334*	-2.981	-1.599	-0.079	1.612*
	(0.149)	(0.198)	(2.303)	(1.738)	(0.318)	(0.929)
Kleibergen-Paap F	22.7	36.4	0.8	0.9	5.1	1.5
Hansen J	-	-	-	-	4.7	12.3
4d sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
2d sector*year FE	No	Yes	No	Yes	No	Yes
Observations	2224	2224	2339	2339	2120	2120
Sectors	205	205	216	216	196	196

Second-stage results of IV regressions. The dependent variable is log employment in a four-digit sector. $LWPEN_{t-2}$ is low-wage import penetration, $OTPEN_{t-2}$ is import penetration from the rest of the world. The instruments are: the corresponding import penetration measures for the U.S. ($LWPEN_{US}$ and $OTPEN_{US}$) in columns (1)-(2); the interaction between industrial production in low-wage countries and routine tasks intensity ($IP_{LW} * ROUTINE$) and the interaction between industrial production in advanced countries and non-routine tasks intensity ($IP_{OT} * NONROUTINE$) in columns (3)-(4); tariffs, transport costs and exchange rates ($TARIFF_{LW}$, $TARIFF_{OT}$, $TRANSPORT_{LW}$, $TRANSPORT_{OT}$, $EXCH_{LW}$, $EXCH_{OT}$) in columns (5)-(6). All columns include year and four-digit sector fixed effects. Columns (2), (4) and (6) include the interactions between two-digit sector dummies and year dummies. Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Table 7: **Alternative dependent variables**

	(1) Empl.	(2) Value add.	(3) Sales	(4) Wage bill	(5) No. of firms
$LWPEN_{t-2}$	-0.580***	-0.860***	-0.809***	-0.866***	-0.502***
	(0.200)	(0.266)	(0.241)	(0.250)	(0.182)
$OTPEN_{t-2}$	0.026	0.178	0.118	0.028	0.176***
	(0.079)	(0.119)	(0.108)	(0.097)	(0.067)
R^2	0.366	0.291	0.299	0.335	0.336
4d sector FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
2d sector*year FE	Yes	Yes	Yes	Yes	Yes
Observations	2454	2401	2394	2399	2454
Sectors	227	227	227	227	227

OLS regressions. The dependent variable is log employment in a four-digit sector in column (1), log deflated value added in column (2), log deflated sales in column (3), log deflated wage bill in column (4) and log number of firms in column (5). $LWPEN_{t-2}$ is low-wage import penetration, $OTPEN_{t-2}$ is import penetration from the rest of the world. All columns include year and four-digit sector fixed effects and the interactions between two-digit sector dummies and year dummies. Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Table 8: **Alternative lags and low-wage country thresholds**

	Lags			Low-wage country thresholds		
	1 year	3 year	4 year	5%	20%	30%
$LWPEN_{t-lag}$	-0.709***	-0.580**	-0.805***			
	(0.173)	(0.240)	(0.190)			
$OTPEN_{t-lag}$	0.091	-0.037	-0.105			
	(0.075)	(0.074)	(0.067)			
$LWPEN_{threshold}$				-0.465**	-0.385***	-0.432***
				(0.226)	(0.133)	(0.114)
$OTPEN_{threshold}$				-0.023	0.037	0.079
				(0.073)	(0.083)	(0.088)
4d sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
2d sector*year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.370	0.363	0.359	0.363	0.365	0.368
Observations	2676	2231	2006	2454	2454	2454
Sectors	227	227	227	227	227	227

OLS regressions. The dependent variable is log employment in a four-digit sector. $LWPEN$ is low-wage import penetration, $OTPEN$ is import penetration from the rest of the world. They are included with a 1-year lag in column (1), 3-year lag in column (2) and 4-year lag in column (3). They are computed using a 5% threshold (relative to U.S. GDP per capita at current prices in 2006) in column (4), 20% threshold in column (5) and 30% threshold in column (6). All columns include year and four-digit sector fixed effects and the interactions between two-digit sector dummies and year dummies. Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Table 9: **Factor intensity and quality ladder**

	(1)	(2)	(3)	(4)	(5)
$LWPEN_{t-2}$	0.038	-0.493***	-0.627***	-0.423**	0.114
	(0.207)	(0.188)	(0.207)	(0.185)	(0.231)
$LWPEN_{t-2} * SKILL$	0.090***				0.080***
	(0.017)				(0.023)
$LWPEN_{t-2} * CAP$		0.017			-0.000
		(0.018)			(0.023)
$LWPEN_{t-2} * R\&D$			0.306***		0.016
			(0.101)		(0.132)
$LWPEN_{t-2} * LAD$				0.586***	0.458***
				(0.096)	(0.075)
$OTPEN_{t-2}$	0.043	0.026	0.055	0.051	0.063
	(0.074)	(0.079)	(0.074)	(0.082)	(0.078)
4d sector FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
2d sector*year FE	Yes	Yes	Yes	Yes	Yes
R^2	0.378	0.366	0.376	0.366	0.384
Observations	2454	2454	2435	1899	1890
Sectors	227	227	224	174	173
Effect of LWPEN on employment at selected values of interacted variable					
	$SKILL$	CAP	$R\&D$	LAD	-
Mean - sd	-1.105***	-0.622***	-1.119***	-0.875***	-
Mean + sd	1.181***	-0.363	-0.136	0.029	-

OLS regressions. The dependent variable is log employment in a four-digit sector. $LWPEN_{t-2}$ is low-wage import penetration, $OTPEN_{t-2}$ is import penetration from the rest of the world. $SKILL$ is non-production workers ratio in a four-digit sector, CAP is capital intensity, $R\&D$ is R&D expenditure on sales and LAD is quality ladder length. $SKILL$, CAP, $R\&D$ and LAD are centered with mean zero. All columns include year and four-digit sector fixed effects and the interactions between two-digit sector dummies and year dummies. The lower panel reports the estimated coefficient of $LWPEN_{t-2}$ on employment at selected values of the interacted variable (mean minus one standard deviation and mean plus one standard deviation. Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Table 10: **Quality ladder and export unit values**

	(1)	(2)	(3)	(4)
$LWPEN_{t-2}$	0.567	-1.046	0.631	-1.088
	(0.517)	(0.924)	(0.521)	(0.953)
$LWPEN_{t-2} * LAD$		0.867**		0.916**
		(0.374)		(0.383)
$OTPEN_{t-2}$	-0.001	-0.017	-0.003	0.089
	(0.082)	(0.242)	(0.083)	(0.252)
$OTPEN_{t-2} * LAD$		0.005		-0.044
		(0.112)		(0.114)
4d sector FE	Yes	Yes	No	No
6d product FE	No	No	Yes	Yes
2d sector*year	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
R^2	0.170	0.170	0.551	0.555
Observations	44312	44312	44312	44312

OLS regressions. The dependent variable is log Italy's export unit values relative to low-wage countries' export unit values in a six-digit product. $LWPEN_{t-2}$ is low-wage import penetration in the corresponding four-digit sector, $LWPEN_{t-2} * LAD$ is its interaction with quality ladder, $OTPEN_{t-2}$ is import penetration from the rest of the world, $OTPEN_{t-2} * LAD$ is its interaction with quality ladder. Columns (1)-(2) are estimated with four-digit sector fixed effects, columns (3)-(4) are estimated with six-digit product fixed effects. All columns include year dummies and the interactions between two-digit sector dummies and year dummies. Standard errors are clustered at the four-digit level. Significance: * 0.10, ** 0.05, *** 0.01.

Table 11: **Two-digit sectors: OLS**

	(1)	(2)	(3)	(4)	(5)	(6)
$LWPEN_{t-2}$	-3.677***	-1.043***	-3.951***	-1.596***	-3.525***	-2.436***
	(0.303)	(0.347)	(0.389)	(0.467)	(0.329)	(0.555)
$OTPEN_{t-2}$	-0.225**	-0.334***	-0.357***	-0.322***	-0.242***	-0.140
	(0.095)	(0.094)	(0.082)	(0.099)	(0.078)	(0.106)
$DOWNLWPEN_{t-2}$			-5.103***	-0.897	-6.587***	-4.491***
			(0.923)	(1.183)	(0.892)	(1.410)
$DOWNOTPEN_{t-2}$					0.901***	0.834***
					(0.202)	(0.294)
$UPLWPEN_{t-2}$			4.367***	3.576**	2.864**	1.816
			(1.321)	(1.546)	(1.257)	(1.479)
$UPOTPEN_{t-2}$					0.064	0.366
					(0.377)	(0.349)
R^2	0.524	0.734	0.641	0.751	0.689	0.769
2d sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Macro-sector*year FE	No	Yes	No	Yes	No	Yes
Observations	231	231	231	231	231	231
Sectors	21	21	21	21	21	21

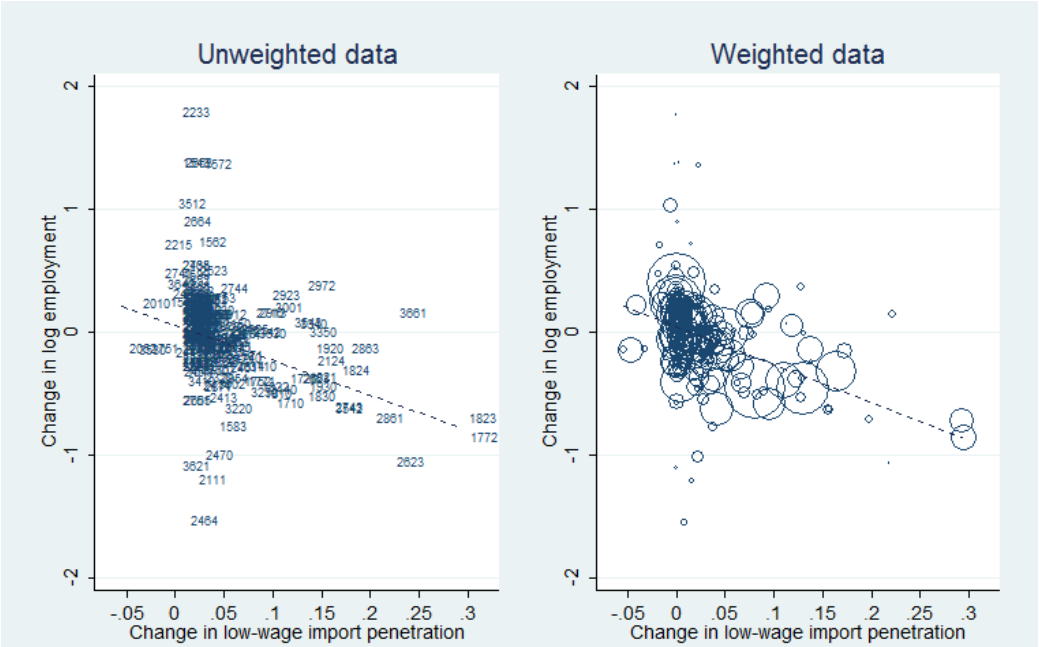
OLS regressions. The dependent variable is log employment in a two-digit sector. $LWPEN_{t-2}$, $UPLWPEN_{t-2}$ and $DOWNLWPEN_{t-2}$ are low-wage import penetration in the same sector, in upstream sectors and in downstream sectors, respectively. $OTPEN_{t-2}$, $UPOTPEN_{t-2}$ and $DOWNOTPEN_{t-2}$ are import penetration from the rest of the world in the same sector, in upstream sectors and in downstream sectors, respectively. Import penetration in upstream and downstream sectors is a weighted average across all sectors (weights are given by input-output coefficients). All columns include year and two-digit sector fixed effects. Columns (4)-(6) include the interactions between macro sector dummies and year dummies. Macro sectors are defined as aggregations of two-digit sectors (see Appendix). Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Table 12: **Two-digit sectors: IV**

	(1)	(2)	(3)	(4)	(5)	(6)
$LWPEN_{t-2}$	-3.926***	-0.759	-4.538***	-2.295**	-4.252***	-4.870***
	(0.311)	(0.517)	(0.427)	(0.918)	(0.445)	(1.524)
$OTPEN_{t-2}$	0.024	-0.341*	-0.207	-0.318	-0.141	0.076
	(0.189)	(0.200)	(0.162)	(0.206)	(0.162)	(0.336)
$DOWNLWPEN_{t-2}$			-4.798***	-1.582	-5.502***	-6.133**
			(0.947)	(1.410)	(1.378)	(2.464)
$DOWNOTPEN_{t-2}$					0.985***	1.549**
					(0.274)	(0.709)
$UPLWPEN_{t-2}$			5.339***	4.646	4.736**	4.785
			(1.877)	(3.085)	(2.227)	(3.400)
$UPOTPEN_{t-2}$					-0.217	-0.253
					(0.514)	(0.624)
Cragg-Donald F statistic	52.7	31.0	25.2	15.1	15.1	3.5
R^2	0.502	0.733	0.625	0.746	0.671	0.729
2d sector FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Macro-sector*year FE	No	Yes	No	Yes	No	Yes
Observations	231	231	231	231	231	231
Sectors	21	21	21	21	21	21

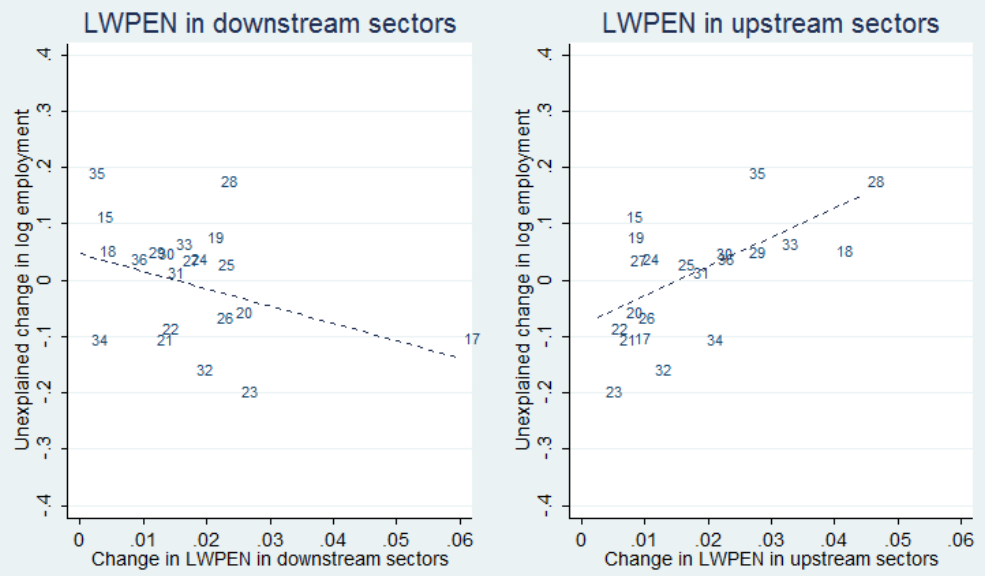
Second-stage results of IV regressions. The dependent variable is log employment in a two-digit sector. $LWPEN_{t-2}$, $UPLWPEN_{t-2}$ and $DOWNLWPEN_{t-2}$ are low-wage import penetration in the same sector, in upstream sectors and in downstream sectors, respectively. $OTPEN_{t-2}$, $UPOTPEN_{t-2}$ and $DOWNOTPEN_{t-2}$ are import penetration from the rest of the world in the same sector, in upstream sectors and in downstream sectors, respectively. Import penetration in upstream and downstream sectors is a weighted average across all sectors (weights are given by input-output coefficients). All columns include year and two-digit sector fixed effects. Columns (4)-(6) include the interactions between macro sector dummies and year dummies. Macro sectors are defined as aggregations of two-digit sectors (see Appendix). The instruments are the corresponding import penetration measures for the U.S. ($LWPEN_{US}$, $UPLWPEN_{US}$, $DOWNLWPEN_{US}$, $OTPEN_{US}$, $UPOTPEN_{US}$ and $DOWNOTPEN_{US}$). Robust standard errors. Significance: * 0.10, ** 0.05, *** 0.01.

Figure 1: **Change in log employment and change in low-wage import penetration (1995-2007)**



The Y-axis measures the log change of employment for 211 Italian manufacturing sectors over the years 1995-2007.The X-axis measures the change in low-wage import penetration for the corresponding sectors 1994-2006. Three sectors are dropped as outliers. Observations in the right panel are weighted by average employment.

Figure 2: **Employment and low-wage import penetration in upstream and downstream sectors (1995-2007)**



The Y-axis measures the residual from a regression of log change of employment in 21 Italian manufacturing 2-digit sectors over the years 1995-2007 on the absolute change in low-wage import penetration and import penetration from the other countries. The X-axis measures the weighted average change in low-wage import penetration in downstream sectors (left panel) and upstream sectors (right panel) over the years 1994-2006 (weights are equal to input-output direct coefficients). Sector codes are reported in the Appendix.

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