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International Competition and Firm Performance: Evidence from Belgium*

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Abstract

We evaluate the impact of international competition on firm-level performance in Belgium. In the manufacturing sector we consider both the impact of global competition through measures of import penetration and the impact of within-EU competitiveness using measures of relative labor cost. In selected manufacturing sectors we identify the strength of international competition through a firm's proximity to the border. In both instances, we consider the impact on a variety of performance dimensions to learn about the mechanisms and about firms' adjustment to these competitive pressures.

Keywords: Efficiency; Markup; Competition, Import penetration.

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1 Introduction

Increased integration of the global economy is bound to generate important welfare gains. Specialization permits countries to increase efficiency by exploiting their comparative advantage and reaping scale economies through exports. Access to imports from anywhere raises the variety of products available to consumers and the range of intermediates that producers can use, while import competition holds prices in check. New technologies and management practices spread through international trade and foreign direct investment, raising dynamic efficiency in the longer term.

Increased integration also exposes firms to more international competition. It forces them to improve continuously in order to survive and prosper. For a country to benefit from the process of internationalization, it is vital that domestic firms find a way to contribute to the global economy. They have to identify niches where they can maintain market share in the face of import competition and become successful exporters. In the case of Belgium, the evolution of the current account has recently become a source of some concern. Once cyclical fluctuations are removed by taking a three-year moving average, Figure 1 reveals a pronounced negative trend.

[Figure 1 approximately here]

Summing trade in goods and services and including both intra-EU and extra-EU trade, the Belgian current account went from a surplus of 9.9 billion euro (equivalent) in 1997 to a deficit of -2.9 billion euro in 2012. The decline started around 2004 and is entirely due to goods exports not holding pace with the increase in goods imports. Excluding services, the trade deficit in goods stood at almost -11 billion euro in 2012. The bottom graph further highlights that the growing deficit for Belgium is a within-EU affair. The external trade balance with the world outside the EU is solid, recording a surplus of 18.3 billion euro in 2012, split equally between goods and services. The problem lies with the intra-EU trade balance which has been in deficit for six of the last seven years. It exceeded -21 billion euro at the end of the period.

Long-term competitiveness is tied to the evolution of total factor productivity (TFP). Growth in TFP measured in value terms (also called TFPR) can come from efficiency gains (also called TFPQ), from lower input prices or from higher output prices, which in turn can reflect exploitation of market power or higher product quality. Recent academic work has found that in response to trade liberalization and increased domestic competition, TFP increased in both India and China, but the underlying mechanisms where very different. The change in India was caused by higher price-cost markups, albeit from a reduced marginal cost base, with little change in efficiency (De Loecker et al. 2012). In contrast, TFP growth in China was accompanied by lower markups, but higher efficiency, driven by firm-level improvements and a more selective entry process (Brandt et al. 2012).

Our objective is to, first, decompose TFP growth of Belgian firms into several components by exploiting detailed information from several firm-level data sets as well as structural relationships between different performance measures. In a second stage, we investigate the relationship between the different components of TFP and shifts in competition due to international factors. In an attempt to gain some insights into the underlying mechanisms of firms' responses, we will investigate, in addition to changes in TFPR, also the impact on output prices, marginal costs, markups, and TFPQ.

The literature has identified several potential responses to increased international competition. In particular, greater import penetration from low-cost trading partners has been documented to lead to the following changes: switching to more capital-intensive sectors (Bernard et al. 2006), adopting more skill-intensive production processes (Mion and Zhu 2013), lowering worker salaries (Autor et al. 2013), lowering final product prices (De Loecker 2011), or increasing product quality (Amiti and Khandelwal 2013).

The dependent variables we consider are more directly related to TFP. A contribution of our analysis is that we explore additional channels of increased international competition. In addition to the import penetration of low-wage or Chinese producers, we also look at the relative cost competitiveness of firms. In the Belgian context, the system of automatic wage adjustment to the cost of living price index is often claimed to lower competitiveness of firms on the international market. Our analysis will indicate on which dimensions firms adjust when faced with labor cost increases that exceed those of the main trading partners. Finally, a third dimension of international competition that we consider is proximity to the border. Firms that compete more directly with competitors in neighboring countries potentially adjust their operations. This channel is likely to be most relevant for service sectors or manufacturing sectors were demand is localized or complementary services (e.g. just in time delivery) are an important competitive advantage.

In the remainder of this report we first discuss, in Section 2, the aggregate evolution of TFP for the Belgian economy and the different measures of international competition. In Section 3 we describe the firm-level data and in Section 4 we introduce the structural framework for the analysis. The dependency of the different performance measures on international competition is described in Section 5 for import penetration, Section 6 for relative wage costs, and Section 7 for distance to the border. Section 8 concludes.

2 Productivity and international competition in the aggregate

The evolution of the trade balance in Figure 1 is mirrored in the evolution of aggregate TFP for the Belgian economy, shown in Figure 2. Several indicators suggest that productivity has declined slightly relative to the group of EU15 countries and more noticeably relative to Germany. Especially in the period since 2004, the year the current account surplus peaked, every indicator shown displays a negative trend.

[Figure 2 approximately here]

Labor productivity (LP) measured as real value added per employee has kept pace best with the evolution in neighboring countries. Relative to Germany, the level was the same in 2012 as in 1997. Since 2004, the relative performance of Belgium fell by approximately 4 percent, both against Germany and against the broader group of EU15 countries. Controlling for hours worked per employee, which seems to have increased substantially in Belgium (in relative terms), the performance is a lot worse. Labor productivity per hour fell by 7 percent against the EU15 and 9 percent against Germany over the full 1997 to 2012 period.

Two more lines are shown in Figure 2. The inverse of the unit labor cost controls for wages, and TFP which is only available for Germany controls for capital intensity. The decline since 2004 is even more pronounced using these alternative measures. As the unit labor cost is defined as the wage per worker divided by value added per worker, its inverse can be interpreted as the value added per unit of wage. It increased in Belgium almost 6 percent more slowly than in the rest of the EU (in this case the EU27). It suggests that the slower productivity growth in Belgium is accompanied by more rapid wage inflation. Relative to Germany, unit labor costs even increase 13 percent faster from 2004 to 2012.

Finally, TFP also declined much more rapidly than LP – the appropriate comparison is with 'LP/empl' using the number of employees as labor input. It suggests that the reason output per worker in Belgium has kept pace with Germany in the first half of the period is a notable capital-deepening in the Belgian economy. Capital per worker grew at a much faster pace than in Germany. This is consistent with the faster wage growth reflected in the unit labor cost measure as it gives firms an incentive to substitute capital for workers.

The adverse evolution of aggregate productivity in Belgium mirrors the emerging current account deficit shown in Figure 1. In the analysis below, we will construct firm-level performance variables and relate them to two sector-level measures of international competition: Chinese import competition and relative wages.

The first measure is constructed by aggregating detailed information from the Transaction Trade data set and the Prodcom survey, both of which are available at the National Bank of Belgium (NBB). The values of import flows from China are aggregated over all importing firms to the 8-digit CN8 product and year level. The value of domestic production is similarly aggregated over all Belgian firms to the 8-digit Prodcom product and year level. As the two product classifications differ, the CN8 trade codes are converted into Prodcom codes.[1] Prodcom codes are harmonized over time to the 2010 classification and aggregated to 102 'sectors', 3-digit Prodcom codes.

Import competition from country c, China in our case, is defined following Mion and Zhu (2013) for all sectors j and years t as follows:

$$\text{Import competition}_{jt}^{CHINA} = \frac{IMP_{jt}^{CHINA}}{(Q_{jt} + IMP_{jt})}. \tag{1}$$

Q_{jt} and IMP_{jt}^{CHINA} are domestic production and imports from China as described above. The import value in the denominator further aggregates import flows over all originating countries, i.e. $IMP_{jt} = \sum_c IMP_{jt}^c$. At their most detailed level, the trade data have been corrected for re-export activities which are an important aspect of Belgian trade.[2]

The import penetration from China, or from low-wage countries in general, has been widely used in the literature to gauge the impact of a competitive shock on domestic firms. Due to the prevalence of re-exporting, we use a slightly different import competition measure which does not subtracts exports in the denominator. Given that the initial level was extremely low in almost all sectors – the highest

[1]For one-to-many correspondences, the production structure is used to infer the import structure. For product code that are split into several codes, the observed import structure in the next year is used to infer the current structure. If a firm no longer imports anything from China, its import composition across all other countries is used. For firms that no longer import at all, the global import structure across all other firms.

[2]More precisely, we multiply all firm-level imports with a fraction that measures the average share of import quantities that are re-exported over all origin and destination countries for a given product and year.

import competition in 1997 was recorded in furniture (2.7%) and textiles (1.6%) – and that China has continuously grown its exports with still a lot of growth potential remaining, the competitive shock should be considered permanent and not simply substituting for imports from other countries.

The second measure is constructed from the 'labor compensation per hour worked' variable in the EU-KLEMS data set. It is only available from 1997 to 2009 and at a relatively coarse aggregation level of eleven broad sectors.[3] We normalize the Belgium wages with those of its three main trading partners, Germany, France and the Netherlands, which account for half of all Belgian exports. We construct relative labor compensation for each of the neighboring countries, c, using the country-specific wage in the denominator.

The reason this variable is plausibly an exogenous shock to the cost competitiveness of Belgian firms is due to the specific form of wage bargaining in the country. Since the Competitiveness Law of 1996, the real salary increase that employers and employees bargain over is capped by the estimated average nominal salary increase in the three neighboring countries minus the expected increase in the domestic price level. The sectoral agreements stipulate, at a very detailed sector, job-type and age or experience level, the real increase for a two-year period, during which salaries increase additionally with the national price index. Especially in the last decade, on average, the real salary increases have been minimal as automatic price indexation already consumed most of the cap. Once we control for time and sector fixed effects

[3] The sectors are (i) food products, beverages and tobacco products (NACE 10, 11, 12), (ii) textiles, wearing apparel and leather products (NACE 13, 14, 15), (iii) wood and paper products, and printing(NACE 16, 17, 18), (iv) coke and refined petroleum products (NACE 19), (v) chemicals and chemical products and basic pharmaceutical products and pharmaceutical preparations (NACE 20, 21), (vi) rubber and plastics products, and other non-metallic mineral products (NACE 22, 23), (vii) basic metals and fabricated metal products, except machinery and equipment (NACE 24, 25), (viii) computer, electronic and optical products, and electrical equipment (NACE 26, 27), (ix) machinery and equipment n.e.c. (NACE 28), (x) transport equipment (NACE 29, 30), (xi) furniture, other manufacturing, repair and installation of machinery and equipment (NACE 31, 32, 33).

in the regressions, changes in labor compensation relative to neighboring countries are mostly driven by unanticipated salary changes abroad. These affect the competitiveness of Belgian firms, both at home and on export markets (predominantly intra-EU), but are unlikely to be caused by domestic factors, such as an increase in productivity.

Figure 3 shows the cumulative changes over the 1997 to 2009 period for both measures of international competition. Observations are sectors with each 2-digit sectors of the relative labor compensation variable on the vertical axis containing several 3-digit sectors, the level at which import competition on the horizontal axis is defined. Overall, the figure shows a lot of sectoral variation that we will exploit in the analysis. There is also no clear correlation between the two indicators. It suggests that the type of competition that sectors face, namely from low-cost Chinese imports or from a disadvantaged position relative to comparable (high-cost) neighboring countries, can differ.

[Figure 3 approximately here]

Not surprisingly, the majority of sectors see a higher fraction of Chinese imports in 2009 than in 1997. In a few sectors the increase is almost 25 percent, but these are exceptions. The average increase is a modest 2.5 percentage points and the median is barely positive at 0.5 percentage points. One in twelve sectors experienced a decline in Chinese import penetration and almost one third of all sectors saw no change at all.

Variation is even larger on the second dimension. Compared to Germany, most Belgian sectors (7 out of 11) saw an increase in compensation per hour (indicated by the light blue square markers). The average increase over the full period was 8.5 percent, but in two sectors it exceeded a 20 percent relative increase. In contrast, relative to France and the Netherlands Belgian wages grew more slowly in the majority of sectors with an average (unweighted) change of -3.3 and -9.0 percent. The underlying annual changes show that that Belgian wage growth accelerated over the sample period growing at approximately the same pace as in France or the Netherlands over the last five years. In the analysis we will exploit the annual changes and relate them to annual changes in firm-level performance.

3 Firm-level data

Our firm-level panel is constructed from five different administrative data sources accessed through the National Bank of Belgium (NBB): (i) the Balance Sheet database, (ii) the Value Added Tax (VAT) database, (iii) the Survey on Industrial Production (Prodcom), and (iv) the Transaction Trade data set. From each source we extract all firms active in the 1997-2010 sample period. To make the sample, firms must at least once over the sample period report positive employment, a physical capital stock (tangible fixed assets) above 100 euro, and positive total assets. The initial analysis is limited to firms that report manufacturing as their primary sector of activity.[4]

The annual accounts provide firm-level information on the wage bill, employment (in number of full-time equivalent employees), tangible fixed assets at the beginning and end of the year, and value added. These statistics have been corrected, annualized, and extrapolated when necessary.[5] The VAT database reports firm sales (total revenue over all its products) and intermediate input consumption. For large firms the same information is also reported in the annual accounts, but the coverage is far more extensive from the VAT reports. Deflators are taken from national accounts

[4]For firms that change their main activity over the sample period, we use the NACE code observed most frequently for the entire period. If several NACE codes are observed with equal frequency, we use the most recent one.

[5]A few changes are made to the date, year, and number of months in the annual accounts where the reported numbers would lead to errors. For example, a closing date of January 2, was change to December 31 of the previous year in order to attribute the reported (flow) values to the previous year. When the accounting period differs from the calendar year, flows are adjusted by taking a weighted average of t and $t+1$ flows. Stocks are adjusted by adding to the current year stock the weighted stock variation between current and next year.

and are available at the 2-digit NACE Revision 2 level.

The Prodcom data set provides the value and quantity produced and sold by each firm for all 8-digit products and years. It is used to compute the volume of output and unit values (output prices).[6] Using the Prodcom survey, we only work with a sub-set of larger firms.

We face a problem that output (production) and prices are recorded at the product-level, while inputs are only available for the firm as a whole. One solution is to allocate inputs to individual products proportionately with their revenue share (?). Another solution is to estimate the functional for of the production technology solely using single-product firms (De Loecker et al. 2012). Since the explanatory variables of interest only vary by sector and in the majority of cases do not differ across products within the firm, we follow an alternative procedure and construct all performance variables at the firm level. It requires aggregation of the output and price variables, but then permits straightforward estimation of a firm-level production function. Output can simply be summed and we use annual revenue shares to create a weighted average price per firm.

Finally, the Transaction Trade data set identifies exporters and importers in general or for specific countries or types of goods.

The Transaction Trade data set is also used to construct the first explanatory variable of interest, Chinese import competition, as described in the previous section. The second explanatory variable of interest comes from the EU-KLEMS database which is available online. To study the relationship between these two measures of international competition and performance, we need a framework to construct different aspects of firm-level performance. We consider in particular TFPR, TFPQ, markups, prices and marginal costs.

[6] We harmonize the product classification to make it consistent over time. When a product is split into several categories, we apply the new production structure to the past. If the firm no longer produces the product, we apply the average production structure over the sample of firms.

4 Recovering productivity, markup and marginal cost

4.1 Structural framework

We recover productivity and firm-specific markups in the same way as De Loecker and Warzynski (2012). First, we consider a general production function, $Q_{it} = F(L_{it}, K_{it}, M_{it})\Omega_{it}$, that applies to all firms. To estimate the Hicks-neutral productivity term Ω_{it}, we take explicitly into account that firms choose input levels endogenously knowing their own productivity level. Importantly, we use a translog specification, such that the output elasticity of inputs is not a constant, as in the Cobb-Douglas case, but variable across firms and over time. This flexibility is necessary to avoid interpreting all variation in variable input shares across firms as direct measures of market power.

We supplement the technology with an assumption of static cost minimization for a variable production factor that is free of adjustment cost. Previous evidence and the system of labor market protections in Belgium, such as restrictions on hiring or firing, and work rules, disqualifies labor as variable input. Instead, we treat it, like capital, as a quasi-fixed production factor that faces adjustment costs. In contrast, intermediate input use is assumed to be perfectly flexible.

Conditioning on the state variables of the firm $\mathbf{s}_{it}$—labor, capital, and potentially also firm characteristics like export, import, or MNE status—we obtain the following first order condition for intermediate input use:[7]

$$\theta_{it} \equiv \frac{\partial Q_{it}}{\partial M_{it}} \frac{M_{it}}{Q_{it}} = \mu_{it} \frac{P_{it}^M M_{it}}{R_{it}}. \tag{2}$$

The firm and time-specific markup is defined as

$$\mu_{it} = \frac{P_{it}}{MC_{it}}, \tag{3}$$

[7]See De Loecker and Warzynski (2012) and De Loecker, Goldberg, Khandelwal, and Pavcnik (2012) for details on the derivation and additional information on the estimation algorithm.

and can be obtained from rearranging the first order condition (2). To evaluate this expression, we need information on total sales (R_{it}), expenditures on intermediate inputs ($P^M_{it} M_{it}$), and the output elasticity of intermediate inputs (θ_{it}). The latter is not observed and requires estimating the production function. We follow De Loecker and Warzynski (2012) closely and describe our estimation routine in Appendix A.

4.2 Estimates

Using the above framework and the production function estimates, we can calculate five performance variables. The production function is estimated separately for 21 2-digit NACE sectors in manufacturing for which enough observations are available (i.e. excluding sectors 11, 12 and 19).[8] Table 1 reports the output elasticities for the three input factors, materials, capital, and labor, and the markups. The reported elasticities are the medians across all firm-year observations in a sector. The markups also vary by firm and over time and we again report the median value.

[Table 1 approximately here]

Estimates of TFPR are given directly by $\hat{\omega}_{it}$. Similarly as for a Cobb-Douglas production function, productivity can be expressed as a residual $r_{it} - \theta^M_{it} m_{it} - \theta^K_{it} k_{it} - \theta^L_{it} l_{it}$, only now the output elasticities vary across firms and over time. The markup μ is calculated from equation (3).

Output prices are constructed as a revenue weighted average of the product-level unit values in the Prodcom survey. We define TFPQ as $\hat{\omega}_{it} - p_{it}$, subtracting the log firm price from TFPR. It is not a perfect measure of firm efficiency, as obtained for example in Atalay (2014), as our measure still includes the effects of input price differences. Finally, marginal costs are given by $p_{it} - \mu_{it}$, subtracting the markup from the price measure.

[8] NACE sector 26 'Computer, electronic and optical products', a relatively small sector in Belgium, is omitted due a low number of observations. This sector is only responsible for about 2 percent of total revenue in Belgian manufacturing.

Summary statistics for the five performance variables are reported in Table 2. They are all expressed in logarithms.

[Table 2 approximately here]

4.3 Equilibrium relationships

Before relating the above performance measures to changes in international competition, we first illustrate how the price, mark-up, and marginal cost estimates vary with domestic wages, both at the firm and the industry level. We always include firm and industry fixed effects, such that the coefficients are identified from changes over time. Additive year effects are included as well to control for cyclical fluctuations that all firms are subject to. These relationships should not be viewed as causal effects or comparative statics, but rather as equilibrium relationships in the data between different endogenous variables of interest.

First, in the first four columns of Table 3, we relate the firm-level price index to wages. The first coefficient reveals an overall positive relationship, but with three sets of fixed effects included the absolute magnitude of the effect is rather low. A 10% salary increase at a particular firm tends to be associated with a price increase of only 0.47%. This effect could be the pass-through of a wage increase into prices or it could represent profit sharing with workers following a price increase.

[Table 3 approximately here]

One reason for the low estimate might be due to more efficient firms paying higher wages, but also charging lower prices, as in the model of Melitz (2003). However, when we control for efficiency differences with the usual measure of revenue-TFP in column (2), the coefficient estimate for wages is lower and even becomes insignificant. The results also suggest that higher efficiency is associated with higher prices, again in contrast with the prediction in Melitz (2003). However, using TFPQ instead of TFPR in column (3) leads to much more plausible estimates. Controlling for firm efficiency using a better proxy brings out a much stronger positive relationship between firm-level wages and prices. These results control already for the fact that more efficient firms might pay higher wages. The estimate now suggests that a wage increase of 10% is on average associated with 3% higher prices. At the same time, higher firm efficiency shows up almost one for one as reduced prices.

Next, we add the industry-level wage of the firm's broad NACE sector as an additional explanatory variable in the regression. Once firm efficiency and the firm-specific wage are controlled for, higher sectoral wages have no noticeable effect on prices. The same price adjustment can be viewed from the perspective of the price-marginal cost ratio. The estimates in column (5) use $\log(\mu_{it})$ as dependent variable in a comparable regression with sector, firm, and year fixed effects. The coefficient on a firm's own wage now turns negative, while that on industry wages is positive, but insignificant.

Firms respond to a wage cost shock not shared by their competitors in the industry, by lowering their mark-up. The passthrough of individual cost-shocks into higher prices is imperfect for the firm-specific wage, but not for sectoral wage changes. Note that reverse causality tends to lower the coefficient on own-wages, which can explain the magnitude of the coefficient, estimated at only -0.011. More profitable firms with higher margins can choose to share some of their profits with workers, leading to a positive effect from the dependent variable on the explanatory variable. Yet another channel is that a firm's market power can be the result of more innovative products that more educated and better paid workers are producing and this effect can be more than proportional, depending on the elasticity of the demand for quality.

The direct impact of efficiency on mark-ups is, as expected, positive and reasonable in size. More efficient firms will, all else equal, operate with lower marginal costs. At a lower point on the demand curve it is profitable to charge a slightly higher markup. If we used TFPR to proxy efficiency, the effect was biased upward because it contains the firm's price level, just as the dependent variable. That point estimate (not reported) was more than an order of magnitude higher.

Finally, as $\ln(MC_{it}) = \ln(p_{it}) - \ln(\mu_{it})$ and the regressions in columns (4) and (5) are linear projections using the same control variables, the effect of wages on marginal costs can be predicted directly from the earlier results. The estimates in column (6) confirm that changes in own-wages show up positively in marginal costs and the estimate is consistent with the earlier two estimates: 0.301 = 0.290 - (-0.011).

The latter estimate might seem quite obvious, higher wages indicate higher marginal costs, but note that the marginal cost interpretation comes entirely from the structural framework. No wage information is used anywhere in the estimation of the marginal cost. Rather, the dependent variable in column (6) is merely constructed as the sum of the following three terms: $\ln(p_{it}) - \ln(\theta_{it}) + \ln(M\text{-share}_{it})$. In spite of the use of indirect information to measure variation in marginal-costs, the effect of wages is around 0.30, exactly the average wage-share in output.

The above results can be considered a sensibility check on the relationships that the different performance measures should display. The intuitive estimates should confer some confidence in the constructed performance variables, which we now use as dependent variables to investigate the effect of international competition.

5 Effect of international competition on firm performance

5.1 Decomposing the impact of Chinese import competition

Following De Loecker et al. (2012) and Brandt et al. (2012), we run several regressions to unpack the impact of increased competition on firm performance. The different performance variables $y = \{TFPR, TFPQ, p, \mu, MC\}$ are related to the measure of Chinese import competition z_{jt} in detailed sector j at time t using the following regression:

$$y_{it} = \gamma z_{jt} + \gamma_i + \gamma_t + \gamma_j + \varepsilon_{ijt}. \tag{4}$$

For some of the performance variables, the effects depend on the level of aggregation at which we measure the import competition and we will report results defining j at the two or three-digit level of the NACE classification.

Including time and sector fixed effects implies that only the sector-specific variation in the import competition over time is exploited. Including firm fixed effects implies that the interpretation of the estimated effects is in terms of changes over time. We will explicitly rely on the different structural relationships from our framework to decompose the overall effect on productivity and illuminate the mechanisms *how* Chinese import competition has mattered.

To put our results in the context of the literature, we start with a standard productivity regression using TFPR as dependent variable. The estimate in column (1) of Table 4 indicates that this popular measure of firm performance is negatively related to increased import competition. As TFPR is often loosely interpreted as a proxy for firm efficiency, the estimate would suggest that firms are slacking off when faced with increased imports from China. This would be puzzling. However, at least since the work of Katayama, Lu, and Tybout (2009) and De Loecker (2011), we know that TFPR also includes price effects which often vary inversely with efficiency.

[Table 4 approximately here]

We can exploit the relationships in logarithms that $TFPQ = TFPR - p$ to decompose the effect. These estimates, in columns (2) and (3), clearly indicate that the overall estimate is dominated by the price effect. One percentage point increase in Chinese import competition on average lowers output prices by 0.7 percent. The effect on TFPQ is much closer to an efficiency impact and the point estimate is now close to zero. If we cluster the standard errors at the 2-digit sectoral level, the standard error on the TFPQ estimate is particularly large and the estimate is not statistically significantly different from zero. Our TFPQ variable is still only a crude measure of efficiency as we do not use the correct production function coefficients nor are we able to control for input price variation across firms.

To interpret the magnitudes of the coefficients, it is useful to note that Chinese import competition increased, on average across sectors, from 0.005 in 1999 to 0.04 in 2010. This implies that over the sample period, all else equal, prices dropped by approximately 2.5 percent as a result of higher Chinese import competition. Especially in light of the future growth potential, Chinese imports are a much larger fraction in the United States, this can be considered a large effect.

Tn the second panel of Table 4 we show the results from running the same regressions with the Chinese import competition measured in more narrow 3-digit industries. The negative effect on prices is almost the same as above, but now the TFPR does not change. As a result, we find a positive and significant effect on TFPQ. Each percentage point increase in Chinese import competition shows up as 1.1% higher TFPQ. The difference in the TFPQ effects in panels (a) and (b) suggests that the efficiency effect is rather narrow. Only firms directly losing market share to Chinese imports are forced to adjust.

The price effect is combination of a pro-competitive force expected to exert a negative pressure on prices, and an opposing effect from cost savings as firms' inputs also become cheaper. To separate both effects, we decompose the change in price using the logarithm of equation (3), $\log(\mu) = p - \log(MC)$, and run two more regressions.

The estimate of Chinese import competition on the price-marginal cost ratio μ, in column (4), reflects how firms adjust on their product market when their market share is under pressure. Remarkably, the positive point estimate suggests that firms increase markups when competition intensifies. It is possible that firms change their output mix towards products with higher margins, e.g. higher quality products, but this is unlikely to be an important factor given the large observed reduction in prices. It is intuitive, however, that the positive effect is only there for firms in the same broad sector where the Chinese imports arrive, but not for firms in the same narrow 3-digit sector (panel b).

As we know that output prices go down without a corresponding decline in markups, it has to be accompanied by an strong reduction in marginal costs, and this is indeed reflected in the point estimates of -0.930 and -0.908 in column (5). Given that this decrease is not accompanied by an increase in physical productivity (TFPQ) in column (2), it leaves an important role for access to cheaper inputs as an explanation for the reduced marginal costs.[9]

Two recent studies, Amiti and Konings (2007) for Indonesia and Goldberg et al. (2010) for India, have shown that the input channel can be an important way for trade liberalization to affect the domestic economy. Both studies use the different extent of tariff reductions for a sector's output and its inputs to identify two separate effects. This identification strategy is not available to us as we use a different explanatory variable. However, we can provide some insights how the above results fit together using the following expression for TFPR from De Loecker and Goldberg (2014):

$$TFPR = \omega_{it} + p_{it} + (x_{it} - \tilde{x}_{it})'\beta. \tag{5}$$

Here, $\tilde{x}_{it}$ is the percentage deviation between the value and physical quantity of input x for observation it relative to the sectoral average. The expression indicates that TFPR estimates obtained using deflated output and inputs, using only sectoral deflators, will still contain firm-specific output price variation, as well as a linear combination of firm-specific input prices differences. This last term will make its way into the marginal cost measure when we do our different decompositions.

We can gauge the quantitative importance of cheaper inputs by exploiting another structural relationship in our framework. In a single-input production technology, as used in most theoretical trade models in the spirit of Melitz (2003), marginal cost is the ratio of the wage rate to its (physical) productivity. In the multi-input case, the wage rate should be replaced by the cost function $f(w)$ which includes all factor prices, including prices of intermediate inputs and raw materials (Marin and

[9]Realizing scale economies is another possibility, but the production function estimates suggest that most firms operate at a point of constant or decreasing returns to scale. The scale of firm operation also did not change much over the sample period.

Voigtlander 2013). In logarithms, the following relationship has to hold:

$$\log(MC) = \log f(w) - \log(TFPQ). \quad (6)$$

Given this linear decomposition, we can simply use the estimates from the linear projections in Table 5 to find an impact of cheaper inputs of 1.096 (= -0.930 - 0.166). Controlling for TFPQ we can isolate the impact of import competition through the input channel. The estimate in column (6) of Table 5 suggests an effect of input price reductions of -1.1088. By additionally controlling for the firm's average wage rate, in column (7), we isolate the effect from intermediate input prices. The point estimate of -0.684 differs from the effect we obtained from the direct calculation above, which is likely be due to heterogeneous effects on TFPQ which we illustrate below.

An alternative way to perform the same calculation is by substituting $TFPQ$ by $TFPR/p$ and using the following equality in logarithms:

$$\log(TFPR) = \log f(w) + \log(\mu).$$

Given the linear projections, plugging in the corresponding estimates from Table 3 leads to the identical effect of Chinese import competition on input prices of 0.680 (= -0.888 - 0.208).

This effect is both plausible and remarkable, but also contrasts with the results in Marin and Voigtlander (2013) who study the impact of export market entry on firm performance. In such analysis it is natural to assume that domestic market conditions do not change. As a result, $\Delta \ln f(w) = 0$ and changes in TFPR have to coincide with changes in markups. Better performance in revenue productivity has to come from the firm raising its prices or the firm realizing efficiency gains that are not passed on to customers. In contrast, changes in import competition affect not only how firms perform, but also the situation they face on the input market. Compared to earlier studies that have used differential effects of tariff declines in firms' output market and input tariff reductions—obtained by multiplying the tariff vector with an input-output matrix—we had to show these effects indirectly.

Note that the implied effect on input prices is also consistent with our direct evidence, in column (3) of Table 5, that showed a strong reduction of firm-level prices due to Chinese import competition. If we run the price regression at the product level, the coefficient is even larger and more significant. Given that Belgian firms lower their prices, it is natural that domestic firms that use these products as inputs benefit. This benefit is in addition to the lower prices for inputs imported from China.

Looking at imports from China in particular, two facts are noteworthy. First, a regression of the unit value at the firm-product level on a set of product and country fixed effects shows substantial price variation by country of origin. In particular, intermediate input imports from China are 19% cheaper than average. Second, the Chinese import share in intermediate inputs is approximately three times higher than its overall import share. Both facts suggest that increased imports from China also confer benefits for Belgian producers, consistent with our regression results.

Finally, the estimates in the bottom panel show that the advantage of cheaper inputs that was particularly pronounced at the 2-digit level almost disappears entirely at the 3-digit level. This is intuitive as within the broader industry definition many more firms source inputs from firms in the same sector and thus benefit from higher Chinese import competition in their own sector. At the more disaggregate level, the similar decline in marginal cost is almost entirely due to higher TFPQ, while the effect through intermediate inputs is only -0.125 and not estimated significantly different from zero.

5.2 Heterogeneous effects of Chinese import competition

The above results show a strong negative effect of Chinese import competition on firm-level prices and marginal costs. The latter effect comes either from an improvement in productivity (cost efficiency), when the explanatory variable is measured at a more detailed level, or from a substantial reduction in input costs, when using the coarse industry classification. Moreover, in the first case the effect on marginal costs outweighs the price effect such that markups improve. Many of these effects are likely to differ across firms. Using observed characteristics to classify firms exhaustively in different groups, we investigate whether there are any systematic differences.[10] We show the results for Chinese import competition measured at both levels of aggregation side by side in Table 5 for a few variables of interest. Full results are reported in Table A.1 in the Appendix.

In the first set of results, panel (a), firms are allocated to the bottom, middle two, or top quartile of the productivity distribution using their productivity level in the first year year we observe them. The Chinese import competition variable is then interacted with each of the three dummies. The literature has identified two possible patterns following trade liberalization. Brandt et al. (2012) show that the efficiency-boosting effect of foreign import competition in China was particularly strong for less productive firms, in particular for state-owned firms. In contrast, Ederington and McCalman (2007) show theoretically and find empirical support for Columbian plants that highly efficient plants have the strongest incentive to bring productivity-enhancing investments forward when import competition increases.

[Table 5 approximately here]

In Belgium, the least efficient firms are clearly forced to adjust. The effect on TFPQ is now strongly positive for both measures and is highly significant, even when clustering the standard errors. This effect is combined with those same firms benefitting most from reduced intermediate input costs. Their output prices are forced markedly lower, but given the sharply reduced marginal costs they are still able to eke out higher margins. The negative estimate on TFPR paints a misleading picture of the impact of Chinese imports on these firms.

The pattern is very different for firms that started out relatively productive. They see higher output prices, but lower efficiency, and insignificant effects for the

[10] Differences in the productivity evolution by firm status can be incorporated in the estimation by including firm characteristics in the law of motion for productivity, as we did for export status. With industry fixed effects in the control function, it is not necessary to include import competition.

three other variables. A possible explanation is that these firms were already highly efficient, but competed on price and were most exposed to the Chinese import competition. To mitigate the effects of increased competition on their output market, they moved into more expensive market segments, witness the large positive price effects. In turn, these adjustments sapped efficiency, witness the lower TFPQ. Recall, as well, that our TFPQ measure still includes firm-specific changes in input prices. Producing for higher market segments is likely to require higher product quality which is achieved with more expensive inputs—consistent with the lower estimate in column (5).

Results distinguishing firms by export status, in panel (c) of Table 6, do not lead to such a straightforward distinction. One dependent variable where firms experience different effects by export status is TFPQ. Greater competition from Chinese firms on the domestic market, is associated with lower TFP for firms that do not export at all, but with higher TFP for exporters to China (possibly among other destinations). These results are consistent with those in Lileeva and Trefler (2010) who find positive efficiency effects from US tariff reductions only for some Canadian firms, namely those that did not export initially, but started to export following the tariff decline. We updated the firms' export status continuously as almost no firms exported to China initially. Using the more disaggregate measure of competition, TFPQ is higher for all type of firms when they face strong competition, but the ordering of the magnitudes of the effects is similar as on the left.

An interesting result is that TFPR falls for both nonexporters and exporters, but for different reasons. Firms only active domestically see their lower efficiency translate in lower revenue productivity. For exporters, the decline is driven by lower output prices.

By import status, a few patterns are worth noting. Firms that directly import intermediate inputs from China enjoy the largest increase in efficiency among the four groups and also the largest drop in their own output price (only for the more aggregate measure). Their efficiency gain contrasts with a less favorable efficiency evolution for firms that do not import. However, these importers choose to pass most of the gains to their clients as lower prices, and both groups enjoy a similar increase in markup.

The contrast between a negative effect on TFPR and a positive effect on markups that was already found in Table 4 even holds for each group of firms separately. The implied reduction in intermediate input cost, in column (5), is estimated highly similar and not statistically different for each of the groups. Firms that do not import directly even witness among the highest point estimate (in absolute value). It underscores the importance of changes in the wider economic environment that are not necessarily tied to a firm's individual situation.

5.3 The impact of relative wage competitiveness

Given the particularly poor trade performance of Belgian firms on the internal EU market, as shown in Figure 1, we also look at an alternative indicator of market competitiveness. A dimension that has received a lot of attention is the evolution of domestic wages relative to those in neighboring countries. Germany, France, and the Netherlands are important trading partners of Belgium as well as competitors on third country export markets. The government closely monitors their wage levels relative to Belgium because the system of automatic wage indexation to the domestic price level risks starting a wage-price spiral that renders Belgian firms uncompetitive internationally. The Competitiveness Law of 1996 even restricts domestic wage bargaining to make sure that increases in nominal wages do not exceed the expected increase in the three neighboring countries.

The impact of changes in foreign wages on the performance of domestic firms is not as clear-cut as that of Chinese import penetration for several reasons. First, the correlation between changes in firm-level and sectoral wages is remarkably low. While the overall correlation is high, with a partial correlation of around 0.70, it reflects primarily that high wage firms operate in high wage sectors. Once we control for sector fixed effects and only look at the correlation in wage changes, the correlation remains positive but is not statistically significant. One reason is that the wage bargaining takes place at a much more disaggregate level than the two-digit NACE industries for which we observe foreign wages. Another reason is that the aggregate evolution is driven by large firms, while the majority of firms in the sample are small. It underscores that firm heterogeneity is important and changes in the competitive environment at the sectoral level are unlikely to have uniform effects.

Second, the response to the wage evolution in the three neighboring countries is not uniform.[11] A regression of the firm-level markup on the different relative wage evolutions for the three neighboring countries c, $\log(\text{wage}^c_{st}/\text{wage}_{it})$, produces very similar, but misleading estimates, see results in columns (1a), (1b), and (1c) of Table 6. This specification restricts the effects of the firm's own and foreign sectoral wage evolutions to have opposite effects of the same magnitude. If both variables are included separately, in column (2), the own-wage effect is uniformly negative, as in Table 3, but the effects for the neighboring countries differ notably. There is no effect of German wage changes, but a strong negative and significant effect of Dutch wage changes.

The pattern is similar if we normalize the foreign wage wage^c_{st} by the sectoral wage level for Belgium wage^{BEL}_{st} rather than the firm's own wage. Enforcing the same magnitude, but opposite signs, we find point estimates around -0.16. These are however driven by large positive effects of Belgian wages, around 0.22, mirroring the results in column (5) of Table 3. We interpreted the positive association as reverse causation: successful sectors are able to raise wages. Foreign wages have insignificant effects on markups in each case, but two of the three point estimates were negative and largest (in absolute value) for the Netherlands (approximately the same size as the effect of domestic wages).

[11] The correlation between (sectoral) wage changes is also not uniform. Wage inflation in Belgium covaries positively with changes in each neighboring country, but changes in Belgian are more than proportional to German changes, but less than proportional to Dutch changes.

[Table 6 approximately here]

Third, higher wages in neighboring countries cannot easily be interpreted as an advantageous relative cost shock for Belgian firms. In column (3) we look at the direct effect on prices, including the firm's marginal costs directly as an explanatory variable in the regression. This now fully controls for the firm's own costs and all else equal higher wages abroad do confer a relative cost advantage. The effects are estimated very imprecisely, but we do not find the expected positive effects. If anything, higher wages abroad are associated with lower prices for Belgian firms including both domestic production and exports. It suggests that reverse causality is again likely. Higher wages abroad reflect a strong performance abroad and requires adjustments by Belgian firms to face the stronger foreign competition. The estimates in Table 6 suggest that lowering markups is one strategy.

The estimates for TFPQ and MC in the lower panel further indicate that firms also raise efficiency in response, but again not uniformly. The point estimate on Dutch wages is very large and highly significant, while that on German wages is effectively zero. Higher wages in France and the Netherlands are also associated with higher input costs for Belgian firms, which is an intuitive effect. The positive estimates for the control variables, firms' own wages and sectoral wages for Belgium, do imply that higher local wages force firms to increase efficiency and raise TFPQ. It is surprising that changes in foreign wages lead to effects of a similar sign and even higher magnitude.

To explain the counterintuitive effects on prices, we looked for differential effects on Belgian exporters and firms only selling domestically. While markups are significantly higher for exporters, consistent with the evidence in De Loecker and Warzynski (2012), the impact of foreign wage changes barely varies by export status. The point estimates on the interaction term with the relative wage variable is negative for each of the three partner countries, but estimated relatively small and always insignificant. If anything, it strengthens the interpretation of high wage growth abroad as an indicator of a strong performance of foreign firms rather than an advantageous cost evolution for Belgian firms.

5.4 Distance to the border

One problem with the previous results is that the evolution of wages in neighboring countries is by construction the same for all firms in Belgium, while they are likely to be affected differentially. Given that the wage evolution for Germany and the Netherlands was rather different, it is no surprise we do not find easily interpretable patterns.

A solution is to allow effects to differ by firms' location. In some sectors, the competitive impact from wage evolutions in neighboring countries is likely to be particularly pronounced near the border. This is the case in sectors where demand is local, just-in-time delivery is important, or where goods have a service component. We conjecture that one example of such a sector is food manufacturing.

Limiting the sample to firms in that sector (NACE 10), we run regressions for each of the five performance variables as dependent variable and interacting the relative wage variable with an indicator whether the firm is located in a postal code adjacent to the country border. As the regressions still include firm fixed effects, we cannot identify the direct effect of proximity to the border. Moreover, the year fixed effects now also absorb the average effects of the relative wage evolution which cannot be identified in a regression limited to just one sector. What we can identify is whether firms located near the border are disproportionately affected by adverse wage changes. We include different border dummies for each of the three neighboring countries and interact each with the corresponding relative wage.

The results that use the Belgian sectoral wage as normalization, in the first line of Table 7, show particularly strong effects for firms located near the German border. Three of the five coefficients are estimated significantly different from zero at the 1% level with standard errors clustered at the postal code level. Higher wages in Germany are associated with lower TFPQ for Belgian firms and higher prices. Both effects are in the expected direction. Faced with competitors that experience a positive cost shock (higher wages), Belgian firms let efficiency slide and raise their prices. At the same time, marginal costs are higher even after accounting for the changes in efficiency and Belgian wages, presumably reflecting higher input costs on German imports or similar price increases by firms facing weaker German competition. The effects of TFPQ and prices compensate and we find no impact on TFPR. Similarly, markups are unchanged given offsetting effects on prices and higher marginal costs.

[Table 7 approximately here]

For firms in postal codes adjacent to the French or Dutch border, we find no statistically significant effects of wage changes on the other side of the border. The only point estimate that is almost significant is a higher mark-up in response to a Dutch wage increase, but the estimated magnitude is very small. When we conduct the same analysis using the firm-level wage to normalize relative wage changes, the positive effect on the mark-up does become statistically significant. In this specification, higher wages in France also raise the markups for Belgian firms located along the French border.

We find two intuitive patterns. Higher wages in Germany lead to higher prices for Belgian firms along the border. As they lower efficiency and face more expensive inputs, it has no effects on markups or TFPQ. Higher wages in France or the Netherlands do lead to higher markups, but with no distinct effects on any of the other performance dimensions.

6 Conclusions

Recent development related to globalization as well as wage evolutions have challenged competitiveness of western economies, and in particular small open economies such as Belgium. Increased competition by emerging economies, such as China, has been putting competitive pressures as well as offering new opportunities in terms of access to possibly cheaper intermediate inputs. Within EU, wage developments in Belgium relative to its main trading partners, and especially so Germany, have been a source of concern for the overall competitiveness of Belgian firms both in their domestic and foreign markets. Over the same period the trade balance exhibited a downward sloping trend; the increased market opportunities offered by high growth rates in emerging economies did not suffice to compensate for the decrease in the intra-EU trade balance, and that constitute the largest share of Belgian trade. Going beyond these macroeconomic facts, a crucial question is then what is the capacity of firms to adapt and adjust to these international developments, and how have firms respond to these external shocks.

In this paper we shed light on these issues from a microeconomic point of view. We evaluate the firms responses to increased import Chinese competition and to relative wage developments, on several margins. More precisely, we use a firm-product level database to construct and estimate firm efficiency, output prices, markups and marginal costs. A typical issue in estimating TFP from revenue data deflated by a sectoral index is that firm-specific output prices are embedded in estimated TFP. In order to tackle this issue, we construct firm-level price index and disentangle efficiency (both measured by marginal cost of production and physical productivity (TFPQ), from firm prices. Our results confirm previous studies, that ignoring such price variation may lead to misleading conclusions on the response of firm productivity to external shocks.

Our results suggest that, in Belgium, firms have responded to increased Chinese competition by reducing prices and increasing efficiency. Profit margins went up despite stronger competition from China due to a strong reduction in marginal costs, which we can trace back to the importing of intermediate and capital goods from China itself. These phenomena are particularly important for the firms that lie initially at the bottom of the productivity distribution, and firms that imports goods, in particular intermediate inputs, from China.

In response to wage developments in neighbouring and main trading partner countries, the data reveal different responses according to the country considered. A decrease in French and Dutch wages relative to Belgian ones led to a reduction in marginal costs, efficiency and markups of firms operating in the same sector of activity. Although German wages have exhibited the stronger decline compared to Belgian wages, this has not induced significant response in terms of TFP, prices, markups or marginal costs. By contrast, for firms operating in the food, beverage and tobacco industry located close to the frontier, the increased German wage advantage has translated into a non negligible increase in TFPQ, a strong reduction in prices and a compression of marginal costs.

Appendix: Estimating Output Elasticities

We consider a production function, for each industry separately, of the form:

$$y_{it} = \boldsymbol{x}'_{it}\boldsymbol{\beta} + \omega_{it} + \epsilon_{it} \tag{1}$$

where y_{it} is firm-level deflated revenue, where we deflate using either industry-wide or firm specific prices. The input vector $\boldsymbol{x}_{it}$ contains a translog specification of our three inputs: labor (l_{it}), intermediate inputs (m_{it}) and capital (k_{it}). The unobserved productivity shock known to the firm when making (static) input decisions is denoted by ω_{it}, while ϵ_{it} picks up any measurement error in sales and/or firm-specific prices as well as unanticipated shocks to output and prices.

The estimation and identification of the parameters $\boldsymbol{\beta}$ rely on 1) inverting out the intermediate input demand equation, $m_{it} = m_t(\boldsymbol{x}_{it}, \boldsymbol{z}_{it}, \omega_{it})$, for productivity such that $\omega_{it} = h_t(\boldsymbol{x}_{it}, \boldsymbol{z}_{it})$, and on 2) a law of motion of productivity that allows us to isolate the productivity shock ξ_{it} on which we will form moments to identifiy the production function coefficients ($\boldsymbol{\beta}$) needed to compute the output elasticity θ_{it} by firm and year.

The first stage of (deflated) sales on a function of all inputs ($\boldsymbol{x}_{it}$) and variables affecting input demand ($\boldsymbol{z}_{it}$) has the sole purpose of purging the output data from measurement error and unanticipated shocks to output, denoted by ϵ_{it}.

$$y_{it} = \phi_t(\boldsymbol{x}_{it}, \boldsymbol{z}_{it}) + \epsilon_{it} \tag{2}$$

From this we can obtain $\omega(\boldsymbol{\beta})_{it}$ is obtained from the first stage regression :

$$\omega_{it}(\boldsymbol{\beta}) = \phi_{it} - \boldsymbol{x}'_{it}\boldsymbol{\beta} \tag{3}$$

This allows us to recover the productivity shock used to form moments on. In particular this shock is obtained as follows:

$$\xi_{it} = \omega_{it}(\boldsymbol{\beta}) - E(\omega_{it-1}(\boldsymbol{\beta})|\mathcal{I}_{it-1}) \tag{4}$$

The coefficients of the production function are then estimated using standard GMM. The moments we use to estimate the production function coefficients are thus $E(\xi_{it}(\boldsymbol{\beta})\boldsymbol{d}) = 0$. In the case of our three-input translog production function with labor and capital quasi-fixed and intermediate inputs fully flexible, the set of instruments is

$$\boldsymbol{d}_{it} = \{l_{it}, m_{it-1}, k_{it}, l_{it}^2, m_{it-1}^2, k_{it}^2, l_{it}m_{it-1}, l_{it}k_{it}, m_{it-1}k_{it}, l_{it}m_{it-1}k_{it}\}. \tag{5}$$

The production function coefficients $\boldsymbol{\beta}$ are then used together with data on inputs to compute the output elasticities $\hat{\theta}_{it} = \theta(\hat{\boldsymbol{\beta}}, l_{it}, m_{it}, k_{it})$.

Comments An alternative estimation (and therefore associated identification arguments) does not have to rely on the specification of the intermediate input demand function $m_t(.)$. In particular, either we can not allow for ϵ_{it} which would allow us to go immediately to equation (3), and everything else proceeds in the exact same way. However, allowing for the measurment error and unanticipated shocks to output (and prices) is empirically very important. An alternative is restrict the underlying model of competition and obtain the productivity shock as in Gandhi, Navarro, and Rivers (2013). However, given that we are interested in recovering measures of markups we do not want to impose restrictions on how markups can vary across firms and time.

Finally, the use of sales-weighted firm-specific price can still lead to a bias of the output elasticities. First of all, we appeal to the arguments discussed in De Loecker and Warzynski (2012) that we can at least sign the bias, and in the case of the translog we can write it explicitly as a function of the coefficients, and include that in any reduced-form regression. Second, if we are willing to consider the Cobb-Douglas production function, the predominant functional form in the literature on production function estimation, we do not bias any of our reduced-form estimates of the impact of competitive pressure on margins. We therefore consider various robustness checks in our empirical work using the relevant variation of the markup when including firm fixed effects – i.e., the revenue share of intermediate inputs as the time-invariant output elasticity drops out.

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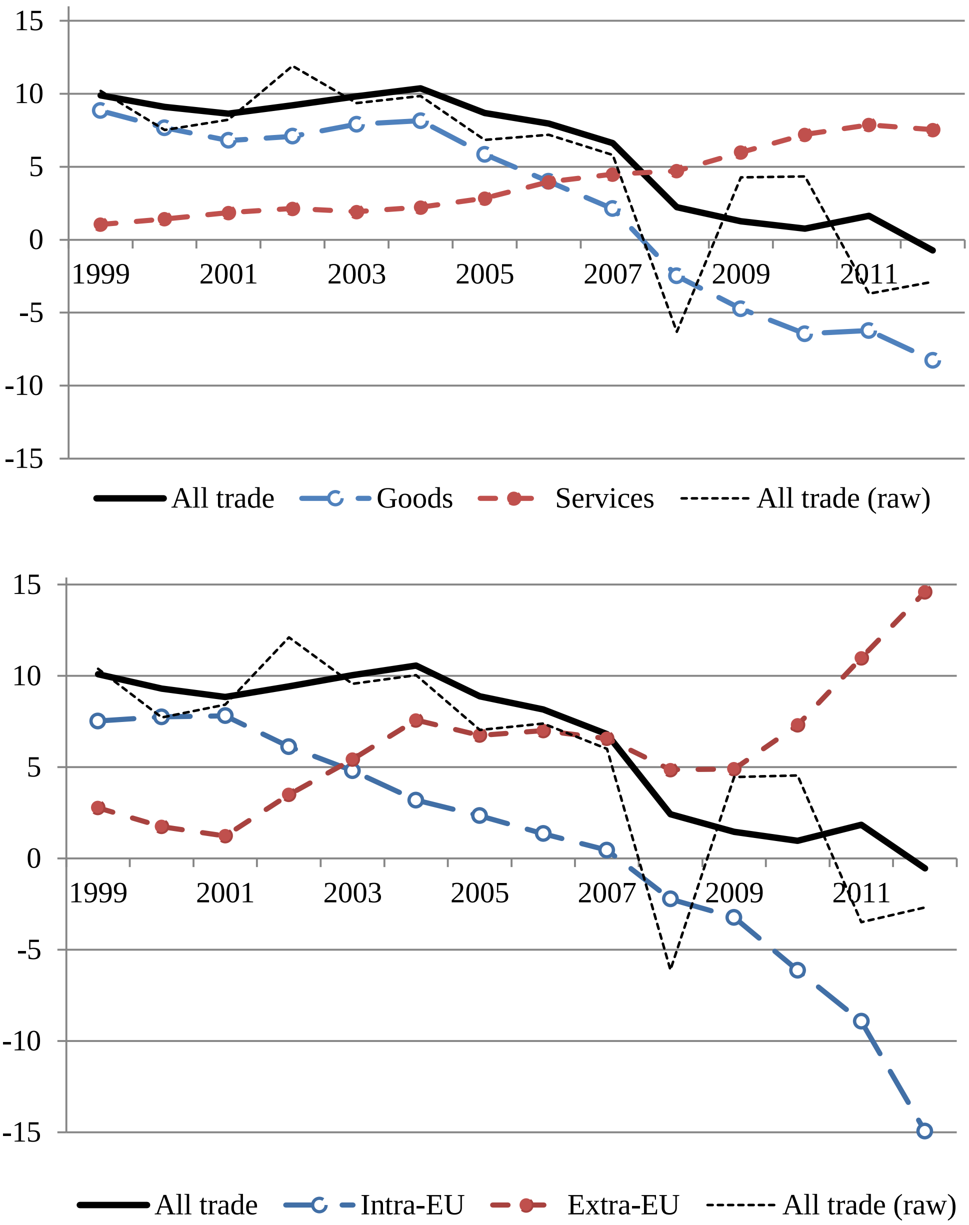
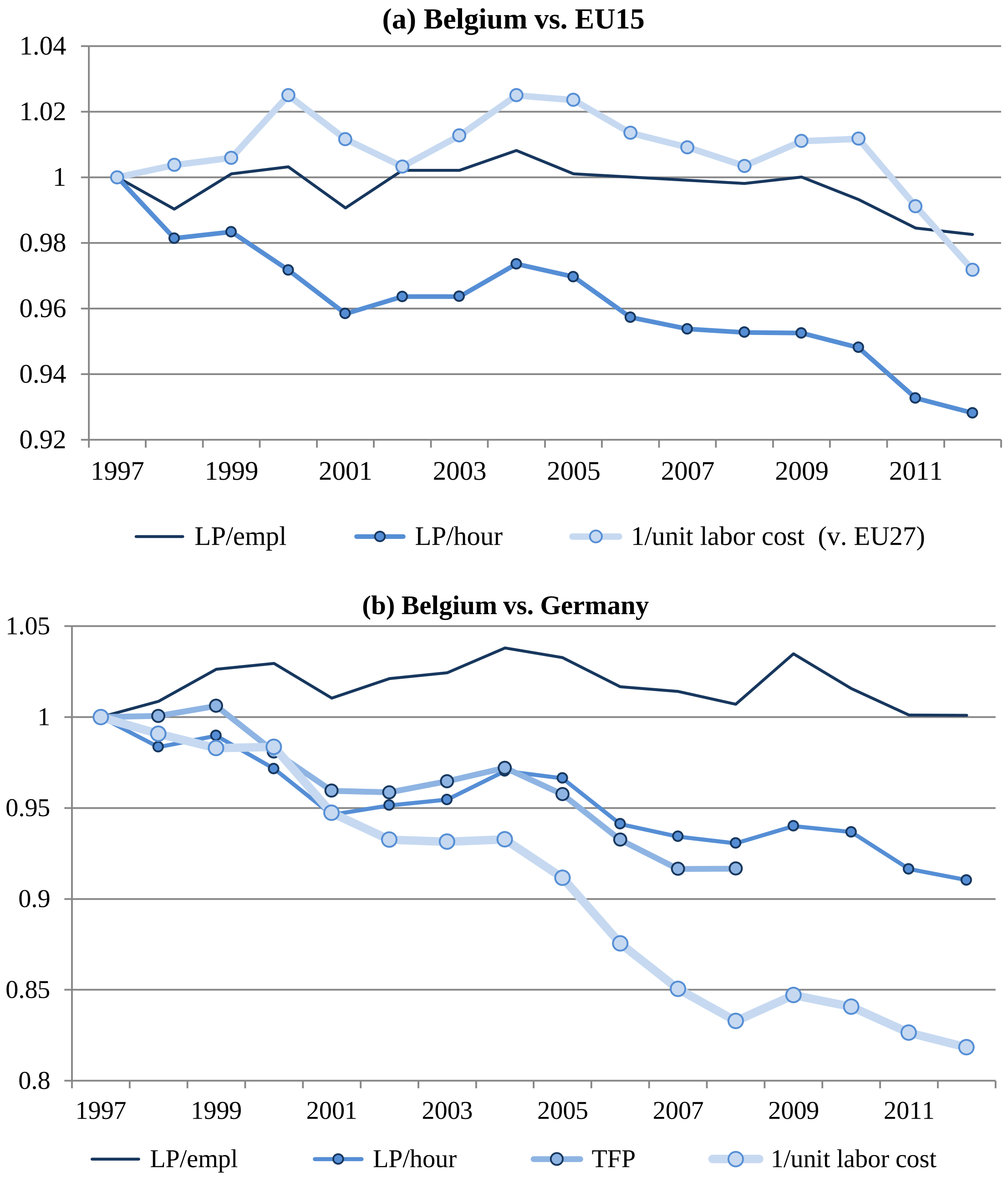
Figure 1: Trade balance: goods vs. services, intra-EU vs. extra-EU



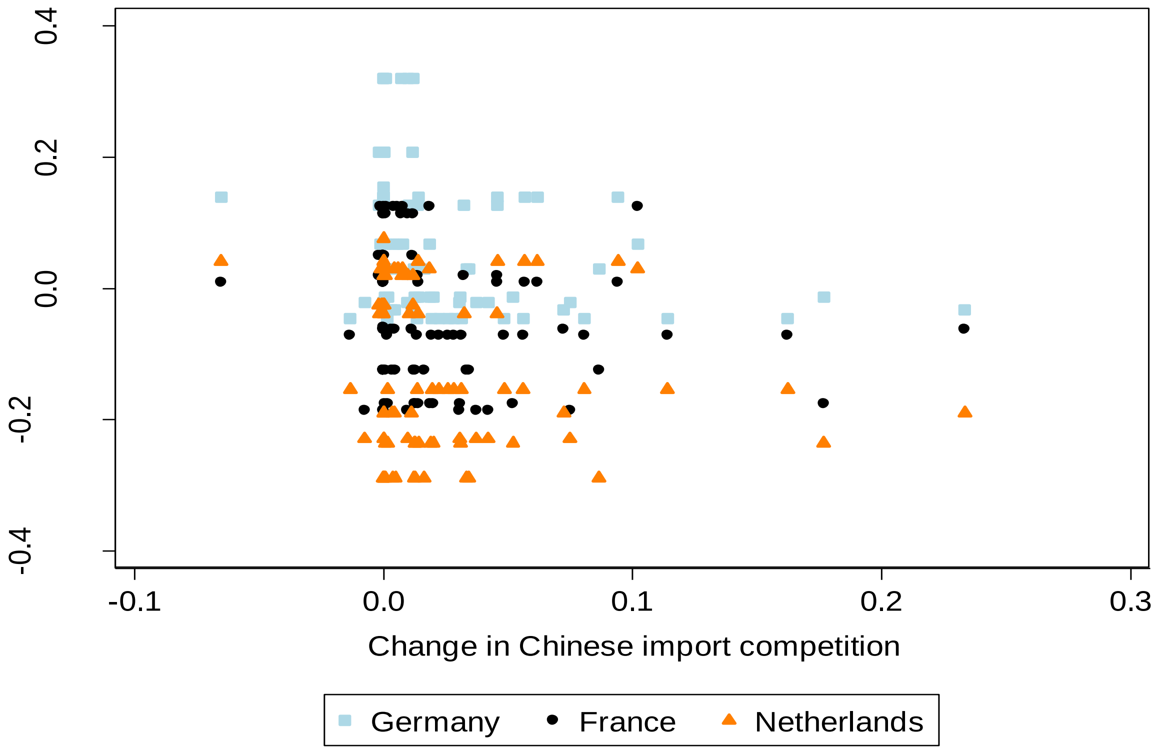
Note: Based on Balance of Payments Statistics from the NBB. In billion euros, raw data series in dashed line, other lines are 3-year moving averages (1997-2012). Top panel includes both intra-EU and extra-EU trade. Bottom panel includes both goods and services trade.

Figure 2: Evolution of productivity for the total Belgian economy



Note: Labor productivity statistics are from Eurostat, unit labor costs from the ECB, and TFP from the EU-KLEMS database.

Figure 3: Two measures of increased international competition



Note: Wages are 'compensation per hour' from EU-KLEMS for 11 industries; import penetration is calculated using detailed Belgian trade statistics from NBB, aggregated to 102 3-digit Prodcom codes. Changes are calculated over the entire 1997-2009 period.

Table 1: Median markups and output elasticities by 2-digit NACE sector

		Output elasticities with respect to:			
		materials	capital	labour	Markup (median)
10	Food products	0.70	0.04	0.21	1.12
13	Textiles	0.69	0.06	0.23	1.02
14	Wearing apparel	0.71	0.03	0.22	1.05
15	Leather and related products	0.73	0.03	0.20	1.06
16	Wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.71	0.03	0.23	1.05
17	Paper and paper products	0.69	0.00	0.31	0.98
18	Printing and reproduction of recorded media	0.63	0.05	0.29	1.06
20	Chemicals and chemical products	0.80	0.05	0.15	1.07
21	Basic pharmaceutical products and pharmaceutical preparations	0.76	-0.02	0.26	1.05
22	Rubber and plastic products	0.75	0.02	0.25	1.06
23	Other non-metallic mineral products	0.72	0.04	0.22	1.10
24	Basic metals	0.62	0.03	0.36	0.94
25	Fabricated metal products, except machinery & equipment	0.69	0.04	0.31	1.13
26	Computer, electronic and optical products	1.31	-0.11	-0.08	2.18
27	Electrical equipment	0.69	0.03	0.27	1.06
28	Machinery and equipment n.e.c.	0.70	0.03	0.26	1.06
29	Motor vehicles, trailers and semi-trailers	0.69	0.05	0.26	0.96
30	Other transport equipment	0.72	0.04	0.26	1.06
31	Furniture	0.70	0.03	0.25	1.10
32	Other manufacturing	0.69	0.04	0.21	1.19
33	Repair and installation of machinery & equipment	0.72	0.01	0.22	1.03

Note : Estimated using algorithm from De Loecker and Warzynski (2012) using a translog production function and assuming labor and the capital stock predetermined. Markup calculated from the output elasticity and revenue share of material input with a correction for the first stage error.

Table 2: Descriptive statistics

	Mean	Standard deviation	Percentiles				
			5th	25th	50th	75th	95th
TFPR	10.76	1.67	6.82	9.99	10.62	12.38	13.03
TFPQ	8.18	3.25	1.91	6.29	8.84	10.39	12.51
$\mu = \ln(P/MC)$	0.05	0.11	-0.08	-0.01	0.04	0.10	0.24
Price	2.57	3.25	-1.86	0.61	1.73	4.22	9.50
MC	2.52	3.25	-1.92	0.54	1.68	4.16	9.46

Note: 52,195 firm-year observations, 6,662 firms; all variables are in logarithms.

Table 3: Pass-through of domestic wages into prices

Dependent variable:	log(P)				log(P/MC)	log(MC)
	(1)	(2)	(3)	(4)	(5)	(6)
Firm-level wage	0.047***	0.023	0.299***	0.290***	-0.011**	0.301***
	(0.015)	(0.017)	(0.003)	(0.017)	(0.005)	(0.020)
Industry-level wage				-0.006	0.050	-0.056
				(0.090)	(0.037)	(0.118)
TFPR		0.078***				
		(0.020)				
TFPQ			-0.952***	-0.952***	0.006*	-0.958***
			(0.001)	(0.005)	(0.003)	(0.004)
Observations	52,195	52,195	52,195	49,779	49,779	49,779
R-squared	0.967	0.967	0.998	0.998	0.735	0.998

Note: Regression includes additive firm, industry, and year fixed effects. Standard errors in parentheses, clustered by sector and year in columns (4) to (6). *** p<0.01, ** p<0.05, * p<0.1

Table 4: Effects of Chinese import competition on several performance dimensions

Dependent variable:	TFPR	TFPQ	Prices	Markup	MC	MC	MC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(a) Chinese import competition measured at the 2-digit level							
CIC 2d	-0.888	-0.166	-0.722**	0.208**	-0.930***	-1.088*	-0.684**
	(0.542)	(0.508)	(0.289)	(0.100)	(0.318)	(0.567)	(0.308)
TFPQ						-0.950***	-0.957***
						(0.005)	(0.004)
firm-level wage							0.305***
							(0.018)
Observations	52,195	52,195	52,195	52,195	52,195	52,195	52,195
R-squared	0.992	0.966	0.967	0.728	0.967	0.998	0.998
(b) Chinese import competition measured at the 3-digit level							
CIC 3d	0.232	1.113**	-0.881**	0.027	-0.908**	0.149	-0.125
	(0.187)	(0.440)	(0.413)	(0.055)	(0.412)	(0.197)	(0.146)
TFPQ						-0.949***	-0.956***
						(0.004)	(0.004)
firm-level wage							0.303***
							(0.016)
Observations	48664	48664	48664	48664	48664	48664	48664
R-squared	0.992	0.966	0.968	0.731	0.968	0.998	0.998

Note: Regression includes additive firm, industry, and year fixed effects as controls. Standard errors in parentheses, in square brackets are clustered by detailed (3-digit) industry.

Table 5: Heterogenous effects of Chinese import competition (CIC) on firm performance

	CIC 2-digit			**CIC 3-digit**		
Dependent variable:	TFPQ (1a)	Prices (2a)		TFPQ (4a)	Prices (5a)	
(a) By initial productivity:	TFPQ	Prices		TFPQ	Prices	
CIC * low	3.507***	-4.339***		1.179**	-1.185***	
	(0.941)	(1.233)		(0.472)	(0.438)	
CIC * medium	-0.078	-0.942**		1.960***	-1.671***	
	(0.617)	(0.462)		(0.531)	(0.467)	
CIC * high	-3.158**	2.445**		-2.976**	3.475**	
	(1.360)	(0.967)		(1.460)	(1.422)	
Dependent variable:	TFPR (1b)	TFPQ (2b)	Prices (3b)	TFPR (4b)	TFPQ (5b)	Prices (6b)
(b) By export status:	TFPR	TFPQ	Prices	TFPR	TFPQ	Prices
CIC * no exports	-1.169*	-1.164*	-0.004	0.113	0.432	-0.319
	(0.618)	(0.666)	(0.376)	(0.213)	(0.275)	(0.294)
CIC * exports, but not to China	-0.945*	-0.016	-0.929***	0.145	1.169**	-1.025***
	(0.565)	(0.544)	(0.346)	(0.210)	(0.462)	(0.380)
CIC * exports, (also) to China	-0.207	1.190*	-1.397**	0.622***	2.257*	-1.635
	(0.421)	(0.674)	(0.587)	(0.226)	(1.256)	(1.253)
Dependent variable:	TFPQ (1c)	Prices (2c)	MC* (3c)	TFPQ (4c)	Prices (5c)	MC* (6c)
(c) By import status:	TFPQ	Prices	MC*			
CIC * no imports	-0.924	-0.352	-0.780**	0.734**	-0.778**	-0.178
	(0.619)	(0.331)	(0.307)	(0.325)	(0.354)	(0.145)
CIC * IMP, not from China	-0.316	-0.581	-0.589*	1.369**	-1.098**	-0.060
	(0.543)	(0.377)	(0.318)	(0.627)	(0.553)	(0.171)
CIC * IMP from China, no interm.	0.129	-0.840	-0.767***	1.255**	-1.022*	-0.276
	(0.695)	(0.601)	(0.283)	(0.637)	(0.583)	(0.184)
CIC * IMP intermed. from China	1.000*	-1.433***	-0.653*	1.233	-0.425	0.099
	(0.554)	(0.463)	(0.357)	(1.172)	(1.126)	(0.256)

Note: All regressions includes additive firm, industry, and year fixed effects as controls. Results in column (5) additionally control for TFPQ and wages. Using the productivity level in the first year they are observed, firms are classified in three terciles. Export and import status are updated annually. Standard errors in parenthesis are clustered at the industry-year level.

Table 6: Impact of wage evolution in trading partners on prices

	partner = Germany			partner = France			partner = the Netherlands		
Dependent variable:	markup	markup	price	markup	markup	price	markup	markup	price
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)	(1c)	(2c)	(3c)
$\log(w_{G/F/N} / w_{Firm})$	0.007			0.011**			0.006		
	(0.007)			(0.005)			(0.006)		
Partner (G/F/N) wage		-0.005	0.012		-0.050	-0.068		-0.182**	-0.168**
		(0.066)	(0.051)		(0.050)	(0.047)		(0.074)	(0.065)
own-wage		-0.007			-0.012**			-0.006	
		(0.006)			(0.005)			(0.006)	
Belgian wage			0.048			0.062*			0.036
(sectoral)			(0.035)			(0.037)			(0.033)
MC			0.989***			0.989***			0.989***
			(0.003)			(0.003)			(0.003)
Observations	49779	52195	49779	49779	51664	49779	52195	52195	49779

Note: Regression includes additive firm, industry, and year fixed effects. Standard errors in parentheses are clustered by

	partner = Germany			partner = France			partner = the Netherlands		
Dependent variable:	TFPR	TFPQ	MC*	TFPR	TFPQ	MC*	TFPR	TFPQ	MC*
	(4a)	(5a)	(6a)	(4b)	(5b)	(6b)	(4c)	(5c)	(6c)
Partner wage	-0.012	-0.065	-0.013	0.256**	0.944***	0.276**	0.562***	0.972***	0.682***
(sectoral)	(0.112)	(0.209)	(0.151)	(0.101)	(0.196)	(0.127)	(0.163)	(0.292)	(0.209)
Own wage	0.302***	0.251***	0.301***	0.301***	0.248***	0.300***	0.299***	0.247***	0.297***
(firm-level)	(0.017)	(0.028)	(0.020)	(0.017)	(0.026)	(0.020)	(0.016)	(0.026)	(0.019)
Belgian wage	0.006	0.201	-0.054	-0.044	0.016	-0.106	0.051	0.270*	0.001
(sectoral)	(0.092)	(0.170)	(0.117)	(0.094)	(0.151)	(0.122)	(0.090)	(0.154)	(0.112)
Observations	49779	49779	49779	49779	49779	49779	49779	49779	49779

Note: Regression includes additive firm, industry, and year fixed effects. Columns (6) additionally contain TFPQ as control. Standard errors in parentheses are clustered by sector.

Table 7: Impact of relative wage evolution on food & beverages sector in border towns

Dependent variable:	TFPR	TFPQ	Prices	Markup	MC* (with TFPQ & wage controls)
	(1)	(2)	(3)	(4)	(5)
(a) Using sector-level wage for Belgium in the calculation of the relative wage:					
[log($w_{Partner}$) - log($w_{Belgium}$)]					
* German border town	0.037	-0.630***	0.667***	-0.014	0.188***
	(0.091)	(0.155)	(0.123)	(0.084)	(0.042)
* French border town	0.097	0.371	-0.274	0.051	-0.045
	(0.157)	(0.275)	(0.243)	(0.054)	(0.139)
* Dutch border town	0.114	0.285	-0.171	0.046	-0.001
	(0.130)	(0.343)	(0.290)	(0.038)	(0.117)
(b) Using firm-level wage in the calculation of the relative wage:					
[log($w_{Partner}$) - log(w_{Firm})]					
* German border town	-0.002	-0.077	0.074	-0.020	0.102
	(0.035)	(0.068)	(0.092)	(0.016)	(0.069)
* French border town	-0.040	-0.084	0.044	0.047***	0.005
	(0.065)	(0.064)	(0.042)	(0.014)	(0.057)
* Dutch border town	-0.039	0.006	-0.044	0.026*	-0.005
	(0.042)	(0.124)	(0.110)	(0.014)	(0.046)

Note: N = 8,489. Each regression includes three explanatory variables of interest, the interactions between the relative wage and the relevant border community dummy constructed at the 4-digit postal-code level. All regressions includes additive firm and year fixed effects as controls. Results in column (5) additionally control for TFPQ and wages. Standard errors in parenthesis are clustered at the postal code level.

Table A.1: Heterogenous effects of Chinese import competition measured at the 2-digit level (CIC 2-digit) on firm performance

Dependent variable:	TFPR	TFPQ	Prices	Markup	MC (with TFPQ & wage controls)
	(1a)	(2a)	(3a)	(4a)	(5a)
(a) Benchmark:					
CIC 2-digit	-0.888	-0.166	-0.722**	0.208**	-0.684**
	(0.542)	(0.508)	(0.289)	(0.100)	(0.308)
(b) By initial productivity:					
CIC * low	-0.831	3.507***	-4.339***	0.344***	-1.042***
	(0.537)	(0.941)	(1.233)	(0.104)	(0.350)
CIC * medium	-1.020*	-0.078	-0.942**	0.220**	-0.730**
	(0.564)	(0.617)	(0.462)	(0.107)	(0.326)
CIC * high	-0.713	-3.158**	2.445**	0.083	-0.331
	(0.527)	(1.360)	(0.967)	(0.101)	(0.277)
(c) By export status:					
CIC * no exports	-1.169*	-1.164*	-0.004	0.289***	-0.631*
	(0.618)	(0.666)	(0.376)	(0.110)	(0.325)
CIC * exports, but not to China	-0.945*	-0.016	-0.929***	0.202*	-0.763**
	(0.565)	(0.544)	(0.346)	(0.106)	(0.325)
CIC * exports, (also) to China	-0.207	1.190*	-1.397**	0.079	-0.550*
	(0.421)	(0.674)	(0.587)	(0.108)	(0.290)
(d) By import status:					
CIC * no imports	-1.276**	-0.924	-0.352	0.268***	-0.780**
	(0.579)	(0.619)	(0.331)	(0.099)	(0.307)
CIC * IMP, not from China	-0.896	-0.316	-0.581	0.156	-0.589*
	(0.551)	(0.543)	(0.377)	(0.108)	(0.318)
CIC * IMP from China, no interm.	-0.711	0.129	-0.84	0.126	-0.767***
	(0.467)	(0.695)	(0.601)	(0.122)	(0.283)
CIC * IMP intermed. from China	-0.433	1.000*	-1.433***	0.241**	-0.653*
	(0.533)	(0.554)	(0.463)	(0.117)	(0.357)

Note: All regressions includes additive firm, industry, and year fixed effects as controls. Results in column (5) additionally control for TFPQ and wages. Using the productivity level in the first year they are observed, firms are classified in three terciles. Export and import status are updated annually. Standard errors in parenthesis are clustered at the industry-year level.

Table A.2: Heterogenous effects of Chinese import competition measured at the 3-digit level (CIC 3-digit) on firm performance

Dependent variable:	TFPR	TFPQ	Prices	Markup	MC (with TFPQ & wage controls)
	(1b)	(2b)	(3b)	(4b)	(5b)
(a) Benchmark:					
CIC 3-digit	0.232	1.113**	-0.881**	0.027	-0.125
	(0.187)	(0.440)	(0.413)	(0.055)	(0.146)
(b) By initial productivity:					
CIC * low	-0.006	1.179**	-1.185***	-0.026	-0.230*
	(0.201)	(0.472)	(0.438)	(0.053)	(0.138)
CIC * medium	0.289	1.960***	-1.671***	0.034	-0.176
	(0.196)	(0.531)	(0.467)	(0.065)	(0.171)
CIC * high	0.499*	-2.976**	3.475**	0.111	0.350
	(0.292)	(1.460)	(1.422)	(0.113)	(0.220)
(c) By export status:					
CIC * no exports	0.113	0.432	-0.319	0.171**	-0.182
	(0.213)	(0.275)	(0.294)	(0.076)	(0.144)
CIC * exports, but not to China	0.145	1.169**	-1.025***	-0.043	-0.029
	(0.210)	(0.462)	(0.380)	(0.059)	(0.168)
CIC * exports, (also) to China	0.622***	2.257*	-1,635	-0.090	-0.232
	(0.226)	(1.256)	(1.253)	(0.095)	(0.256)
(d) By import status:					
CIC * no imports	-0.044	0.734**	-0.778**	0.043	-0.178
	(0.187)	(0.325)	(0.354)	(0.059)	(0.145)
CIC * IMP, not from China	0.270	1.369**	-1.098**	0.007	-0.060
	(0.233)	(0.627)	(0.553)	(0.066)	(0.171)
CIC * IMP from China, no interm.	0.233	1.255**	-1.022*	0.068	-0.276
	(0.219)	(0.637)	(0.583)	(0.079)	(0.184)
CIC * IMP intermed. from China	0.809***	1,233	-0.425	-0.028	0.099
	(0.275)	(1.172)	(1.126)	(0.098)	(0.256)

Note: All regressions includes additive firm, industry, and year fixed effects as controls. Results in column (5) additionally control for TFPQ and wages. Using the productivity level in the first year they are observed, firms are classified in three terciles. Export and import status are updated annually. Standard errors in parenthesis are clustered at the industry-year level.

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