WTO Accession and Firm-level Productivity in Chinese Manufacturing*

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China's policy-makers argued that WTO accession and the deregulation accompanying it would have a beneficial impact on the domestic economy. We exploit cross-sectoral variation in the extent of import tariff reduction and market access to identify the effect on industry and firm-level productivity. The effect on continuing firms is small however we find significant effects on industry-level TFP. These effects are primarily coming through the effect of tariff reduction on domestic prices and the quality of entrants into industry, especially of private firms. This link can be rationalized in the context of a model in which increasing competition following tariff liberalization raises the required threshold of new entrants.

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"The competition arising [from WTO membership] will also promote a more rapid and more healthy development of China's national economy"

Premier Zhu Rongji (Press release, Washington, DC, April 1999)

1. Introduction

China has enjoyed impressive productivity growth in its manufacturing sector for a decade or more (Brandt, Van Biesebrock and Zhang, 2012). In most narratives, China's opening to the international economy and the growth of foreign trade are viewed as key drivers. This process began in earnest in the early 1980s with the establishment of the Special Economic Zones (SEZ) and Economic and Technical Development Zones (EDTZ) in coastal cities. New momentum may have come with China's entry into WTO. Constrained by domestic political economy considerations in their efforts to restructure major segments of industry, Chinese leaders such as Premier Zhu Rongji believed that reforms mandated as a condition for WTO accession would be a catalyst for further change.[1]

Drawing on a firm-level data set that spans the period 1995-2007, our primary purpose is to analyze the effect of several dimensions of these policy reforms on firm and industry-level productivity. The central hypothesis we wish to examine is whether the high productivity we observe in the manufacturing sector can be linked to WTO-related policies; and if so, through what channels. China entered the WTO at the end of 2001, but many policy changes actually predate its entry. We collected information on import tariffs, non-tariff barriers and FDI restrictions over the entire period and investigate the channels through which policy changes may have mattered. Figure 1 illustrates the high productivity growth in Chinese industry over this period, as well as the significant dispersion in average annual TFP across manufacturing sectors between 1998 and 2007.

In our analysis, we focus on those reforms efforts that worked through influencing domestic (Chinese) market access rather than through affecting China's access to overseas markets and

[1] The message in the above quote, made after ironing out final details about the WTO accession with President Clinton, is echoed by several researchers. For example, Lardy and Branstetter (2008, p. xx) also view more competition as an essential source of pressure that forced structural reforms.

exports. Our rationale for doing so is two-fold: First, over the period we examine, eighty percent of China's manufacturing output was consistently sold in the domestic economy (Brandt and Thun, 2010). Exports are an important part of the Chinese economy, but even more important is manufacturing directed to the domestic market. Moreover, through the processing trade, which represents in upwards of 60% of China's trade, Chinese exporters already benefitted from tariff-free imports of intermediates and capital goods. Second, even before entry into WTO, China enjoyed the benefits of MFN, albeit on an annually-renewable basis.[2] Elimination of this uncertainty likely had beneficial effects on Chinese firms, but these benefits are much harder to quantify and we conjecture likely smaller in comparison to those coming through their effect on the domestic market.

To make the argument credible, we need an identification strategy that causally links policy changes to performance changes. Reverse causality due to policy endogeneity is an intuitive and often plausible alternative explanation for a positive correlation between policy and performance changes (Besley and Case, 2000). Policy makers might have lowered import tariffs selectively after learning which sectors are likely to enjoy strong productivity growth and thus be able to cope with increased foreign competition. We argue that the striking uniformity of the post-reform import tariff rates makes this reverse causality an unlikely explanation for the correlation. Policy changes are almost entirely the result of moving all sectors to the same (low) level of tariff protection, making endogeneity a less serious issue. This argument is further discussed in Section 2.

The sheer size of our data set helps to pin down the effects of liberalization. We observe the universe of state-owned firms and all other firms (collective, private and foreign) with annual sales above 5 million RMB. Limited to the manufacturing sector and the 1998 -2007 period, this results in a sample of 2.05 million observations across 536,945 unique firms. As a result, we can include highly disaggregated 4-digit industry fixed effects and lagged tariff levels without losing all identifying power. The firm data and the construction of the productivity estimates are described in Section 3, as well as the information on tariffs, price changes, and imports.

[2] In the EU, there was no annual renewal process, but it is highly likely that the surge of Chinese imports in Europe post-2001 would lead to reinstatement of discriminatory tariffs. The EU response after the end of the MFA for apparel and textile serves as a good example.

Entry into WTO required a large reduction of import tariffs, as well as the elimination of numerous non-tariff barriers (NTBs). Trade liberalization was accompanied by a lessening of restrictions on foreign direct investment (FDI). In estimating the effects we focus primarily on the role of import tariff reductions, which are observed most accurately, but also look for links with the other two. More broadly, and to the extent that changes in NTBs and FDI restrictions are correlated with tariff reductions, their effects will be subsumed in the tariff liberalization effects.

To build confidence in our argument, we examine carefully the mechanism through which the policy had its effect. In principle, import tariffs could matter in two ways: first, through their effect on prices and quantities of imports that compete with locally manufactured goods in the domestic market; and second, through the prices (as well as quality and variety) of imported intermediate goods (Topalova and Khandelwal 2011). In general, we expect these effects to be heterogeneous across firms.

In Section 5 we present effects of tariff liberalization on several dependent variables using the same basic empirical model for each. These results establish that the cross-sectoral variation in tariff liberalization was only weakly related to the variation in import growth, while the link with sectoral price declines is very strong. Despite very low import shares for inputs, input tariff cuts are passed-through one-for-one into the input price index. In the short run, domestic firms can accomplish such price reductions by lowering price-cost margins, which we also find linked to tariff liberalization, but in the long run they must be backed up by productivity increases. Tariff reduction plays an important role here, however the association between productivity growth and tariff cuts is much stronger at the sector-industry level than it is at the firm level.

There are several potential reasons for the much stronger relationship at the industry level, most notably, the reallocation of resources among firms, as well as the influence of net entry. In section 6, we decompose productivity growth into three major components, and examine their individual links with tariff liberalization. And here we find a strong link between tariff liberalization and the contribution of net entry to sector productivity. Moreover, this effect is working primarily through the entry of higher productivity private firms. Over this period private sector entry is sizeable in nearly all sectors, but our analysis suggests that the "quality" of the entrants is heavily conditioned by the degree of competition they face. Falling tariffs effectively raise the productivity thresholds these firms must achieve in order for entry to be profitable.

2. Liberalization of China's Foreign Trade and Investment Regime

2.1 Evolution of the policy regime

In the late 1970s China embarked on a radical economic reform path that opened its economy to the rest of the world. Beginning in 1980 with the establishment of the four Special Economic Zones (Shenzhen, Xiamen, Zhuhai, and Shantou) and in 1984 with the setting up of Economic and Technical Development Zones in fourteen coastal cities, China encouraged foreign direct investment (FDI) as a means of developing a manufacturing export sector through the importation of much-needed capital, managerial know-how, and technology. Outside of these zones it allowed for the importation and licensing of new technologies and capital goods as part of a policy of modernizing existing domestic enterprises. China concurrently began to reduce tariff and non-tariff barriers to trade, and to extend direct trading rights to firms, culminating in its entry into the World Trade Organization (WTO) in 2001. China's renewed openness combined with domestic economic and institutional reform initiatives served as important catalysts to economic growth which has averaged nearly 8 percent per annum in terms of GNP per capita.

2.2 Quantifying the reduction in protectionism

Branstetter and Lardy (2008) observe that even before China's accession to WTO at the end of 2001, China's manufacturing sector already experienced a high degree of openness. There are several dimensions to this. First, as part of a policy of encouraging FDI for exporting, China allowed the duty-free importation of raw materials and parts and components involved in export processing. Exemption of import duties was further expanded in the late-half of the 1990s to certain type of domestic firms and organization. Branstetter and Lardy (2008) report that less than 40 percent of all imports were subject to tariffs in 2000. Second, beginning in the early 1990s, China began to lower their domestic tariffs. From an average of 43.2 percent in 1992, by 2001 the average tariff at the 8-digit HS level fell to 15.3. This was accompanied by a reduction in the imports regulated by non-tariff barriers through licenses and quotas (Branstetter and Lardy, p. 635). In Figure 2 we indicate the evolution of the fraction of sectors covered by an average import tariff in excess of fifteen percent or that contain a product subject to a nontariff barrier or FDI restriction (or prohibition).

Import tariffs are reported at the 8-digit level of the Harmonized System product classification. To use these in the firm and industry level analysis, we map them into China's Industrial Classification (CIC) system at the 4-digit level.[3] To avoid a bias in the sectoral average by the low trade volumes in heavily protected product lines, we use unweighted averages. Input tariffs are a weighted average of output tariffs, using industry-input shares from the 2002 Input-Output table. Reflecting the higher level of aggregation of the Chinese IO table, our input tariffs are effectively at the 3-digit level. By constructing a consistent industry classification over time, accounting for the important reforms in 2003, we obtain a measure of inward tariff protection at the industry that is comparable over the 1992 to 2007 period.

Drawing on annual circulars released by the Ministry of Foreign Trade and Economic Cooperation and the Ministry of Commerce, we also assembled information on the licensing of imports and exports. The measure of non-tariff barriers used in Figure 2 is the fraction of sectors, at the 4-digit CIC level, that contains at least one 8-digit HS product subject to an import license. It declined from 15.3% in 1997 to 1.2% in 2007 after a brief rise to 22.6% in 2000. The average fraction of products subject to such a license is much smaller, falling from 5.5% to 0.04% over the same period.

Information on FDI restrictions comes from the same source. Sectors can be subject to an FDI restriction or a total prohibition and the indicator in Figure 4 captures both forms. The total number of sectors subject to some form of FDI restriction declines from high of 87 (out of 425 sectors) in 1997 to 47 in 2007. The decline is more rapid for the restrictions than the prohibitions, which made up one fifth of the total in 2007.

The cross-sectoral correlation between the incidence of different forms of protection is positive in 1997—a partial correlation of 0.27 between NTB and FDI restrictions, 0.16 for NTBs and tariffs over 15%, but no correlation between FDI restrictions and tariffs. By 2007, however, all correlations have become very weak and not statistically significant from zero. The reduction

[3] We build on an HS-CIC concordance table created by the NBS, which we extended to CIC sectors and HS codes not included in the original table. We also correct about 100 mistakes in the original concordance. Changes in the HS system in 2002 affecting nearly ten percent of all product lines and in the CIC system in 2003 required us to construct multiple concordances between goods (HS) and sectors (CIC).

between 1997 and 2007 in the different forms of protection is somewhat similar across sectors, with bilateral correlations of the changes all between 0.1 and 0.2.

Figure 3 summarizes the evolution of average input and output tariffs over the entire 1992-2007 period. Several patterns stand out. First, output tariffs tend to be substantially higher than input tariffs. The large difference is reflective of very different treatment of final goods from raw materials, intermediates inputs, and capital imports. As a result, effective rates of protection are considerably higher than the stated tariff rates. Second, tariff reduction has proceeded in two spurts—with large and widespread reductions between 1992 and 1997 and in 2002—and more heterogeneous and gradual reductions in the 1997-2001 and 2002-2007 periods. Tariff reductions became more predictable as negotiations proceeded, and after WTO entry the reductions followed a predetermined pattern. And third, by the end of the period, the average difference between input and output tariffs declined to less than four percentage points. Combined with the rising share of value added in total output, this contributes to a gradual reduction in the effective rate of protection.

The average evolution hides important variation across industries that we can use to identify effects. The dashed lines illustrate that industries still differ significantly in the protection they receive, but also that the experience of different sectors is likely to have differed substantially. In addition to the average decline, Figure 4 highlights the important tariff compression.

3. Literature, empirical model, and estimation

3.1 Literature

Much of the literature focuses on the potential positive effects of broad-based tariff reductions on domestic industries. One channel featured prominently in the early literature is the role of foreign competition in exerting downward pressure on price-cost margins.[4] Studies using either accounting measures of price-cost margins or an adaptation of the Hall methodology to parameterize the average mark-up as a function of trade protectionism systematically find evidence of downward pressure on these margins. Roberts and Tybout (1996) contains studies for four developing countries that use accounting measures, while Levinsohn (1993), Harrison

[4] See Tybout (2003) for a review of the theory and evidence behind this mechanism.

(1994), and Krishna and Mitra (1998) utilize the second methodology in analysis of Turkey, Cote d'Ivoire, and India.

The effect of trade liberalization can also work through size rationalization: Smaller firms are forced to exit and production at higher scale is more efficient. Firm-level studies found support for this mechanism following the Canada-U.S. FTA (Head and Ries 1999; Baggs 2005), but not in Mexico (Tybout and Westbrook 1995). In a recent study revisiting the Canadian experience, Baldwin and Gu (2008) find an effect of liberalization on the size of production runs within plants, pointing to an important within-plant scale effect.

These effects at the extensive margin are consistent with the heterogeneous firm model of Melitz (2003). Each firm operates at a constant level of productivity, but as trade barriers fall and firms enter the domestic market, the minimum threshold level of productivity that the marginal firm needs to achieve to survive rises. In the context of Columbia's trade liberalization experience, Eslava *et al* (2004) show that mechanism is a quantitatively important channel. The reallocation of inputs and outputs is not limited to firm entry and exit however. Hsieh and Klenow (2009) demonstrate that market distortions tend to be larger in developing countries like China or India than in the United States, resulting in a wider dispersion of productivity among active firms. This suggests that as competition increases following trade liberalization, the scope for productivity improvement through factor reallocation among firms is likely to be larger in these countries.

In these mechanisms, trade liberalization can improve aggregate productivity even without any change at the micro level. To raise long-run productivity growth, firm-level changes are needed. For example, stronger competition could force firms to improve technical or allocative efficiency. Investment in new technology can do the same, but the loss in domestic market share to imports works in the opposite direction and lowers investment incentives. If trade liberalization is part of a bilateral agreement, increased market access in the trading partner's economy could provide investment incentives, as in the Canada-U.S. FTA that Lileeva and Trefler (2010) study. In a more open economy, firms must also satisfy more demanding clients, either overseas or locally (Javorcik, 2004).

Goldberg, *et al.* (2010) adopt a production structure from endogenous growth models that features a declining domestic production cost in the number of imported input varieties.

Following trade liberalization and the expansion of the range of imported products, the domestic industry endogenously raises its productivity and is able to introduce more new products for export as well. The Indian experience provides evidence for the importance of this mechanism. They estimate that lower input tariffs account for almost one-third of new product introductions, driven primarily by increased firm access to input varieties. In the case of Indonesia, Amiti and Konings (2007) find stronger firm-level productivity effects of input tariff cuts than for output tariffs.

To identify the effect of trade liberalization on productivity, most studies follow a two-step approach. In the first stage a productivity measure is constructed, which in the second stage is regressed on measures of trade liberalization, trade flows or tariff levels. The second stage regression can be run in levels, as in Pavcnik (2002) for Chile, but often firm-fixed effects are included. [5] Trefler (2004) uses double (time) differences. Studies differ in the use of tariff rates or trade flows as measures of trade liberalization, in the way productivity is constructed, and in the extent to which they are able to control for demand side factors in the regression. Identification always comes from differences across industries in the extent of the liberalization, i.e. the different pattern of changes in protectionism across industries.

Schor (2004) and Amiti and Konings (2007) follow a similar approach, studying the experience of Brazil and Indonesia, but they include in their regression the level of tariff protection on a sector's intermediate inputs. Both studies find that tariff reductions on inputs are more effective in raising productivity than tariff cuts on outputs. Allowing for separate effects by productivity deciles, Schor (2004) highlights the relatively stable and positive effect on productivity of cuts in input tariffs through the productivity distribution. Output tariff reductions, however, improve productivity at the bottom of the distribution, but diminish it at the top.

Heterogeneous effects of trade liberalization can be rationalized by a model of endogenous technology adoption, as in Ederington and McCalman (2009), which formalizes an earlier critique of Rodrik (1992). Heterogeneous firms decide when to adopt a technology improvement, which depends crucially on their expected market share as the fixed costs of adoption have to be recovered. As trade liberalization increases the expected degree of competition, and reduces the

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[5] Other studies that follow the same basic set-up are Eslava, Haltiwanger, Kugler and Kugler (2004) and Fernandes (2007) for Colombia, and Sivadasan (2009) and Topalova and Khandelwal (2011) for India.

firm's expected market share, some less productive firms will postpone adoption. Firm characteristics that are related to fast technology adoption and indirectly to high productivity levels will enhance the productivity boosting effects of trade liberalization. Ederington and McCalman (2009) finds support for this effect in the case of Colombia, but note that the effects are in the opposite direction of those in Schor (2004): "An increase in tariff barriers should result in larger firms, exporting firms and younger firms having higher productivity growth". (p. 18)

3.2 Empirical specification

In light of the previous discussion, we will estimate equations of the form:

$$\Delta^k \ln X_{st} = \ln X_{st} - \ln X_{st-k} = \beta_1 T_{st-k} + \beta_2 \Delta^k T_{st} + \alpha_t + \varepsilon_{st} . \quad (1)$$

Trade protectionism (T) will be measured using either the import tariff or the effective rate of protection. As suggested by Figure 4, the effective rate of protection tends to be higher and declines more as tariffs are generally lower for inputs. In our analysis, we will use the same two explanatory variables: lagged tariffs and the first difference in rates of protectionism. The former informs us to what extent the cross-sectoral pattern of the dependent variable is associated with initial rates of protection, while the latter captures the association between tariff declines and changes in the dependent variable, controlling for both the initial rate of protectionism and an unobserved but constant industry effect.

Equation (1) can also be estimated in levels with industry fixed effects. This will be particularly useful when we estimate versions of (1) with dependent variables such as trade flows, prices, or contributions of alternatives sources of sector productivity growth, where the level has a more intuitive interpretation than the growth rate. We can also run the regression at the firm level with firm fixed effects.

Interpretation of β_2 as the causal effect of, for example, tariff reduction on productivity growth, depends on the endogeneity of the policy change. Some authors have relied on the unexpected nature and the broad-based implementation of policy change (see Trefler, 2004 for Canada). Tariff cuts affecting all sectors are announced suddenly and applied quickly thereafter, leaving individual industries little time to lobby for exemptions or preferential treatment.

Industry or even plant-fixed effects can also be used to absorb heterogeneous factors that are correlated with the reduction in protectionism. Fernandes (2007) utilizes this strategy in her analysis of Colombia, and also uses lagged measures of the tariff changes, as these are less likely to be correlated with contemporary productivity shocks. Trefler (2004) goes one step further to control for potential endogeneity and uses double-time differences. He looks for an effect of the change in protectionism on the change in productivity growth.

Instruments for tariffs that are unlikely to be correlated with productivity changes can also be used. Trefler (2004) uses the share of unskilled labor in total employment as a proxy for the likelihood that a sector organizes itself and tries to block tariff liberalization.

3.3 Endogeneity of tariff reductions

In their study of Indonesia, Amiti and Konings (2007) use the initial tariff level as an instrument for the change in tariffs. The underlying assumption is that policy-makers did not discriminate between sectors and basically lower tariff protection to the same low level for each industry. Thus, the change in tariff reduction is entirely explained by the initial situation, not by policy discretion. Topalova (2007) makes a similar argument in her study of poverty and inequality in India.

This last argument largely fits the Chinese case. In Figure 4 we show the change in import tariffs against the initial level of protection. The top panel shows the change between 1992 and 2007, which covers the full period of China's trade liberalization. The dispersion of protection across sectors is extremely wide in 1992, with nine sectors receiving protection of more than 100 percent. By 2007, only a single industry has an import tariff above 40 percent and only nine exceeded 25 percent threshold. As a result, the relationship between tariff reduction and initial protection is almost one-to-one. The dashed line has a slope of minus one and the solid line, which represents the prediction of a simple linear regression, has a slope of -0.84.

The results highlight that viewed from the perspective of the full period there was limited policy discretion in the implementation of the trade liberalization. In 1992 the average tariff rate was 43.8 percent with a standard deviation of 28.0 percent; the reduction in the standard deviation by 2007 to 7.0 percent is equally remarkable as the average reduction to 9.9 percent.[6] Moreover, the partial correlation between protectionism in these two years is extremely high—

[6] Another indicator for the lack of dispersion in 2007 is that half of all sectors received an import tariff between 5.3% and 13.5%, for an interquartile range of only 8.2% wide. The comparable range in 1992 was 40%.

0.70—suggesting that the dispersion in 2007 is well explained by the initial dispersion. Including industry-fixed effects in our regressions will help absorb any differential treatment across sectors constant over time. However, the second panel of Figure 4 indicates that the situation is not as clean in the post-WTO period. Towards the end of the sample period there is slightly more heterogeneity in the extent of tariff reduction across sectors.

Results in Table 1 from annual regressions of tariff levels in 1995, 2001 and 2007 on industry characteristics are largely consistent with this description of the process. Explanatory variables include the kinds of goods being produced (intermediate, capital or consumer goods), product complexity, capital and skill intensity of the same sectors in the US, and finally, initial characteristics of these sectors in China, namely, skill and capital intensity, employment, ownership mix, and market concentration. Coefficient estimates in column (1) for 1995 indicate that sectors dominated by intermediate and capital goods received less protection, as did sectors that in the U.S. are more capital and skill intensive. One explanation for the low tariffs on intermediates and capital goods is their role in firm upgrading.[7] The influence of a number of "China-specific" characteristics likely reflect early political economy considerations: Capital-intensive, more concentrated sectors enjoyed higher levels of protection, as did those sectors largest in terms of manufacturing jobs. Controlling for these attributes, however, sectors in which SOEs were more prominent did not enjoy more protection. In fact, the coefficient is negative, albeit insignificant. In all, the R-squared for the cross-sectoral regression in 1995 was approximately 0.50, a reasonably good fit.

In columns (2) and (3), we report analogous regression results for 2001 and 2007. By and large, the results are consistent with an across-the-board and indiscriminate lowering of tariff rates. Nearly every single coefficient becomes smaller in absolute value and less statistically significant. By 2007, none of the industry characteristics that are China-specific at the bottom of Table 1 are still significant predictors of tariff differences. The only two characteristics that are important statistically are product complexity (positively) and skill intensity (negatively).

Finally, we investigate if any of the variation in the reduction of import tariffs illustrated in Figure 4 is related to initial productivity levels, which would be the case if policymakers reduce

[7] Duty free imports for capital goods and intermediates used in export processing may have also mandated lower tariffs on these kinds of goods in order to prevent diversion from export processing to the rest of the economy.

tariffs mostly in competitive industries that are expected to be able to withstand foreign competition. Following Topalova and Khandelwal (2011) we run simple regressions of alternative measures of current protection on lagged levels of productivity. We perform this analysis at the industry-level separately for the pre- and post-WTO period and report the coefficient on lagged productivity (TFP) in Table 2. For the pre-WTO period, the coefficients on our tariff measures are typically positive, but insignificant, and provide some suggestion that trade protection is lowest in those sectors that used to have lowest productivity. As such, any association between tariff reductions and subsequent productivity gains is unlikely to be the result of reverse causality. Note however that for the pre-WTO period the relationship between TFP and NTBs is negative, implying that non-tariff barriers, which were much more selectively used, were less likely to be found in sectors with higher productivity. The columns on the right, which are for the post-WTO period, more broadly indicate that protection—both tariffs and NTBS--are lower (higher) for sectors that previously had higher (lower) productivity.

Policy endogeneity can thus not be totally ruled out, especially in the post-WTO period. This is consistent with anecdotal evidence that the policy-setting process over commitments to reduce tariffs and NTBSs with entry into WTO became more politicized and subject to lobbying. Generally speaking, and in the context of continued reduction in tariff levels, China succeeded in obtaining smaller scheduled post WTO reductions in sectors with lower pre-WTO TFP. In the regressions investigating an impact of tariffs (or NTBs) on productivity, it will be important to include lagged levels of protectionism to control for these effects. We will also need to be careful in providing a causal interpretation to the post-WTO results.

4. Data

We use annual firm-level data for 1995 and then 1998-2007 for all state-owned industrial firms and non-state owned firms with sales above 5 million RMB. The information is collected through annual surveys by the National Bureau of Statistics (NBS) and discussed in detail in Brandt et al (2012). Aggregates for employment, sales, capital, and exports for these firms match almost perfectly the totals reported annually in the China Statistical Yearbook. Compared to the universe of firms observed in the 2004 Economic Census, our sample of "above-scale" industrial firms represents the bulk of industrial activity in China. In 2004, these firms accounted for 91 percent of the gross output, 71 percent of employment, 97 percent of exports, and 91 percent of total fixed assets.

For the analysis in the paper, we focus on manufacturing firms with more than eight workers.[8] A change in the firm IDs in 1998 makes it impossible to link firm level information for1995 with the later years, but we include data for 1995 in the industry-level analysis. For the period between 1998 and 2007, we observe an unbalanced panel of firms that increases in size from 145,511 firms in 1998 to 311,323 in 2007. As firm identifiers often changed as they went through restructuring or M&A activity, we supplement the firm IDs with information on the firm's name, sector, and address to establish links over time. On average, we match 6 percent of the firms on the basis of this information. To account for changes in the Chinese Industry Classification (CIC) codes in 2003, we merged some industries to obtain a consistent classification of sectors over the entire sample period.

The dependent variable in much of the analysis is productivity growth for industry *s*, calculated as

$$\Delta\ln P_{st} \equiv \Delta\ln Y_{st} - \bar{w}_s \, \Delta\ln L_{st} - \bar{m}_s \, \Delta\ln M_{st} - (1 - \bar{w}_s - \bar{m}_s) \, \Delta\ln K_{st} \, . \qquad (2)$$

The share-weighted growth in inputs is subtracted from output growth, using the industry-specific average wage share in output in the two years over which the growth rate is calculated ($\bar{w}_i$) as the weight, and similarly for the material share $\bar{m}_i$.[9] In robustness checks using a value-added production function, the material input is omitted from equation (2) and value added is used instead of gross output in the first term. One, two and three-year differences are used. Similar calculations at the firm level produce the index-number productivity measure used in Brandt et al. (2012). The factor shares are now the firm-specific averages over the two years. In robustness checks, we use parametric productivity estimates that rely on the proxy-estimator from Olley and Pakes (1996).

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[8] We drop the few firms with fewer than eight employees as they fall under a different legal regime.

[9] Labor is measured as total employment and the real capital stock series is constructed using the same algorithm as in Brandt et al. (2012). Employee compensation consists of wages and from 2003 onwards also supplementary benefits. These measures of compensation likely underestimate total payments to labor. Labor's share of value added is only 28.3 percent on average, while the national income accounts suggest an overall share of labor of around 50 percent. The correct share for manufacturing is likely to be intermediate and in Brandt et al. (2012) we experimented with adjustment factors.

We use the official two-digit output price deflator for gross output, which is available for the entire time period. An input price deflator is constructed by weighting output prices by input shares from the 2002 Input-Output table. Real value-added is constructed by double-deflating gross output and input costs using the appropriate deflators.

In the empirical analysis, we utilize information on a firm's registered type (*qiye dengji zhuce leixing*) to construct ownership categories. We group firms into five categories: state, hybrid (township & village enterprises, local government owned, etc.), private, subsidiaries of firms from Hong Kong, Macao or Taiwan (HMT), and foreign-owned firms. When ownership is mixed, we use the following order to categorize firms: foreign, HMT, state, hybrid, private.

We also use information on import volumes at the industry level. These data are aggregated up from a data set containing the universe of firm-level trade transactions covering the 2000-2006 period – Manova and Zhang (2012) provide extensive details on the data set. In principle, we could use information from UN Comtrade to conduct an analysis over a longer time period, but that would not enable us to distinguish between export processing and ordinary trade. Given that the large fraction of trade entering the country under the trade processing regime is exempt from import duties, it is often important to isolate imports flows that are actually subject to import tariffs.

The source and construction of the information on alternative forms of protection---import tariff rates, non-tariff barriers, and FDI restrictions—was discussed in Section 2.2.

5. Effects of tariff reductions

5.1 Import volumes

In order to analyze the effect of tariff changes on import volumes, we utilize equation (1), only now with the level of imports as our dependent variables. Table 3 documents the results of these regressions at the 4-digit CIC industry for the period between 2000 and 2006.[10] To help put this in context, over this period imports of manufactured goods increased three and a half fold. In column 1 we report results for the effect of tariffs on total imports. The coefficient of -1.53 implies that a one percentage point reduction in output tariffs is associated with an increase in

[10] We utilize the trade transaction data and aggregate up to the 4-digit CIC level on the basis of a correspondence we constructed between the 8-digit HS and CIC

imports in the same sector of 1.53 percent. Use of imported intermediates is elastic with respect to tariffs, but the coefficient is small in absolute value if one believes that China is a price taker on world markets. The low precision of the estimate is also noteworthy: Despite significant variation in the explanatory variable, the coefficient is not significant at the 10 percent level.[11]

One possible explanation for the small and insignificant estimate is that a sizable portion of imports, most notably, those goods coming in as part of the processing trade, enter duty free. In the next two columns of Table 3, we disaggregate imports and report results separately for "processing" imports and imports by ordinary trade. As we expect, the point estimate is significantly larger in the case of ordinary trade, 1.95 against 0.45 for processing trade, but the estimate is still not statistically significant for ordinary trade. Lags in the time it takes for imports to respond to tariff cuts may be responsible, but the results in the last column relating two-year import growth rates to tariff cuts over the same two-year period are virtually identical. Industries with higher levels of tariff protection import less, significant at the 10 percent level, but reductions in tariffs are only weakly related to higher imports, even over a two-year period.[12]

To examine import behavior at the firm level, we match our industry firm-level sample to information on all trade transactions in the customs records.[13] We use the BEC system to identify imports that are unprocessed or processed intermediate goods (categories 22, 42, and 53) or materials (categories 21 and 31), and obtain a firm-level estimate of intermediate inputs that are directly imported. We use this information in two ways: first, to estimate the fraction of manufacturing firms that use imported inputs, and second, dividing imported intermediates and materials by the total reported use of raw materials and intermediates in the enterprise data, to calculate the share of all inputs that consist of imports.

[11] We have run the same regressions using as unit of observation the much more detailed 6 or 8-digit HS classification system of goods which requires less or no aggregation of tariff rates. The results are qualitatively similar. The point estimates are larger, but still not significantly different from zero. For consistency with the results using other dependent variables, we have reported the industry-level results in Table 3.

[12] Looking for trade responses by different Broad Economic Categories (BEC) of goods revealed small, but insignificant differences with the trade response largest for materials and unprocessed intermediate inputs.

[13] In 2006, more than two-thirds of all the import flow by value is accounted for. The balance is imports by firms that could not be matched, and more significantly, imports by trading firms that act for firms importing indirectly and by non-manufacturing firms, e.g. retailers. Over time, the role of trading companies declined as a growing percentage of firms obtained direct trading rights. This suggests that the figures reported in Table 4 may overestimate the increases in either the percentage of firms using imported intermediate goods, or their share of inputs.

Descriptive statistics in Table 4 illustrate that imports of intermediates remain relatively low over the entire 2000-2006 period despite the huge overall increase in imports. The percentage of firms directly importing any intermediates or materials rose only slightly form 11.2 percent in 2000 to 12.9 percent in 2006. Similarly, we observe relatively modest increases in the share of imported intermediate used by firms, which increases from 7.8 percent of total intermediates in 2000 to 9.4 percent in 2006. Breaking total imported intermediate goods into duty-free imports used by export processing firms, and imports coming in through ordinary trade, we find that almost the entire increase in the participation rate comes from ordinary trade. As for the share of imported intermediates, the two types of trade experience similar increases, but use of imported intermediates as part of ordinary trade remains less than half as important as duty free imports.

These estimates conceal huge differences in the use of imported inputs across ownership types that narrow only marginally over this time period. In 2006 more than half of all foreign firms in our sample are directly importing intermediates—similar to 2000-- compared to only 3 percent of private firms, and 4 percent of SOEs. On average, slightly less than twenty percent of intermediate goods used by foreign firms were directly imported; for domestic firms it was less than one percent. Firm level regressions (not reported) for imports that allow for differences by ownership, involvement in the processing trade, and their interactions reveal that non-export processing private firms and FIEs are the most sensitive to reductions in intermediate goods tariffs, but in 2006, the last year for which we have data, these imports represented only 0.7 percent of total intermediates used by this group of firms.

In summary, following very significant tariff reductions, we observe only a limited impact on trade flows. Rapid growth in domestic Chinese manufacturing production leads to greater absolute imports of raw materials, intermediates and capital goods, but the increased inflow is only weakly related to reductions in trade protection. This behavior is in sharp contrast with the large effects of this channel documented for India in Goldberg et. al. (2010). The effect of trade liberalization on domestic firms does not seem to run through a loss of market share to importers, which often features prominently in theory models.

5.2 Price Levels

Limit pricing by domestic Chinese firms provides one possible explanation for the muted response of trade flows to tariff reductions. The work of Salvo (2010) on the Brazilian cement industry illustrates this can be an effective competitive response to trade liberalization. Rather than share the domestic market with imported products, domestic firms lower their prices to keep imports at bay. The adjustment to a tariff cut is then shifted from the quantity to the price dimension.

We once again use equation (1), but now with the change in the domestic output deflator as our dependent variable. The Chinese National Bureau of Statistics calculates the deflator at the 2-digit CIC level for the entire sample period (1995-2007). Brandt et. al. (2012) calculated a more detailed 4-digit price deflator, but this is only available for the 2000-2005 period. We use the more aggregate series to extend it to the end of the sample period. To facilitate interpretation of the point estimates we also express the price changes in the dependent variable in percentage point reductions, as opposed to percentages in the previous Table.

Results in Table 5 suggest that the effect of tariff cuts on domestic prices is both large and estimated very precisely. The two alternatives deflators give similar results: a one percentage point decline in the sector tariff reduces the annual price deflator by 0.23 to 0.30 percentage points. Over a two year period, responses are larger, especially based on the more disaggregate series, which rises to 0.49. The estimation precision is slightly higher for the more disaggregate series, but for both price deflators the difference with the results for import volumes in Table 3 is pronounced: The t-statistics are four times as higher than before.

In the next two columns of Table 5 we regress the change in the input price deflator on the input tariff reductions. The two series are calculated by pre-multiplying the vector of output prices or tariff rates by the input-output matrix. As a result, both input series are a weighted average of the output series using the sectoral input shares as weights. The regressions again produce positive and highly significant point estimates, but the absolute magnitudes are much higher than for the output series. As the share of imported intermediates in total inputs is approximately ten percent, the point estimate should be 0.10 if domestic prices did not change in response and the pass-through of tariff reductions was one. However, the point estimates are much higher and for the disaggregate series near unity. This implies that each percentage point reduction in tariff rate shows up one-for-one in the input price deflator covering both domestically produced and imported intermediates. Domestic producers must have responded strongly to the trade liberalization. For output prices, the point estimates also exceed the import penetration, but the difference is less pronounced. Price competition for intermediate inputs might be much stronger. In the final goods markets domestically produced and imported products often compete in different market segments thereby giving domestic firms slightly more market power.

To investigate what these effects on domestic prices imply for the price-cost margins we adopt the framework of De Loecker and Warzynski (2012). They exploit the observation that cost-minimizing firms will equate the output elasticity of each variable input to the revenue share of that input, adjusted for the marginal production cost. This holds (locally) for any production function and demand system. In a simple Cobb-Douglas production function it implies that the optimal price-cost margin has to equal α_L/s_L, the ratio of the labor coefficient in the production to the wage share in revenue. The change in the logarithm of the firm-specific price-cost margin can thus be measured by the negative of the change in the wage share in revenue and we can use this as dependent variable in regression (1).

In panel (d) of Table 5 we present the estimates using the change in ERP as the explanatory variable. Either with or without including year fixed effects, the results indicate that price-cost margins are lower when trade protection is reduced. The data suggest that, faced with lower trade barriers, firms increased payments to labor as a percentage of total revenue. The interpretation from the model is that formerly a fraction of the marginal product of labor was appropriated by the firm as profits. Following the liberalization, the firm's ability to earn rents is reduced and the share of revenue that labor is able to capture increases. In the limit, for perfect competition, this share should converge to the output elasticity of labor in the production function. The point estimates are intuitive and consistent with the direct evidence we find on price levels, but the effects are not estimated very precisely.

5.3 Productivity growth at the firm-level

The previous results suggest that Chinese firms responded to trade liberalization only modestly by conceding market share to imports, and more pronouncedly by lowering domestic prices. In the short run, this can be achieved by lowering price-cost margins, but this kind of strategy is only sustainable in the long run if productivity can be increased. Can the increase in TFP documented at the outset of the paper be linked to tariff behavior?

Our starting point is a firm level version of equation (1) using changes in firm productivity as our dependent variable. In the first four columns of Table 6, we report the effect of one and two-year changes in tariff protection on firm TFP, where changes are annualized and thus directly comparable. In this regression, we also control for the lagged level of tariff protection. We report results for all firms in the sample, as well as for a balanced panel of firms that only includes firms in operation every year between 1998 and 2007.[14] In columns 5-8, we report the results of the regressions in levels including both firm and time fixed effects. Finally, in columns 9-12 and 13-16, we report results separately of the regression in changes for the pre and post-WTO period separately.

Several things are noteworthy. First, over the entire period, tariff reduction is associated with a significant increase in firm level productivity, with the effects appreciably larger for the full sample of firms than the balance sample. Second, controlling for firm and time fixed-effects, the impact of tariff reduction is much smaller, albeit still highly significant. And third, the effect of tariff liberalization appears to be substantially larger in the post-WTO period.

To put these estimates in context, over the entire period of liberalization the effective rate of protection fell ninety percent. With a coefficient on ERP of -0.20, this implies overall improvement in TFP that we can link to tariff reduction of slightly less than twenty percent. Alternatively, it works out to an increase of TFP of 1.5 percent on an annual basis. On the other hand, a coefficient of -0.10 implies an increase that is half of this. These increases are respectable, but small by comparison to the overall TFP growth that we document at the outset of the paper for industry. Insofar as tariff liberalization mattered even more for productivity in China, it had to be through other channels. There are two other potentially important margins to consider: 1. entry and exit; and 2. improvements resulting from the reallocation of inputs to more productive firms. Thus, we turn next to industry level analysis.

[14] For the "all firms" sample, we include observations (year-on-year changes) in years that exclude the change between the year of entry and second year and the second-to-last year and exit in order to exclude start-up or winding down years where the firm was not operating for the whole period and "stock" measures of inputs would not correspond well to "flow" levels of output. As a result, the sample remains the same for the regressions in changes and levels. In contrast, for the results for the balanced panel, we do not exclude the first and last year-on-year changes as the vast number of observations remain active prior to and after the sample period. As a result, the level regressions include more observations than the regressions on changes as the lagged information is not available to compute growth rates in the entry year.

5.4 Productivity growth at the industry-level

We estimate a version of equation (1) using now industry-level productivity for our four hundred plus sectors as our dependent variable. Results in Table 7 are comparable to those in Table 6, but now at the industry level.

In the first three columns of Table 7, we report the effect of the one-year, two-year, and three-year changes in tariff protection. As before changes are annualized and thus directly comparable. Calculated on a one-year basis, the coefficient of -0.583 in column (1) implies that a ten percentage point reduction in ERP is estimated to lead to a permanent six percent improvement in productivity. A reduction spread out over two years is estimated to require a reduction in ERP of fifteen percentage points to have the same effect, while over three years a twenty percent reduction is necessary. In columns (4) and (5) we report the results using alternative estimation methods for the model with one-year changes. Estimating the equation in levels and including industry-fixed effects, as in Amiti and Konings (2007) leads to a slightly smaller effect. Using industry-fixed effects in addition to time-differencing--analogous to the double-differencing of Trefler (2004)--shows that trade liberalization leads to an increase in productivity slightly larger than that we find using one year changes reported in column (1). In general, the coefficients obtained at the industry level are significantly larger—two to three times larger-- than those obtained at the firm level, suggesting that other channels through which tariff liberalization mattered are likely important.

In columns (1) through (5), the coefficient on lagged productivity is also negative and statistically significant. Industries that previously enjoyed stronger protection operate at a lower level of total factor productivity. We hesitate to give this a causal interpretation as our earlier results in Table 1 suggest that the initial distribution of protection was not random. Controlling for these effects however, we find that the reduction of tariff rates to the same low levels in all sectors leads to the most pronounced productivity effects in sectors where the decline in ERP is most pronounced.

Further robustness checks are provided in colunns (6) and (7) of Table 7, and illustrate that the effects become slightly stronger over time. In the post-WTO period 2001-2007 the point estimate of -0.673 is nearly a third larger than in the pre-WTO period 1995-2001 (-.505), however even for the pre-WTO period the magnitudes remain sizeable. Several factors may help to explain the larger effect including deeper integration with the international economy, elimination of some of the NTBs because of WTO, as well as the development of trade infrastructure, both in terms of hardware and institutions. Tariff declines also became much more predictable in the later period under WTO and productivity responses should be more rapid. Of course, as suggested by Figure , we cannot totally rule out some effect of endogeneity.

Results using labor productivity, column 8), are nearly identical to the TFP results, suggesting that differences between sectors in capital accumulation are orthogonal to the trade liberalization. The estimated effects reported in column (9) are also five times lower for TFP measured using a gross output rather than a value added production function, which is as expected given that the total growth rate is also four to five times lower.

Finally, we examine the combined effects of the use of NTBs and tariffs on TFP.[15] In order to do so, we augment our original specification to include NTBs in a way exactly analogous to tariffs, i.e. we include lagged NTBs and their changes. We also include their interactions with our two tariff variables, lagged ERP and changes in ERP. In column (10), we report the results for the full period, and then in columns (11) and (12) do so separately for the pre and post WTO periods. The inclusion of the NTBs has little impact on the coefficients on tariff protection, which are very robust. Additively, the NTBs also are not significant. However, the interaction of the change in the effective rate of protection with the NTBs in levels is positive, and highly significant, suggesting that the presence of NTBs neutralized much of the impact of the tariff reduction in those sectors. Over the full period, the coefficient on the interaction term is 0.411 compared to -0.610 on the tariff change, implying a net effect of -0.20 of tariff reduction on productivity in these sectors. This is only a third of its effect in those sectors in which NTBs were not present. A comparison of columns (11) and (12) also suggests that the ability of the NTBs to counteract the effects of tariff reduction was especially pronounced in the post-WTO period. Of course, in the post WTO period these kinds of barriers were also much less frequently to be found.

5.5 Decomposing the industry-level effects

[15] We also examined the effects of restrictions on FDI, but the coefficients were small and insignificant. This may be related to the fact that much of the change occurs in a single year (2002), and that in the pre and post-WTO periods there were only a small number of changes.

We have shown that at the industry level tariff reductions are strongly related to productivity growth. There are several possible explanations for such a pattern. One possibility is that it reflects the causal effect of trade liberalization on productivity-enhancing restructuring, as envisioned by some Chinese leaders. Reverse causation, and tariffs lowered selectively only when industries are showing promise for future growth, is less likely to explain the results given the uniformity of final tariff rates and our controls for the lagged levels of trade protection.

We can explore alternative channels for the effects by using linear decompositions of the aggregate change and using each term as a separate dependent variable in regressions of the form of (1). Our decomposition is exact for the change in aggregate productivity that is defined as the difference in weighted (log) productivity levels:

$$\Delta \ln P_t = \sum_{i}^{\text{continuing}} \overline{s_i}\, \Delta p_{it} + \sum_{i}^{\text{continuing}} \Delta s_{it}\, [\overline{p_i} - \ln P_{t-k}] + \sum_{n}^{\text{entrants}} s_{nt}\, [p_{nt} - \ln P_{t-k}] + \sum_{x}^{\text{exiting firms}} s_{xt-k}\, [p_{xt-k} - \ln P_{t-k}]$$

We end up with three terms, each of which has an intuitive interpretation. The first term captures the contribution of firm-level productivity growth to the industry average, the 'within' term. The second term captures the productivity effects of weight changes, the 'between' term, and is associated with the reallocation on resources among firms. This can be positive if market shares move to a firm with above-average productivity or negative if the reverse happens. We follow Griliches and Regev (1995) and use the average values over the two periods—for the firm share or productivity—to weight the differences in order to avoid the introduction of an additional term with the interaction of the changes in shares and productivity. Our choice splits this term equally over the within and between terms. The last two terms contain the effect of net entry on aggregate productivity. We follow Haltiwanger (1997) and normalize all productivity levels by the lagged aggregate value to take into account that unbalanced panels can have different weights for entering and exiting firms. As a result the contribution of net entry will be positive if on average entering firms perform better relative to the lagged average than exiting firms.

We are not interested in the contribution of the individual terms to aggregate productivity growth per se – Brandt et al. (2012) already establishes that the extensive margin of firm restructuring through entry and exit was extremely important. Rather, we perform the above decomposition for each sector and investigate which term is most strongly correlated with the reduction in ERP by using each of them separately as dependent variable in equation (1). As we need to follow individual firms over time, we can only conduct this analysis over the 1998 to 2007 period; moreover, in contrast to previous analyses, we only use the first and end year. In order to correctly identify the trade liberalization that each surviving firm is undergoing, we only include those that remain in the same sector throughout. The relationship between aggregate productivity growth and the tariff liberalization is in column (1) of Table 8. Because of the linear regression and linear decomposition, the effects of the three terms in columns (2) to (4) aggregate exactly to the overall effects.

Our results indicate that the relationship between industry-level productivity growth and tariffs is dominated by the effect going through the entry and exit channel. Lowering trade protection strongly increases the productivity effect of extensive margin churning. Sectors that experience the largest tariff cuts are characterized by far greater productivity differences between entering and exiting firms. The coefficient on ERP change in column (4) is 93 percent of the aggregate effect in the first column. Performing the same analysis separately over the pre-WTO and post-WTO sub-periods suggests that the association between net entry and trade liberalization was particularly strong in the later period. It is consistent with tariff cuts becoming more predictable and entirely irreversible. The within-firm growth contribution to the aggregate also shows up with a negative sign, but it is not significantly different from zero. Market share movements, on the other hand, are actually to the least productive firms in the sectors with the largest liberalization, but the effect is barely significant.

Note that much of the effect of the tariff liberalization through net entry is occurring through its influence on the entry side. The contribution of new entrants to industry TFP is the product of their share of output and their TFP premium over incumbents in the initial period. In order for these firms to make a significant contribution to industry TFP growth, they need to have some combination of market share and relatively high TFP. Table 9 shows how output shares (averaged across CIC sectors) and firm head counts change over the sample period from 1998-2007 among firms of different ownership types and entry/continuing/exit status. There has been a huge shift in the output share towards new private firms as well as a substantial increase in the number of private firms.

5.6 Position of different types of firms in the productivity distribution

The above decomposition results suggest that the strongest channel through which tariff reductions raise sectoral productivity is through the entry of new firms. It might seem surprising that firms would be so eager to enter in sectors where trade protection is eliminated, but a positive contribution does not necessarily indicate a lot of entry. The quality of entrant matters as well, as the productivity level of each entrant is normalized by the aggregate productivity level of the sector in the previous period.

To investigate where in the productivity distribution new firms enter and how this depends on the level of protection of the sector, we estimate the following regression:

$$\ln TFP_{st} = \alpha ERP_{st-k} + \sum_k \beta_k \, \text{type}_{st}^k + ERP_{st-k} * \sum_k \gamma_k \, \text{type}_{st}^k + \alpha_t + \alpha_s + \varepsilon_{st.} \quad (3)$$

The level of productivity is now the dependent variable and the explanatory variables are a set of firm-type characteristics and the same variables interacted with the degree of tariff protection in each sector.

In the first two columns of Table 10 the contemporaneous ERP variables are used, with $k=0$ in equation (3). In the next two columns we use ERP variables lagged one year. In the first and third columns of Table 10, we only use three dummy variables: one for entrants, one for exiting firms, and one for incumbents. Only the first full year after entry and the last full year before exit are used, to make sure we do not use partial years of activity. First, these results indicate that entrants have higher and exiting firms have lower levels of productivity than incumbents. Second, each of the three types of firms tends to have relatively lower productivity levels in sectors that receive strong trade protection. These results are a lot less pronounced when lagged protection is used.

In the second and fourth column, we distinguish firm-types further by estimating different effects for four ownership types: state-owned firms (SOE), hybrid firms with mixed ownership, private firms, and (at least partially) foreign-owned firms. The un-interacted ownership variables indicate that SOEs tend to have the lowest levels of productivity, on average. More interesting are the triple interactions between ownership, activity status (entry or exit), and degree of protection. They indicate that the patterns are similar for hybrid, private, and foreign firms, but very different for SOEs.

For the first three ownership types, the tariff rates are not systematically related to the productivity of incumbents. Firms that are about to exit have significantly lower productivity, but this selection on productivity is blunted in highly protected sectors where the correlation between exit and low productivity is reduced. The lower productivity for exiting firms in open sectors is particularly pronounced for private firms. Similarly, the higher average productivity of new entrants is a particular feature of open sectors. In more protected sectors, unproductive firms enter as well. Low degrees of trade protectionism heighten the association between productivity and entry or exit. The entrants in open sectors are especially productive, and the exiting firms in the same sectors are particularly unproductive. In protected sectors, the productivity differences between entrants and exiting firms are not as systematic.

The pattern for SOEs is radically different from the other types of firms. On average, these firms have lower productivity and this is particularly true for incumbent firms in highly protected sectors and for exiting firms in the same sectors. In contrast, the few new SOEs do not really enter with higher productivity in more open sectors, as was the case for private or foreign firms. Their productivity is unrelated to the degree of protection. Entry and exit of SOEs does not seem to be the outcome of a selection mechanism based on productivity, as was strongly the case for private firms. The survival of unproductive SOE incumbents in highly protected sectors further differentiates them from other firm types.

Conclusions

To be added.

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Table 1: Industry characteristics associated with the level in tariff protection

	1995 Output Tariff (1)	2001 Output Tariff (2)	2007 Output Tariff (3)
Trade categories			
intermediates(BEC)	-0.203**	-0.109**	-0.049
	(-2.9)	(-2.7)	(-1.7)
capital goods(BEC)	-0.186*	-0.055	-0.056
	(-2.6)	(-1.3)	(-1.9)
cons. Goods(BEC)	0.117	0.064	0.047
	(1.6)	(1.5)	(1.6)
differentiated(Rauch)	0.023	0.020	0.030**
	(0.9)	(1.4)	(2.9)
US characteristics			
capital intensity	-3.707*	1.413	1.007
	(-2.4)	(1.6)	(1.6)
skill intensity	-5.418*	-3.770*	-2.816**
	(-2.1)	(-2.5)	(-2.6)
Chinese characteristics			
top 4 market share	0.169***	0.071*	0.013
	(3.3)	(2.4)	(0.6)
log employment	1.869**	1.123**	0.247
	(2.8)	(2.9)	(0.9)
logK/L ratio	2.033	0.419	0.488
	(1.7)	(0.6)	(1.0)
SOE sales share	-0.056	0.001	-0.004
	(-1.6)	(0.0)	(-0.3)
elementary educ.share	0.461*	0.118	0.096
	(2.3)	(1.0)	(1.2)
R2	0.490	0.373	0.327
Observations	380	380	380

*Note: t-statistics in parentheses. ***,**, and * indicates significance at the 1%, 5%, and 10% level.*

Table 2: Effect of lagged productivity on current rates of protection

	Import Tariffs		ERP		NTB 1		NTB 2		FDI
	Pre-WTO 1998-2001	Post-WTO 2002-2007	Pre-WTO 1998-2001	Post-WTO 2002-2007	Pre-WTO 1998-2001	Post-WTO 2002-2007	Pre-WTO 1998-2001	Post-WTO 2002-2007	Post-WTO 2002-2007
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
TFPt-1	0.003	-0.003***	0.011	-0.009*	-0.041*	-0.042***	-0.026*	-0.025**	-0.004
	(1.6)	(-3.7)	(1.0)	(-2.3)	(-2.2)	(-4.0)	(-2.0)	(-2.9)	(-0.2)
TFPt-2	0.002	-0.003**	-0.004	-0.008	-0.079**	-0.043***	-0.058**	-0.027*	-0.030
	(0.9)	(-2.8)	(-0.2)	(-1.9)	(-3.0)	(-3.8)	(-3.2)	(-2.6)	(-1.9)

*Note: t-statistics in parentheses. ***,**, and * indicates significance at the 1%, 5%, and 10% level.*

Table 3: Effect of import tariffs on trade flows (year-on-year, 2000-2006)

	Total trade	Processing trade	Ordinary trade	Ordinary trade (2-year change)
	(1)	(2)	(3)	(4)
Lagged tariff change	-0.425	-0.195	-0.517	-0.971
	(-1.6)	(-0.6)	(-1.5)	(1.9)*
Change in tariffs	-1.526	-0.449	-1.947	-2.105
	(-1.3)	(-1.5)	(-1.3)	(-1.6)
Observations	2,442	2,372	2,409	1,998

*Note: t-statistics in parentheses. ***,**, and * indicates significance at the 1%, 5%, and 10% level.*

Table 4: Use of imported intermediates

	Fraction of firms using			Imported intermediates as a		
	Total trade	Duty-free	Ordinary trade	Total trade	Duty-free	Ordinary trade
	(1)	(2)	(3)	(4)	(5)	(6)
2000	11.2%	9.6%	6.2%	7.8%	5.5%	2.4%
2006	12.9%	9.8%	8.7%	9.4%	6.6%	2.9%

Table 5: Effect of import tariffs on price indices

Dependent variable	Output prices		Input prices	
	ln(Pt/Pt-1)	ln(Pt/Pt-2)	ln(Pt/Pt-1)	ln(Pt/Pt-2)
	(1)	(2)	(3)	(4)
(a) Price changes based on 2-digit CIC industries (1995-2007)				
Tariff change	0.233***	0.294***	1.702***	1.932***
	(5.4)	(6.3)	(18.5)	(19.1)
(b) Price changes based on 4-digit CIC industries (2001-2007)				
Tariff change	0.297***	0.487***	1.023***	1.261***
	(6.1)	(6.5)	(10.4)	(9.3)
(c) Price changes based on 2-digit CIC industries (2001-2007)				
Tariff change	0.441***	0.524***	2.257***	2.613***
	(7.7)	(6.6)	(25.2)	(21.2)
(d) Price-cost margin changes (1998-2007)				
	Without year fixed effects		With year fixed effects	
PCM = (P-MC)/P	ln(PCM)-ln(PCMt-1)	ln(PCM)-ln(PCMt-2)	ln(PCM)-ln(PCMt-1)	ln(PCM)-ln(PCMt-2)
ERP change	-0.045**	-0.058*	-0.024*	-0.044
	(2.3)	(1.9)	(1.7)	(1.5)

*Note: t-statistics in parentheses. ***,**, and * indicates significance at the 1%, 5%, and 10% level.*

Table 6: Effect of protectionism on productivity at the firm level

(a) 1998-2007, only observations without industry changes

	1 year changes		2 year changes	
	Balanced	All firms	Balanced	All firms
	(1)	(2)	(3)	(4)
Lagged ERP level	-0.024	-0.029	-0.023	-0.032
	(1.3)	(1.3)	(1.1)	(1.2)
Change in ERP	-0.166	-0.239	-0.189	-0.303
	(3.2)***	(4.1)***	(1.9)*	(2.4)**
Observations	242,684	897,365	214,914	626,768

(b) 1998-2007, same regressions in levels with firm-FE and year-FE

	Productivity level			
	Balanced	All firms	Balanced	All firms
	(5)	(6)	(7)	(8)
Lagged ERP level	-0.036	-0.094		
	(4.2)***	(13.0)***		
Twice lagged ERP level			0.048	-0.031
			(7.3)***	(4.7)***
Observations	294,150	897,365	292,766	626,768

(c) 1998-2002, only observations without industry changes

	1 year changes		2 year changes	
	Balanced	All firms	Balanced	All firms
	(9)	(10)	(11)	(12)
Lagged ERP level	-0.003	-0.008	0.008	0.004
	(0.1)	(0.4)	(0.5)	(0.2)
Change in ERP	-0.053	-0.093	0.032	-0.007
	(1.3)	(2.4)**	(0.5)	(0.1)
Observations	241,244	362,303	180,933	626,768

(d) 2002-2007, only observations without industry changes

	1 year changes		2 year changes	
	Balanced	All firms	Balanced	All firms
	(13)	(14)	(15)	(16)
Lagged ERP level	-0.072	-0.060	-0.076	-0.076
	(2.5)**	(1.2)	(2.7)***	(1.9)*
Change in ERP	-0.440	-0.587	-0.521	-0.598
	(4.0)***	(4.3)***	(3.6)***	(3.1)***
Observations	371,440	535,062	357,894	410,936

*Note: t-statistics in parentheses. ***,**, and * indicates significance at the 1%, 5%, and 10% level.*

Table 7: Effect of protectionism on productivity at the industry level

	ERP									ERP and ILR[1]		
	1998-2007					1998-2002	2002-2007	1998-2007 1 year diff		1998-2007	1998-2002	2002-2007
	1 year diff	2 year diff	3 year diff	FE iso diff	FE w/ diff	pre-WTO	post-WTO	LP	TFPQ			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
lagged ERP	-0.082***	-0.060***	-0.048***	-0.148***	-0.113***	-0.070***	-0.087**	-0.081***	-0.019***	-0.096***	-0.085***	-0.099***
	(-5.8)	(-5.4)	(-5.0)	(-4.8)	(-4.4)	(-4.6)	(-3.3)	(-5.6)	(-5.9)	(-5.2)	(-3.8)	(-3.4)
change in ERP	-0.584***	-0.388***	-0.298***	-0.363***	-0.646***	-0.505***	-0.673***	-0.577***	-0.110***	-0.610***	-0.493***	-0.807***
	(-10.5)	(-7.6)	(-6.2)	(-4.7)	(-10.0)	(-7.9)	(-7.5)	(-10.1)	(-8.7)	(-10.4)	(-7.7)	(-7.8)
lagged ILR										0.027	-0.001	0.061
										(1.3)	(-0.1)	(1.7)
change in ILR										-0.021	0.024	0.000
										(-0.5)	(0.2)	(0.0)
change in ERP * lagged ILR										0.411***	0.324**	0.890**
										(3.4)	(2.8)	(2.8)
change in ERP * change in ILR										0.030	-2.463	0.293
										(0.1)	(-1.8)	(0.8)
lagged ERP * change in ILR										-0.014	0.096	0.074
										(-0.2)	(0.3)	(0.5)
lagged ERP * lagged ILR										0.066	0.065	0.183
										(1.9)	(1.8)	(1.8)

Note: (1) ILR stands for import license requirement

*t-statistics in parentheses. ***,**, and * indicates significance at the 1%, 5%, and 10% level.*

Table 8: Decomposition of industry-level effect

(a) Homogeneous benchmark 1998-2007

(N=424)	Haltiwanger (1997) decomposition					
1998-2007	Industry-level	Within	Between	Net entry	Entry	-Exit
	(1)	(2)	(3)	(4)	(5)	(6)
Lagged ERP level	-0.457	-0.085	0.033	-0.405	-0.446	0.041
	(2.8)***	(1.4)	(1.2)	(2.9)***	(3.2)***	(2.1)**
Change in ERP	-0.610	-0.098	0.058	-0.571	-0.613	0.042
	(2.7)***	(1.2)	(1.6)	(3.0)***	(3.2)***	(1.5)

(b) Homogeneous benchmark 1998-2002

(N=424)	Haltiwanger (1997) decomposition					
1998-2002	Industry-level	Within	Between	Net entry	Entry	-Exit
	(7)	(8)	(9)	(10)	(11)	(12)
Lagged ERP level	-0.087	-0.074	-0.008	-0.005	-0.071	0.067
	(1.0)	(1.7)*	(0.4)	(0.1)	(1.1)	(3.5)**
Change in ERP	-0.228	-0.173	0.000	-0.055	-0.128	0.072
	(1.4)	(2.1)**	(0.0)	(0.5)	(1.1)	(2.0)**

(c) Homogeneous benchmark 2002-2007

(N=424)	Haltiwanger (1997) decomposition					
2002-2007	Industry-level	Within	Between	Net entry	Entry	-Exit
	(13)	(14)	(15)	(16)	(17)	(18)
Lagged ERP level	-0.390	-0.182	0.059	-0.268	-0.315	0.048
	(2.9)***	(2.8)***	(2.4)**	(2.7)***	(3.2)***	(2.2)**
Change in ERP	-0.745	-0.178	-0.010	-0.558	-0.597	0.039
	(2.6)***	(1.3)	(0.2)	(2.7)***	(2.9)***	(0.9)

*Note: t-statistics in parentheses. ***,**, and * indicates significance at the 1%, 5%, and 10% level.*

Table 9: Share of output and firm number by ownership type and surviving/exit/entrant status

ownership type	1998		2007		change of share 1998-2007		
	share of firms that still exist in 2007	share of firms that exit before 2007	share of firms that survive from 1998	share of firms that enter after 1998	by continuing firms	due to net entry	total
	(1)	(2)	(3)	(4)	(5)=(3)-(1)	(6)=(4)-(2)	(7)=(5)+(6)
Output share							
SOE	19%	18%	14%	16%	-5%	-2%	-6%
COL	12%	20%	2%	2%	-10%	-18%	-28%
PRI	2%	3%	5%	27%	3%	25%	28%
HMT	8%	6%	4%	9%	-4%	3%	-2%
FGN	9%	4%	7%	14%	-2%	10%	8%
Total	100%		100%		-18%	18%	0%
Head count							
SOE	10%	31%	6%	17%	-4%	-14%	-18%
COL	10%	24%	2%	3%	-8%	-21%	-29%
PRI	2%	4%	4%	46%	2%	42%	43%
HMT	4%	6%	2%	8%	-2%	2%	0%
FGN	4%	4%	2%	10%	-2%	6%	5%
Total	100%		100%		-15%	15%	0%

Table 10: Position of different types of firms in the productivity distribution

	Dependent variable: TFP level			
	Concurrent ERP		Lagged ERP (1 year)	
Entrant	0.187	1.167	0.178	1.163
	(17.5)***	(18.5)***	(15.2)***	(18.7)***
Exiting firm	-0.218	-0.257	-0.217	-0.253
	(10.1)***	(17.8)***	(10.5)***	(17.5)***
Hybrid		0.522		0.519
		(13.4)***		(13.3)***
Private		0.476		0.464
		(16.4)***		(16.4)***
Foreign		0.257		0.242
		(9.3)***		(8.5)***
Incumbent*ERP_{t-x}	-0.218		-0.116	
	(2.2)**		(1.3)	
* SOE		-0.337		-0.263
		(3.1)***		(2.6)***
* Hybrid		-0.048		0.015
		(0.5)		(0.2)
* Private		-0.124		-0.026
		(1.1)		(0.3)
* Foreign		-0.114		-0.011
		(1.1)		(0.1)
Entrant*ERP_{t-x}	-0.222		-0.099	
	(2.5)***		(1.1)	
* SOE		-0.015		0.053
		(0.1)		(0.5)
* Hybrid		-0.098		-0.037
		(1.0)		(0.4)
* Private		-0.318		-0.192
		(2.8)***		(1.8)*
* Foreign		-0.364		-0.242
		(3.3)***		(2.2)**
Exiting*ERP_{t-x}	-0.211		-0.127	
	(1.8)*		(1.2)	
* SOE		-0.616		-0.520
		(5.1)***		(4.7)***
* Hybrid		0.243		0.247
		(2.3)**		(2.5)**
* Private		0.452		0.446
		(5.0)***		(5.5)***
* Foreign		0.178		0.218
		(1.6)		(2.1)**

*Note: t-statistics in parentheses, standard errors are clustered at industry level. ***,**, and * indicates significance at the 1%, 5%, and 10% level.*

Figure 1:

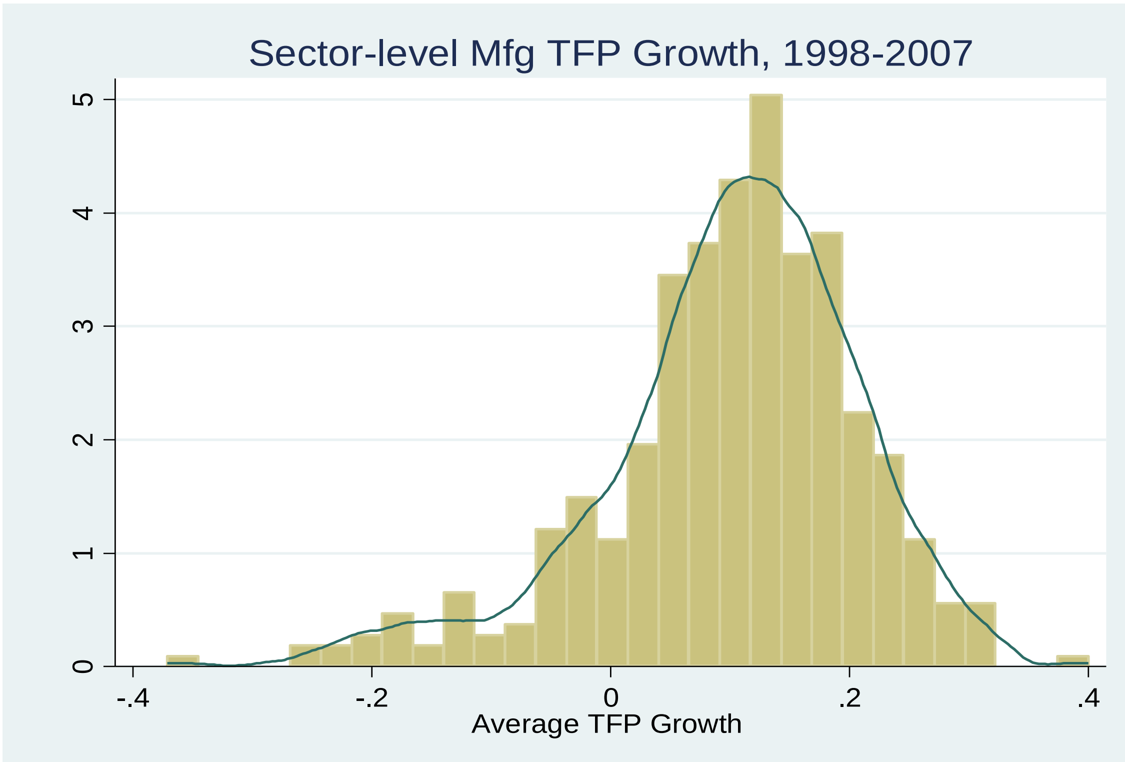

Sector-level Mfg TFP Growth, 1998-2007
0
1
2
3
4
5
-.4
-.2
0
.2
.4
Average TFP Growth

Figure 2: Fraction of sectors covered by different type of trade or investment restrictions

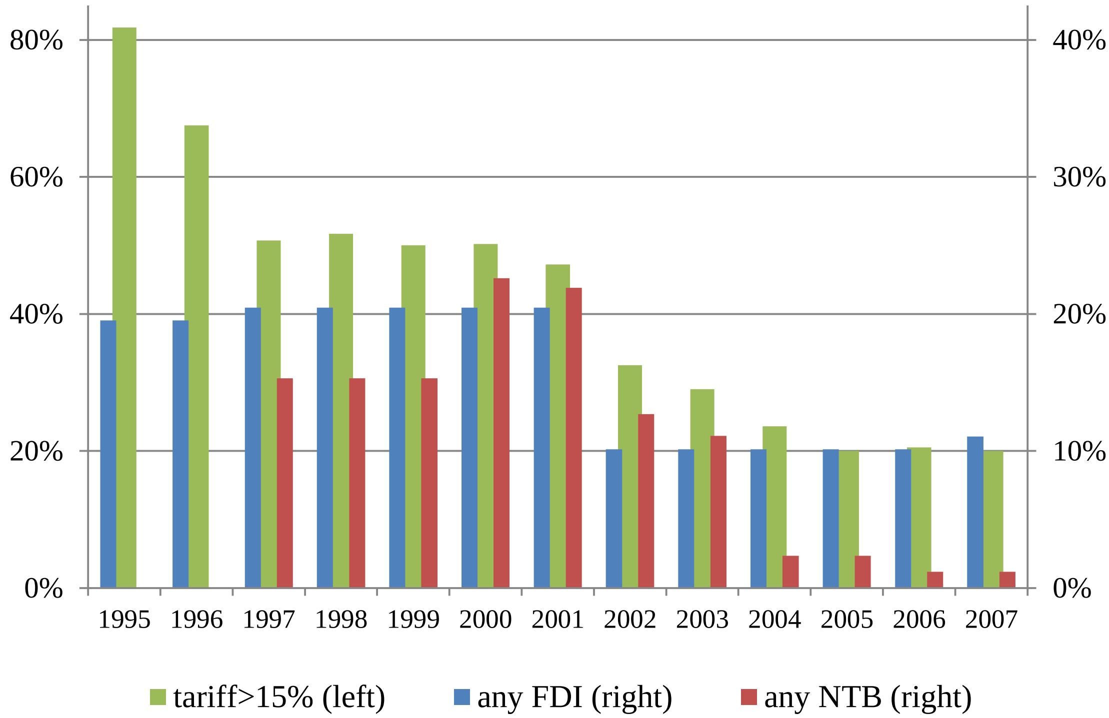


Figure 3: Evolution of tariffs and effective rate of protection

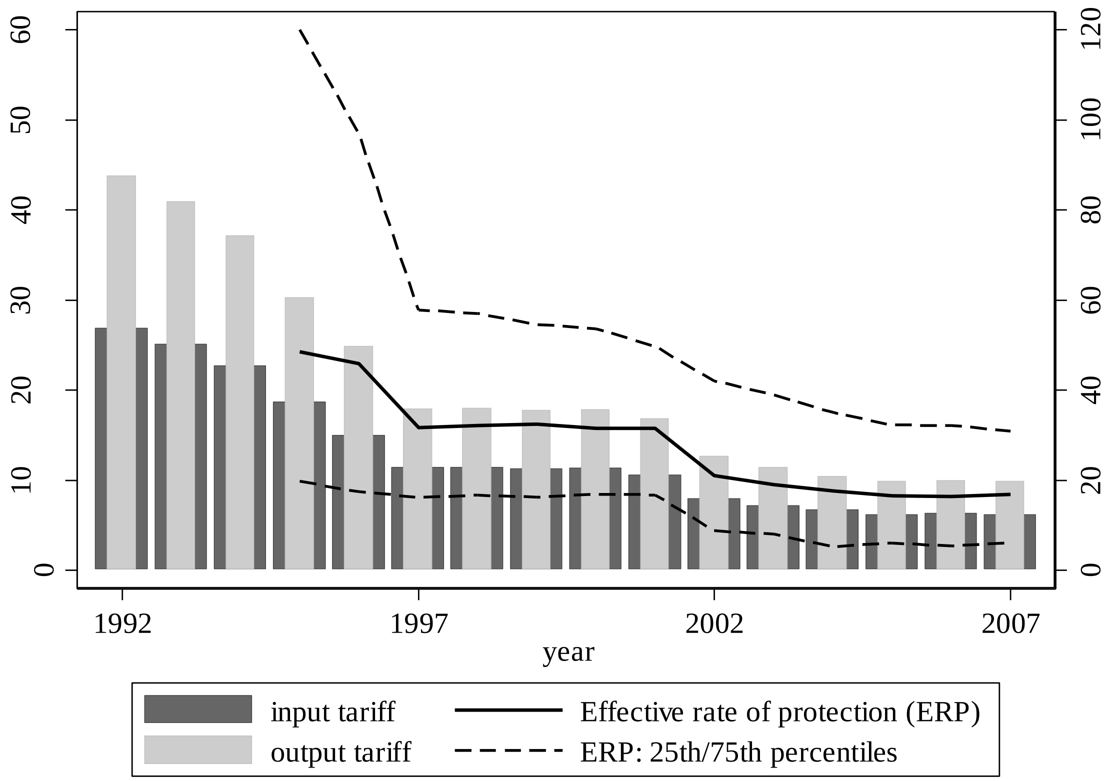
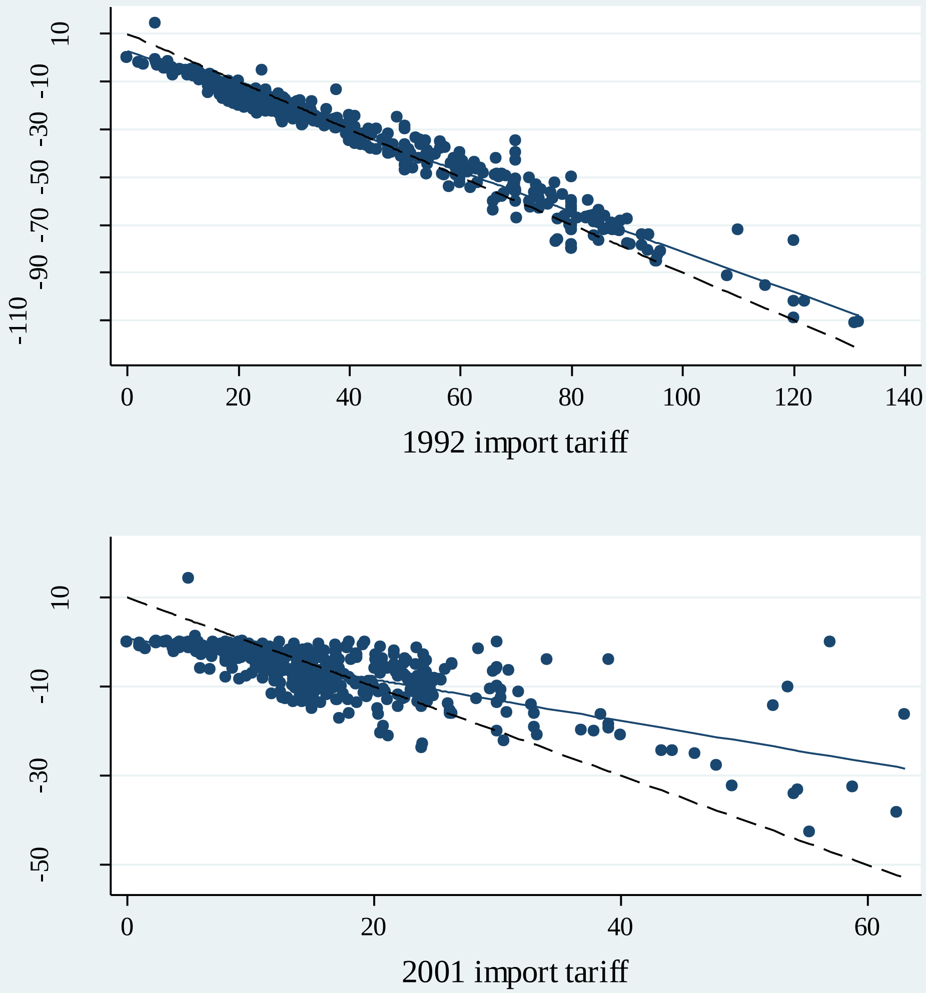


Figure 4: Import tariffs at the sector level (CIC 4-digit)



Notes: 4-digit manufacturing sectors. Dashed black line has slope -1.
Solid blue is regression line (slope -0.84 above, -0.46 below).