THREE ESSAYS ON THE CHINESE ECONOMY

by

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Abstract

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This dissertation comprises three essays. In the first two chapters, I examine the performance of Chinese firms in the context of trade liberalization: one chapter looks at the quality of China's exports and the other investigates the productivity impact of China's tariff reduction. In the third chapter, I study the change induced by a tax reform in the institutional incentive structure faced by Chinese village leaders.

In Chapter I, "*Quality and Input Choices: Evidence from Chinese Exporters*", I use the detailed firm-level information about Chinese exports between 2000 and 2006 to estimate market- and product-specific demand functions for China's exports of Electrical Machinery and recover the latent quality ranking as the demand residual. I apply an instrument based on the idea of the Hausman-Nevo instrument to this multi-market and multi-origin data for identification. I then combine the quality measure with other firm-level information to identify factors underlying the across-firm variation in the measured quality. I find significant quality premium in exports to North America and the European countries by firms that import intermediate inputs from rich countries. I also find a positive correlation with wage, which holds not only for Chinese non-state-owned firms, but also for Hong Kong, Macao, Taiwan and other foreign-invested firms, which suggests quality upgrading to appeal to rich consumers in developed countries to be one channel through which globalization contributes to skill premium in skill-scarce economies.

In Chapter II, "*WTO Accession and Firm-level Productivity in Chinese Manufacturing*", a joint work with Loren Brandt, Johannes Van Biesebroeck and Yifan Zhang, we explore cross-sectoral variation in the extent of import tariff reduction to identify its impact on firm performance and its contribution to significant productivity growth over the period from 1995 to 2007. China's import tariffs varied a lot across sectors in the earlier years and became highly uniform after the entry into WTO. This suggests that tariff reduction, once conditioned on lagged levels of tariffs, is to a large extent orthogonal to a sector's productivity growth prospects, which allows us to evaluate the productivity impact of tariff reduction with the cross-sectoral variation across sectors. We find that increased import competition induced by tariff reduction had a much greater effect on domestic firms by driving down prices than by stealing market share away, especially for sectors that mainly produce intermediate inputs. Furthermore, we find most of the effect has happened at the extensive margin through selecting entrants of higher productivity, and especially 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.

In Chapter III, "*Tax Reform, Local Resources and Village Leader Elections in Rural China*", I study the impact of China's rural tax reform in the late 1990s and early 2000s on the local political equilibrium in China's villages. The tax reform eliminated village levies and informal taxes, which consequently weakened village leaders' authority in taxing the villagers. I use an enriched yet simple retrospective voting model to illustrate that the reform may have both reduced and enhanced a village leader's re-election incentive: even though a village leader gained less by choosing to behave opportunistically after the reform, he may have been more likely to do so because staying in office became less valuable. My empirical analysis of the difference in re-election rates before and after the reform across villages suggests the reducing effect to be stronger in villages with cleaner elections; moreover, the abundance of local non-tax revenue resources, such as cultivated

land, can mitigate the impact of the reform.

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Chapter I

Quality and Input Choices: Evidence from Chinese Exporters

1 Introduction

Quality and cost advantages can both contribute to a firm's profitability. Improving quality enables a firm to charge a higher price without losing market share, while a cost advantage allows a firm to profit from selling more at lower prices. In the early stage of their participation in international trade, less-developed economies export mainly products with low-quality content to make the best use of the abundant resource of cheap and unskilled labour. One concern about this development strategy is that when product quality and quantity are imperfect substitutes, the markets for low-quality products are limited; as a result, it is not guaranteed that the less-developed economies can benefit from trade and the economic growth supported by this specialization in low-end manufacturing products may not be tenable.¹ Studies on the industrial policies of the newly

¹The discussion on the demand-side determinants of the pattern of trade can be traced back to Linder (1961). Summaries of early literature can be found in Deardorff (1984) and Leamer and Levinsohn (1995). Later development includes the theoretical models in Copeland and Kotwal (1996), Murphy and Shleifer (1997) and the empirical test by Hallak (2006, 2010). Sutton (2007) provides a mechanism that can generate a quality threshold. Hallak and Sivadasan (2009) introduce quality minimum requirement into the seminal heterogeneous firm trade model of Melitz (2003) and analyse the consequence.

industrialized economies also suggest that the transition toward more sophisticated products and the cultivation of dynamic comparative advantage are crucial.²

Despite the important role of quality, few empirical studies explicitly focus on the quality differentiation by exporters from developing countries. This is possibly due to the lack of directly observable information on quality.³ In this study, I use the rich export information from China’s customs records to estimate the quality ranking among Chinese exporters at the firm-, product- and market-specific level. I then combine the quality estimates with other firm level information to identify possible channels through which quality is differentiated across firms. I focus on products classified under HS Chapter 85. These are “*electrical machinery and equipment and parts thereof; sound recorders and reproducers, television image and sound recorders and reproducers, and parts and accessories of such articles*”.⁴ There are two reasons to focus on these products. First, this chapter accounts for a large proportion of China’s total ordinary trade. Among the 97 2-digit HS chapters, it has been the top one in China’s exports through ordinary trade since 2001. The share reached 12% by 2006. Second, these products are highly differentiated,⁵ intensive in R&D and thus have a potential for quality differentiation and upgrading. I find significant quality premium in exports to rich countries by firms that import intermediate inputs from rich countries and by firms that pay higher wages.

Direct measures of quality are rare. One common practice is to use unit value as a proxy for quality.⁶ However, this is problematic because a high price may indicate either high quality or low cost efficiency. When information on both price and quantity

²For summaries on related studies, see Balassa (1988), Rodrik (1995), Harrison and Rodriguez-Clare (2010).

³Brooks (2006) argues that low quality contributes to the low export intensity observed among Colombian plants. But the quality measure is based on unit value and constructed at industry level. Hallak and Sivadasan (2009) investigate firm-level data and find conditional exporter premium in output unit value and/or factor use in India, the United States, Chile, and Colombia. The conditional premium in unit value is interpreted as reflecting selection on quality.

⁴Descriptions at finer level can be found in the appendix.

⁵According to the index developed in Rauch (1999).

⁶Hallak and Schott (2011) provide a list of research based on this measure.

is available, a better alternative can be constructed. Conceptually, quality can be taken as a demand shifter that captures any attribute of a product affecting consumers' willingness to pay.⁷ A quality improvement thus shifts a demand curve upward and outward. Holding price constant, larger market share is a reflection of higher quality.⁸ Based on this intuition, I estimate market group- and product group-specific demand functions to measure price elasticities as precisely as possible⁹ and then take the residuals from estimating such a demand system as a measure of quality.

The reliability of this empirical measure of quality depends crucially on consistently estimating the demand system. One econometric challenge is that the unobserved quality affects quantity demanded and price simultaneously.¹⁰ As a result, the OLS estimate of the price coefficient would be biased toward zero. In turn, the quality ranking based on the OLS residuals would be reversed for some observations. This point is illustrated in Figure 1. In Figure 1, each point represents an observation of a firm exporting product HS85291020¹¹ to the United States in year 2006. For simplicity, I divide the observations into two groups, those of low quality and those of high quality.¹² The “x” points represent observations with low quality and the diamond points represent observations revealed to be of high quality. The dashed line represents the OLS fitted line pooling the low-quality points and high-quality points together. The distance of each point to this fitted line would be the quality estimate based on OLS estimation. A reversal means the low-quality

⁷The attribute can be related to either objective characteristics of a product or subjective evaluation by consumers.

⁸This idea of relating unobserved quality to conditional market share originated from the IO literature. Examples of recent studies on trade based on this idea are Hummels and Klenow (2005), Hallak and Schott (2011), Gervais (2010), and Khandelwal (2010). This method does not distinguish between objective aspects of quality, such as technology and the subjective evaluation by consumers.

⁹Throughout the paper, product group is defined as one 4-digit HS line; product is defined as one 8-digit HS line. I refer to one 8-digit product produced by a firm as a variety.

¹⁰Quality is positively correlated with price because higher quality usually costs more to produce; on the other hand, since quality is a demand shifter, it is positively correlated with quantity.

¹¹According to the 8-digit Chinese classification of products, HS85291020 includes “Aerials and aerial reflectors of all kinds; parts suitable for use therewith for radio-broadcast receivers and their combinations, television receivers”.

¹²This is based on my quality estimation, which will be discussed shortly.

“x” points above the fitted line would have higher quality than the diamond points below the OLS fitted line.

To address this endogeneity problem, I require an instrument that captures only the quality-independent part of the price variation to consistently estimate the price coefficient. The rich information I have on the origins and destinations of firms’ exports provides a way to construct such an instrument. For each destination market m , I carefully select a set of markets subject to demand shifters independent of those on market m . I then use the average price that firms in the same production location charge on these other markets as an instrument for the prices they charge on market m .¹³ As expected, my instrumental variable strategy increases the magnitude of the OLS estimates by 100% on average. Moreover, the estimates are robust to different ways of constructing instruments. Small changes in the criteria in selecting the set of markets for instruments do not have a substantial impact on the estimation results. Choosing different products in constructing instruments give similar estimates as well when the estimates are significant. Once I have recovered latent quality ranking as measured by the residual of the demand equation, I use these estimates to investigate the relationship between quality and firms’ input choices.

For the quality analysis, I focus on exports to destinations where per capita GDP is high because I expect more quality differentiation in these markets. I find a robust relationship between importing activities and product quality among Chinese non-state-owned firms. Firstly, there is significant difference in product quality between importers and non-importers among Chinese non-state-owned exporters. More interestingly, this association between importing status and export quality varies with the types of products imported and the sources of the imports. Looking into the type of imported products, I

¹³My instrument is based on the one developed in Hausman (1996) and Nevo (2001). However, I need to take extra caution in selecting the set of markets for constructing instrument to address quality differentiation across markets which is absent in Hausman (1996) and Nevo (2001) but important in this paper.

find that importers of intermediate inputs rather than capital goods are more likely to produce higher quality products. Looking into the origin of imports, I find the positive association to be stronger if the imported inputs are from rich countries. A similar pattern is found using continuous measures of importing activities, such as total value and the number of product lines imported. My data also allows me to investigate the association between quality and wages. I find wages to be positively correlated with quality for not only Chinese non-state-owned firms, but also for foreign-invested firms, including those invested by Hong Kong, Macao and Taiwan investors, but the correlation is not as strong as it is for the Chinese non-state-owned firms. For the Chinese SOEs, no such correlation is found.

This paper contributes to the existing literature in several ways. First of all, I develop a method to obtain an improved measure of quality at the micro level using transaction trade data. The unit value and quantity information in my data allows me to use demand residual as a measure of quality ranking. Demand residual is an improvement over unit value as a proxy for quality because it is not confounded by differences in cost efficiency. Even though this method is not new, this paper is the first, to my knowledge, to explore the multi-origin and multi-market structure of the transaction-level trade data for identification and to recover the latent quality of exports at the firm- and market-specific level. The multi-market and multi-origin structure of the micro trade data also provides room for constructing instruments that better satisfy the identifying assumptions of the Hausman-Nevo instrument.¹⁴

Second, given that quality is one specific aspect of productivity, my investigation of the association between quality and importing activities is related to a more general

¹⁴Firm-level input prices, which affect production cost, have often been used as price instruments in estimating the output demand function. However, my investigation of the relationship between the estimated quality and firms' input choices suggests input prices are endogenous because firms use different input to produce output of different quality. This calls into question the validity of input prices as instruments for output price in demand estimation. My instrument is less susceptible to this concern because it is origin-destination specific instead of firm specific.

literature on the impact of imports on firm productivity. Some studies have found positive impacts of imported inputs on productivity, such studies include those of Amiti and Konings (2007) for Indonesia, Kasahara and Rodrigue (2008) for Chile and Halpern et al. (2005) for Hungary.¹⁵ With a richer set of measures on firm performance and importing activities, Kugler and Verhoogen (2009) and Manova and Zhang (2011) also find positive association among Colombian and Chinese firms respectively. Regarding the specific channels through which imported inputs affect productivity, Goldberg et al. (2010) identify expanded product scope to be an important one in India. Findings in this paper echo the existing evidence on positive impacts of imports on firm performance but suggests facilitating quality upgrading as a specific channel through which easier access to imported inputs may contribute to firm productivity.

Third, my finding of a positive correlation between quality and wages also relates to a large body of literature on the impact of trade liberalization on wage inequality, especially in developing countries. During the process of trade liberalization in developing countries, skill premium has not been evolving as described by the Stolper-Samuelson theorem in the traditional Heckscher-Ohlin model.¹⁶ In a recent study on China, Han et al. (2012) find that skill premium rises faster in regions more exposed to international trade. Trade-induced skill-biased technology adoption, which is absent in the traditional trade model, has been proposed as the main factor that could have offset the well-known Stolper-Samuelson force. Such studies as those by Acemoglu (2003), Yeaple (2005) and Zhu and Trefler (2005) emphasize technology changes at the firm level. Harrigan and Reshef (2011) and Burstein and Vogel (2012) further introduce the important interaction between a firm's productivity and the skill intensity of its production technology and hence assert the possibility that the reallocation of resources also contributes to skill premium. Verhoogen (2008) and Bustos (2011) find micro evidence among Mexican firms

¹⁵Muendler (2004) finds no such evidence for Brazil.

¹⁶Goldberg and Pavcnik (2007) provide a review of the empirical facts on globalization and wages.

and Argentinian firms that are supportive of the skill-upgrading mechanism. My finding of a positive correlation between wage and export quality to rich markets is consistent with this technology explanation of increasing skill premium in developing countries and suggests producing higher quality products for consumers in rich countries as a more specific driving force of the skill premium.

The remainder of the paper is organized as following. In Section 2, I develop a simple model to motivate the empirical work and highlight my identification strategy. In Section 3, I give a brief overview of the data explored in this study. In Section 4, I present the demand estimation. In Section 5, I present the empirical analysis on the association between quality and input choices. I present my conclusion in Section 6.

2 Model

This section presents a model of a firm's endogenous quality choice. The model is in the same spirit as existing ones¹⁷ in that it delivers the same result of heterogeneous firms choosing different technology or inputs to differentiate quality. But it has a few distinct features. First, the model shows that a firm's decision on input and output quality is independent of quality-adjusted input-factor price; as a result, the difference in quality adjusted factor price across production locations would generate variation in output price that is independent of quality variation and potentially can be used to identify the price coefficient in the output demand function. This provides a foundation for the exclusion restrictions in my demand estimation in Section 3. Second, the model shows that when the demand elasticities of quality vary across markets, firms will differentiate quality across markets. On one hand, firms ship higher quality goods to high-income markets where demand is more responsive to quality upgrading. On the other hand, in markets where consumers' willingness to pay for quality is very low, no firm has the incentive

¹⁷For example, models in Verhoogen (2008), Johnson (2011), Kugler and Verhoogen (2011), Baldwin and Harrigan (2011) and Hallak and Sivadasan (2009).

to offer a higher quality version of its variety. As a result, the price variation in these markets across firms from different production locations will just reflect the variation in the regional quality-adjusted factor price and can be used as instruments to identify the demand curves in markets where quality is differentiated. This provides a foundation for the construction of the instrumental variables from the data I have for this study. Third, when there exists stronger complementarity between imported inputs and firms' efficiency in producing quality, firms that are more capable in producing quality will self select to be importers and produce higher quality. Combining the last two points, the model predicts a positive correlation between the use of imported inputs and the quality of exports to high-income markets. The predictions on the correlation between quality and input choices, specifically wage and importing activities, will be confronted with data in Section 4.

2.1 Demand

Assume a Dixit-Stiglitz CES utility function for a representative consumer in country m

$$U_m = \left(\int_{i \in V_m} \xi_i^{\gamma_m} q_i^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}} \quad (\text{I.1})$$

where i denotes varieties, V_m is the set of varieties available to consumers in market m , q_i denotes the consumption of variety i and ξ_i is the quality of variety i . As in Hallak (2006), γ_m captures the intensity of consumers' preference for quality in market m . σ is the elasticity of substitution among varieties of the same quality.

Given a budget E_m , each variety's price p_i , and quality ξ_i , utility maximization leads to the following demand function

$$q_i = A_m \xi_i^{\gamma_m(\sigma-1)} p_i^{-\sigma} \quad (\text{I.2})$$

where $A_m = \frac{E_m}{\int_{i \in V_m} p_i^{1-\sigma} \xi_i^{\gamma_m(\sigma-1)} di}$ is an aggregate demand shifter in market m that affects the demand for all varieties. ξ_i enters the demand equation for variety i as a demand

shifter.¹⁸ Conditional on the same price, quantity demanded is increasing in ξ . Moreover, given the same improvement in ξ_i , the magnitude of the shift will depend on γ_m , the intensity of consumers' preference for quality in market m .

2.2 Supply

Production Technology, Factor Markets and Unit Cost Function

Production involves two types of activities: quality-independent activities and quality-differentiating activities. These activities can either be directly undertaken within a firm, or be embedded in the intermediate input that a firm purchases from its suppliers. To make activities within or outside the firm comparable, I assume that x hours of either type of activity within the firm is equivalent to employing one unit of quality-independent or quality-differentiating intermediate input with x hours of "embedded" labour. To allow firms to differentiate quality across markets, I denote the variety by firm f in market m by fm . Using $L_{1,fm}$ and $L_{2,fm}$ for the hours of quality-independent and quality-differentiating activities, respectively, I assume the following production function for variety fm with quality ξ_{fm} :

$$Q(L_{1,fm}, L_{2,fm}; \xi_{fm}) = \min \left\{ \phi_f L_{1,fm}, \frac{L_{2,fm}^{\frac{1}{\eta}}}{\left(\frac{\xi_{fm}^\lambda}{1-\rho} - \frac{\rho \mu_f^\lambda}{1-\rho} \right)^{\frac{1}{\lambda}}} \right\} \quad (\text{I.3})$$

The parameters deserve some detailed explanation. For the quality-independent activity, ϕ_f represents firm f 's efficiency in using quality-independent input. Holding output quality fixed, firm f needs $\frac{1}{\phi_f}$ units of quality-independent activity to produce one unit of output. As for the quality-differentiating activity, I assume the following quality production function:¹⁹

¹⁸ $\xi_i^{\gamma_m(\sigma-1)}$ will also be my measure of quality.

¹⁹This is based on the production function in Kugler and Verhoogen (2011).

$$\xi_{fm} = \left(\rho \mu_f^\lambda + (1 - \rho) \tilde{l}_{2,fm}^\lambda \right)^{\frac{1}{\lambda}} \quad (\text{I.4})$$

where (1) $\tilde{l}_{2,fm}$ represents the quality of the quality-differentiating input, with $\tilde{l}_{2,fm} = l_{2,fm}^{\frac{1}{\eta}}$, where $l_{2,fm}$ is the amount of quality-differentiating activity embedded in the input and $\eta > 1$ captures the degree of diminishing return in producing quality; (2) μ_f represents firm f 's efficiency in using quality-differentiating input; (3) $\lambda < 0$ captures the degree of complementarity between quality efficiency μ_f and input quality $\tilde{l}_{2,fm}$; and (4) ρ captures the relative importance of μ_f versus $\tilde{l}_{2,fm}$. Solving for $l_{2,fm}$ from (I.4) as a function of ξ_{fm} gives the conditional demand for the quality-differentiating activity that enters as the quality-differentiating component of the production function in (I.3).

Suppose that input factor markets are local. Specifically, for firms in region j , the cost per labour hour is w_j . As a result, the unit cost function conditional on input quality $\tilde{l}_{2,fm}$ for firm f at location j is

$$c_j(\phi_f, \tilde{l}_{2,fm}) = w_j \left(\frac{1}{\phi_f} + \tilde{l}_{2,fm}^\eta \right) \quad (\text{I.5})$$

Firm Optimization

Given the demand equation specified in (I.2), the optimal price conditional on input quality $\tilde{l}_{2,fm}$ is a constant mark-up over unit cost in (I.5):

$$p(\tilde{l}_{2,fm}; \phi_f) = \frac{\sigma}{\sigma - 1} w_j(f) \left(\frac{1}{\phi_f} + \tilde{l}_{2,fm}^\eta \right) \quad (\text{I.6})$$

Define $\bar{A}_m = \frac{1}{\sigma} \left(\frac{\sigma}{\sigma - 1} \right)^{1 - \sigma} A_m$. The associated operating profits from market m will be

$$\pi(\tilde{l}_{2,fm}; \phi_f, \mu_f) = \bar{A}_m w_{j(f)}^{1 - \sigma} \left(\rho \mu_f^\lambda + (1 - \rho) \tilde{l}_{2,fm}^\lambda \right)^{\frac{\gamma_m(\sigma - 1)}{\lambda}} \left(\frac{1}{\phi_f} + \tilde{l}_{2,fm}^\eta \right)^{1 - \sigma} \quad (\text{I.7})$$

Firm f chooses input quality $\tilde{l}_{2,fm}$ to maximize the profits in (I.7). The first order condition gives

$$\frac{\gamma_m}{\phi_f} = \frac{\rho\eta}{1-\rho} \mu_f^\lambda \tilde{l}_{2,fm}^{*\eta-\lambda} + (\eta - \gamma_m) \tilde{l}_{2,fm}^{*\eta} \quad (\text{I.8})$$

It can be proved that the solution to (I.8) exists and is unique. A sufficient condition for the second order condition to hold is $\gamma_m < \eta$, i.e, the cost function is sufficiently convex in quality relative to the demand function. Equation (I.8) suggests the optimal input quality by firm f for its shipment to market m , $\tilde{l}_{2,fm}^*$, is a function of consumers' preference for quality γ_m and the two efficiencies ϕ_f and μ_f , i.e, $\tilde{l}_{2,fm}^* = \tilde{l}_2(\mu_f, \phi_f, \gamma_m)$. Given the quality production function in (I.4), the optimal output quality depends on the same factors, thus

$$\xi_{fm}^* = \xi(\mu_f, \phi_f, \gamma_m) \quad (\text{I.9})$$

Substituting in the optimal quality $\tilde{l}_{2,fm}^*$, the conditional price in (I.6) becomes

$$p_{fm}^* = \frac{\sigma}{\sigma-1} w_j \left(\frac{1}{\phi_f} + \tilde{l}_{2,fm}^{*\eta} \right) = p(\mu_f, \phi_f, \gamma_m, w_{j(f)}) \quad (\text{I.10})$$

Comparison between function $\xi(\mu, \phi, \gamma)$ in (I.9) and function $p(\xi, \mu, \gamma, w)$ in (I.10) suggests that local factor price level w affects only the price and not the quality. For a demand estimation with quantity sold on the left-hand side, price on the right-hand side and ξ being part of the error term, it is exactly the variation in w that can be used to identify the price coefficient.

Quality Determinants

Comparative static analysis of ξ_{fm}^* reveals that

$$(A) \quad \frac{d\xi_{fm}^*}{d\mu_f} > 0$$

This means the optimal quality ξ^* is increasing in a firm's efficiency in using quality-differentiating input. This is the direct result of the complementarity between firms'

quality efficiency μ and input quality $\tilde{l}_2$.

$$(B) \quad \frac{d\xi_{fm}^*}{d\phi_f} < 0$$

This means the optimal quality ξ^* is decreasing in a firm's quality-independent efficiency ϕ . This is because firms with a disadvantage in ϕ have the incentive to compensate for this by choosing higher quality.

$$(C) \quad \frac{d\xi_{fm}^*}{d\gamma_m} > 0$$

This means the optimal quality increases in the intensity of consumers' preference for quality γ . This is because a same quality improvement boosts demand more in the more quality sensitive markets. For the extreme case of $\gamma_{m'} = 0$, the profit maximization condition in (I.8) suggests all firms will choose $\tilde{l}_{2,fm'}^* = 0$. The optimal pricing in (I.10) then becomes

$$p_{fm'}^* = \frac{\sigma}{\sigma - 1} w_j \frac{1}{\phi_f} \quad (\text{I.11})$$

The average over all firms from the same production location j is then

$$\bar{p}_{jm'}^* = \frac{\sigma}{\sigma - 1} w_j \int \frac{g_{jm'}(\phi)}{\phi} d\phi \quad (\text{I.12})$$

where $g_{jm'}(\phi)$ is the marginal distribution of ϕ conditional on producing in location j and selling to market m' . Assuming the same distribution of ϕ conditional on selling to m' across production locations, i.e, $g_{jm'}(\phi) = g_{m'}(\phi)$ for $\forall j$, the variation in $\bar{p}_{jm'}^*$ across j would reflect only variation in w_j .

Introducing Imported Inputs

Imported inputs are introduced as quality-differentiating inputs with stronger complementarity with firms' quality-differentiating efficiency μ . The quality production function

associated with imported input is then

$$\xi_{fm} = \left(\rho \mu_f^{\lambda'} + (1 - \rho) \tilde{l}_{2,fm}^{\lambda'} \right)^{\frac{1}{\lambda'}} \quad (\text{I.13})$$

where $\lambda' < \lambda < 0$ implies a higher degree of complementarity between $\tilde{l}^2$ and μ . It can be proved that firm f with $\phi_f \mu_f^\eta = \frac{(1-\rho)\gamma_m}{\eta-(1-\rho)\gamma_m}$ is indifferent between domestic and imported quality-differentiating input. Firms with either higher μ or lower ϕ will find it more profitable to import inputs with higher quality content $\tilde{l}^2$ and produce higher ξ ; conversely, it is more profitable for firms with either lower μ or higher ϕ to use domestic quality-differentiating input with lower quality content $\tilde{l}^2$ and produce lower quality ξ .

Summary

The model delivers three important results. First, firms' underlying attributes and consumers' quality preference are the common factors that determine firms' choices on input quality, output quality and price. The optimal price depends on these factors as well as the local quality-adjusted factor price. As a result, the variation in the quality-adjusted factor price across production locations generates a price variation that is orthogonal to the variation in quality. This provides a micro-foundation for my instrumental variable strategy in the demand estimation in Section 4. Second, firms have stronger incentives to upgrade quality in markets where consumers' demand is more responsive to quality change and do not do so when consumers' willingness to pay for a quality upgrade is too low. This implies that one can use prices charged in markets where consumers are not quality sensitive to capture information on the production location-specific quality-independent part of production cost. Third, when imported quality-differentiating inputs are more complementary to firms' ability in producing quality, more capable firms will find it more profitable to use imported inputs to produce higher quality. Combining this with the second point on quality differentiation across markets, I expect to see imported inputs to allow quality upgrading for sales to quality sensitive markets.

3 Data

3.1 Customs Data

My primary dataset is China's Customs records for 2000-2006. This dataset provides information on the 8-digit HS product code, quantity, total value, exporter and importer identity, ownership type, origin, destination, form of trade, and transportation method associated with every export and import transaction by firms located in China. The original data are at the monthly level. To estimate the demand functions, I aggregate observations by year in cells defined by exporter identity, destination market, 8-digit HS code and origins of exports at the prefecture level in China. According to customs documents, origin is the location of production in most of the cases. I use origin as one dimension of the cell that defines an observation out of concern that products produced by the same firm at different locations may not be the same.

There are two aspects of China's exports that require special attention. First, a lot of Chinese exporters are involved in processing trade,²⁰ which can be identified from the "form of trade" variable in the customs data. Due to possible transfer pricing, transaction prices in processing trade may very well reflect only part of the production costs. As a result, these transactions may not be informative about the demand condition on the destination market. For the purpose of estimating price elasticities, I use only export transactions labelled as ordinary trade. Second, a substantial amount of export transactions are conducted by trading agencies instead of manufacturing firms. Trading agencies can be identified by names in the customs data.²¹ Since I cannot identify the original producers, I exclude these indirect exports in the analysis.

²⁰About half of China's exports are through ordinary trade and the other half are through processing and assembly trade. In processing trade, Chinese firms import parts duty-free from abroad, process and assemble them, and export the final products.

²¹I use Chinese characters with the meaning of "trading" or "importing and exporting" as identifiers. The same practice is also adopted in Khandelwal et al. (2011a), Manova and Zhang (2011) and Khandelwal et al. (2011b).

The composition of China’s total exports of HS85 products in the year 2000, 2003 and 2006 are shown in the top panel of Table 1.²² Direct export in the form of ordinary trade is the focus of this study. Since many of the exports to Hong Kong will be re-exported to other markets not recorded in China’s customs, they are also excluded.²³ I also drop transactions where the unit value falls below the 1st and above the 99th percentile within each 8-digit HS product-destination market-year cell. I summarize the exporting and importing activities of firms in my customs working sample in the second panel of Table 1.

3.2 China’s Annual Manufacturing Survey Data

The second source of data is China’s Annual Manufacturing Survey (AMS) 2000-2006. AMS covers all State Owned Enterprises (SOE) and firms of other types of ownership with annual sales above 5 million RMB. The survey collects information on firms’ industry classification (CIC), capital stock, wage cost, total employment, total exports, total output value, etc. I match the customs data and the AMS data by firms’ names. I summarize the exporting and importing activities of the matched sample in the bottom panel of Table 1. Given that AMS selects firms on size, it is not a surprise that firms in the matched sample are on average larger in export scale. However, there is no substantial and systematic difference in other measures of trading activities between the customs working sample and the matched sample.

3.3 Other Data

Information on destination markets’ per capita GDP is from the Penn World Tables. Pair-wise distances between countries are from CEPIL.

²²Processing and assembly exports account for the majority of the "Other" category.

²³For discussions of China’s exports through Hong Kong, see Fung and Lau (2003) and Ferrantino and Wang (2008).

4 Demand Estimation

4.1 Specification

The unit of observation is by exporting firm f , destination market m , 8-digit HS product h and year t . My estimation equation is

$$\ln(Q_{fght}) = \alpha^{g(m)j(h)} \times \ln(P_{fght}) + A_{mht} + \xi_{fght} + \epsilon_{fght} \quad (\text{I.14})$$

where $\ln(Q_{fght})$ is the log of physical quantity sold of product h by firm f to country m in year t ; $\ln(P_{fght})$ is the log of the associated unit value; A_{mht} is a market-product-time fixed effect included to absorb demand factors common to all exporters of product h to market m in year t ; ξ_{fght} denotes product quality, which is unobservable and is very likely to affect price and quantity simultaneously; ϵ_{fght} absorbs all exporter idiosyncratic demand shocks independent of price. $g(\cdot)$ and $j(\cdot)$ refer to the market group that country m belongs to and the product group that product h belongs to, respectively.

The purpose of estimating the demand function is to recover the latent quality ranking as demand residuals. It is essential to estimate the price coefficient properly. There are two issues that need to be addressed. First, unobserved quality simultaneously determines price on the right-hand side and quantity on the left-hand side, for the reason that varieties of better quality are usually more costly to produce and priced higher and that varieties of better quality are also demanded in larger quantities conditional on price. This leads to an upward bias of the OLS estimates of the price coefficient. To identify the price coefficient, I am going to construct and use a Hausman-Nevo instrument that captures the quality-independent part of the cost variation across different production locations in China. I will discuss this in more detail in the next subsection. The second issue is that the price coefficient is not necessarily the same across markets and products. It is not enough just to be able to consistently estimate an average price coefficient since

imposing a constant demand elasticity while heterogeneity exists will contaminate the residual as a quality measure. So I allow the price coefficient α to vary across market group g and product group j . I divide the global market into seven groups according to geographical location and level of development. The seven groups are:²⁴ the United States and Canada (NA); Latin American countries (LA); European Union member countries (EU); Singapore, Japan and Korea (SJK); other countries in Asia (RAS); Australia and New Zealand (AZ); African countries (AF). Product group g is defined along the 4-digit HS lines.²⁵ Once I get consistent estimates of the elasticities, I can purge the influence of price by subtracting $\hat{\alpha}^{g(m)j(h)} \times \ln(P_{fmht})$ from $\ln(Q_{fmht})$ as well as the influence of aggregate demand factors A_{mht} by demeaning within each mht cell. In the end, the quality measure would be an estimate of the residual $\xi_{fmht} + \epsilon_{fmht}$, denoted by $\hat{\xi}_{fmht}$.

4.2 Identification Strategy

Given the rich information I have on the origins and destinations of firms' exports, I can construct a Hausman-Nevo instrument to identify the price coefficients. With multi-market observations on prices, such an instrument uses prices on other markets as instruments. This type of instrument has been used in studies on ready-to-eat cereal markets by Hausman (1997) and Nevo (2001). In general, there are two sources of variation in observed prices: one is variation in supply-side factors, such as production, transportation or distribution cost, and the other is variation in demand-side factors, such as product quality. The first type of variation is useful in identifying the price coefficient in the demand function, while the second causes endogeneity problems and leads to inconsistent estimates if not addressed. A useful instrument must pick up variation of the first type to be relevant, and be free of the second type to be valid. In a multi-

²⁴I drop the observations associated with exports to the non-EU member European countries. The estimates for this group is very imprecise because of the small number of observations relative to the number of countries and products.

²⁵Thus the specification in (I.14) is equivalent to regressing $\ln Q$ on $\ln P$, controlling for market by product and by year fixed effects for each market group and 4-digit HS4 sector separately.

market context, the two-source variation argument takes a more specific form: prices charged by firms on two different markets can be correlated either because of common cost shocks or common demand shocks. To capture common cost shocks, I construct the instrument using prices charged by firms producing in the same prefecture in China; to avoid common demand shocks, I use prices from carefully selected markets that are far apart in terms of both geographical distance and levels of development.

For an illustrative example, think about firms in Dongguan, a manufacturing cluster in China’s Pearl River Delta area, that export to both Japan and Kenya. Because the two markets are quite far apart both on a geographical map and in levels of economic development, one can reasonably believe they have very different demand structures and are subject to independent demand shocks. On the other hand, these firms may share common cost shocks due to the localization of input markets. This allows me to use the prices that exporters from Dongguan charge in Kenya to construct instruments for the prices they charge in Japan.

I use prefecture as the production-origin identifier²⁶ and apply two criteria in selecting the set of markets in constructing instruments. For an observation subscripted with $fmht$, the prices charged by any exporter f' shipping goods from location $o(f)$, the prefecture where firm f is located, to any market m' in year t will be used to construct instrument for $\ln(P_{fmht})$ if

1. The geographical distance between country m and m' is above the 30th percentile in the distribution of geographical distance among all country pairs.
2. The per capita GDP of country m' is at least 1.5 times the standard deviation of the world distribution lower than that of country m .

The instrument for $\ln(P_{fmht})$ is then the average of prices of observations with subscript $f'm'h't$

²⁶There are about 300 unique locations.

$$IV_{f m h t} = \overline{\ln P}_{f' m' h' t} \quad (\text{I.15})$$

Notice the average is taken across all f' , m' and h' . The f' s and m' s are chosen as aforementioned; the h' s cover all the 8-digit HS lines in my sample.²⁷ For identification, the instrument retains the destination- and year-specific, across-prefecture variation in export prices to markets m' . The exclusion restriction, which is embedded in the market-selection criteria, requires in this context that the demand shocks from markets m' , where the average is taken, to be independent of the demand shocks in market m , where the price coefficient is to be estimated. The first criterion rules out markets that may share geographically local demand shocks; the second addresses the possibility that exporting firms may ship products of the same quality to markets with a similar degree of development and thus a similar preference for quality.²⁸

4.3 Demand Estimation Results

Table 2 summarizes the sample for demand estimation. Column (1) reports the number of observations for each market group. Column (2) and (3) report the number and percentage of observations with non-missing values for instrument. For richer markets such as the United States, Canada, European Union members countries, Australia, New Zealand, Singapore, Japan and Korea, less than 10% of the observations have missing value for instrument. Column (4) reports the number of 4-digit HS lines with negative and significant²⁹ estimates for the price coefficient. The best results are achieved for

²⁷To average across different products, the product-specific mean is taken out.

²⁸There are cases where no observation $f' m' h' t$ exists, i.e, there is no firm f' in the same prefecture $o(f)$ as firm f shipping to any market m' that satisfies the two selection criteria in year t . As a result, the instrument constructed as above would take missing value for such observations. By construction, observations in richer markets are less likely to take missing value. When this happens, I use the origin- and destination-specific mean over all years to construct a proxy for the missing value. If it is still missing, I take the average across all destination markets. The last resort is to take the provincial average of the origin prefecture.

²⁹The significance level is set at 10%.

the North American market and the EU market, with about 2/3 of the 4-digit product lines having significant and negative estimates. The last two columns report the number and percentage of observations associated with the count in column (4). For the North American and EU markets, more than 85% of the total observations are associated with negative and significant estimates for price coefficients.

Table 3 summarizes the OLS and IV estimates of the price coefficients. The means and medians are over product lines with negative and significant IV estimates using all observations for each market group.³⁰ Column (1) reports the average of OLS estimates; column (2) reports the average of OLS estimates using only the sample taking non-missing values for the instrument. Column (3) and (4) are for the IV estimates. Column (5) to (8) are the medians of the estimates. In general, for product lines with precise IV estimates, the magnitude of the IV estimates is about 1.5 to 2 times larger than the OLS estimates, suggesting the instrument is correcting the inconsistent OLS estimates in the expected direction. Moreover, the similarity between the estimation results with the full sample and the sub-sample with non-missing values for the instrument suggests the proxy strategy does not affect the estimation substantially.

Given my interest in quality differentiation and the precision of the estimates, I will focus on two markets groups in the following quality and input analysis. The two market groups are the North American market, which includes the United States and Canada, and the EU member countries. The two panels of Figure 2 show the OLS and IV estimates for these two market groups.

4.4 Robustness Check

As illustrated by the model on firms' decisions on input and output quality, the identification strategy in the demand estimation relies on a few key assumptions. Any violation of these assumptions will make the instrument invalid and the estimates of the price co-

³⁰This is corresponding to the count in columns (4) to (6) in Table 2.

efficient inconsistent. In the end, this will cause reversal in the measured quality ranking as illustrated in Figure 1. In this subsection, I check the robustness of the estimates shown above by constructing several alternative instruments and comparing the estimation results. Results using different instruments are similar, which is assuring.

The key potential threat to the validity of the instrument is the existence of quality differentiation in the set of markets selected in constructing the instrument. This would introduce correlation between the instrument and the endogenous price variable through the quality channel and make the instrument invalid. To address this concern, I first utilize the large number of markets available in my data and change the criteria in selecting the set of markets in constructing instruments. More specifically, I supplement the main instruments with another two stricter alternative instruments.³¹ One of the alternative instruments is constructed by adopting a per capita GDP disparity criterion of 1.75 times the standard deviation away while holding the geographical distance criterion at the 30th percentile; for the second alternative, I hold the per capita GDP criterion at 1.5 times the standard deviation and increase the geographical criterion to be above the 40th percentile. It turns out that the rank correlation coefficients among quality estimates based on different instruments are above 0.98. Figure 3 shows the estimates with the additional IVs together with the ones based on the main IV. An important observation is that stricter rules in selecting markets to construct instruments do not systematically change the magnitude of the estimates. Accordingly, overidentification tests fail to reject the hypothesis that the main instrument is exogenous for 41 out of the 48 product groups in the North American market and 42 product groups in the European market.

³¹I face a trade-off between instrument validity and instrument strength in selecting the geographical distance and per capita GDP disparity cut-offs: the farther away the two markets, the more likely they have independent demand shocks and the more confident I am in the validity of the instrument; on the other hand, the stricter I am in selecting markets, the more observations would need proxy values for instruments and the less variation can be utilized, and in turn, the less efficient the estimates would be. Thus it is desirable to find a balance point where the estimation results are robust to small changes in cut-offs.

The overidentification test is informative about the validity of the main instrument based on the assumption that the stricter instruments are valid. In other words, passing the overidentification test only suggests that the estimates based on different instruments are similar but not necessarily consistent. In cases where exports to even the poorest destinations are vertically differentiated, the estimates would be inconsistent no matter how strict the criteria. To address this concern, I explore the product dimension of my data and use only unit values of products classified as homogeneous goods in Rauch (1999) that are also used as inputs in producing products under HS Chapter 85 as instruments.³² It turns out that the instruments constructed this way are much weaker and the first stage F -statistic is less than 6 for more than half of the 48 product groups. However, the rank correlation coefficient among quality estimates based on my main instrument and this alternative instrument is still as high as 0.75. Figure 4 shows the comparison between the estimates of price coefficients that are significant with both instruments. Again, the magnitude of the estimates with the alternative instrument is not systematically larger than that with the main instrument.

5 Quality and Input Choices

With price coefficients in hand, I calculate the following firm-, product-, market- and year-specific residuals as a measure of quality.

$$\hat{\xi}_{fhmt} = \ln(Q_{fhmt}) - \hat{\alpha}^{g(m)j(h)} \times \ln(P_{fhmt}) - \hat{A}_{mht} \quad (\text{I.16})$$

This measure contains the last two terms $\xi_{fhmt} + \epsilon_{fhmt}$ in (I.14). In this section, I use these quality measures to identify input factors related to firms' quality choices in their exports to the North American and European markets, as well as the heterogeneity of

³²I use a concordance between the HS product classification and sectors in China's 2002 input-output table to identify inputs.

this input-output association across firms of different ownership types.

The regression specification is

$$\widehat{\xi}_{fhmt} = \sum_k \gamma_1^{k,O} \times IMPORT_{ft}^k + \gamma_2^O \times WAGE_{ft} + \gamma_3^O \times KLRatio_{ft} + CONTROLS_{ft} \Gamma + \nu_{fhmt} \quad (\text{I.17})$$

The variables of interest on the right-hand side are $IMPORT^k$, $WAGE$ and $KLRatio$. They all vary at the firm and year level. $IMPORT^k$ s stand for measures of importing activities from China's customs data. $WAGE$ is measured with a firm's total wage bill divided by its total employment size. $KLRatio$ is the ratio of real capital stock³³ and total employment. γ_1^k , γ_2 and γ_3 , the coefficients for $IMPORT^k$, $WAGE$ and $KLRatio$, are allowed to vary by firms' ownership types. This is because firms of different ownership types may have to incur different costs to access input markets. The four ownership types are Chinese state-owned enterprises (SOE); Chinese non-state-owned firms (Non-SOE); Hong Kong-, Macao- or Taiwan-owned firms (HMT); and other foreign-owned firms (FGN). Control variables $CONTROLS$ include a third-order polynomial of firm size measured by total employment, a dummy indicating whether the destination is North America or Europe, firms' sector³⁴ by prefecture location pair fixed effects and year by experience³⁵ pair fixed effects. Error term ν_{fhmt} captures both random shocks that affect firms' quality choice and measurement errors in the estimated quality.

China's customs records provide information on firms' imports in as much detail as on firms' exports. This allows me to construct not only extensive measures - importing status dummies - but also intensive measures, such as the total and unit value of imports, as well as the number of imported 8-digit HS product lines. I include only firms' imports through ordinary trade as those duty-free imports for processing and assembly that are

³³The measure of real capital are borrowed from Brandt et al. (2012).

³⁴Sector here is at the 4-digit Chinese Industry Classification (CIC) level. More information on the overtime concordance of this classification system can be found in Brandt et al. (2012).

³⁵Experience is proxied by the year when a firm is first observed to export in my data.

under strict regulation and cannot be used in producing for exports through ordinary trade. I further differentiate the origins and the types of imports. According to whether the imports are from one of the 20 most advanced countries, I divide imports into two categories, those from rich countries and those from other countries.³⁶ Regarding the types of imported goods, I use the UN's BEC (Classification by Broad Economic Categories) classification and identify imports as either intermediate inputs or capital goods.

Table 4 reports the regression results with importing status dummies. For the regression results presented in Panel (a), *IMPORT* measures in regression equation (I.17) include just a dummy indicating whether a firm imports anything at all. The first finding is that importers on average have a quality premium and it is significant among Chinese firms. Specifically, holding price constant, the market share of Chinese non-state-owned firms who are also importers is about 14.5% higher than the non-importers in the same ownership category. This positive correlation between quality and importing activities is consistent with the existing evidence that imports have a positive impact on firm productivity, as argued in Amiti and Konings (2007), Kasahara and Rodrigue (2008), Halpern et al. (2005), Kugler and Verhoogen (2009) and Manova and Zhang (2011), but suggests quality upgrading, as opposed to cost saving, as a specific channel through which this impact takes place. Notice that I am using the same data source as Manova and Zhang (2011). However, I focus on a different set of firms. Manova and Zhang (2011) study firms involved in processing trade while I focus on firms that export through ordinary trade. The advantage of focusing on processing and assembly exporters is that one knows for sure the related imports will be used in producing for foreign markets. This does not apply to firms exporting through ordinary trade as these firms sell a substantial portion of their output to China's domestic market. However, one may be concerned to what extent firms involved in processing and assembly trade are behaving like profit-maximizing

³⁶The 20 rich countries are: Luxembourg, Norway, the United States, Singapore, Switzerland, Netherlands, Austria, Canada, Iceland, Denmark, Australia, Belgium, Germany, Japan, France, Sweden, Italy, Britain, Finland and Spain.

agents in making decisions on input, output and price. Many of the processing firms operate only as a producing unit of a much longer value-generating chain with important decisions made elsewhere. Firms that export through ordinary trade are less of concern in this aspect.³⁷

The second finding is that wage is positively associated with quality and the correlation is significant for all ownership categories except SOEs. This finding relates to a large body of literature on the impact of globalization on wage inequality, and especially skill premium. The Stolper-Samuelson theorem in the classical Heckscher-Ohlin model predicts that skill premium will increase with trade in skill-abundant countries but decrease in skill-scarce countries because of the opposite changes in the relative price of skill-intensive tradables in the two types of countries. This prediction is inconsistent with what actually happened: first, the price of the skill-intensive products in the skill-abundant countries has been stable or declining; second, skill premium has been increasing in the skill-scarce countries. To explain the observed patterns, skill-biased technology adoption has been proposed in many studies as a factor missing in the traditional trade model but can offset the Stolper-Samuelson force and lead to increasing skill premium in all countries. Acemoglu (2003), Yeaple (2005) and Zhu and Trefler (2005) emphasize the technology change at the firm level. Harrigan and Reshef (2011) and Burstein and Vogel (2012) extend the model by introducing the interaction between the firm heterogeneity in productivity and the skill intensity of production technology to further allow impacts through the reallocation channel. Verhoogen (2008) and Bustos (2011) also find supportive evidence for this skill-upgrading mechanism in Mexican firms and Argentinian firms respectively. Studies on the wage structure in China, by Whalley and Xing (2010) and Han et al. (2012), also find increasing skill premium, especially

³⁷Another difference is that Manova and Zhang (2011) cover all HS product lines while I am investigating only one chapter of HS products. I choose not to cover all products in this paper because my quality measure is recovered from estimating a demand system instead of being inferred from unit value alone. Demand systems for different products should be estimated separately and the work here can be easily applied to other HS chapters.

in the coastal region, where firms are more integrated into the global economy. A full accounting decomposition of the change in skill premium in China is beyond the scope of this study, but the positive correlation between wages and the quality of exports to high income markets suggests the impact of globalization on skill premium can be the combined consequence of the integration into the global market and selection of technology, and more specifically, the technology selection can be related to quality upgrading. Capital intensity, however, is found to be contributing to quality and, for Hong Kong-, Macao- and Taiwan-invested firms, the coefficient is even negative. This differs from observations from other countries, such as Mexico in Verhoogen (2008), and deserves further investigation in future research.

In Panel (b) and (c) of Table 4, imports are differentiated by the type of products imported - whether it is intermediate input or capital goods³⁸ - and further by the origins of the imports - whether the imports come from one of the 20 most advanced countries. Panel (b) shows that it is the imports of intermediate inputs that matters for Chinese non-state-owned firms. As for the measure of capital intensity, the contemporary status of capital goods importing is not significantly correlated with product quality.³⁹ In Panel (c), the status of importers of each type of product is further examined in connection with the origins of the imports. For Chinese non-state owned firms, it turns out that it is the imports from the advanced countries that is most related to quality production. Interestingly, the positive correlation with imports from rich countries also holds for foreign-invested firms, which suggests the previous negative but insignificant result for foreign-invested firms is mainly driven by imports from countries other than the top 20 advanced ones. In these regressions, the relation between quality and wage remains, but of slightly smaller magnitude.

³⁸HS lines matched to BEC - the United Nations's Broad Economic Classification - categories 41, 42 and 521 are identified as capital goods; lines matched 111, 121, 21, 22, 31, 32, 321, 322, 42 and 53 are identified as intermediate input. BEC classification can be found at [http : //unstats.un.org/unsd/cr/registry/regcst.asp?Cl=10](http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=10)

³⁹Using the status of capital goods importing in the previous year gives similar results.

Table 5 investigates the imports in intermediate inputs in more detail. In Panel (a), a continuous measure of the log value of total imports of intermediate input replaces the status dummy. Again, a positive association is found for Chinese non-state-owned firms. The estimates of the coefficients of wage and capital labour ratio are about the same as before. In Panel (b), the total imports are divided into imports from advanced countries and imports from other countries. Interestingly, for the Chinese non-state-owned firms, the positive association found in earlier results is purely driven by imports from the advanced countries; for foreign-invested firms, the imports from advanced countries are positively associated with quality by a magnitude even larger than that of the Chinese firms, while the imports from other countries are negatively correlated with quality. Panel (c) looks at the number of different products at the 8-digit HS level of firms' imports of intermediate input. The pattern is similar to the regressions with values of imports. Table 6 replicates these exercises for capital goods. Overall, imports of capital goods are not correlated with quality production among Chinese firms. For Hong Kong-, Macao- and Taiwan-invested firms, imports of capital goods from countries other than the most advanced ones are negatively correlated with quality, both in terms of value of imports and the number of different products imported. For other foreign-invested firms, the association is positive for imports from the most advanced countries and negative for other countries. The patterns found in Table 5 and Table 6 do not change if imports of intermediate input and capital goods are included simultaneously.

6 Conclusion

Using the detailed price and quantity information on firms' exports between 2000 and 2006 from China's customs data, I estimate the market- and product-specific demand functions for China's exports and recover the latent quality as the demand residual. Combining my quality measure with import data from China's customs data and China's

Annual Manufacturing Survey data, I investigate the association between quality and firms' input choices. I find importing activities, primarily by non-state-owned Chinese firms and in some cases foreign-invested firms, are positively and significantly associated with higher quality in exports to the more quality demanding North American and European destinations. This suggests facilitating quality upgrading might be a specific channel through which easier access to imported inputs contributes to firm productivity. I also find wages to be positively correlated with quality which suggests incentives to upgrade quality of exports to rich countries can be one of the forces behind the documented increasing skill premium in developing countries in the process of trade liberalization.

7 Figures and Tables

Figure 1: Demand and quality estimation (e.g., HS85291020)

Figure 2: OLS and IV estimates

Figure 3: IVs based on different market selection criteria

Figure 4: IV based on homogeneous input

Table 1: Data summary

	2000		2003		2006	
<u>Exports Decomposition:</u>						
Billion USD	ordinary	other	ordinary	other	ordinary	other
	trade	trade	trade	trade	trade	trade
Indirect ⁽¹⁾	3.2	4.7	4.7	70	9.2	9.7
Direct	3.5	34.4	9.5	66.7	31.9	176.8
<u>Customs working sample</u>						
# of exporters	3,465		9,366		18,105	
median exp. value (USD)	38,305		59,176		67,253	
median # of HS8 product exp.	4		6		5	
median # of destinations	6		11		12	
% importing IMT	56%		53%		41%	
% importing CAP	38%		39%		29%	
median value of imp. IMT ⁽²⁾	163,976		123,843		127,544	
median value of imp. CAP ⁽³⁾	68,655		56,496		59,709	
median # of HS8 imp. IMT	9		8		7	
median # of HS8 imp. CAP	4		4		4	
<u>Matched working sample</u>						
# of exporters	1,332		3,377		7,484	
median exp. Value (USD)	44,846		100,069		159,560	
median # of HS8 product exp.	3		4		5	
median # of destinations	7		13		16	
median size by employment	262		244		220	
median wage (CHN Yuan)	11,920		10,381		14,789	
% importing IMT	59%		60%		55%	
% importing CAP	39%		45%		40%	
median value of imp. IMT#	124,574		154,527		177,175	
median value of imp. CAP	49,198		53,265		60,613	
median # of HS8 imp. IMT	9		10		9	
median # of HS8 imp. CAP	4		4		4	
% imp. IMT from RICH	48%		50%		45%	
% imp. CAP from RICH	31%		36%		32%	
median value of imp. IMT from RICH (USD)	108,389		115,161		114,360	
median value of cap. IMT from RICH (USD)	59,548		51,076		54,400	
median # of HS8 IMT from RICH	8		7		7	
median # of HS8 CAP from RICH	4		4		3	

(1) "Indirect" means exporting through a trading company; (2) IMT stands for intermediate inputs; (3) CAP stands for capital goods.

Table 2: Demand estimation: sample count

	(1)	(2)	(3)	(4)	(5)	(6)
Market group	# of obs.	# of obs. with non-missing value for instrument	% of obs. with non-missing value for instrument	# of HS4 lines with sig. ⁽¹⁾ and neg. estimate of price elasticity (out of 48)	# of obs. with sig. and neg. estimate of price elasticity	% of obs. with sig. and neg. estimate of price elasticity
U.S. and Canada	67,714	66,346	98%	30	57,967	86%
European Union countries	177,444	165,824	93%	31	155,188	87%
Australia and New Zealand	21,957	21,309	97%	20	12,201	56%
Singapore, Japan and Korea	79,227	71,446	90%	18	31,088	39%
Rest of Asia	219,819	156,651	71%	22	129,246	59%
Latin American countries	63,258	47,835	76%	15	30,142	48%
African countries	52,786	12,056	23%	18	29,968	57%

(1) Significant at level 10%.

Table 3: Summaries of estimates of price coefficients from demand estimation: mean and median of OLS vs. IV estimates by market group

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean				Median			
	OLS		IV		OLS		IV	
Market group	all obs.	obs. with non-missing instrument	all obs.	obs. with non-missing instrument	all obs.	obs. with non-missing instrument	all obs.	obs. with non-missing instrument
Pooled	-0.85	-0.84	-1.54	-1.74	-0.91	-0.89	-1.48	-1.52
U.S. and Canada	-0.85	-0.85	-1.92	-2.04	-0.87	-0.87	-1.84	-1.61
European Union countries	-0.82	-0.81	-1.45	-1.38	-0.86	-0.85	-1.28	-1.31
Australia and New Zealand	-0.86	-0.86	-1.77	-2.07	-0.93	-0.93	-1.82	-1.83
Singapore, Japan and Korea	-0.85	-0.84	-1.58	-1.58	-0.83	-0.82	-1.37	-1.33
Rest of Asia	-0.87	-0.85	-1.64	-1.43	-0.93	-0.89	-1.42	-1.46
Latin American countries	-0.91	-0.91	-1.71	-1.64	-0.92	-0.94	-1.64	-1.56
African countries	-1.03	-1.06	-1.82	-1.96	-0.95	-0.94	-1.69	-1.24

Table 4: Quality and importing status (N=112452)

(a) Importing status dummy

	(1)	(2)	(3)
	Dummy for importing	log of wage	capital labour ratio
Non-SOE	0.145* (0.062)	0.178*** (0.047)	0.005 (0.032)
SOE	0.331* (0.159)	0.068 (0.073)	-0.040 (0.091)
HMT	0.130 (0.074)	0.128** (0.049)	-0.131** (0.042)
FGN	-0.054 (0.089)	0.155*** (0.046)	0.042 (0.040)

(b) Importing status dummy by types of products

	(1)	(2)	(3)	(4)
	Dummy for importing intermediate input	Dummy for importing capital goods	log of wage	capital labour ratio
Non-SOE	0.230*** (0.066)	-0.065 (0.075)	0.172*** (0.048)	0.004 (0.032)
SOE	0.027 (0.230)	0.087 (0.221)	0.081 (0.072)	-0.035 (0.091)
HMT	0.114 (0.076)	-0.108 (0.086)	0.139** (0.048)	-0.120** (0.042)
FGN	-0.011 (0.094)	-0.072 (0.092)	0.155*** (0.047)	0.045 (0.041)

(c) Importing status by types and origins of imports

	(1)	(2)	(3)	(4)	(5)	(6)
	Dummy for importing intermediate input from rich countries	Dummy for importing intermediate input from other countries	Dummy for importing capital goods from rich countries	Dummy for importing capital goods from other countries	log of wage	capital labour ratio
Non-SOE	0.237** (0.076)	0.108 (0.074)	-0.092 (0.079)	-0.069 (0.091)	0.154** (0.048)	0.002 (0.032)
SOE	-0.117 (0.181)	0.144 (0.172)	0.048 (0.177)	-0.105 (0.155)	0.084 (0.073)	-0.028 (0.088)
HMT	0.158 (0.081)	-0.044 (0.092)	0.112 (0.104)	-0.261** (0.101)	0.115* (0.048)	-0.114** (0.042)
FGN	0.122 (0.093)	-0.251** (0.091)	0.168 (0.096)	-0.131 (0.097)	0.133** (0.048)	0.046 (0.042)

***significant at 0.1% level; ** significant at 1% level; * significant at 5% level

Error terms are clustered at the firm level.

Table 5: Quality and importing intermediate inputs

(a) Value of imports (N=112452)

	(1)	(2)	(3)
	value of imports	log of wage	capital labour ratio
Non-SOE	0.027*** (0.007)	0.155** (0.048)	-0.005 (0.033)
SOE	0.006 (0.014)	0.099 (0.072)	-0.031 (0.088)
HMT	0.011 (0.009)	0.126** (0.047)	-0.128** (0.042)
FGN	0.015 (0.009)	0.129** (0.047)	0.012 (0.042)

(b) Value of imports by origins (N=112452)

	(1)	(2)	(3)	(4)
	value of imports from rich countries	value of imports from other countries	log of wage	capital labour ratio
Non-SOE	0.023** (0.009)	0.009 (0.008)	0.139** (0.048)	-0.003 (0.033)
SOE	-0.004 (0.014)	0.006 (0.014)	0.092 (0.075)	-0.023 (0.087)
HMT	0.021* (0.010)	-0.009 (0.009)	0.107* (0.046)	-0.127** (0.042)
FGN	0.040*** (0.009)	-0.022* (0.009)	0.101* (0.048)	0.005 (0.043)

(c) Number of imported product lines by origins (N=112452)

	(1)	(2)	(3)	(4)
	Number of varieties from rich countries	Number of varieties from other countries	log of wage	capital labour ratio
Non-SOE	0.154* (0.065)	-0.040 (0.062)	0.138** (0.048)	0.003 (0.033)
SOE	-0.041 (0.093)	0.074 (0.100)	0.064 (0.076)	-0.023 (0.088)
HMT	0.076 (0.066)	-0.116* (0.049)	0.118** (0.046)	-0.101* (0.042)
FGN	0.199*** (0.045)	-0.171*** (0.046)	0.086 (0.048)	-0.002 (0.044)

***significant at 0.1% level; ** significant at 1% level; * significant at 5% level

Error terms are clustered at the firm level.

Table 6: Quality and importing capital goods

(a) Value of imports (N=112452)

	(1)	(2)	(3)
	value of imports	log of wage	capital labour ratio
Non-SOE	0.006 (0.007)	0.185*** (0.048)	0.011 (0.032)
SOE	-0.001 (0.014)	0.101 (0.076)	-0.027 (0.090)
HMT	-0.003 (0.010)	0.139** (0.047)	-0.115** (0.041)
FGN	0.009 (0.009)	0.129** (0.048)	0.021 (0.041)

(b) Value of imports by origins (N=112452)

	(1)	(2)	(3)	(4)
	value of imports from rich countries	value of imports from other countries	log of wage	capital labour ratio
Non-SOE	0.000 (0.008)	0.003 (0.008)	0.177*** (0.048)	0.015 (0.032)
SOE	-0.004 (0.013)	-0.002 (0.014)	0.095 (0.076)	-0.017 (0.089)
HMT	0.022 (0.012)	-0.026* (0.010)	0.118* (0.047)	-0.110** (0.041)
FGN	0.033*** (0.010)	-0.015 (0.009)	0.094 (0.049)	0.002 (0.042)

(c) Number of imported product lines by origins (N=112452)

	(1)	(2)	(3)	(4)
	Number of varieties from rich countries	Number of varieties from other countries	log of wage	capital labour ratio
Non-SOE	-0.023 (0.065)	-0.011 (0.074)	0.181*** (0.048)	0.020 (0.033)
SOE	-0.033 (0.087)	0.070 (0.103)	0.053 (0.080)	-0.031 (0.091)
HMT	0.033 (0.090)	-0.164* (0.067)	0.142** (0.047)	-0.095* (0.040)
FGN	0.159** (0.055)	-0.148* (0.061)	0.104* (0.048)	0.009 (0.041)

***significant at 0.1% level; ** significant at 1% level; * significant at 5% level

Error terms are clustered at the firm level.

8 Appendix

Table Appendix 1: HS4 Description

HS4	Description
8501	Electric motors and generators (excluding generating sets)
8502	Electric generating sets and rotary converters Generating sets with compression-ignition internal combustion piston engines (diesel or semi diesel engines):
8503	Parts suitable for use solely or principally with the machines of heading 8501 or 8502
8504	Electrical transformers, static converters (for example, rectifiers) and inductors
8505	Electro/magnets; permanent magnets and articles intended to become permanent magnets after magnetisation; Electro-magnetic or permanent magnet chucks, clamps and similar holding devices; Electro-magnetic couplings, clutches and brakes; Electro-magnetic li
8506	Primary cells and primary batteries
8507	Electric accumulators, including separators therefore, whether or not rectangular (including square)
8509	Electro-mechanical domestic appliances, with self-contained electric motor
8510	Shavers, hair clippers and hair-removing appliances, with self-contained electric motor
8511	Electrical ignition or starting equipment of a kind used for spark-ignition or compression-ignition internal combustion engines (for example, ignition magnetos, magneto-dynamos, ignition coils, sparking plugs and glow plugs, starter motors); Generators (f
8512	Electrical lighting or signalling equipment (excluding articles of heading 8539), windscreen wipers, defrosters and demisters, of a kind used for cycles or motor vehicles
8513	Portable electric lamps designed to function by their own source of energy (for example, dry batteries, accumulators, magnetos), other than lighting equipment of heading 8512
8514	Industrial or laboratory electric(including induction or dielectric) furnaces and ovens (including those functioning by induction or dielectric loss); Other industrial or laboratory equipment for the heat treatment of materials by induction or dielectric
8515	Electric (including electrically heated gas), laser or other light or photo beam, ultrasonic, electron beam, magnetic pulse or plasma arc soldering, brazing or welding machines and apparatus, whether or not capable of cutting; Electric machines and appara
8516	Electric instantaneous or storage water heaters and immersion heaters; Electric space heating apparatus and soil heating apparatus; Electro-thermic hair-dressing apparatus (for example hair dryers, hair curlers, curling tong heaters) and hand dryers, Elec
8517	Electrical apparatus for line telephony or line telegraphy, including line telephone sets with cordless handsets and telecommunication apparatus for carrier-current line system or for digital line systems; Videophones Telephone sets; Videophones:
8518	Microphones and stands therefor; Loudspeakers, whether or not mounted in their enclosures; Headphones and earphones, whether or not combined with microphone, and sets consisting of a microphone and one or more loudspeakers; Audio-frequency electric amplif
8519	Turntables (record-decks), record-players, cassette-players and other sound reproducing apparatus, not incorporating a sound recording device
8520	Magnetic tape recorders and other sound recording apparatus, whether or not incorporating a sound reproducing device
8521	Video recording or reproducing apparatus, whether or not incorporating a video tuner
8522	Parts and accessories suitable for use solely or principally with the apparatus of headings 8519 to 8521
8523	Prepared unrecorded media for sound recording or similar recording of other phenomena, other than products of Chapter 37 Magnetic tapes:

8524	Records, tapes and other recorded media for sound or other similarly recorded phenomena, including matrices and masters for the production of records, but excluding products of chapter 37
8525	Transmission apparatus for radio-telephony, radio-telegraph, radio-broadcasting or television, whether or not incorporating reception apparatus or sound recording or reproducing apparatus; Television cameras; still-mage video cameras and other video camer
8526	Radar apparatus, radio navigational aid apparatus and radio remote control apparatus
8527	Reception apparatus for radio-telephony or radio-broadcasting, whether or not combined, in the same housing, with sound recording apparatus or a clock
8528	Reception apparatus for television, whether or not incorporating radio-broadcast receivers or sound or video recording or reproducing apparatus; Video monitors and video projectors
8529	Reception apparatus for television, whether or not incorporating radio-bro
8529	Parts suitable for use solely or principally with the apparatus of headings 8525 to 8528
8530	Electrical signaling, safety or traffic control equipment of railways, tramways, roads, inland waterways, parking facilities, port installations or airfields (other than those of heading 8608)
8531	Electric-sound or visual signalling apparatus (for example, bells, sirens, indicator panels, burglar or fire alarms), other than those of heading 8512 or 8530
8532	Electrical capacitors, fixed, variable or adjustable (pre-set)
8533	Electrical resistors (including rheostats and potentiometers), other than heating resistors
8534	Printed circuits
8535	Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits (for example, switches, fuses, lighting arresters, voltage limiters, surge suppressors, plugs, junction boxes), for a voltage exce
8536	Electrical apparatus for switching or protecting electrical circuits, or for making connections to or om electrical circuits (for example, switches, relays, fuses, surge suppressors, plugs, sockets. Lamp-holders, junction boxes), for a voltage not exceedi
8537	Boards, panels, consoles desks, caninets and other bases, equipped with two or more apparatus of heading 8535 or 8536, for electric control or the distribution of electricity, including those incorporating instruments or apparatus of Chapter 90, and numer
8538	Parts suitable for use solely or principally with the apparatus of headings 8535, 8536 or 8237
8539	Electric filament or discharge lamps, including sealed beam lamp units and ultra-violet or infra-red lamps; Arc-lamps
8540	Thermionic, cold cathode or photocathode valves and tubes (for example, vacuum or vapour or gas filled valves and tubes, mercury arc rectifying valves and tubes, cathode-ray tubes, television camera tubes) Cathode-ray television picture tubes, including v
8541	Diodes, transistors and similar semi-conductor devices; Photosensitive semi-conductor devices, including photovoltaic cells whether or not assembled in modules or made-up into panels; Light emitting diodes; Mounted piezo-electric crystal
8542	Electronic Integrated circuits and microassemblies
8543	Electrical machianes and apparatua having individual functions, not specified or included elsewhere in this Chapter Particle accelerators:
8544	Insulated (including enamelled or anodised) wire, cable (including co-axial cable) and other insulated electric conductors, whether or not fitted with connectors; Optical fibre cables, made up of individually sheathed fibres, whether or not assembled with
8545	Carbon electrodes, carbon brushes, lamp carbons, battery carbons and other articles of graphite or other carbon, with or without metal, of a kind used for electrical purposes Electrodes:
8546	Electrical insulators of any material

8547	Insulating fittings for electrical machines, appliances or equipment, being fittings wholly of insulating material apart from any minor components of metal (For example, threaded sockets) incorporated during moulding solely for purposed of assembly, other
8548	Waste and scrap of primary cells, primary batteries and electric accumulators; Spent primary cells, spent primary batteries and spent electric accumulators; Electrical parts of machinery or apparatus, not specified or included elsewhere in this Chapter

Chapter II

WTO Accession and Firm-Level Productivity in Chinese Manufacturing

(joint with Loren Brandt, Johannes Van Biesebroeck and Yifan Zhang)

"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 et al. (2012)). In most narratives, the 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 the 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 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 policy reforms on firm and sector-level productivity. Over this period, industry-level *TFP* growth averaged more than 12 percent per annum. The central hypothesis we wish to examine is whether the dispersion in productivity growth we observe within the manufacturing sector, as shown in Figure 1, can be linked to these 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. Drawing on information we collected on import tariffs, non-tariff barriers and *FDI* restrictions over the entire period, we investigate the relative importance of alternative mechanisms through which policy changes may have mattered.

We focus on reform efforts that facilitated access to the domestic Chinese market for the rest of the world, not on the effects coming from China's access to overseas markets and 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 domestically (Brandt and Thun (2010)). Exports are an important part of the Chinese economy, but even more important is manufacturing activity directed to the domestic market, including intermediate inputs. Moreover, through the processing trade regime, which represents more than half of China's total trade, exporting firms already benefitted from tariff-free imports of intermediates. Second, even before entry into the WTO, China already enjoyed most-favored nation status in several countries, albeit on an annually-renewable basis in the United States.² Elimination of this uncertainty is likely to have had positive effects on Chinese firms, but such a benefit is hard to quantify and we conjecture

¹The 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, Branstetter and Lardy (2008) also view more competition as an essential source of pressure that forced structural reforms.

²In the EU, there was no annual renewal process, but a surge of Chinese imports in Europe could very well have led to reinstatement of discriminatory tariffs. This is exactly what happened when the MFA (Multi-Fiber Agreement) for apparel and textile products ended in 2006.

it is likely to be smaller than the effects coming through increased competition in the domestic market.

To make our 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 (Besley and Case (2000)). Policy makers might have lowered import tariffs selectively after learning which sectors are most 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. 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.

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 detailed 4-digit industry fixed effects and lagged tariff levels even in a regression in first differences without losing all identifying power.

Entry into the WTO required large reductions 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*). We focus primarily on the role of tariff reductions, which are observed most accurately, but also look for links with the other two policy variables. 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. In principle, import tariffs could matter in two ways: through the effect on prices of imports that compete with locally manufactured goods, and through the prices (as well as quality and variety) of imported intermediate goods (Topalova and

Khandelwal (2011)). We focus on the combined effect, using the change in effective rate of protection as explanatory variable, but we have also estimated the effects of tariffs on outputs and inputs separately as a sensitivity check.

To build confidence in our argument, we carefully examine the mechanism through which the policy change had its effect. We estimate the effects of tariff liberalization on several dependent variables using the same specification for each. The results establish that the cross-sectoral variation in liberalization was only weakly related to the variation in import growth, while the link with reductions in sectoral price indices and price-cost margins is much stronger. In particular, despite a very low import share for most inputs, tariff cuts for inputs are passed-through one-for-one into the sectoral input price indices. In the short run, domestic firms can match price reductions for imports by lowering price-cost margins, but in the long run these cuts must be backed up by productivity increases.

Tariff reduction is found to play an important role there, but the association between productivity growth and tariff reductions is stronger at the sector than at the firm level. We investigate potential explanations by decomposing the sector-level productivity growth into three components and using each one as a separate dependent variable in the same specification as before. The link between tariff liberalization and the contribution of net entry to sector productivity is by far the strongest of the three. The beneficial effect of reallocating resources from exiting to entering firms is strongly associated with the liberalization. This effect is working primarily through the entry of especially productive private firms in more competitive sectors. Private sector entry is large in nearly all sectors over this period, but the quality of the entrants is increasing in the degree of competition they will face. Falling tariffs effectively raise the productivity threshold that these firms must achieve in order for entry to be profitable.

The remainder of the paper is organized as following. Section 2 discusses the history of China's relevant policies. Section 3 reviews the literature on trade liberalization effects

and motivates the identification strategy of this paper. Section 4 describes the data. Section 5 shows the empirical findings on the impact of the tariff reduction on various variables of interest and pins down the channels through which it affects industry and firm-level productivity growth. Section 6 concludes.

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 Economic and Technical Development Zones in fourteen coastal cities, China encouraged foreign direct investment (*FDI*) to develop a manufacturing export sector through the importation of much-needed capital, managerial know-how, and technology. Outside of these zones it allowed the importation and licensing of new technologies and capital goods as part of a policy of modernizing existing domestic enterprises. It concurrently started 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 for 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 its accession to WTO at the end of 2001, China's manufacturing sector was already relatively open on several dimensions.

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, as well as the capital equipment to be used. Exemption of import duties was further expanded in the late-half of the 1990s to certain type of domestic firms and organizations. Branstetter and Lardy (2008) report that in 2000 less than 40 percent of imports were subject to tariffs. Second, beginning in the early 1990s, China started to lower its domestic tariffs. The average tariff at the 8-digit HS level was lowered from an average of 43.2 percent in 1992 to 15.3 in 2001. This was accompanied by a reduction in the share of imports regulated by non-tariff barriers through licenses and quotas (Branstetter and Lardy (2008), p. 635).

In Figure 2 we plot 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 set at the 8-digit level of the Harmonized System product classification. We map them into China's Industrial Classification (CIC) system at the 4-digit level for the firm and industry-level analysis.³ To avoid biasing the sectoral average by the low trade volumes in heavily protected product lines, we use an unweighted average. Input tariffs are a weighted average of output tariffs, using industry-input shares from the 2002 Input-Output (IO) table. Reflecting the higher level of aggregation of the Chinese IO table, the 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 1995 to 2007 period.

Drawing on annual circulars of the Ministry of Foreign Trade and Economic Cooperation and the Ministry of Commerce, we also assembled information on the licensing

³We extend the HS-CIC concordance table created by the NBS to include all manufactured products (HS) and manufacturing sectors (CIC) and correct several mistakes (about 100). Changes in the HS system in 2002 (affecting nearly ten percent of all product lines) and in the CIC system in 2003 required multiple concordance tables.

of imports and exports. The measure of non-tariff barriers 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 weighted average fraction of products subject to such a license is much smaller, declining from 5.5% to 0.04% over the same period.⁴ Information on *FDI* restrictions comes from the same sources. Sectors can be subject to an *FDI* restriction or a total prohibition and the indicator in Figure 2 includes either. The total number of sectors subject to some form of *FDI* restriction declined from a 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 correlation across sectors between the different forms of protection is positive in 1997: We observe a partial correlation of 0.27 between *NTB* and *FDI* restrictions, 0.16 between *NTBs* and tariffs over 15%, but no correlation between *FDI* restrictions and high tariffs. By 2007, however, the correlations between tariffs and either *NTBs* or *FDI* restrictions have become very weak and not statistically significant from zero, while the correlation between *NTB* and *FDI* has dropped to 0.1. This behavior reflects the convergence of import tariffs to a fairly uniform level in all sectors and the dwindling importance of recorded *NTBs*.⁵

Figure 3 provides more information on the evolution of import tariffs over the 1995-2007 sample period. Several patterns stand out. First, output tariffs are on average substantially higher than input tariffs, reflecting the very different treatment of final goods from raw materials, intermediates inputs, and capital imports. As a result, effective rates of protection (*ERP*) are considerably higher than the stated tariff rates.⁶ Second, tariff reduction has proceeded in two spurts, with large and widespread reductions between

⁴Here we use as weight the world trade volume at the 6-digit HS level from the UN Comtrade database.

⁵The reductions in *NTBs* and output tariffs between 1997 and 2007 are orthogonal however, suggesting that there is some independent information in the two sets of changes.

⁶In the Figure 3, note that that the left and right axis use different scales.

1992 and 1997, and then again in 2002, with more heterogeneous and gradual reductions in the other years. Tariff reductions became more predictable as negotiations proceeded, and after WTO entry followed a predetermined pattern. Third, by the end of the period the average difference between input and output tariffs fell to less than four percentage points. Combined with the rising share of value added in total output, this narrowing contributes to a gradual reduction in the effective rate of protection. The average evolution hides important variation across industries that we use to identify the effects. The dashed lines, denoting the inter-quartile range for *ERP*, highlight that industries initially differed tremendously in the protection they received. The narrowing of the band, from approximately 20-120% in 1995 to 5-30% in 2007, highlights the important tariff compression. The experience of different sectors must have differed substantially.

3 Literature, Empirical Model, and Estimation

3.1 Literature

A large literature investigates the potential positive effects of broad-based tariff reductions on domestic industries. One channel featured prominently in the early literature is the impact of foreign competition on price-cost margins.⁷ Studies using either accounting measures of the price-cost margin 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 (1994), and Krishna and Mitra (1998) utilize the second methodology in studies for Turkey, Cote d'Ivoire, and India.

The effect of trade liberalization can also work through size rationalization: Smaller

⁷Tybout (2003) reviews the theory and evidence behind this mechanism.

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 on the size of production runs within plants, pointing to an important within-plant scale effect at the product level.

These effects at the extensive margin are consistent with the heterogeneous firm model of Melitz (2003). Each firm is assumed to operate with a constant level of productivity, but as trade barriers fall and foreign firms start selling in the domestic market, the minimum level of productivity that the marginal firm needs to break even rises. In the context of Columbia's trade liberalization experience, Eslava et al. (2004) show this mechanism is quantitatively important. 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. As competition increases following trade liberalization, the scope for productivity improvement through factor reallocation among active firms is likely to be larger in these countries.

In these mechanisms, trade liberalization can improve aggregate productivity even without any change for individual firms. 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 achieve the same, but the loss of domestic market share to imports lowers investment incentives and works in the opposite direction. 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 domestic production cost that declines in the number of imported input varieties. When trade is liberalized and the range of imported products expands, the domestic industry endogenously raises its productivity and is able to introduce new products for export as well. The Indian experience provides evidence for the importance of this mechanism. Lower import tariffs on inputs are estimated to account for almost one-third of new product introductions, driven primarily by increased firm access to input varieties.

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. The second stage regression can be run in levels, as in Pavcnik (2002) for Chile, but often firm-fixed effects are included or the equation is estimated in first differences.⁸ Treffler (2004) even uses double (time) differences to control for heterogeneity in baseline growth rates. 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. from different patterns 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 additionally include in the regression the level of tariff protection on a sector's intermediate inputs. Both studies find that tariff reductions on inputs raise productivity more than tariff reductions on outputs. They do not model the underlying mechanism, but the relative sizes of these effects are consistent with the Indian evidence and the endogenous growth model in Goldberg et al. (2010).

⁸Some other studies that follow the same basic set-up are Eslava et al. (2004) and Fernandes (2007) for Colombia, and Sivadasan (2009) and Topalova and Khandelwal (2011) for India.

Allowing for separate effects by productivity deciles, Schor (2004) further highlights that the positive effect of cuts in input tariffs on productivity are relatively constant across the productivity distribution. Output tariff cuts, 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). The decision of heterogeneous firms on when to adopt productivity-enhancing technological improvements will depend crucially on their expected market share as the fixed costs of adoption need to be recovered. As trade liberalization raises the expected degree of competition and reduces expected market share, some firms will postpone adoption. Firms with characteristics that are related to fast technology adoption, most likely firms with a high productivity level, are likely to suffer most from trade liberalization: An increase in tariff barriers should result in larger firms, exporting firms and younger firms having higher productivity growth. (Ederington and McCalman (2009) p. 18) They find support for these predictions in the case of Colombia, but recall that the evidence for Brazil in Schor (2004) pointed in the opposite direction.

3.2 Empirical specification

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

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

The specification can represent a firm-level (i) regression or one at the industry level (s), in which case the optional i subscript is omitted. We will use several dependent variables, namely, trade flows, price indices, productivity growth, and the individual terms in a linear decomposition of sectoral productivity growth. These regressions can also be estimated in levels with firm or industry-fixed effects included, which lead to very similar results.

The key explanatory variable is the level of trade protectionism (T) which is measured using either the import tariff or the effective rate of protection (ERP). The effective rate of protection tends to be higher, as tariffs are generally lower for inputs than for final goods (see Figure 3), and has declined more over the sample period. We include both the lagged level of protectionism and the first difference. The first variable informs us to what extent the variation of the dependent variable across sectors is associated with initial rates of protection, while the second variable captures the association between tariff declines and changes in the dependent variable, controlling for the initial rate of protectionism and an unobserved but constant year effect. The same time lag k is used for both variables. The interpretation of β_2 as the causal effect of, for example, tariff reduction on productivity growth, depends on the exogeneity of the policy change. An unexpected and broad-based implementation, as in the case of the Canada-U.S. FTA, would be helpful in this regard. Treffer (2004) argues that tariff cuts affecting all sectors were announced suddenly and applied quickly thereafter, leaving individual industries little time to lobby for exemptions or preferential treatment. An additional element in his study is the use of double-time differences to control for initial heterogeneity in growth rates and sole focus on a correlation between tariff cuts and the change in productivity growth. The industry or firm-fixed effects already absorb heterogeneous but constant factors that are correlated with the reduction in protectionism. Fernandes (2007) relies on this in her analysis for Colombia. She also uses lagged tariff changes, as these are less likely to be correlated with contemporary productivity shocks.

Several researchers rely on instruments for tariffs that are unlikely to be correlated with productivity changes. Treffer (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. 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 lowered tariff protection to the same level for each sector.

Thus, the change in tariff reduction is explained entirely by the initial situation, not by policy discretion. Topalova (2007) makes a similar argument in her study of poverty and inequality in India.

3.3 Endogeneity of tariff reductions

This last argument also fits the Chinese situation rather well. In Figure 4 we plot the change in import tariffs on the vertical axis against the initial level of protection on the horizontal axis. 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 had an import tariff above 40 percent and only nine exceeded the 25 percent threshold. As a result, the relationship between tariff reduction and initial protection is almost one-to-one. Note also the good fit of the dashed line that has a slope of minus one.⁹

The results suggest that over the full period there was very little policy discretion in the extent of trade liberalization in each sector. The average import tariff declined from 43.8 to 9.9 percent between 1992 and 2007, but equally remarkable was the decline in standard deviation across sectors from 28.0 to 7.0 percent over the same period.¹⁰ Moreover, the partial correlation between tariff rates in these two years is extremely high at 0.70. The dispersion in 2007 is well explained by the initial dispersion, suggesting that the decline was almost entirely proportional. The only flexibility left for policy makers was the timing of when exactly to reduce a particular sector's tariff rate and the lagged rate of protection is included in the regression to control for the existing degree of protection in a sector when its rates came down.

⁹The solid line on the graph represents a simple linear regression of the change on the level; it has a slope of -0.84 and R-squared of 0.96.

¹⁰Another indicator of the lack of dispersion in 2007 is that half of the sectors received an import tariff between 5.3% and 13.5%, for an inter-quartile range of only 8.2%; the corresponding range in 1992 was 40%.

The bottom panel of Figure 4 indicates that there is more heterogeneity in the extent of tariff reductions in the post-WTO period (2001-2007). For example, the observations above the solid regression line on the right of the graph are sectors with relatively high tariff rates at the eve of WTO accession that experience below average tariff declines. This leaves some scope for policy endogeneity, but only in an expectational sense as tariff cuts after 2001 are already fixed in the accession agreement. Policy makers can only tailor the cuts for specific sectors to satisfactory productivity performance insofar as performance could be predicted when the agreement was being negotiated. It is not the dependency of policy on unobservables that one usually worries about.

Results in Table 1 for regressions of tariff levels on industry characteristics in three separate years are consistent with the above description of the liberalization process. The estimates in column (1) for 1995 -the earliest year for which such regressions are possible - indicate that tariffs were significantly lower for sectors producing intermediate and capital goods and for sectors that are more capital or skill intensive in the United States. This is consistent with a desire to force firms in crucial sectors for industrial development to improve by exposing them to more foreign competition.¹¹ Sectors with high levels employment, especially of less educated workers, and more concentrated sectors also enjoyed higher tariffs. The importance of these China-specific characteristics before 1995 likely reflects political economy considerations.

The corresponding estimates for tariffs in 2001 and 2007, reported in columns (2) and (3), are by and large consistent with an across-the-board and indiscriminate lowering of all tariff rates. With only a single exception, coefficients all become smaller in absolute value and less statistically significant. By 2007, none of the China-specific industry characteristics (at the bottom) are significant predictors of tariff rates. The only two variables that are still statistically significant are product complexity (positively) and

¹¹Duty free imports of capital goods and intermediates in the export processing sector may have also required lower tariffs on these goods to prevent their diversion from export processing to the rest of the economy.

skill intensity (negatively). The fit of the regression also declines markedly.

Finally, we investigate whether the variation in import tariff reductions illustrated in Figure 4 is related to initial productivity levels, as would be the case if policy makers concentrate tariff cuts in sectors they expect to be able to withstand foreign competition. Following Topalova and Khandelwal (2011), we run industry-level regressions of various measures of current protection on lagged levels of productivity. We perform this analysis separately for the pre and post-WTO period and use one or two-year lags. Table 2 contains the coefficients on lagged productivity (*TFP*). In the pre-WTO period, the coefficients are not statistically significant and even positive in the regressions for tariffs and *ERPs*. As such, any association between tariff reductions and subsequent productivity gains is unlikely to be the result of reverse causality. The relationship between lagged *TFP* and *NTBs* or *FDI* restrictions is negative, however, implying that these measures are more likely to be found in sectors with low productivity and suggesting a more selective use. The regressions for the post-WTO period indicate more broadly that protection is lower for sectors that had higher productivity levels one or two years earlier.

Policy endogeneity can thus not be totally ruled out in the post-WTO period, but as mentioned before this was only possible on an ex-ante basis, i.e. based on the expected performance of the sectors. There is some anecdotal evidence that the policy-setting process over commitments to reduce tariffs and *NTBs* with entry into the WTO became more politicized and subject to lobbying as negotiations progressed to more contentious sectors. The inclusion of lagged levels of protection in all regressions will absorb some of these effects. In addition, we will be more careful to assign causal interpretations to post-WTO results.

4 Data

We use annual data for 1995 and 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 China’s 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, they 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.¹²

A change in the firm IDs in 1998 makes it impossible to link observations in 1995 with the later years, but the data for 1995 are included in the industry-level analysis. For the period between 1998 and 2007, we observe an unbalanced panel that increases from 145,511 firms in 1998 to 311,323 in 2007. As firm identifiers often changed due to 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. Only four percent of the links rely on this additional information, but one-sixth of the firms that are observed for more than one year experience a change in their official ID at some point in the sample period. To account for changes in the Chinese Industry Classification (CIC) codes in 2003, some industries are merged to obtain a consistent classification over the entire sample period.

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

$$\Delta \ln P_{st} \equiv \Delta \ln Y_{st} - \bar{s}_L \Delta \ln L_{st} - (1 - \bar{s}_L) \Delta \ln K_{st} \quad (\text{II.2})$$

¹²We drop the few firms with fewer than eight employees as they fall under a different legal regime.

The right hand side represents the difference between output growth and the share-weighted growth in inputs, where $\bar{s}_L$, the industry-specific average wage share in output in the two years over which the growth rate is calculated, is used as the weight for labor. One minus this share is used for capital.¹³ One and two-year differences are used. Real value-added is constructed by double-deflating gross output and material inputs using the appropriate deflators: the official two-digit output price deflator and an aggregation of the same series using a vector of input shares for each industry from the 2002 Input-Output table as weights. In robustness checks using a gross output production function, material input is added to equation (II.2) in the same way as labor input and gross output is used instead of value added in the first term. 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).

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 four categories: state, hybrid (township & village enterprises, local government owned, etc.), private, and foreign, which includes subsidiaries of firms from Hong Kong, Macao or Taiwan (HMT).¹⁴

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.¹⁵ In principle, we could use information from UN Comtrade to conduct an

¹³Labor 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 averages only 32.4 percent in our sample, 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.

¹⁴When ownership is mixed, we use the following order of priority to categorize firms: foreign, state, hybrid, private.

¹⁵This uses the same HS-CIC correspondence table discussed in footnote 3.

analysis over a longer time period, but these data do 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 important to identify imports flows that are actually subject to import tariffs.

The source and construction of the different measures of protection - import tariff rates, non-tariff barriers, and *FDI* restrictions - was already discussed in Section 2.2.

5 Effects of Tariff Reductions

5.1 Import volumes

The first place we expect to find evidence for an effect of import tariff reductions on the domestic economy is in the import flows. We use the annual growth in imports for 4-digit CIC industries as the dependent variable in equation (II.1) and report the estimates over the 2000-2006 period in Table 3. Note that over this period, total imports of manufactured goods increased by a factor of three and a half. The coefficient in column (1) for total imports is -1.53 implying that a one percentage point reduction in (output) tariff is associated with an increase in imports in the same sector of 1.53 percent. If one believes that China is a price taker on world markets, this elasticity is rather small. The low precision of the estimate is especially noteworthy: Despite substantial variation in the explanatory variable and a sample size of 2,442 observations, the coefficient is not even statistically significant at the 10 percent level.¹⁶

One possible explanation for the small and insignificant estimate is the duty-free entry of a sizable portion of imports, most notably under the processing trade regime. In the

¹⁶We have run the same regressions using as units of observation the much more detailed 6 or 8-digit HS classification 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 in the paper using other dependent variables, we report the industry-level results in Table 3.

next two columns of Table 3, we disaggregate imports and report results separately for ordinary trade and "processing trade" imports. As expected, the elasticity is larger for ordinary trade, 1.95 against 0.45 for processing trade, but both of the estimates are still not statistically significant. A delay in the import response to tariff cuts could be a possible explanation, but the results in column (4) that relate two-year import growth rates to tariff cuts over the same two-year period are virtually identical. Industries with higher initial tariff levels have lower import growth, significant at the 10 percent level, but reductions in tariffs are only weakly related to higher imports, even over a two-year period.¹⁷

To examine import behavior at the firm level, we matched the detailed trade transactions in the customs records to the firm-level sample.¹⁸ 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) to obtain a firm-level estimate of intermediate inputs that are imported (directly). We use this information in two ways: first, to estimate the fraction of manufacturing firms that use imported inputs, and second, to calculate the share of raw materials and intermediate inputs reported in the firm-level data that consist of imports.

Descriptive statistics in Table 4 illustrate that the importance of intermediates that are imported directly by Chinese manufacturing firms remains rather low, despite the huge increase in total imports in the economy. The percentage of firms that directly import any intermediates or materials increased only slightly from 11.2 percent in 2000 to 12.9 percent in 2006. The increase in the share of intermediates that are imported

¹⁷Looking for different trade responses by Broad Economic Categories (BEC) of goods revealed small, but insignificant differences with the trade response largest for materials and unprocessed intermediate inputs.

¹⁸In 2006, approximately two-thirds of total imports by value are accounted for. The balance is imports by firms that could not be matched, notably, trading firms that act as agents for firms importing indirectly and by non-manufacturing firms such as retailers. Over time, the role of trading companies declined as more firms obtained direct trading rights. As a result, the statistics in Table 4 are likely to overestimate the increases in either the percentage of firms using imported intermediate goods and their share of inputs.

is also modest, increasing from 7.8 percent of total input use in 2000 to 9.4 percent in 2006. Almost the entire increase in the participation rate comes from ordinary trade, consistent with the diminished advantage of duty-free imports under the export processing regime. Still, imported intermediates that enter as ordinary trade remain less than half as important as duty-free imports.

These estimates conceal huge differences across ownership types that stay relatively constant over this period. More than half of all foreign firms in the sample directly import intermediates in 2006, compared to only 3 percent of private firms, and 4 percent of SOEs. On average, almost twenty percent of all inputs used by foreign firms were directly imported; for domestic firms it was less than one percent. Regressions similar to those reported in Table 3 but at the firm level and with imported intermediates as dependent variable (not reported) reveal that private and foreign firms which are only engaged in ordinary trade are the most responsive to import tariff cuts. However, in 2006, the last year for which we observe the detailed information, these imports represented only 0.7 percent of their total input use.

In summary, the significant tariff reductions only have a limited impact on trade flows. Rapid growth in domestic Chinese manufacturing production leads to much higher imports of raw materials, intermediates and capital goods, but the increase is only weakly related to reductions in protection. This is in sharp contrast to the large effects documented for India in Goldberg et al. (2010). Any effect of trade liberalization on Chinese 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 and price-cost margins

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 liberal-

ization. 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 shifts from the quantity to the price dimension.

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

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 a sector's tariff rate reduces the annual price deflator by 0.23 to 0.30 percentage points. Over a two year period, responses are larger, especially for the more disaggregate series, with an estimate of 0.49. The estimation precision is slightly higher for the more disaggregate series, but in both cases the difference with the results for import volumes in Table 3 is pronounced. The t-statistics are four times higher and all estimates are easily statistically significant at the 1% level.

In the next two columns of Table 5 we regress the change in the input price deflator on the input tariff reductions. These variables are calculated by pre-multiplying the vector of output prices or tariff rates by the Chinese Input-Output matrix. Both input series are thus a weighted average of the corresponding output series using the sectoral input shares as weights. The regressions again produce positive and highly significant point estimates, but they are much higher than for output prices suggesting that the weighting matters greatly. If tariff reductions were passed on completely and prices of domestically produced inputs did not adjust, the point estimate should equal the share of imported intermediates in total inputs, approximately 0.10. However, the point estimates are much

higher and for the disaggregate series near unity. Reductions in input tariffs show up one-for-one in the input price deflator that covers both domestically produced and imported intermediates. Price competition for intermediate inputs seems to be very fierce, as 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. Domestically produced and imported final goods often compete in different market segments which shelters domestic firms somewhat from the import competition.

To investigate how these effects on domestic prices translate into changes in firms' price-cost margins we adopt the framework of De Loecker and Warzynski (2012). They exploit the fact 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, but for a Cobb-Douglas production function it implies that the optimal price-cost margin for each firm has to equal $\frac{\alpha_L}{s_L}$, the ratio of the output elasticity with respect to labor and the wage share in revenue. If the production technology is constant over time, the negative of the change in the wage share in revenue ($-\Delta \ln s_L$) is a direct measure of the change in the logarithm of the price-cost margin. In panel (d) of Table 5 we present estimates using this expression as the dependent variable in regression (II.1) and the change in trade protection (ERP) as the explanatory variable. The results indicate that price-cost margins decline most appreciably in sectors where trade protection is reduced the most. Year-fixed effects explain some, but not all of the effects. The underlying variation in the data that identifies these effects is that firms increase payments to labor as a percentage of total revenue in sectors where tariffs come down. In the framework of De Loecker and Warzynski (2012) the interpretation is that initially a fraction of the marginal product of labor is appropriated by the firm as profits. With trade liberalization and reduced market power, prices will be lower at each output level and the share of revenue that goes to labor increases. In the limit, for perfect competition, this share should converge

to the output elasticity of labor in the production function. The estimates are intuitive and consistent with the direct evidence 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 by aggressively lowering domestic prices and conceding only little market share to imports. 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 reductions?

Our starting point is a firm-level version of equation (II.1) with firm productivity growth as dependent variable. We again add the lagged level of tariff protection as control. In the first four columns of Table 6, we report the effect of changes over one or two years, where changes are annualized and thus directly comparable. We run separate regressions for the full sample of firms, and for a balanced panel of firms that remain in operation throughout the entire period.¹⁹ In columns 5-8, we report the results for corresponding regressions in levels that include both firm and time-fixed effects. Finally, in columns 9-12 and 13-16, we report results for the pre and post-WTO periods separately.

Several patterns are noteworthy. First, over the entire period, tariff reduction is strongly associated with a significant increase in firm-level productivity growth. Second, the effects are appreciably larger for the full sample of firms than for the balance sample. *TFP* growth of new entrants or exiting firms is apparently more closely related to tariffs than it is for incumbents. Third, estimating the effects in level with firm (and time) fixed

¹⁹In the "all firms" sample we still omit year-on-year changes that would include the year of entry or the last year of operations prior to exit. This is to avoid inappropriate comparisons where a firm might not have been operating for the entire year and "stock" measures of inputs do not correspond well to "flow" levels of output. We do not omit the first and last year-on-year changes for the balanced panels as there are no comparable concerns. As a result, the sample is the same for the regressions in changes and levels for the "all firms" sample, but not for the "balanced panel" sample.

effects produces a smaller estimate of the impact of tariff reduction, albeit still highly significant. Fourth, the elasticity of productivity with tariff liberalization appears to be substantially larger in the post-WTO period. As discussed earlier, this could partially be the result of policy endogeneity based on expected future performance.

To put the magnitudes in context, the effective rate of protection fell sixty percentage points over the full period. A coefficient on ΔERP of -0.239 then implies that a total improvement in TFP of nearly 15 percent can be linked to the trade liberalization. This converts to a one percent permanent increase in TFP per year, or one-eighth of firm-level TFP growth. For firms in the balanced panel, the contribution is slightly smaller. As suggested by Figure 3, differences in the reductions in the ERP across sectors are even larger, for example, for industry in the 20th percentile, the ERP rose 5 percent, while for those in the 80th percentile it fell 110 percent. This translates into a permanent annual difference in TFP growth of two percent.

These effects are respectable, but not that large in comparison to the overall TFP growth for manufacturing that we document at the outset of the paper, or the dispersion in rates across sectors. There are other channels though for tariff liberalization to influence productivity growth in China. In addition to TFP improvements for continuing firms, there are two other potentially important margins: Entry and exit or improvements resulting from the reallocation of inputs to more productive firms. We evaluate the importance of these two channels in an analysis at the industry level.

5.4 Productivity growth at the industry level

We now estimate equation (II.1) using industry-level productivity growth for the 424 sectors as dependent variable. The interpretation of the results in Table 7 is comparable to those in Table 6. In the first column of Table 7, we report the effect of one-year changes in tariff protection estimated over the full period. The coefficient of -0.584 implies that a ten percentage point reduction in ERP leads to a permanent six percent

improvement in industry-level productivity. On the basis of column (8), a tariff reduction spread over two years is estimated to require a reduction in *ERP* of fifteen percentage points to have the same effect. The coefficient on lagged productivity in column (1) is also negative and statistically significant, a result that is robust in all specifications in Table 7. Industries that initially enjoy stronger protection tend to experience lower rates of total factor productivity growth. We hesitate to give this a causal interpretation as the earlier results in Table 1 suggest that the initial distribution of protection was not random. Controlling for these effects however, we find that a reduction in 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.

Results in columns (3) and (5) illustrate that the effects become slightly stronger over time, but the elasticity of -0.505 for the pre-WTO period (1995-2002) is only a quarter below the -0.673 estimate for the period after China joined the WTO (2002-2007). Several factors may help to explain the more pronounced 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 more predictable once China joined the WTO and productivity responses may have become more rapid as a result. Of course, as suggested by Figure 4, we cannot totally rule out some forward-looking policy endogeneity.

In columns (2), (4), and (6), we examine the combined effects on *TFP* of the use of non-tariff barriers together with tariffs.²⁰ We include a dummy variable that measures the presence of any *NTBs* in an industry in the original specification in a way analogous to tariffs, i.e. adding both lags and changes, and also include all interactions between the two policy instruments. The coefficients on the changes in tariff protection are rather robust to this change and increase only slightly in absolute value. The coefficients on

²⁰We also examined the effects of restrictions on *FDI*, but the coefficients were small and insignificant. Most of the changes for *FDI* occurred in a single year (2002), making the effect difficult to discern from the substantial tariff declines occurring in the same year.

the *NTBs* all tend to be insignificant, with one key exception. The interaction of the change in the effective rate of protection with lagged *NTBs* is always positive, large, and estimated to be highly significant. This suggests that the presence of *NTBs* in a sector neutralizes most of the impact of a tariff reduction: The baseline effect of -0.610 is reduced to one-third of its size (the coefficient on the interaction term is 0.411). This ability to counteract the effects of tariff reduction was especially pronounced in the post-WTO period - the interaction coefficient is 0.890 compared to 0.324 pre-WTO - but of course, *NTBs* were much less frequently used as time progresses.

In the bottom panel of Table 7 we report the results for various robustness checks. The lower effect for two-year changes in column (8) has already been mentioned. Estimating the equation in levels with industry-fixed effects, as in Amiti and Konings (2007), lowers the elasticity with respect to changes in *ERP*, as was the case for the firm-level estimates. Using industry-fixed effects in addition to time-differencing - analogous to the double time-differencing of Treffer (2004) - results in slightly larger effects of trade liberalization on productivity growth. Using labor productivity as dependent variable, in column (11), gives nearly identical results, and suggests that differences between sectors in capital accumulation are orthogonal to the trade liberalization. Finally, the elasticity is estimated to be five times smaller using a gross-output based measure of *TFP*, in column (12), which is lower than the 3:1 ratio of the relative growth rates for the two *TFP* measures, estimated in Brandt et al. (2012).

One thing that stands out is that the coefficients estimated at the industry level in Table 7 are significantly larger than the estimates at the firm level in Table 6. The increase in absolute magnitude is most pronounced in the pre-WTO period. This relationship suggests that channels other than firm-level changes were important for the full impact of tariff liberalization, which we now investigate.

5.5 Decomposing the industry level effects

There are several potential explanations for the strong relationship between tariff reductions and productivity growth. The channel envisioned by some Chinese leaders is that it reflects the causal effect of productivity-enhancing restructuring, which would be consistent with the higher estimates at the industry level compared to the firm level. We explore the importance of alternative channels by linearly decomposing sectoral productivity growth and then using each term in the decomposition as the dependent variable in separate regressions of the form of (II.1).

The decomposition we use is exact for the growth in sectoral productivity if we define the aggregate level ($\ln P_t$) as the weighted aggregate of the firm-level log-productivity levels ($\ln P_{it}$):

$$\begin{aligned} \Delta \ln P_t = & \sum_i^{\text{continuing}} \bar{s}_i \Delta P_{it} + \sum_i^{\text{continuing}} \Delta s_{it} [\overline{\ln P_u} - \ln P_{t-k}] \\ & + \sum_n^{\text{entrants}} s_{nt} [\ln P_{nt} - \ln P_{t-k}] - \sum_x^{\text{exiting firms}} s_{xt-k} [\ln P_{xt-k} - \ln P_{t-k}] \end{aligned}$$

We end up with four 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 one captures the productivity effects of changes in the firm-weights, the "between" term, and is associated with the reallocation of resources among firms. This effect 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 that interacts the changes in shares and productivity.²¹ The last two terms contain the effect

²¹Petrin and Levinsohn (2012) demonstrate that such a term tends to be very volatile and the interpretation is not obvious. Using the average share or productivity level as weight in the within and

of net entry on aggregate productivity. We follow Haltiwanger (1997) and normalize all productivity levels by the lagged aggregate productivity level 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 entering firms tend to perform better relative to the lagged aggregate than exiting firms.

We are not interested in the contribution of each term 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 then investigate using equation (II.1) which term has the strongest correlation with the reduction in *ERP*. As we need to follow individual firms over time, we can only conduct this analysis from 1998 onwards. To identify correctly the extent of tariff reduction that each firm is exposed to, we only include surviving firms that remain in the same sector throughout. In contrast with the previous analyses, only the first and last year of each period are used to construct each term, not the intervening years. The relationship between the aggregate productivity growth and the tariff cuts over the entire period is in column (1) of Table 8. The estimate of -0.610 is very similar to the estimate using all annual changes in Table 7 (-0.584).²²

Because of the linear regression and linear decomposition, the estimates of the four terms in columns (2) to (5) aggregate exactly to the overall effect. In the first panel for the full sample period, the effect from the entry channel is by far the most important and

between terms splits the contribution of the interaction term equally over the first two terms. Petrin and Levinsohn (2012) further argue that the between term only contributes to a welfare-consistent measure of technological change if there are frictions that prevent the efficient allocation of resources. The evidence in Hsieh and Klenow (2009) suggests this is not an unnatural assumption for China.

²²A comparison of the results in Tables 6, 7 and 8 reveals effects similar in magnitude at the firm and industry level for the full period and for the post-WTO period, but much less so than for the pre-WTO period. The pre-WTO coefficients are also typically smaller, but the differences are much less than meets the eye. Note that in Table 6, as we move from the balanced to the full panel the increase in the coefficient on the change in *ERP* from -.053 to -.093. It more than doubles in Table 8 to -.228 when we calculate the industry level aggregate by output-weighting the micro-level estimates. Finally, in Table 7, it is almost as large at the post-WTO period when we aggregate inputs and outputs before calculating *TFP*, and extend the pre-WTO period backwards to 1995.

accounts for the entire industry-wide effect. The positive contribution of the within term (negative point estimate) is cancelled out by small, but opposite effects from the between and exit terms. This is not entirely surprising as an enormous share of the aggregate output in 2007 is accounted for by firms that enter in the nine year period between 1998 and 2007. The stark contrast between the strong correlation with the reduction in trade protection for the entry term and the almost total lack of relationship for the other terms is remarkable. Trade liberalization strongly increases the productivity contribution of firm-churning at the extensive margin. Sectors that experience the largest tariff cuts are characterized by far greater productivity differences between entering and exiting firms.

Over the shorter sub-periods before and after WTO entry, the total contribution of net entry to productivity growth will be less important by construction, but the strength of the correlation with tariff cuts could go either way. The estimate in column (14) is almost identical to that in column (4) highlighting that the relationship between the entry-contribution and tariff cuts is equally strong after China joined the WTO and estimated just as precisely. This is especially remarkable given that the variation in the dependent and explanatory variable is far lower in the later period. The fact that tariff reductions have become more predictable and irreversible, and that firms thus could anticipate and prepare for the changes is likely to strengthen the relationship.

In the period prior to WTO entry, the productivity contribution from entry is only weakly associated with tariff reductions, and largely offset by the opposite, and significant, effect through exit. With the overall effect of net entry channel small, the "within" term is responsible for almost the full correlation between industry-level productivity growth and tariff cuts. Note that the estimate of -0.173 in column (7) is far larger than the earlier firm-level estimate, column (9) in Table 6, even though it measures the same effect. The difference is the weights in the within term, suggesting that the larger surviving firms are far more likely to experience strong productivity growth in sectors that were liberalized. Note that the estimated effects for the within term are remarkably similar

in the two periods.²³ This suggests that the pressure on firms to improve their productivity growth when faced with lower tariff protection has been more persistent than the pressure operating through the net entry channel.

The insignificant coefficient estimates for the between terms in all periods indicate that market share changes were not correlated with tariff cuts. Over the full period, see column (3), the weak positive estimate even suggests that the increase in market share of highly productive firms is less likely or at least less important in sectors that liberalized most. The positive coefficients for the (-) exit term are also rather low, but they suggest that exit of highly unproductive firms is a less important contributor to aggregate *TFP* growth in sectors that liberalized most.

The most important pattern in Table 8 is the strong correlation between tariff cuts and the contribution of new entrants to industry *TFP*. This contribution is a combination of the entrants' output share and their productivity premium over the previous period's average. More than four-fifths of all firms active in 2007, accounting for approximately two-thirds of aggregate output, entered between 1998 and 2007. The breakdown across ownership categories of new entrants differs considerably from the composition of incumbents in 1998. At the end of the sample period, private firms accounted for one-third of aggregate output and half of all active firms. Moreover, 92% of private firms were new entrants, who produced 85% of private firm output. In contrast, the market share of SOEs was comparable in 1998 and 2007, but almost half of SOE output in 2007 was produced by firms already in operation in 1998. Regressions (not reported) show that private firm entry is very high across all sectors, but the sectoral composition is not related to the tariff reductions. We next investigate where new firms enter in the productivity distribution to verify whether the quality of entrants is related to trade

²³The large estimate on the lagged *ERP* variable in column (12) indicates that sectors that were still heavily protected in 2002 did not enjoy strong productivity growth in the following years. If policy-makers could have anticipated some of this and conditioned future tariff cuts on it, some of the post-WTO effects could be due to reverse causality.

liberalization.

5.6 Position of different types of firms in the productivity distribution

To investigate the relationship between trade protection and the relative productivity of new entrants and exiting firms, we estimate the following regression:

$$\ln TFP_{st} = \alpha ERP_{st-k} + \sum_z \beta_z type_s t^z + ERP_{st-k} * \sum_z \gamma_z type_s^z + \alpha_t + \alpha_s + \epsilon_{st} \quad (\text{II.3})$$

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

We use the contemporaneous *ERP* variable ($k = 0$) in the first two columns of Table 9 and one-year lagged *ERP* in the next two columns. In the first and third columns, we use only three dummy variables to define firm-types: entrants, exiting firms, and incumbents. There are three noteworthy findings. First, entrants have higher and exiting firms lower levels of productivity than incumbents, confirming the results in Brandt et al. (2012).²⁴ Second, each of the three types of firms tends to have relatively lower productivity levels in sectors that receive strong trade protection. Third, the link between productivity and tariffs is a lot less pronounced when lagged protection is used.

Results in the second and fourth column further distinguish between four ownership categories: state-owned firms (SOE), hybrid firms with mixed ownership, private firms, and foreign-owned firms. In total, effects now vary across twelve different firm types (SOE-entrants, etc.). The earlier results survive and become even more pronounced. The non-interacted ownership variables indicate that SOEs (the omitted category) tend

²⁴As in the case of the other firm-level regressions in Table 6, we drop the first full year of entry and the last year before exit to make sure we do not use partial years of activity.

to have far lower levels of productivity on average, confirming results from several earlier studies. The triple interactions between ownership, activity status, and degree of protection are even more revealing, and identify similar patterns for hybrid, private, and foreign firms, but very different ones for SOEs.

For the first three ownership types, tariff rates are not systematically related to the productivity level of incumbents. While firms that are about to exit have on average significantly lower productivity, this selection on productivity is significantly dampened in highly protected sectors. When tariff rates are sufficiently high, the negative correlation between exit and productivity disappears entirely. The association between low productivity levels and exit is stronger in unprotected sectors and is particularly pronounced for private firms. Similarly, the superior productivity level of new entrants is a unique feature of open, unprotected sectors. When import tariffs are sufficiently high in a sector, unproductive firms are as likely to enter. Low trade protection heightens the association between productivity and entry or exit, indicative of stronger market selection. In open sectors, entrants are more productive than incumbents, and exiting firms less. In protected sectors, the productivity differences between entrants and exiting firms are less systematic. This mechanism is consistent with the close link between tariff rates and the contribution of the entry-term to aggregate productivity which we illustrated in the previous section.

The patterns are radically different for one type of firms: SOEs have lower productivity levels than the other ownership types on average, but this is especially true for incumbent SOEs in highly protected sectors and for exiting SOEs in the same sectors. In contrast, the few new SOEs that enter the sample do not enter with higher productivity in more open sectors, as was the case for private or foreign firms. Their productivity level is entirely 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.

6 Conclusion

We have shown that the strong productivity record of China in the time period studied, from 1995 to 2007, is strongly and significantly related to the tariff reductions that accompanied (and preceded) China's entry into the WTO. Since most tariffs are cut to a remarkably uniform and low level, the extent of liberalization in each industry is almost entirely determined by the extent of initial protection. Reverse causality, i.e. tariff reductions being tied to sectors' productivity growth record, is highly unlikely to explain much of the correlation and moreover could only be based on expected performance. We include the lagged level of protection in the regressions to control for the initial competitive environment. The conclusion is that reduced protection of the domestic industry from foreign competition lead to higher domestic productivity growth.

The mechanisms through which tariff reduction has exerted its impact on productivity were unanticipated, and slightly unusual. No strong link could be found between tariffs and import volumes, including the usage of imported inputs. However, input tariff cuts show up one-for-one in the input price index. Accordingly, we find that Chinese firms accommodate such price pressure through downward adjustment of their price-cost margins. Squeezed profit margins are also reflected in the selection of entering and exiting firms across the productivity distribution. By decomposing sectoral productivity growth into contributions by continuing firms, reallocation among continuing firms, and net entry, we show that the association between tariffs cuts and the net entry contribution is by far the strongest link. Firm-level productivity changes are systematically related to tariff cuts, but only in the pre-WTO period does this explain a large fraction of the total relationship at the industry level. A firm-level analysis further indicates that for private and foreign-owned firms, tariff reduction has systematically pushed less efficient firms to

exit and replaced them with more productive new entrants; such a pattern does not exist for state-owned firms. Given the importance of newly entering private firms, the competitive selection mechanism dominates and contributes substantially to the productivity growth of the Chinese manufacturing sector in the period under investigation.

These findings highlight the price pressure from potential imports and the associated competitive selection mechanism as an important channel through which trade liberalization affects domestic productivity. This is in contrast with alternative mechanisms found in the context of trade liberalization in other countries, such as easier access to more varieties of and better quality inputs in the case of India by Goldberg et al. (2010). The effectiveness of this mechanism implies that government should try not to intervene in price setting. Secondly, the different response to tariff reduction by state-owned firms from private and foreign-owned firms implies that the former enjoy other forms of protection than trade barriers; further reform is needed to eliminate the remaining inefficiencies among the state-owned firms. Thirdly, our study shows that tariff reduction helps to select better private firms to enter, but it does not affect the size of the entering body of private firms. As a key component of the overall productivity growth, the size of entry itself is worth further investigation which we leave for future research.

7 Figures and Tables

Figure 1: Distribution of sectoral productivity growth, 1998-2007

Figure 2: Fraction of sectors covered by various 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: Observations are 4-digit manufacturing sectors. Dashed line has slope -1.
Solid line is regression with slope -0.84 above, and -0.46 below.

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

Dependent variable:	Output Tariff 1995 (1)	Output Tariff 2001 (2)	Output Tariff 2007 (3)
Trade categories (BEC):			
Intermediates	-0.203*** (-2.9)	-0.109*** (-2.7)	-0.049 (-1.7)
Capital goods	-0.186*** (-2.6)	-0.055 (-1.3)	-0.056* (-1.9)
Consumer Goods	0.117 (1.6)	0.064 (1.5)	0.047 (1.6)
Differentiated goods (Rauch)	0.023 (0.9)	0.020 (1.4)	0.030*** (2.9)
U.S. industry characteristics			
Capital intensity	-3.707** (-2.4)	1.413 (1.6)	1.007 (1.6)
Skill intensity	-5.418** (-2.1)	-3.770*** (-2.5)	-2.816*** (-2.6)
Chinese industry characteristics			
Top 4 market share	0.169*** (3.3)	0.071*** (2.4)	0.013 (0.6)
Log employment	1.869*** (2.8)	1.123*** (2.9)	0.247 (0.9)
Log(K/L) ratio	2.033* (1.7)	0.419 (0.6)	0.488 (1.0)
SOE sales share	-0.056 (-1.6)	0.001 (0.0)	-0.004 (-0.3)
Elementary education share	0.461** (2.3)	0.118 (1.0)	0.096 (1.2)
R ²	0.490	0.373	0.327
Observations	380	380	380

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

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

Dependent variable:	Tariffs	ERP	NTB	FDI
	(1)	(2)	(3)	(4)
(a) Pre-WTO 1995-2001				
TFP _{t-1}	0.003	0.011	-0.026**	-0.025***
	(1.6)	(1.0)	(-2.0)	(-2.9)
TFP _{t-2}	0.002	-0.004	-0.058***	-0.027***
	(0.9)	(-0.2)	(-3.2)	(-2.6)
(b) Post-WTO 2002-2007				
TFP _{t-1}	-0.003***	-0.009**	-0.025***	-0.004
	(-3.7)	(-2.3)	(-2.9)	(-0.2)
TFP _{t-2}	-0.003***	-0.008*	-0.027***	-0.030*
	(-2.8)	(-1.9)	(-2.6)	(-1.9)

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

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

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

Notes: Regressions in first differences at the 4-digit industry level. t-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 4: Use of imported intermediates

	Fraction of firms using imported intermediates			Imported intermediates as a share of total intermediates		
	Total trade (1)	Processing trade (2)	Ordinary trade (3)	Total trade (4)	Processing trade (5)	Ordinary trade (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 price change ($\Delta \ln P_O$)		Input price change ($\Delta \ln P_I$)	
	1-year change (1)	2-year change (2)	1-year change (3)	2-year change (4)
(a) Price changes based on 2-digit CIC industries (1995-2007)				
Tariff change	0.233*** (5.4)	0.294*** (6.3)	1.702*** (18.5)	1.932*** (19.1)
(b) Price changes based on 4-digit CIC industries (2000-2007)				
Tariff change	0.297*** (6.1)	0.487*** (6.5)	1.023*** (10.4)	1.261*** (9.3)
(c) Price changes based on 2-digit CIC industries (2000-2007)				
Tariff change	0.441*** (7.7)	0.524*** (6.6)	2.257*** (25.2)	2.613*** (21.2)
Dependent variable:	$\Delta \ln PCM$ with $PCM = (P-MC)/P$			
	Without year fixed effects		With year fixed effects	
	1-year change	2-year change	1-year change	2-year change
(d) Price-cost margin changes (1998-2007)				
ERP change	0.045** (2.3)	0.058* (1.9)	0.024* (1.7)	0.044 (1.5)

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

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

	Balanced panel 1 year changes	All firms	Balanced panel 2 year changes	All firms
(a) Full sample period (1998-2007), dependent variable is firm-level productivity change				
	(1)	(2)	(3)	(4)
Lagged ERP level	-0.024 (1.3)	-0.029 (1.3)	-0.023 (1.1)	-0.032 (1.2)
Change in ERP	-0.166*** (3.2)	-0.239*** (4.1)	-0.189* (1.9)	-0.303** (2.4)
Observations	242,684	897,365	214,914	626,768
(b) Full sample period (1998-2007), regressions in levels with firm-FE				
	(5)	(6)	(7)	(8)
Lagged ERP level	-0.036*** (4.2)	-0.094*** (13.0)		
Twice lagged ERP level			-0.048*** (7.3)	-0.031*** (4.7)
Observations	294,150	897,365	292,766	626,768
(c) Pre-WTO period (1998-2002), firm-level productivity change				
	(9)	(10)	(11)	(12)
Lagged ERP level	-0.003 (0.1)	-0.008 (0.4)	0.008 (0.5)	0.004 (0.2)
Change in ERP	-0.053 (1.3)	-0.093** (2.4)	0.032 (0.5)	-0.007 (0.1)
Observations	241,244	362,303	180,933	626,768
(d) Post-WTO period (2002-2007), firm-level productivity change				
	(13)	(14)	(15)	(16)
Lagged ERP level	-0.072** (2.5)	-0.060 (1.2)	-0.076*** (2.7)	-0.076* (1.9)
Change in ERP	-0.440*** (4.0)	-0.587*** (4.3)	-0.521*** (3.6)	-0.598*** (3.1)
Observations	371,440	535,062	357,894	410,936

Note: All regressions only include firms that did not change industries in the two years considered (for 1 or 2 year changes). t-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 7: Effect of tariff protection on productivity at the industry level

Dependent variable is ΔTFP	Full period (1995-2007)		pre-WTO (1995-2002)		post-WTO (2002-2007)	
	(1)	(2)	(3)	(4)	(5)	(6)
lagged ERP	-0.082*** (-5.8)	-0.096*** (-5.2)	-0.070*** (-4.6)	-0.085*** (-3.8)	-0.087*** (-3.3)	-0.099*** (-3.4)
ΔERP	-0.584*** (-10.5)	-0.610*** (-10.4)	-0.505*** (-7.9)	-0.493*** (-7.7)	-0.673*** (-7.5)	-0.807*** (-7.8)
$\Delta ERP * \text{lagged NTB}$		0.411*** (3.4)		0.324*** (2.8)		0.890*** (2.8)
$\Delta ERP * \Delta NTB$		0.030 (0.1)		-2.463* (1.8)		0.293 (0.8)
lagged ERP * ΔNTB		-0.014 (-0.2)		0.096 (0.3)		0.074 (0.5)
lag. ERP*lag. NTB		0.066* (1.9)		0.065* (1.8)		0.183* (1.8)
lagged NTB		0.027 (1.3)		-0.001 (-0.1)		0.061* (1.7)
ΔNTB		-0.021 (-0.5)		0.024 (0.2)		0.000 (0.0)

Full period (1995-2007)						
Dependent variable:	ΔTFP	ΔTFP 2-year change	TFP with sector FE	ΔTFP with sector FE	ΔLP	ΔTFP Gross output
	(7)	(8)	(9)	(10)	(11)	(12)
lagged ERP	-0.082*** (-5.8)	-0.060*** (-5.4)	-0.148*** (-4.8)	-0.113*** (-4.4)	-0.081*** (-5.6)	-0.019*** (-5.9)
ΔERP	-0.584*** (-10.5)	-0.388*** (-7.6)	-0.363*** (-4.7)	-0.646*** (-10.0)	-0.577*** (-10.1)	-0.110*** (-8.7)

Notes: NTB stands for non-tariff barriers and it measures import license requirements in a sector. t-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 8: Decomposition of the industry-level effect (following Haltiwanger, 1997)

	Total effect	Within	Between	Entry	–Exit
(a) Full period (1998-2007)					
	(1)	(2)	(3)	(4)	(5)
Lagged ERP level	-0.457*** (2.8)	-0.085 (1.4)	0.033 (1.2)	-0.446*** (3.2)	0.041** (2.1)
Change in ERP	-0.610*** (2.7)	-0.098 (1.2)	0.058 (1.6)	-0.613*** (3.2)	0.042 (1.5)
(b) Pre-WTO period (1998-2002)					
	(6)	(7)	(8)	(9)	(10)
Lagged ERP level	-0.087 (1.0)	-0.074* (1.7)	-0.008 (0.4)	-0.071 (1.1)	0.067** (3.5)
Change in ERP	-0.228 (1.4)	-0.173** (2.1)	0.000 (0.0)	-0.128 (1.1)	0.072** (2.0)
(c) Post-WTO period (2002-2007)					
	(11)	(12)	(13)	(14)	(15)
Lagged ERP level	-0.390*** (2.9)	-0.182*** (2.8)	0.059** (2.4)	-0.315*** (3.2)	0.048** (2.2)
Change in ERP	-0.745*** (2.6)	-0.178 (1.3)	-0.010 (0.2)	-0.597*** (2.9)	0.039 (0.9)

Notes: The different terms of a linear decomposition of sectoral productivity growth, combining the methods of Griliches and Regev (1995) and Haltiwanger (1997), are each used as dependent variable in separate regressions. Number of observations is 424 in each regression. t-statistics in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% level.

Table 9: Position of different types of firms in the productivity distribution

	Dependent variable: TFP level			
	Concurrent ERP		1-year lagged ERP	
	(1)	(2)	(3)	(4)
Entrant	0.187 (17.5)***	1.167 (18.5)***	0.178 (15.2)***	1.163 (18.7)***
Exiting firm	-0.218 (10.1)***	-0.257 (17.8)***	-0.217 (10.5)***	-0.253 (17.5)***
Hybrid		0.522 (13.4)***		0.519 (13.3)***
Private		0.476 (16.4)***		0.464 (16.4)***
Foreign		0.257 (9.3)***		0.242 (8.5)***
Incumbent * ERP(t-x)	-0.218 (2.2)**		-0.116 (1.3)	
* SOE		-0.337 (3.1)***		-0.263 (2.6)***
* Hybrid		-0.048 (0.5)		0.015 (0.2)
* Private		-0.124 (1.1)		-0.026 (0.3)
* Foreign		-0.114 (1.1)		-0.011 (0.1)
Entrant * ERP(t-x)	-0.222 (2.5)***		-0.099 (1.1)	
* SOE		-0.015 (0.1)		0.053 (0.5)
* Hybrid		-0.098 (1.0)		-0.037 (0.4)
* Private		-0.318 (2.8)***		-0.192 (1.8)*
* Foreign		-0.364 (3.3)***		-0.242 (2.2)**
Exiting firm * ERP(t-x)	-0.211 (1.8)*		-0.127 (1.2)	
* SOE		-0.616 (5.1)***		-0.520 (4.7)***
* Hybrid		0.243 (2.3)**		0.247 (2.5)**
* Private		0.452 (5.0)***		0.446 (5.5)***
* Foreign		0.178 (1.6)		0.218 (2.1)**

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

Chapter III

Tax Reform, Local Resources and Village Leader Elections in Rural China

1 Introduction

China has a large rural population and the governance of the rural area has always been an important issue, especially in recent years when there have been increasing complaints about corrupt local cadres. The central government has taken a series of actions aimed at relieving the existing rural tensions, such as the enforcement of village leader elections and the more recent rural tax reform. Understanding how the rural governance system works and what the recent reform has brought to the villages can provide important insights for future policy making. The village governance structure is a complicated system with many agents involved and interacting with each other. These agents include upper governments (township, county, province and central government), village leaders, village party secretaries and the villagers. There are studies addressing the role of one or some of these agents, but most of these studies are in the form of anecdotes and are mainly qualitative. This paper focuses on the interaction between village leaders and villagers through an election mechanism in the context of the tax reform, and tries to provide some quantitative measure of the impact of the reform on the effectiveness of the

election mechanism in disciplining village leaders.

The analysis is carried out in a retrospective voting framework. This model is suitable for two reasons: Firstly, even though imperfect, a voting mechanism is now universally in place in rural China and works (Brandt and Turner (2003)). The election for village leaders started in some villages as early as the beginning of the 1980's and then were formalized and widely carried out with the establishment of the Organic Law of Village Committees in 1998.¹ Secondly, village leaders acquired more discretion over local public policies, such as taxation and public goods provision, after the decollectivization in the late 1970's, thereby providing something that the village leaders can be held accountable for through the election mechanism. The essence of the retrospective voting model is that voters allow some rents to the politician to make the short-run grabbing behavior, which is the worst result for the voters, less desirable. Taking the rents allowed by the voters as "inside rents" and the short-run maximum rents the politician can grab as "outside rents", a retrospective voting model predicts that decreases of "inside rents" and "outside rents" work in opposite directions on the discipline effect of the election mechanism. The recent tax reform provides a policy experiment that lowers the inside and outside rents of an incumbent simultaneously by eliminating village levies and informal taxes. These levies and taxes used to be one source of funding to finance local public projects. As a result, financing projects becomes more costly and thus inside rents decrease. The reform also sets a ceiling for local taxation, which reduces outside rents. These two changes drive an incumbent's incentive for re-election in opposite directions. Which one is stronger turns out to be an empirical question.

Concerns about the fairness of the elections call for the introduction of election quality into the traditional retrospective voting model. An extended model shows that the cleaner the election, the larger the net effect of the reform on re-election incentive, be it positive or negative. On the other hand, since village leaders are less dependent on

¹A trial version of the Organic Law was introduced in 1988.

tax and fee revenue when more non-tax resources are available, the abundance of local non-tax resources will mitigate the reform's impact on re-election incentives.

A survey in 2005 from 101 villages in 5 provinces provides rich information on the attributes of villages and village leaders, the tax reform, village local public projects and recent elections.² Data show variation in several important dimensions. Firstly, the timing structure of elections and fiscal reform differs across regions. All of the 101 villages held one election before the reform, while 30 of them had the most recent elections before the reform and 71 of them had the elections after the reform. Secondly, changes of incumbents' re-election rates after the reform differ across provinces. For example, in Jiangsu province, the re-election rate increased from 59% to 74%, while in Sichuan, it decreased from 78% to 69%. Thirdly, abundance of local non-tax financial resources, such as cultivated land, collective or contract firms, and transfers from upper governments, differs. Lastly, the survey shows elections have been carried out in different ways across villages, and thus quality varies. Investigating these variations in the way suggested by the retrospective voting model, I find cleaner elections significantly amplify the negative effect of the reform; having more cultivated land, which is a potential source of land sales revenue, helps to mitigate the negative impact on re-election rate; while transfer from the upper government does not significantly affect the impact of the tax reform.

The remainder of the paper is organized as follows: Section 2 reviews China's relevant policies on rural public finance system and governance structure; Section 3 reviews the literature; Section 4 shows an extended retrospective voting model that incorporates the roles of election quality, tax reform and resources abundance; Section 5 describes the data; Section 6 reports the empirical results; and Section 7 concludes.

²The survey was carried out by CCAP (Center for Chinese Agricultural Policy), IGSNRR (Institute of Geographical Sciences and Resources Research), CAS (China's Academy of Science), in collaboration with the University of Toronto and University of California, Davis.

2 A Brief History of China's Rural Public Finance System and Governance Structure

China's rural taxation and governance systems have been changing over time with the development strategy of the central government and the role of agriculture in the national economy.

Upon the establishment of the People's Republic of China in 1949, land was confiscated from landlords and reallocated to individual households that were either landless or just owned small amounts of land (Roll (1974)). As a result, the household retained most of the agriculture surplus that had been previously collected by the landlords. Households were also taxed by the government, but at a rate no higher than 11% at the beginning of the 1950s (Zhou (2004)). While the central government had strong incentives to extract larger surpluses from agriculture to support industrialization - the top issue on the new republic's agenda - it was very costly and almost impossible to further increase the tax rate.

Collectivization of agriculture was adopted as a solution. Production teams, brigades and people's communes were established from the bottom to higher levels as local collective organizations. Agriculture transactions took place only between the collective organizations and the state through a compulsory procurement program. Decisions regarding what to produce and how much to produce were all from above, as also were the rules for income distribution. Taxes were collected by the state implicitly in the form of "price scissors" from the exchanges between industrial and agricultural products. Under this highly regulated production and distribution system, household income was kept at the subsistence level. The emigration out of rural areas was strictly restricted through the household registration system. Few decisions on public investments were made at the production-team level and households didn't pay directly for local public services.

In terms of governance, local cadres were appointed by higher level government officials, and thus not accountable to the peasants. This system provided poor incentives to the cadres of production brigades and teams. The people's commune was the lowest level of formal administrative organization. The commune leaders who made most of the decisions about public investments were appointed by the upper governments and thus were only accountable to upper government officials but not to the commune members. The leaders of production brigades and teams had little opportunity to be promoted into the formal administrative system, so the incentive from above was weak. Meanwhile, the higher government collected almost all the agriculture surplus. As a result the resources under the control of local cadres were rather limited, which left the local cadres poorly motivated from below as well.

Decollectivization began in 1978 with the legalization of the Household Responsibility System. Individual households again became the residual claimants of agriculture production. On top of the implicit taxes through quotas, individual households began to be subject to explicit taxes, such as the tax on special agriculture products introduced in 1983 and the tax on the use of cultivated land introduced in 1987. Beyond these agriculture-related taxes paid to higher levels of government³, households were also taxed by local governments in less formal ways. The levies that went to the township governments were for the expenditure in education supplement, social help, family planning, collective transportation and militia exercises; the fees levied by villages were for public accumulation, public welfare and administrative fees at the village level. There were also payments in the form of fines, apportionments of expenditure or fundraising for public projects. These informal taxes and fees took various forms across regions and it is very difficult to provide an estimate of the value (Aubert and Li (2002)). Local governments are largely responsible for the funding of all the provision of local govern-

³Before 1984, the tax revenue was forwarded to the state; after the tax reform in 1984, the revenue was kept at the provincial level.

ment goods (Zhang et al. (2004)). Moreover, profits by village enterprises, revenue from sales of village assets and rents from land can all be used to finance local public projects. Bernstein and Lu (2003) provide a comprehensive review of peasants' burdens in China.

The most recent tax reform started with pilot villages in 1998, and was widely carried out nationally since 2000. The first step of the reform was the elimination of township and village levies and other informal fees collected by local cadres. At the same time, the formal agriculture and agricultural special product tax rates were raised. The previous village levies used to fund public accumulation, public welfare and administration costs were replaced by a more formal tax, the agricultural tax surcharges, which were restricted to be no more than 20% of the agriculture taxes. Accordingly, there were also changes in the management of village accounting and decision-making processes regarding village public investments. The reform was promoted in the following years. In the year 2004, Prime Minister Wen Jiabao promised to eliminate the agriculture-related taxes in five years. The step of the reform was speeded up again in 2005, and the agriculture-related taxes were actually eliminated from January 1st, 2006. The change in taxation has also been accompanied in changes in expenditure reassignments and subsidies transferred from the upper governments to counties, towns and villages.

The village governance structure has been under substantial reform as well. The shift of the basic rural economic unit from the production team to household required a corresponding change of the rural governance structure for carrying out state policies and dealing with local public issues. In some areas, village administration was left in paralysis after the decollectivization, and there was increasing unrest. Election and self-governance were proposed as a solution for selecting more capable local cadres and to facilitate better implementation of state policies that might not be welcomed by villagers (Kelliher (1997)). After a 3-year legislation process, the National People's Congress approved the draft of the Organic Law of Village Committees in 1987. This law established villagers' committees as the mass organizations of self-governance through which villagers manage

their own affairs, educate themselves, and meet their own needs. These committees are composed of three to seven members, each serving for three years until the next election. Committee members are supposed to be chosen in popular elections, in which all adult, registered villagers have the right to vote and stand for office (Li and O'Brien (1999)). Many villages started to hold elections for village leaders with the implementation of the draft. According to Kelliher (1997), elections had been carried out at least in some villages in 18 of China's 30 provinces by 1990, and villages in other provinces caught up in 1993 and 1996. In 1998, the formal Organic Law of Village Committees was established and the legislative process on the provincial level followed. The strengthened legal infrastructure for the system of village self-governance provides more support and protection for the operation of village self-governance nationwide.

3 Literature Review

Baggs (2005) provides a comprehensive review of the literature of political economy of public finance. There are basically two views regarding the nature of government: one is that the government is a benevolent planner; the other is that the government is composed of rational individuals who conduct rent seeking to maximize their own benefits rather than the benefits of the governed. Following the second view, conflicts between the interests of politicians and citizens become the main issue and the key question is how to make the government run in the public interest. A principal-agency framework, with politicians being the agent and electorate being the principal, has been widely adopted in studies along the second branch.

Based on different informational structures, three kinds of models have been developed: one emphasizing the selection of the proper person to the office with only the type of politicians being private information; one emphasizing the discipline of politicians with only the action of politicians being private information; and one that combines the pre-

vious two scenarios. Work has been done along each of the three lines. Since a village in China is a small electorate and people in a village are likely to know each other well, asymmetric information about the virtue or competence of village cadres does not seem to be a big issue in this context. What matters more is the discipline effect of election, which is at the core of models in the second category. The canonical model of this type is by Barro (1973) and Ferejohn (1986). This paper follows the idea of Ferejohn but adopts a simple version of the basic model to facilitate the introduction of election quality into the model.

On the empirical side, there have been studies about the systems in rural China for public financing, for public goods provision, and for governance. Several recent studies try to compare the fiscal outcomes between different regimes through which a village leader is selected - whether being appointed by the upper governments or elected by villagers (Luo et al. (2007), Zhang et al. (2004), Wang and Yao (2006)). Brandt and Turner (2003) look into the election mechanism and uses the change of arrangement of land property rights as a measure of the rent-seeking behavior of village leaders. With cross-sectional data on 60 villages in 2000, they find an increase in rent seeking leads to a lower probability of being re-elected, even though the election procedures are very susceptible to corruption. A potential weakness of their analysis is the endogeneity of re-election outcomes and policy choice. In this paper, rather than estimating a villager's re-election function, I pursue a more reduced form analysis that examines how an exogenous shock, the fiscal reform, affects the village political equilibrium through the impact on the re-election incentives of incumbents. The availability of information on two elections in a village allows better control of the village and incumbent heterogeneity that may cause endogeneity bias. This paper also differs from existing studies by addressing the interaction between elections and fiscal reform, instead of treating the two issues separately.

4 A Retrospective Voting Model with Imperfect Elections

This part introduces election quality into the traditional two-period retrospective voting model and shows that an increase in taxation costs will lead to a lower re-election rate while a decrease in tax ceiling will have the opposite effect. Furthermore, the magnitudes of these effects depend on the quality of the election - the cleaner the election, the larger the impact.

4.1 Model Setup

In this model, I use t for taxes paid by villagers and T for tax ceiling or the maximum a village leader can tax. B is villagers' benefit from consuming the public goods and C is the true cost of providing the public goods, which is a random variable uniformly distributed on $[0, \bar{C}]$. C is observable only to the village leader and not to the villagers. $\sigma \in (0, 1)$ stands for the effective taxation coefficient, meaning only a proportion σ of taxes paid by villagers will become the village's fiscal revenue. Regarding the election, $\underline{u}$ is the re-election threshold utility level of villagers, meaning that villagers are only willing to re-elect an incumbent if they achieved at least this level of utility during the incumbent's term. R is the incumbents' benefit of getting re-elected. q represents the quality or corruptibility of elections, which is the probability of the villagers' failing to oust an incumbent who provided a utility level lower than the re-election threshold $\underline{u}$.

Assumptions

To focus attention in this illustrative model, I assume (1) villagers are homogenous, meaning aggregation of private preferences is not an issue; (2) candidates for village leaders are homogenous, meaning there is no selection effect and election serves only as

a discipline mechanism.⁴

Timing of the Game

At the starting point, a village leader is in office and observes C ; then the leader chooses how much to tax the villagers (t) and whether to provide a discrete public goods, knowing that the maximum tax he can extract from the villagers is T . After the village leader taxes the villagers by t and makes decision on public goods provision, the villagers receive their net benefit, either $B - t$ if the public goods are provided, or $-t$ otherwise. An election takes place and the villagers choose whether to keep the incumbent for another term. The villagers would like to re-elect the incumbent as long as the net benefit $B - t$ is no lower than a threshold $\underline{u}$ and to oust the incumbent otherwise. However, the election does not function perfectly in the sense that an incumbent can still win the re-election with probability q even though the villagers want to oust him.

4.2 Optimization Problem of an Incumbent with Given Re-election Threshold $\underline{u}$

Suppose the re-election threshold set by the villagers is $\underline{u}$. Then, after observing C , the village leader needs to solve the following problem and will end up with a value function of state C , $V(C)$.

$$V(C) = \text{Max} \left\{ \begin{array}{l} \text{Max}_t \quad \sigma t - C + R \\ \text{s.t.} \quad B - t \geq \underline{u} \end{array} , T + qR \right\} \quad (\text{III.1})$$

Conditional on choosing to provide the public goods, the village leader's problem is:

⁴This is for simplification of the theoretical analysis. There could also be selection effects as the overall rents of being village leader have been changed by the fiscal reform, which may change the pool of village leader candidates. However, investigation of the relationship between the reform and observed attributes of winners and losers in the sampled elections does not reveal any systematic observation (results available upon request), which suggests the selection effect may be weak at least in the short run.

$$\begin{aligned} \text{Max}_t \quad & \sigma t - C + R \\ \text{s.t.} \quad & B - t \geq \underline{u} \end{aligned} \tag{III.2}$$

The solution to this problem is: $\tilde{t} = B - \underline{u}$, which is independent of cost state C . The incumbent's payoff from providing the public goods and taxing the villagers by $\tilde{t}$ under cost state C is

$$V_e(C) = \sigma(B - \underline{u}) - C + R \tag{III.3}$$

The value of state C is thus

$$V(C) = \text{Max}\{V_e(C), T + qR\} = \text{Max}\{\sigma(B - \underline{u}) - C + R, T + qR\} \tag{III.4}$$

The solution to this problem is a threshold for C ,

$$\hat{C} = \sigma(B - \underline{u}) - T + (1 - q)R \tag{III.5}$$

When the cost state is above this threshold, the village leader will choose not to provide the public goods and tax the maximum T ; when the cost state is no higher than $\hat{C}$, the village leader will choose to provide the public goods and tax the villagers by $\tilde{t} = B - \underline{u}$.

4.3 Villagers' Optimal Re-election Threshold $\underline{u}^*$ and the Equilibrium

Knowing the village leader's rule of behavior for any given $\underline{u}$, the villagers' problem is to find the best $\underline{u}$ that solves the following problem:

$$\text{Max}_{\underline{u}} \quad \underline{u} \frac{\hat{C}}{\underline{C}} - T(1 - \frac{\hat{C}}{\underline{C}}) \tag{III.6}$$

Substituting in the cost threshold as a function of $\underline{u}$ in (III.5) gives the solution $\underline{u}^*$ to the villagers' problem

$$\underline{u}^* = \frac{\sigma B + (1 - q)R - (1 + \sigma)T}{2\sigma} \quad (\text{III.7})$$

Substituting the equilibrium re-election rule (III.7) into the behavior rule of the village leader in (III.5) gives the equilibrium cost threshold:

$$\hat{C}^* = \frac{\sigma B + (1 - q)R - (1 - \sigma)T}{2} \quad (\text{III.8})$$

$\hat{C}^*$ represents the discipline effect of election: higher $\hat{C}^*$ means the village leader is willing to provide the public goods and tax reasonably under more cost states and only choose to provide no public goods and grab the maximum short-term rents for a small set of extremely high cost states. The expression shows that the incidence of the bad behavior depends on easiness of taxation σ , election corruptibility q , future benefits of getting re-elected R and rent ceiling T . The discipline effect is stronger when, other factors held constant, taxation is easier (larger σ), or election is cleaner (lower q), or future benefit of getting re-elected is larger (higher R), or rent ceiling is lower (smaller T). Furthermore, the equilibrium probability of an incumbent getting re-elected is:

$$P^* = \frac{\hat{C}^*}{\bar{C}} + q(1 - \frac{\hat{C}^*}{\bar{C}}) \quad (\text{III.9})$$

and the equilibrium turnover rate is:

$$TR^* = 1 - P^* = (1 - q)(1 - \frac{\hat{C}^*}{\bar{C}}) \quad (\text{III.10})$$

Whether the equilibrium re-election rate P^* increases or decreases with election corruptibility q is not clear-cut. On one hand, a cleaner election, thus lower q , would strengthen the discipline effect of the election, reduce the incidence of opportunistic behaviour by increasing $\hat{C}^*$ and thus raise the re-election rate. On the other hand, a cleaner election

also means bad incumbents are more likely to be ousted, which would lower re-election rate. The overall effect depends on the environment.

4.4 Comparative Static Analysis of the Equilibrium Re-election Rate

1. Taxation costs σ and re-election rate P^*

$$\frac{dP^*}{d\sigma} = \frac{(1-q)(B+T)}{2\bar{C}} \geq 0 \quad (\text{III.11})$$

which means the higher the taxation costs (thus lower σ), the lower the equilibrium re-election rate.

2. Potential rents T and re-election rate P^*

$$\frac{dP^*}{dT} = -\frac{(1-q)(1-\sigma)}{2\bar{C}} \leq 0 \quad (\text{III.12})$$

which means the lower the rent ceiling, the higher the re-election rate.

3. $\frac{dP^*}{dT}$, $\frac{dP^*}{d\sigma}$ and election quality q

$$\frac{d}{d(1-q)} \left[\frac{dP^*}{d\sigma} \right] = \frac{B+T}{2\bar{C}} \geq 0 \quad (\text{III.13})$$

with $\frac{dP^*}{d\sigma} \geq 0$. This means the cleaner the election (lower q and higher $1-q$), the larger the effect of a change in taxation costs on equilibrium re-election rate.

$$\frac{d}{d(1-q)} \left[\frac{dP^*}{dT} \right] = -\frac{1-\sigma}{2\bar{C}} \leq 0 \quad (\text{III.14})$$

with $\frac{dP^*}{dT} \leq 0$, this means the cleaner the election (lower q and higher $1-q$), the larger the effect of a change in rent ceiling on equilibrium re-election rate.

Overall, the cleaner the election, the larger the effects of changing taxation costs or rent ceiling on the equilibrium re-election rate. This is the hypothesis that I am going to test against the data.

4.5 Econometric Model

The econometric model derived directly from the theory is the following:

$$P_{i,v,t} = \alpha_1 TCeil_{v,t} + \alpha_2 TCost_{v,t} + \alpha_3 TCeil_{v,t} * ElecQ_v + \alpha_4 TCost_{v,t} ElecQ_v + \alpha_5 ElecQ_v + X_{i,v,t} \mathbb{B} + \mu_{i,v,t} \quad (\text{III.15})$$

where the left-hand side is a binary variable indicating whether an incumbent gets re-elected or not. Subscript v stands for village; i stands for village leader; and t stands for time. $TCeil$ represents tax ceiling; $TCost$ represents taxation costs. Both are village- and time-specific. $ElecQ$ represents election quality, which is time-invariant. X are other village, village leader or time control variables. α_1 and α_2 are both expected to be negative because of the disincentive effect of a higher tax ceiling (higher outside rents) and higher taxation costs (lower inside rents). α_3 and α_4 are expected to be negative for the same reasons as α_1 and α_2 , as cleaner elections amplify the impacts of taxation costs and tax ceilings. α_5 is undetermined because, even though lower election quality provides lower re-election incentives, the proportion of re-elected incumbents whom the villagers fail to oust also increases with corrupted elections.

China's recent rural fiscal reform increases taxation costs and lowers the tax ceiling at the same time. As the model shows, these two changes work in opposite directions on the equilibrium re-election rate. Since I don't have separate measures of taxation costs and tax ceilings, it is impossible to separately estimate α_1 and α_2 . As an alternative, I am going to investigate the overall effect of the reform, which is theoretically ambiguous and needs an empirical answer. I change (15) to an estimation equation for the reform's overall effects.

$$P_{i,v,t} = \beta_1 Ref_{v,t} + \beta_2 Ref_{v,t} * Res_{v,t} + \beta_3 Ref_{v,t} * ElecQ_v + \beta_4 ElecQ_v + \beta_5 Res_{v,t} + X_{i,v,t} \mathbb{B} + \mu_{i,v,t} \quad (\text{III.16})$$

where $Ref_{v,t}$ is a dummy indicating whether the tax reform has taken place in village v at the time of election t . The overall effect of the reform would depend on the relative magnitudes of $\alpha_1\Delta TCeil$ and $\alpha_2\Delta TCost$. In other words, the effect is determined by parameters α_1 , α_2 and changes in tax ceiling $\Delta TCeil$ and taxation costs $\Delta TCost$ because of the reform. These changes may very well differ across villages in the sense that villages with more local non-tax resources are less dependant on tax revenue and thus less affected by the fiscal reform. So besides the reform dummy $Ref_{v,t}$, I also introduce its interaction with local non-tax resources Res and expect β_2 to have the opposite sign of β_1 . β_3 is expected to be of the same sign as β_1 since cleaner elections amplify whatever the net effect of the reform.

Unobserved attributes of candidates (either incumbents or challengers) may cause identification problems. Candidates with favourable unobserved attributes are more likely to win and show up in later elections, and thus the average unobserved quality of candidates in later elections can be systematically higher than those in earlier ones. Thus, failing to control for the unobserved ability of candidates may cause bias in the estimates of the effect of the reform. To address this potential problem, I use a sub-sample of incumbents who have already won one election as incumbents. Since there are only two elections per village in most cases in my data, this is equivalent to using the sub-sample of the second election where the incumbent is the winner in the first election. The specific timing structure in my data - some villages having both elections before the reform while others having one before the reform and one after the reform - allows me to investigate the impact of the tax reform with this sub-sample. Basically, I will be comparing the re-election outcome in the second election of the incumbents who won the previous election in villages with different tax reform status.

The estimation equation with the sub-sample takes the following form:

$$P_{v,t} = \gamma_1 Ref_{v,t} + \gamma_2 Ref_{v,t} * \Delta Res_{v,t} + \gamma_3 Ref_{v,t} * ElecQ_v + \gamma_4 \Delta Res_{v,t} + X_{v,t} \mathbb{B} + \mu_{v,t} \quad (\text{III.17})$$

The motivation of this specification is the following: given that incumbents in all the villages in this sample are winners of the previous election, I ask how the changes between the previous and the current election affect the likelihood of being re-elected again. The changes of interest include the reform status of the village⁵, its interactions with the election quality and the changes in local non-tax resources. Since there is no case of one individual having been village leader in different villages, I drop the individual subscript i . I expect γ_1 to be positive if the incentive effect of decreasing outside rents is dominating and negative if the disincentive effect of decreasing inside rents is dominating. Similar to the relationship between β_1 and β_2 , β_3 , the model predicts γ_2 to have the opposite sign of γ_1 and γ_3 to have the same.

5 Data and Measure of Election Quality

The data are from a recent survey of 101 villages from 50 towns. Every two sample towns are randomly drawn from a county. Thus the sample covers 25 counties. Every five counties are randomly drawn from one of the following five provinces: Jiangsu, Sichuan, Shaanxi, Jilin and Hebei.

The survey covers many aspects of village political and economic life. The following is a list of contents that provide useful variation for the my empirical work:

First, the survey collected village demography, endowments, economic development and structure information for the year 1997, 2002 and 2004. In the re-election regressions, I control the village characteristics at the 1997 level for elections held between 1999 and 2002, and control them at the 2002 level for later ones. Table 1 provides a summary of

⁵The earlier elections happened before the tax reform in all villages.

some key characteristics. The amounts of cultivated land and collective or contract firms vary a lot across villages.

Second, the survey provides detailed personal information about a long list of village leaders. The earliest dates back to the 1960s, and even the shortest one starts from 1995. I extract from the list information about incumbents in the most recent two elections. Some attributes of these incumbents are summarized in Table 2. There are 172 elections for which I can identify the incumbents' re-election outcomes, 103 before the reform and 69 after the reform. Village leaders who chose not to run are treated as losing the election; those who resigned before the election without obvious exogenous reasons, such as being promoted or death, are treated as losing as well. Table 3 shows before-and-after-reform comparison of re-election likelihood. As is shown, changes of re-election rates differ across provinces. For example, in Jiangsu province, the re-election rate increases from 59% to 74%; while in Sichuan province, it decreases from 78% to 69%.

Third, the timing of the tax reform and the most recent two elections varies across villages. The timing of the tax reform is mainly determined by provincial governments. The upper part of Table 4 shows that most of the sample villages in Jiangsu (15 out of 21) implemented the tax reform in 2001, and most of the sample villages in Shaanxi (18 out of 20) implemented the reform in 2003. Elections are supposed to be held every three years, so the timing of the most recent two elections depends on the year of the first election. For some villages, the first election dates back as early as the beginning of 1980s. The numbers of villages having elections in each year are shown in the lower part of Table 4. In Shaanxi, all the sample villages had both elections before the reform, while most of the villages in the other provinces had one election before the reform and one after. This specific structure of the data allows me to identify the impact of the reform from the re-election outcomes in the second election of the sub-sample of incumbents who were winners in the first election in my data.

Fourth, the survey covers all the projects carried out between 1997 and 2004. These

projects include roads, bridges, irrigation projects, schools, etc. Table 5 shows the distribution of the number of projects across villages between 1997 and 2004. Table 6 shows the distribution of the starting year of these projects. Table 7 shows the total number of village public projects with financial support from upper governments and the village average amount of transfers by year and province. It is obvious that following the wide implementation of the fiscal reform in 2002, a lot more projects were started in the year 2003 when the upper governments increased earmark transfers in public projects by a huge amount. Since transfers from upper governments are one of the most important sources of local non-tax revenue, the rich variation shown in Table 7 across years and regions provides an opportunity to check how the reforms' tightening effect differs with the abundance of local non-tax revenue.

Fifth, the survey also covers election protocols. There was no significant change in election protocols between the two elections. So I use only the measures of the most recent ones and treat election quality as time invariant. Election protocols are grouped in several categories: preparation, organization, nomination, absentee balloting, voting and vote counting. I select 19 measures that are important dimensions of election quality and show large variation in the sample. Table 8 shows the pairwise correlation between these measures. To help focus attention, only the significant correlations are presented. The large number of significant coefficients indicates that election quality is quite consistent in the sense that elections more fair in one stage are more likely to be fair in other stages too. For the analysis of how election quality may change the reform's effects on equilibrium re-election rate, I prefer to use a simple one dimension measure of election quality in the regression. Using the correspondence analysis method (MCA), I construct an index from these 19 original measures. Table 9 shows the results of the MCA. The first dimension captures 68% of the total inertia. The corresponding coordinates quantify the categorical variables and are used to construct the index measuring election quality for each village. Larger contribution comes from the variables being assigned sparser

scales, such as whether the final list of candidates needs to be approved by upper governments, whether the villagers fill the ballots by themselves, whether absentee balloting by family members is widely used, and whether the voting is formally carried out. Table 10 compares the village with the worst election against the one with the best election according to my MCA results. The results are consistent with the general sense about good elections. The MCA measure of election quality differs a lot across provinces. Table 11 shows the average score of each province. The elections in Jilin are the cleanest, and those in Hebei are the most problematic. Regressions of the score on provincial and county dummies show that 44% of the variation comes from between-province difference while 28% of the variation is within-county.

6 Impacts of Tax Reform on Re-election Rates

In this section, I test the predictions from the simple model against the data, using specifications (III.16) and (III.17) discussed above.

Panel (a) of Table 12 are for the regression results running (III.16). Column (1) corresponds to regressing re-election outcome on just village attributes, incumbent attributes and year dummies with pooling observations from all villages over time. Village attributes include the log of the village population and per capita income. Incumbent attributes include the log of the incumbent's age and years of education, party membership status, whether the family name is a dominant one in the village, family relative income and the way the incumbent first entered office. Column (2) introduces reform dummy and column (3) further adds election quality and measures of local non-tax resources. Non-tax resources of interest include the log of the amount of cultivated land, the amount of transfer from above and a dummy indicating whether a village has any collective or contract firms. Interaction terms of the reform with election quality and measures of non-tax resources are introduced in column (4). Column (5) shows the results estimated

together with an equation with public project investment financed by the village on the left-hand side and the same set of variables on the right-hand side. Public project investment financed by the village is a variable at the discretion of the incumbent and thus simultaneously determined with his decision on whether to behave well and get re-elected or grab the maximum rents and risk being ousted. This relationship justifies estimating the re-election function and village investment function together with the seemingly unrelated regression (SUR) method to improve efficiency. There are many anecdotes about how village leaders contract public projects to their relatives to extract rents, so it's appealing to consider investment financed by villages as a measure of the theoretical t , which is the summation of the true cost of projects and rents taken by village leaders. The model does not give specific predictions on how the reform would affect t , so the utilization of this variable here is purely for improving estimation efficiency.

The control variables explain about 15% of the total cross-sectional and overtime variation in re-election outcome. Inclusion of election quality and local non-tax resource raises it by about 6%; introducing the interaction terms does not substantially improve the explanatory power of the model. The variables of interest are not significant even in the SUR regression. The only significant variables are election quality and the abundance of cultivated land. The effect of a cleaner election in helping to oust unsatisfactory incumbents seems to be dominant as election quality is negatively associated with re-election rate. The amount of cultivated land has a positive coefficient suggesting more land makes being in office more valuable and thus raises the re-election rate.

Even though the timing of the tax reform is determined at a higher level of government and exogenous to the village, there is still concern about identification of the coefficients of the interacted terms with the pooled regression since the unobserved attributes of a village or incumbent may affect election quality, village resources and re-election result simultaneously. For example, in villages where households are widely located it might be more difficult to monitor the election process especially if a floating ballot is adopted.

Thus the election quality might be low. Meanwhile, the need for public projects might also be different, which would then affect the incumbent's re-election incentive and the election outcome. To address the issue related to unobserved village attributes, I add village fixed effects to the specification.

Column (6) to (10) are the same as Column (1) to (5) except the inclusion of village fixed effects. Since my measure of election quality is time invariant for a given village, it is dropped in these regressions. Two facts are noteworthy in these regressions. First, the explanatory power of these variables in explaining the within-village over time variation of the re-election rate is much stronger. The within group R squared is above 40%. Second, in the last regression with all the interactions, the coefficient of the reform dummy is negative but insignificant; however the interaction with election quality is negative and significant. This is consistent with the prediction of the simple retrospective voting model that cleaner elections can amplify the impact of the tax reform. Having collective or contract firms also amplifies the negative effect of the tax reform, suggesting that having these firms is more of an indicator of the opportunity cost of being village leader than a source of an alternative revenue to tax. As a result, in villages where the opportunity cost of being village leader is higher, the tax reform has a larger negative impact on the likelihood that an incumbent would stay in office for another term.

The theoretical model captures only the discipline effect of elections, but elections may also serve as a selection mechanism because villagers not only use future voting to constrain the behaviour of incumbents, they also use voting to put more suitable candidates into office. This makes the task of identifying the discipline effect more difficult as I do not observe as many candidates' attributes as the villagers do. If the villagers detect certain attribute that I do not observe, such as altruism, then incumbents running for the most recent elections may on average have more of this attribute than those running in the previous ones because they were just "selected" against their predecessors and have higher probability to win in later and thus after-reform elections. As a result,

the impact of the reform on the election outcome identified from the pooled sample or the within-village overtime variation may confound the impact on the disciple effect and the selection effect. Since there is no incumbent that has been village leader for multiple villages in my data and incumbents with attributes the villagers do not like are less likely to be seen in future elections, it is impossible to control for incumbents fixed effects. To address this problem, I restrict my sample to incumbents who have won the first election in my data and compare their re-election outcome in the second election across villages with different reform statuses. I have 43 incumbents in the second election who were also winners in the previous one. The identification comes from the fact that when the last election took place, 30 villages already had implemented the reform while the other 13 had not.

Panel (b) of Table 12 reports the regression results of specification (III.17) with this selected sample. I am asking the specific question that, given these incumbents have won the previous election, how changes between the two elections affect their outcome in the last election observed in my data. The changes of interest include the reform status, the change in resources, the interactions between these two and the interaction between the reform status and election quality. Since there is barely any variation in the status of having a collective or contract firm or not, this measure of resource is dropped from the regressions here. As in Panel (a), variables of interest are introduced step by step. Allowing for heterogeneity in the impact of the reform substantially improves the explanatory power of the model, from 3% to about 20%. The coefficient of the reform dummy is still negative but insignificant. The interactions with election quality is significantly negative and the interaction with the amount of cultivated land is positive and marginally significant. The interaction with the log of the transfer from above is positive but not significant.

The average re-election rate in the last election is around 74%. The standard deviation of the quality index is about 1 for the 101 villages in my sample. Thus everything else

being the same, the re-election rate in two villages with election quality one standard deviation away will differ by 25%, about a third of the average re-election rate. In between the two elections, there has been no change in the amount of cultivated land in 21 out of the 43 villages; it has increased in only 2 villages and decreased in 20 villages. Among these 20 villages, the average change is about -10%; that is, a log ratio of about 0.07. Given such a change in the amount of cultivated land, the re-election rate between two villages with different statuses will differ by about 9%.

7 Conclusion

This paper looks at the political equilibrium in China's villages in the context of the recent rural fiscal reform. The central government, in carrying out this reform, intended to reduce burdens on rural households and improve village governance by limiting the authority of elected village leaders. The actual effects of the reform turn out to be two-sided. Tightening the grabbing hands on one side, the reform also makes the financing for public expenditure more costly, thus reducing inside rents and incumbents' incentives for re-election. In other words, the reform strengthens and weakens the discipline effect of the election mechanism at the same time, and which one dominates is an empirical question. The empirical results show a significant net negative effect of the reform in villages with cleaner elections. Given that lower re-election rates are also a reflection of short-run behavior of the village leaders, it's possible that welfare of the villages has decreased after the reform - even though the village leaders can grab less, they are more likely to grab.

Both the implementation of village leader elections and the fiscal reform emerged from the central government's intention to improve village governance. However, as this paper shows, the two changes may have worked against each other in serving their ex ante common purpose. Then what would be a more effective way of improving China's

village governance? Further, what constraints make the central government choose fiscal centralization over other alternatives, such as improving election quality to strengthen the discipline effect of the existing election mechanism, as the solution to the tension prevailing between villagers and local cadres? Related questions are: what are the determinants of election quality? and how difficult is it for the central government to improve it?⁶ I leave these important questions for future research.

There are another two dimensions along which this paper can proceed. One is that this paper only addresses two agents in the village governance system. What is left out of the current analysis is the direct influence of upper governments, the indirect influence of upper governments through the appointment of the party secretary and the interaction between the appointed party secretary and the elected village leader in administering village affairs. The other is that the current empirical work focuses on the interaction between the fiscal reform and the discipline effect of the election by checking whether incumbents become more opportunistic after the reform but does not provide much insight into the interaction with the selection effect of the election mechanism, namely, what is the impact of the reform on the pool of candidates who are willing to be village leaders. A lot more research needs to be done to achieve a better understanding of rural China's political equilibrium.

8 Tables

⁶Our measure of election quality shows that 28% of the variation is within county. If election differs within counties, it's very likely to be endogenous to other local attributes, which calls for caution when trying to claim causality relationship between implementation of election and other economic or social phenomena in rural China.

Table 1: Summary of village attributes: 1997 and 2002

	1997		2002	
	mean	sd.	mean	sd.
Number of Households	374	221	381	224
Prop. of hh doing only agr.	59%	29%	47%	30%
Prop. of hh doing no agr.	8%	14%	10%	14%
Prop. of hh running family business	7%	32%	6%	10%
Population	1386	799	1381	791
Labor	674	388	682	385
Prop. of locally employed labor	8%	13%	8%	11%
Prop. of labor commuting between the village and working place	8%	9%	10%	11%
Prop. of labor employed and living outside of the village	14%	16%	24%	26%
Prop. of illiterate labor	15%	37%	10%	17%
Per capita Income (in 1997 Yuan)	1577	833.	2158	1206
Cultivated Land (acre)	407	329	341	370
Prop. of contract land	23%	41%	23%	41%
Prop. of responsibility land	78%	41%	78%	41%
Number of villages with firms	42		46	
Number of villages with collective or contract firms	22		18	

Table 2: Summary of incumbent attributes: before and after the fiscal reform

	Before the Reform	After the Reform
Number of Obs.	103	69
Mean of age in the election year	45 (sd. 8.05)	48 (sd. 7.66)
Mean of years of education obtained	9 (sd. 2.40)	9 (sd. 2.95)
Prop. of incb. who are also party members	77%	77%
Prop. of incb. who were employed outside the village	13%	20%
Prop. of incb. related to dominant families	44%	51%
How became the VL		
Prop. of directly elected	43%	52%
Prop. of elected by the party branch	4%	4%
Prop. of appointed by upper governments	38%	33%
Prop. of others	15%	10%
Relative income before being VL		
Prop. of far above village average	11%	13%
Prop. of above village average	38%	43%
Prop. of village average	44%	38%
Prop. of below village average	6%	6%
Prop. of far below village average	2%	0%

Table 3: Re-election outcomes

	Before the Reform			After the Reform		
	# win	# lose	Likelihood of Winning	# win	# lose	Likelihood of Winning
Jiangsu	10	7	59%	14	5	74%
Sichuan	18	5	78%	11	5	69%
Jilin	7	7	50%	13	11	54%
Shaanxi	23	11	68%	0	0	/
Hebei	5	7	42%	4	9	31%

Table 4: Timing of the fiscal reform and elections

		1998	1999	2000	2001	2002	2003	2004
# of villages with the fiscal reform in the year	Jiangsu	0	0	1	15	4	0	0
	Suchuan	0	0	0	1	13	3	3
	Shaanxi	0	0	0	0	2	18	0
	Jilin	1	0	0	1	12	7	0
	Hebei	0	0	1	2	12	5	0
# of villages with elections in the year	Jiangsu	/	0	0	19	1	0	20
	Suchuan	/	0	0	17	3	3	14
	Shaanxi	/	18	0	1	18	1	0
	Jilin	/	0	1	20	0	0	21
	Hebei	/	3	6	1	2	15	1

Table 5: Distribution of the number of projects between 1997 and 2004

# of projects	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
# of villages	3	3	5	11	12	11	16	11	6	14	2	3	2	1	1
% of villages	3%	3%	5%	11%	12%	11%	16%	11%	6%	14%	2%	3%	2%	1%	1%

Table 6: Distribution of starting years of the projects during 1997 and 2004

Year Begin	# of projects	% of projects
1997	9	1.00%
1998	136	15.06%
1999	84	9.30%
2000	73	8.08%
2001	79	8.75%
2002	112	12.40%
2003	247	27.35%
2004	160	17.72%
2005	3	0.33%

Table 7: Number of projects with financial support from upper governments and village average investment from upper governments

Year	# of proj. with financial support from upper gov.	village average inv. from upper gov. (10,000 Yuan)	# of proj. with financial support from upper gov.	village average inv. from upper gov. (10,000 Yuan)	# of proj. with financial support from upper gov.	village average inv. from upper gov. (10,000 Yuan)
	All 6 Prov.		Hebei		Jiangsu	
1998	55	6.76	9	5.34	10	6.55
1999	39	5.34	2	0.59	9	1.19
2000	29	6.03	6	1	5	4.05
2001	21	2.44	3	3.17	2	2.15
2002	49	3.45	8	2.44	8	3.98
2003	101	14.25	7	5.25	14	13.69
2004	74	13.01	16	2.4	13	35.43
	Jilin		Shaanxi		Sichuan	
1998	6	2.53	15	10.84	15	8.77
1999	1	0.46	14	18.67	13	6.04
2000	0	0	10	3.34	8	22.08
2001	0	0	7	2.51	9	4.48
2002	16	7.43	7	0.89	10	2.3
2003	19	11.44	30	15.65	31	25.36
2004	7	3.33	25	18.68	13	5.67

Table 8: Correlation between election protocols

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
1. Village gathering before elec. <i>0. No 1. Yes</i>																					
2. In-charge of the committee <i>0. PS or Above 1. Others</i>	0.29 <i>0.01</i>																				
3. Above influence on nominee <i>0. Yes 1.No</i>	0.25 <i>0.01</i>																				
4. Above approval+A36 of list <i>0. Yes 1. No</i>		0.22 <i>0.03</i>	0.30 <i>0.00</i>																		
5. Representativeness of candidates <i>1. No 2. Partly 3 yes</i>		0.30 <i>0.01</i>	0.27 <i>0.02</i>																		
6. Villagers' importance in nomination <i>scale 0-5, 5 most important</i>			-0.48 <i>0.00</i>	-0.30 <i>0.00</i>	0.68 <i>0.00</i>																
7. Fill one's own ballot <i>0. No 1. Yes</i>				0.22 <i>0.03</i>	0.27 <i>0.03</i>	0.36 <i>0.00</i>															
8. FM fill ballots of absentee <i>0. Widely used 1. Not widely used</i>			0.21 <i>0.03</i>			-0.27 <i>0.01</i>	0.43 <i>0.00</i>														
9. Women vote by themselves <i>continuous 0-100%</i>	-0.22 <i>0.04</i>																				
10. Absentee proportion <i>continuous 0-100%</i>																			-0.28 <i>0.01</i>	0.46 <i>0.00</i>	
11. Who is proxying? <i>0. Others 1. Nobody or FM only</i>																			0.27 <i>0.01</i>	0.29 <i>0.02</i>	0.32 <i>0.00</i>
12. Absentee asked? <i>0. No 1. Yes</i>	0.22 <i>0.05</i>																				

Table 8: Correlation between election protocols, Continue

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
13. Absentee rules <i>1. Badly 2. So so 3. Strictly</i>					0.22 <i>0.04</i>		0.43 <i>0.00</i>	0.34 <i>0.00</i>		-0.24 <i>0.02</i>		0.36 <i>0.00</i>							
14. Ballots <i>0. Others allowed 1. Fixed only</i>			0.20 <i>0.04</i>		0.43 <i>0.00</i>	0.37 <i>0.00</i>		0.30 <i>0.00</i>		-0.27 <i>0.01</i>	0.31 <i>0.00</i>		0.26 <i>0.04</i>						
15. Secret ballots <i>1. No Secret Ballot 2. SB, weak imp. 3. SB, strict imp.</i>						0.36 <i>0.00</i>	0.30 <i>0.01</i>			-0.29 <i>0.01</i>	0.26 <i>0.04</i>		0.31 <i>0.00</i>	0.31 <i>0.01</i>					
16. Voting formal? <i>0. No 1. Yes</i>			0.25 <i>0.01</i>		0.27 <i>0.02</i>	0.40 <i>0.00</i>	0.62 <i>0.00</i>	0.60 <i>0.00</i>	0.38 <i>3.95</i>	-0.39 <i>0.00</i>			0.40 <i>0.00</i>	0.35 <i>0.00</i>	0.38 <i>0.00</i>				
17. Address <i>0. No 1. Yes</i>			0.20 <i>0.05</i>	0.25 <i>0.01</i>	0.32 <i>0.01</i>	0.42 <i>0.00</i>		0.27 <i>0.01</i>	0.25 <i>2.51</i>				0.34 <i>0.00</i>	0.36 <i>0.00</i>	0.50 <i>0.00</i>	0.32 <i>0.00</i>			
18. Commitments <i>0. No 1. Yes</i>				0.23 <i>0.02</i>	0.34 <i>0.00</i>	0.41 <i>0.00</i>		0.32 <i>0.00</i>	0.30 <i>3.02</i>			0.26 <i>0.01</i>	0.41 <i>0.00</i>	0.39 <i>0.00</i>	0.48 <i>0.00</i>	0.29 <i>0.00</i>	0.68 <i>0.00</i>		
19. Counting transparent <i>1. Not transpt. 2. So so 3. Transpt.</i>			0.33 <i>0.00</i>	0.28 <i>0.02</i>	0.36 <i>0.00</i>	0.44 <i>0.00</i>	0.30 <i>0.01</i>			-0.25 <i>0.01</i>	0.28 <i>0.02</i>	0.27 <i>0.04</i>	0.27 <i>0.01</i>			0.38 <i>0.00</i>	0.31 <i>0.01</i>		

*Association between any two nominal variables is measured by Cramer's phi; correlation between a nominal variable and a quantitative variable is measured by point biserial correlation coefficient; correlation between any two quantitative variables is measured by Pearson's product moment correlation coefficient. Only coefficients significant at 5% level are shown in this table. The p-values are provided under the coefficients.

**The election protocols we select are: (1) whether there is a villagers' meeting before the election to introduce the procedure, (2) whether Party Secretary or officials from upper governments are in charge of the election committee, (3) whether the upper governments have influence on the nomination of candidates, (4) whether the final list of candidates needs to be approved by the upper government, (5) villages' evaluation of the pool of candidates, (6) whether villagers play an important role in the nomination process, (7) whether villagers fill the ballots by themselves, (8) whether absentee balloting by family members is widely used, (9) the proportion of women voters voting by themselves, (10) the proportion of absentee votes, (11) the restrictions on who can proxy, (12) whether the preference of the absentee is reflected, (13) whether the absentee balloting rules are strictly followed, (14) whether fixed or floating ballots have been used, (15) whether there is secret ballot rule and whether it's strictly carried out, (16) whether the voting is formally carried out, (17) whether the candidates give addresses and (18) make commitments, (19) whether the counting process is transparent.

Table 9: MCA results, first dimension

	mass	overall quality	% inertia	coordinates	sqcorr	contribution
Protocol 1						
No	0.031	0.12	0.005	0.094	0.038	0
Yes	0.022	0.12	0.007	-0.133	0.038	0
Protocol 2						
PS or Above	0.044	0.402	0.003	0.103	0.093	0
Others	0.008	0.402	0.018	-0.537	0.093	0.002
Protocol 3						
No	0.025	0.823	0.029	1.14	0.755	0.032
yes	0.028	0.823	0.026	-1.016	0.755	0.029
Protocol 4						
No	0.034	0.747	0.008	0.521	0.739	0.009
Yes	0.019	0.747	0.015	-0.942	0.739	0.017
Protocol 5						
No	0.018	0.783	0.026	1.156	0.632	0.024
Partly	0.004	0.277	0.015	0.849	0.14	0.003
Yes	0.03	0.757	0.019	-0.812	0.705	0.02
Protocol 6						
0	0.001	0.206	0.008	1.532	0.115	0.001
1	0.015	0.855	0.045	1.936	0.815	0.054
2	0.008	0.418	0.007	0.641	0.325	0.003
3	0.01	0.389	0.015	-0.832	0.322	0.007
4	0.014	0.663	0.028	-1.25	0.532	0.022
5	0.005	0.55	0.017	-1.494	0.492	0.012
Protocol 7						
No	0.042	0.847	0.011	0.549	0.807	0.013
Yes	0.011	0.847	0.04	-2.104	0.807	0.048
Protocol 8						
Not widely used	0.029	0.844	0.028	1.08	0.812	0.034
Widely used	0.024	0.844	0.035	-1.329	0.812	0.042
Protocol 9						
<25%	0.008	0.519	0.011	0.872	0.372	0.006
25%~50%	0.018	0.444	0.009	0.51	0.354	0.005
50%~75%	0.015	0.181	0.008	-0.294	0.105	0.001
>75%	0.012	0.643	0.013	-0.939	0.538	0.011

	mass	overall quality	%inertia	coordinates	sqcorr	contribution
Protocol 10						
50%~75%	0.001	0.026	0.008	0.721	0.026	0
25%~50%	0.011	0.841	0.034	1.982	0.839	0.043
<25%	0.041	0.834	0.01	-0.535	0.833	0.012
Protocol 11						
Nobody or FM only	0.013	0.636	0.018	1.127	0.615	0.016
Others	0.04	0.636	0.006	-0.359	0.615	0.005
Protocol 12						
No	0.033	0.616	0.01	0.482	0.519	0.008
Yes	0.019	0.616	0.017	-0.828	0.519	0.013
Protocol 13						
Badly	0.031	0.863	0.017	0.831	0.83	0.021
So so	0.438	0.008	-0.558	0.395	0.005	-0.633
Strictly	0.007	0.815	0.042	-2.417	0.681	0.042
Protocol 14						
Fixed only	0.021	0.787	0.033	1.33	0.752	0.036
Others	0.032	0.787	0.021	-0.853	0.752	0.023
Protocol 15						
No SB.	0.034	0.827	0.017	0.757	0.797	0.02
SB., weak imp.	0.007	0.515	0.01	-0.245	0.027	0
SB., strict imp.	0.011	0.859	0.041	-2.129	0.854	0.052
Protocol 16						
No	0.038	0.858	0.022	0.857	0.838	0.028
Yes	0.015	0.858	0.055	-2.124	0.838	0.068
Protocol 17						
No	0.033	0.803	0.027	0.989	0.8	0.032
Yes	0.02	0.803	0.044	-1.618	0.8	0.052
Protocol 18						
No	0.039	0.817	0.015	0.696	0.817	0.019
Yes	0.014	0.817	0.043	-1.936	0.817	0.052
Protocol 19						
Not transpt.	0.012	0.816	0.03	1.675	0.766	0.034
So so	0.012	0.136	0.009	0.3	0.082	0.001
Transpt.	0.028	0.819	0.017	-0.841	0.811	0.02

Notes: Refer to the notes of Table 8 for description of the 19 election quality-related categorical variables.

Table 10: Election protocols of villages with the highest and lowest MCA score of election quality

The Best	The Worst
Villagers meeting held before the election to give instructions on election procedure	No villagers meeting held to give instructions on election procedure
PS or officials from upper gov. in charge of election committee	PS or officials from upper gov. in charge of election committee
No influence on nomination process from upper gov.	Upper gov. influence nomination process
Candidates list doesn't need to be approved by upper gov.	Missing information on whether candidates list needs to be approved by upper gov.
Candidates are representative of villagers' preference	Candidates don't represent villagers' preference
Evaluation of villagers importance in nomination process: 4	Evaluation of villagers importance in nomination process: 1
Villagers all fill the ballots by themselves	Villagers don't fill the ballots by themselves
Filling ballots for family members is not common	Filling ballots for family members is common
50%~75% of the women voters vote by themselves	Less than 25% of the women voters vote by themselves
Less than 25% of the ballots are absentee ballots	Missing information on the proportion of absentee ballots
Absentees can't vote or only family members can vote on behalf of them	People other than family members can vote on behalf of absentees
Ask the absentees before filling their ballots	Missing information on whether asking the absentees before filling the ballots on their behalf
Rules about absentee balloting are strictly implemented	Rules about absentee balloting are not strictly implemented
Fixed ballot boxes only	Both fixed and floating ballot boxes are used
Secret ballot and the rule is strictly implemented	No secret ballot
Voting is formal	Voting is not formal
Address given	No address given
Commitment made	No commitment made
Counting process is transparent	Counting process is not transparent

Table 11: Provincial summaries of the MCA score of election quality

	Mean	Std.	Min	Max
Jiangsu	-0.23	0.72	-1.37	1.09
Sichuan	-0.33	0.73	-1.65	0.90
Shaanxi	-0.02	0.89	-1.26	1.86
Jinlin	1.11	0.65	-0.20	2.14
Hebei	-0.93	0.88	-1.80	1.67

Table 12 Impacts of the tax reform on re-election outcome

(a) Whole sample

Dependent Variable: Re-election outcome (=1 if win; =0 if lose or not run)	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) SUR	(6) Vil. FE	(7) Vil. FE	(8) Vil. FE	(9) Vil. FE	(10) Vil. FE SUR
Reform dummy		0.021 (0.124)	-0.093 (-0.573)	0.534 (0.801)	0.534 (0.875)		-0.171 (-0.824)	-0.135 (-0.554)	-0.635 (-0.838)	-0.635 (-1.231)
Reform * Election Quality				0.024 (0.238)	0.024 (0.285)				-0.180* (-1.844)	-0.180*** (-2.935)
Reform * Cultivated land				-0.072 (-0.885)	-0.072 (-0.952)				0.060 (0.695)	0.060 (0.945)
Reform * Transfer from above				0.005 (0.850)	0.005 (1.110)				-0.001 (-0.087)	-0.001 (-0.196)
Reform * Collective/Contract firm dummy				-0.140 (-0.740)	-0.140 (-0.807)				-0.209 (-1.349)	-0.209* (-1.802)
Election Quality			- 0.096** (-2.003)	-0.098* (-1.778)	-0.098* (-1.819)					
Cultivated land			0.010** (2.124)	0.011** (2.274)	0.011 (1.323)			-0.148 (-0.614)	-0.038 (-0.135)	-0.038 (-0.185)
Transfer from above			0.003 (1.484)	0.002 (0.603)	0.002 (0.637)			0.002 (0.656)	0.004 (1.100)	0.004* (1.665)
Collective/Contract firm dummy			0.074 (0.787)	0.114 (1.011)	0.114 (1.045)			-0.330** (-2.206)	-0.177 (-1.087)	-0.177 (-0.749)
Controls										
Village attributes ¹	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Village fixed effects	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Incumbent attributes ²	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	172	172	172	172	172	172	172	172	172	172
r ²	0.154	0.154	0.212	0.224	0.224	0.412	0.417	0.430	0.466	0.466

Note: *t* statistics in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$

(1) Village attributes include population and per capita income. (2) Incumbents' attributes include age, education, party membership, whether the family name is a majority one in the village, family relative income and the way the incumbent entered office

Table 12 Impacts of the tax reform on re-election outcome, Continue

(b) Subsample with incumbents winning the previous election

Dependent Variable: Re-election outcome (=1 if win; =0 if lose or not run)	(11)	(12)	(13)	(14)	(15)
	OLS	OLS	OLS	OLS	SUR
Reform dummy		-0.084	-0.088	-0.018	-0.018
		(-0.394)	(-0.403)	(-0.069)	(-0.078)
Reform * Election quality				-	-
				0.246**	0.246**
					*
Reform * change in cultivated land				(-2.427)	(-2.730)
				1.343	1.343*
Reform * change in transfer from above				(1.681)	(1.891)
				0.006	0.006
				(0.772)	(0.868)
Change in cultivated land			0.079	-0.269	-0.269
			(0.263)	(-0.613)	(-0.690)
Change in transfer from above			0.003	0.004	0.004
			(0.940)	(0.735)	(0.826)
Controls					
Other controls ¹	Yes	Yes	Yes	Yes	Yes
N	43	43	43	43	43
r2	0.002	0.006	0.031	0.197	0.197

Note: *t* statistics in parentheses. Significance level: * $p < 0.10$, ** $p < 0.05$ and *** $p < 0.01$

(1) Other controls include the incumbent's age and a dummy indicating whether it is before or after 2004.

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