Measuring Trade Barriers:
An Application to China's Domestic Trade

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Abstract

Domestic trade protectionism across Chinese provinces appears to high and rising even as China has become more integrated with the global economy (Young, 2000; Poncet, 2003). I examine this claim for the period 1992 to 2002 by exploiting Chinese provincial level domestic trade data. Because of the difficulty in measuring trade barriers and limited domestic trade data, existing studies on the topic relied on indirect inferences or estimation of border effects. I apply a method of calculating trade barriers that addresses the limitation of the data with making minimal estimation assumptions. I find that the ad valorem tariff-equivalent level of domestic trade barriers for all goods and services are 54%, 56%, and 61% in 1992, 1997, and 2002, respectively. Trade barriers in manufacture goods, however, are substantially lower at 49% in 2002. Furthermore, I verify that domestic trade barriers rose from 1992 to 1997, as suggested by previous studies, and continued to rise in the later period of 1997 to 2002. Finally, I derive an extended version of the trade barriers measure in a gravity model that allows for product upgrading. This accounts for features of industries that have experienced high growth in China in the later period. With this extension, I find that the change in domestic fixed trade barriers is even more pronounced than in the benchmark model. As domestic trade is almost twice as large as international trade in China's economy, an implication of the findings of this paper is that domestic trade can potentially overtake international trade as the more important driver of China's growth if decline in domestic trade barriers were to hasten.

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1 Introduction

China has experienced a surge in global integration over the last two decades, as indicated by the tremendous growth in its international exports and imports. However, recent studies claim that domestic market integration within China is low and has worsened over the same period (Young, 2000; Poncet, 2003, 2005). Separating domestic demand into *intra*provincial, *inter*provincial, and international purchases, provincial input-output data shows that the share of intraprovincial and international purchases had increased steadily from 1987 to 2002, with the intraprovincial share rising more rapidly than the international share. Over the same period, the share of interprovincial trade decreased.[1] This empirical observation is puzzling because one would expect a country that is undergoing increasing integration to be more open to both domestic and international trade. One explanation is that the increase in international imports replaced domestic imports. But the even bigger magnitude in the increase of local share relative to international import share would suggest that trade diversion is not the complete story. Another more common explanation that has emerged is that domestic protectionism had risen in China. Is domestic protectionism high and rising in China? Answering this question is the aim of this paper.

The natural way to proceed with answering the question is to examine domestic trade barriers. But trade barriers are inherently difficult to measure, as they take many shapes and forms. Most of what we know about trade barriers come from the international trade literature, where they take the form of freight costs, distance cost, a border effect, language and colonial linkages, and tariffs. But domestic trade barriers are more mysterious as they are oftentimes ad hoc and idiosyncratic. If most people in the same country speak the same language, share the same national border, and are governed under the same national government, what form do these barriers take?

Anecdotal stories give us a glimpse of these barriers. To ensure demand for its domestic automobile company, Shanghai's municipal government only allowed cars produced by its local joint venture firm with Volkswagen to operate in the taxi fleet (Li, Qiu, Sun, 2003). Another well known story recounts how the local government of Shenzhen prohibited sales of newspaper from Guangzhou, its neighboring city, in order to retain revenues from the sales of its own local state-owned newspaper (Gilley, 2001). Aside from these examples, other types of domestic trade barriers include physical barriers, outright prohibition through administrative decree, financial benefits for firms selling local goods, fees on firms selling non-local goods, local purchasing quotas, commercial registration licenses, "technical certification"

[1] The following terms are used interchangeably: domestic/interprovincial trade, local /intraprovincial purchases.

(Young, 2000; Naughton, 2000). As best put it by Naughton (2000), "Local government don't blockage their borders or impose tariffs. But their pervasive influence over the local regulatory apparatus enables them to impose significant non-tariff barriers to outside firms that can significantly increase the costs of trade and cross-border investment." Whatever form these barriers take, it is clear that non-tariff barriers are employed extensively as trade impediments in domestic trade.[2]

To get around the problem of not having comprehensive data on these amorphous domestic trade barriers, scholars studying the question similar to this paper have drawn indirect inferences through other observable economic variables. Analyzing prices and industrial structure across provinces, Young (2000) points out that sizable internal trade barriers must exist when provinces of such different factor endowments exhibit convergence in their industrial structure. A critique of making the argument based on convergence in industrial structure is that they might reflect the growth of the regions or technological transfers (Naughton, 2000). Holz (2008) also shows that the United States, as a benchmark for a country free of distortions, indicates a similar level of convergence in industrial structure across states. Other studies exploit price data of homogeneous goods (Poncet, 2003; Li, 2007) and argue that the presence of price differentials across provinces must be indicative of sizable barriers. But these price data are only for selected industries that are not representative of domestic trade, and as Naughton (2000) points out, intraindustry trade for manufacturing is the most important source of trade. Therefore, these measures are at best indirect inference of domestic trade barriers, giving us at best an incomplete or, worse, inaccurate portrayal, of the state of domestic protectionism within China.

The most direct measures of trade barriers thus far come from an examination of domestic trade flows. Poncet (2003, 2005) and Naughton (2001) use interprovincial trade data gathered from provincial level input-output table to study the question. Naughton draws descriptive statistical inferences from these data, while Poncet (2003) estimates the domestic border effect across Chinese provinces from a gravity equation, and finds a worsening domestic border effect. The estimation of border effect in an OLS regression as in Poncet (2003) requires one to have appropriately controlled for income, distances, and prices. An inconvenient feature about the available domestic trade data for each Chinese province is that the trade flows are aggregated across all outside provinces. As such, an OLS estimation requires making assumptions on how to aggregate the distances and prices across provinces. The resulting estimates of the border effect could then be potentially sensitive to the con-

[2] Domestic trade barriers are not specific to China. In Russia, regional governments restrict beer imports from other regions by issuing a legislation on "licensing and accreditation" of beer retailers (Guriev, Yakovlev, Zhuravskaya, 2007).

struction of distances and prices. Furthermore, the border effect represented by the dummy variable on domestic trade may capture only parts of the trade barriers.

Like these scholars, I analyze the question with direct interprovincial trade data to exploit their direct relevance to the question; but I take a different analytical approach. The measure of trade costs that I apply in this paper has parsimonious data requirements and bypasses the estimation issues mentioned above. This measure is based on a simple insight from the gravity equation, that the ratio of the local purchases of two regions over their respective bilateral trade give us an expression of trade barriers. This insight was first pointed out in Head and Ries (2001) and further expounded by Novy (2009). The intuition of this measure of trade costs is this: consider three regions A, B, and C. Supposed that A and B have the same volume of bilateral trade with C, but A buys more from itself than B does from itself. Then it has to be the case that the average bilateral trade barrier between A and C is larger than between B and C. This is true because the gravity equation tells us that trade flows should be higher if trade barriers are lower. This measure of trade barrier is robust across a broad class of trade models that lead to the gravity equation (Anderson and Van Wincoop, 2003; Eaton and Kortum, 2002; Chaney, 2008; and Melitz and Ottaviano, 2009).

It also has four advantages over estimating the border effect in an OLS regression: (1) it captures trade barriers without making functional form assumptions beyond that prescribed by a broad class of trade models (the gravity equation)[3] (2) it does not make any assumptions on the aggregation of prices and distances (3) it only requires data on trade flows, and (4) it is not an estimation, but a calculation that is based on an implication from a well known and robust theoretical formula. So it does not suffer from typical estimation problems that stem from misspecification or measurement errors from other explanatory variables. As far as I know, few studies have applied this measure of trade costs in the international trade literature (Eaton, Kortum, Neiman, Romalis, 2011; Novy, 2011; Jacks, Meissner, Novy, 2008), and no other studies have used it to analyze domestic trade barriers in China.

Using this measure of trade barrier, I calculate the levels of trade barriers for the period 1992-2002. All of previous studies on the topic examine data only up to 1997. I update the time series under examination to 2002.[4] The calculated trade barriers levels indicate that

[3]For example, in the estimation of border effects, the additional assumption beyond the gravity equation is that variable trade costs are log-linear in the border effects. The method of Head and Ries (2001) does not make such an assumption.

[4]There are two reasons for why data of the period 1997 to 2002 is of special interest. First, China entered the WTO in 2001. One of the terms of membership in the WTO is free mobility of goods, people, and capital across the territory within the country. To meet these requirements, the central government might have more actively clamped down on illegal local protectionist activities, leading to a decrease in domestic trade barriers. Second, the increase from import competition through trade liberalization decreases the effectiveness of local protectionist measures, lessening the incentives of local governments to erect them. (Li, Qiu, Sun, 2003) However, my results do not indicate a general decline in the domestic trade barriers.

domestic trade protectionism in China is not as fragmented as previous studies indicate, but it had indeed risen. Expressed in ad valorem tariff-equivalent terms, domestic trade barriers of goods and services average to be 54% in 1992, 56% in 1997, and 61% in 2002. When looking at only manufacture goods, which account for the bulk of domestic trade, domestic trade barriers average to be 49%. This is substantially lower than the figure for all goods and services. Despite a rising trend, domestic trade barriers are still much lower than international trade barriers, which are on average 4 times the size of domestic trade barriers.

I examine the source of both international and domestic barriers by relating them to a range of geographic and government policy-related variables. While international trade barriers of provinces are well explained by geographic factors, domestic trade barriers are not and are found to be positively associated with the size of state-owned enterprises in the local economy. Looking at the changes in the domestic trade barriers for the same period. I find that they broadly increased across provinces throughout the period 1992-2002. The increase during the period 1992-1997 is consistent with the closest comparable study using these data, Poncet (2003, 2005). But the increase for 1997-2002 is more surprising, as anecdotal accounts of more active government policies against domestic trade barriers and increased import competition should discourage a rise in the domestic trade barriers. My empirical analysis finds that an explanation for the rise in this later period is the path dependency of State-owned enterprises (SOE) in erecting trade barriers. Provinces that have a larger presence of SOE in the initial year indicates a higher increase in trade barriers in subsequent years.

In the last part of the paper, I consider the interpretation of the measure of trade barriers when we move beyond the broad class of trade models that it is based on. Given the rise of high-tech industries in China, I consider an extended trade model that could reflect particular features of these industries. In this model, firms are allowed to adjust their product quality by choosing the amount of fixed cost they want to incur in each period in response to trade liberalization, in addition to the decision to enter or leave the market as in the standard Chaney (2008) model. I find that once we take endogenous product upgrading into account, the measured trade costs from the benchmark understates the changes of the fixed trade barrier in both directions. I show evidence in support of this model for the Chinese provinces and suggest the industries where this problem might arise. At last, I discuss the relevance of this problem with regard to individual provinces.

My contribution in this paper consists of both application and theoretical components. I apply the proposed methodology to a new application with new data in order to answer an interesting question in a way that could overcome the problems encountered in previous studies. My empirical findings add to and update the data and content in the literature on Chinese domestic trade protectionism. Furthermore, I contribute to the general trade literature on the measurement of trade barriers, by examining the implications of the trade cost measure in an extended version of the benchmark model. This paper will proceed as follows. In the first section, I show some facts about domestic trade in China, and then explain the method of calculating trade barriers in the way of Head and Ries (2001) and Novy (2009). In the second section, I present the results and discuss them. In the third section, I examine an extended version of the gravity equation, taking into account endogenous product improvements, and show how the measured trade costs in the previous section is affected. Section four concludes.

2 Motivating Facts

It is well known that China's integration with the global economy has increased tremendously since the reform period. In the five year period between 1997 to 2002, China's global trade as a percent of its GDP rose from 39 percent to 52 percent, with a 100 percent growth in the level of trade flows.[5] The economic significance of China's international trade is widely recognized by its impact on both the Chinese economy and the economy of its trading partners. But if the size of China's international trade flows is considered to be great, then the size of China's domestic trade is immense, being twice as large. As a percent of China's GDP, it was 82 percent in 1997 and rose to 93 percent in 2002. This is a factor 2.1 of China's international trade in 1997, and a factor 1.8 in 2002. Table 1 summarizes these numbers.

The role of domestic trade is furthermore broadly important across all Chinese provinces. While the distribution of international trade is strongly skewed toward the regions that are naturally advantaged, domestic trade has been distributed more equitably. Table 2 reveals this observation for the year 2002. Due to its proximity to the ocean, the coastal area has been favored in global trade, with Guangdong and Shanghai being most open to international trade. As Table 2 shows, the average percentage of trade in GDP of the coastal area is the highest (60 percent), followed by the center region (10 percent), and then the western region (9 percent). This hierarchy of openness to international trade is consistent with the geographic features of the regions. However, domestic trade is even more important than international trade in all provinces except Guangdong and Shanghai. The percentage of domestic trade over GDP for the coastal, center, and western regions are similar, respectively, at 115 percent, 97 percent, and 109 percent. The relative importance of domestic trade over international trade is furthermore greater the more inland is the region. This can be seen by the ratio of domestic trade over international trade as shown in the last column of Table 2.

[5] Trade is referred to as the sum of imports and exports.

It is on average greatest for the western region, then the center, and the least to the coastal region. This observation conforms to intuition, that the landlocked part of China has to rely more on domestic trade rather than international trade due to its disadvantaged position for global trade.

The data described above establish the economic significance of domestic trade for the Chinese economy. However, recent analyses on the Chinese economy argue that a puzzling trend has emerged: domestic trade protectionism in China is high and rising. The most prominent of these studies is Young (2000), who infers from price and industry data that China has devolved into "a fragmented internal market with fiefdoms controlled by local officials." Using direct domestic trade data, Naughton (2000) argues that contrary to Young's claim, domestic trade in China is plentiful. He points out that China is more open to domestic trade than its closest comparable units of countries, Europe and ASEAN countries.[6] The data described in Tables 1 and 2 support Naughton's claim and show that Chinese provinces indeed have a high degree of openness to domestic trade. However, did this high degree of domestic trade openness happen *in spite* of high domestic trade barriers? I will turn to the calculation of domestic trade barriers in the next section.

The second part of Young's claim is that internal trade barriers have been rising in China. Data provided in the provincial regional input-output tables appears to provide evidence in support of rising domestic trade barriers at first sight. Figure 1 shows the average composition of final demand across the provinces. Between 1987 and 2002, the share of within-province (local) purchases increased by 10.8 percentage points to 74.5 percent in 2002, whereas purchases from other provinces dropped by 13.7 percentage points to 20.9 percent. The share of international imports rose by 2.6 percentage points during this time.

While the decomposition shows a decreasing share of domestic trade, by itself it is not a conclusive statement that domestic trade barriers had increased. This is because the changes in the relative size of the domestic imports to local purchases not only depends on trade barriers, but also on the relative changes in economic size and input costs of the pair of trading regions. A shrinking ratio of domestic imports to local purchases may reflect the relatively faster growth of the size of the local economy than the rest of China, or it could indicate that input costs in the local economy is decreasing faster than the rest of China. In order to isolate the contribution of change in trade barriers, one has to appropriately controlled for the aforementioned variables. Poncet (2003, 2005) makes such an analysis. Using an OLS regression on these domestic trade data and bilateral international trade data

[6]He finds that intra-European Union exports is 12.4 percent of GDP in 1980 and 13.6 percent in 1990. Exports of ASEAN countries (Singapore, Malaysia, Thailand, Indonesia, and the Philippines) make up 13 percent of their GDP in 1997. In comparison, interprovincial trade in China is four times as large.

for provinces, she regresses the log ratio of domestic or international imports over local purchases against measures of relative economic size, input costs, and variables that capture trade costs. She specifies trade cost as a domestic border effect and a distance measure[7]. The domestic border effect variable is interpreted as a summary of domestic trade barriers. She finds that the provincial border leads to 1992 trade within province that is a factor 24 times trade with the rest of China. This number rises to 31 in 1997. An inconvenient feature about the available Chinese domestic trade data is that they aggregate the interprovincial purchases across all outside provinces. In her analysis, Poncet (2005) treats this aggregation problem by constructing the rest-of-China explanatory variables as a production-weighted geometric average of the provinces[8]. The resulting estimates of the border effects could then be potentially sensitive to the aggregation assumptions in the construction of the aggregated measure of distances and prices. Furthermore, the assumption that trade barriers is log-linear in the border effect may capture only parts of the trade barriers.

Like Poncet (2003, 2005), I analyze the question with direct interprovincial trade data to exploit their direct relevance to the question; but I take a different analytical approach to measure trade barriers. The measure of trade costs that I apply in this paper does not require data on distances and prices, therefore it bypasses the need to make aggregation assumptions on these variables. Additionally, it relaxes the assumption that trade barriers are log-linear in border effects. In the following section, I explain this method.

3 Calculation of Trade Costs

An insight from Head and Ries (2001) gives us a measure of trade barriers that forms the basis for my analysis. It is simple: by taking the ratio of bilateral trade flows over local trade, scaled to some parameter values, we have a measure that capture all trade barriers. Novy (2009) finds that this measure is consistent with the gravity equation, and robust across a variety of trade models. In this section, I explain the derivation of this measure of trade barriers.

One of the most robust empirical relationship in economics is the gravity equation, which relates trade between two country to their economic sizes, bilateral trade barriers, costs of production in the exporter country, and how remote the importer is to the rest of the world. In recent years, studies have developed the microfoundations for the gravity equation (Anderson and Van Wincoop, 2003; Eaton and Kortum, 2002; Chaney, 2008). In the model

[7]In her OLS estimation, the variable trade barrier is log-linear in the border effect, i.e. $ln\tau_{ir} = \delta ln d_{ir} + B$, where τ_{ir} is the variable trade barrier, d_{ir} is distance, and B is the domestic border effect. It takes the value 1 if the trade is an interprovincial trade.

[8]The explanatory variables constructed this way are distances and input prices.

of Anderson and Van Wincoop (2003) and Eaton and Kortum (2002), trade costs take the form of only variable costs; whereas, in Chaney (2008) trade requires an additional bilateral exporting fixed costs, following Melitz (2001). Regardless of whether the model only includes or also fixed costs of exporting, the measured trade barrier is the same. What differs is the interpretation of the measured trade costs and hence the implied magnitude of true trade costs. In models with only variable trade costs, the measured costs is interpreted as the geometric average of bilateral variable costs.[9] With fixed costs, as is the case here, the measured costs is the geometric average of variable and fixed costs scaled with model parameters. Fixed cost of exporting introduces an additional adjustment to the changes in trade flows in response to a fall in trade barriers — the extensive margin of trade. When the fixed costs of exporting fall, new firms enter into exporting. This margin of adjustment has been shown in empirical trade to be quantitatively significant.

The measure of trade barriers used by this paper will be based on the gravity equation derived from Chaney's model of heterogeneous firms with bilateral fixed costs of exporting. The main reason for this decision is that fixed trade barriers appear to be the most important form of domestic trade barriers among Chinese provinces. As described in the anecdotal stories given in the introduction, domestic trade barriers are oftentimes non-tariff fees and administrative regulations, that are more realistically interpreted as fixed barriers than variable barriers. Furthermore, these fixed barriers are potentially bilateral in nature (i.e. the example with Guangzhou vs. Shenzhen newspaper blockade) I will show in the following sections that the results are invariant to whether one assumes there are fixed or variable trade barriers. However, it does impact the interpretation. I refer to the trade cost calculation from the Chaney model as the benchmark measured trade costs.

In Chaney (2008), trade barriers take two forms in the model, a variable trade barrier τ_{ir} and a fixed cost of exporting, F_{ir}. The variable trade barrier τ_{ir} is an iceberg cost; in order to deliver one unit of good to i from r, $\tau_{ir} > 1$ unit of good has to be delivered. The resulting trade equation in general equilibrium is reminiscent of Anderson and Van Wincoop (2003) and Eaton and Kortum (2002), except that it is augmented with a fixed cost of exporting and the Pareto parameter γ governing the distribution of firm productivities. The gravity equation supported by this model is:

$$X_{ir} = \frac{Y_i \cdot Y_r}{Y} \left(\frac{w_r \tau_{ir}}{\theta_i} \right)^{-\gamma} F_{ir}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \tag{1}$$

This says that imports of region i from region r (X_{ir}) are positively related to the eco-

[9]The measured trade cost in the case with only variable costs would be $\bar{t}_{ir}^M = \left(\frac{X_{ii}X_{rr}}{X_{ir}X_{ri}}\right)^{\frac{1}{2\gamma}} = (\tau_{ri}\tau_{ir})^{\frac{1}{2}}$. There is a one to one mapping between the measured and true trade costs.

nomic size of both regions (Y_i and Y_r), negatively related to variable trade costs (τ_{ir}), labor costs (w_r), fixed cost of exporting (F_{ir}, where $\frac{\gamma}{\sigma-1} > 0$), and positively related to θ_i, where θ_i is a remoteness measure of the importer country, $\theta_i = \sum_k \frac{Y_k}{Y} (w_k \tau_{ik})^{-\gamma} F_{ik}^{-\left(\frac{\gamma}{\sigma-1}-1\right)}$. This remoteness variable captures the trade diversion effect. The intuition is as follows: the further away is i from the rest of the world (captured by a weighted sum of the trade costs τ_{ik} and F_{ik}), the more likely that r could export more to i due to less competition from third party countries in the importer country. This has similar interpretation as the multilateral resistance term in Anderson and Van Wincoop (2003). σ is the elasticity of substitution.

As Head and Ries (2001) and Novy (2009) show, we can relate data on trade flows to the unobservable trade barriers by taking ratios of bilateral trade flows of two regions over local purchases of each of the two regions:

$$\frac{X_{ir}X_{ri}}{X_{ii}X_{rr}} = \left(\frac{\tau_{ri}\tau_{ir}}{\tau_{ii}\tau_{rr}}\right)^{-\gamma} \left(\frac{F_{ri}F_{ir}}{F_{rr}F_{ii}}\right)^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \tag{2}$$

This relationship between observable trade data and unobservable trade barriers eliminates the need to worry about the omission of unspecified or unobserved trade barriers. There are three things to note here. First, if the fixed costs of exporting are not bilateral, i.e. $F_{ri} = F_r$, or if they are constant across locations, i.e. $F_{ri} = F$, the fixed costs drop out of this measure and the measured trade costs would simply be interpreted as variable trade costs, as in models without fixed costs of exporting like Eaton and Kortum (2002), and Anderson and Van Wincoop (2003). The measure based on Chaney (2008), however, has the interpretation of capturing a mix of variable and fixed trade costs. Second, these trade costs between region i and r are measured relative to local trade (X_{ii} and X_{rr}). I do not assume that local trade is costless, but for reduction of clutter, I normalize the own trade costs to 1 ($\tau_{ii} = 1, F_{ii} = 1$) from now on. Third, I do not assume that the trade cost is symmetric between i and r. Defining the geometric average of trade costs between the region pair i and r as $\bar{t}_{ir} = \left(\frac{X_{ir}X_{ri}}{X_{ii}X_{rr}}\right)^{-\frac{1}{2\gamma}}$, we have a measure of the average bilateral trade barrier between regions i and r :

$$\bar{t}_{ir}^{M} = \left(\frac{X_{ii}X_{rr}}{X_{ir}X_{ri}}\right)^{\frac{1}{2\gamma}} = (\tau_{ri}\tau_{ir})^{\frac{1}{2}} (F_{ri}F_{ir})^{\frac{1}{2}\left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)} \tag{3}$$

By constructing the variable on the left hand side of this equation, with data that is relatively easy to obtain, we have a comprehensive measure of trade barriers, or the unobservables on the right hand side of the equation. $\bar{t}_{ir}^{M} - 1$ can be interpreted as the ad valorem, tariff-equivalent bilateral average trade cost between i and r.

The reason why this measure of trade costs is a good reflection of the underlying true trade barriers is that the ratio of own purchases over trade flows is positively correlated with the true trade barriers. The connection between the measured trade costs and the true fixed trade costs, which is the object of interest, depends on the parameters σ and γ. The measured trade costs become higher as the exponent on the bilateral fixed costs – or the sensitivity of the measured trade costs to the fixed costs – increases, even as the true fixed costs barriers remain the same. In Chaney (2008), the exponent on the bilateral fixed trade barriers is $1-\frac{\gamma}{\sigma-1}$. As long as $\frac{\gamma}{\sigma-1}>1$, the measured trade barriers would be positively correlated to the true fixed trade barriers. From empirical data, Chaney (2008) and other studies are able to verify that indeed $\frac{\gamma}{\sigma-1}>1$.

This paper is also interested in the changes of trade barriers, which can be calculated by the following formula, by defining $\hat{\tau}_{ri}=\frac{\tau_{ri}(t+1)}{\tau_{ri}(t)}$:

$$\hat{t}_{ir}^{M}=\left(\frac{\hat{X}_{ii}\hat{X}_{rr}}{\hat{X}_{ir}\hat{X}_{ri}}\right)^{\frac{1}{2\gamma}}=\left(\hat{\tau}_{ri}\hat{\tau}_{ir}\right)^{\frac{1}{2}}\left(\hat{F}_{ri}\hat{F}_{ir}\right)^{\frac{1}{2}\left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)} \tag{4}$$

Because geographic barriers are invariant to time, the sources of the changes likely stemmed from government-related barriers, which are of primary interest to the discussion of domestic trade protectionism.

4 Domestic Trade Barriers in China

With a framework to measure trade barriers, we can now proceed to answer the main question of this paper: are trade barriers high and increasing in China? I now calculate the trade barriers level and change for each Chinese province for the period 1992-2002. The sources of the domestic trade data are individual provincial input-out tables. Domestic trade flows include agricultural and manufacture goods, construction, transportation, and services.

I use equation (3) and (4) for the subsequent calculations. A limitation to the domestic trade data for Chinese provinces from the regional input-out tables is that they aggregate the bilateral trade data across all outside provinces. I recast it in the notations that reflect this aggregation:

$$\bar{t}_{iD_{-i}}^{M}=\left(\frac{X_{ii}X_{D_{-i}D_{-i}}}{X_{iD_{-i}}X_{D_{-i}i}}\right)^{\frac{1}{2\gamma}}=\left(\tau_{iD_{-i}}\tau_{D_{i}i}\right)^{\frac{1}{2}}\left(F_{iD_{-i}}F_{D_{i}i}\right)^{\frac{1}{2}\left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)}$$

Domestic trade for each province i is taken as between itself and the rest of China, which I denote D_{-i} , the rest of China being treated as if it is one separate region. As shown in Appendix 1, this measured trade barrier can be interpreted as an approximation of the geometric average of the bilateral trade barriers between province i and the rest of China, relative to local trade barriers. The data requirements for this calculation are local purchases (X_{ii}), interprovincial imports ($X_{iD_{-i}}$), interprovincial exports ($X_{D_{-i}i}$), and rest of China purchases from itself ($X_{D_{-i}D_{-i}}$). Since provincial input-output tables are published in five years intervals, this analysis employs data from 1992, 1997, and 2002. The data for 1992 and 1997 are drawn from Poncet (2003). Due to the sensitive nature of provincial input-output tables to Chinese officials, only the final demand columns of these tables, which indicate the total outflows and total inflows, were available to Poncet (2003) and Naughton (2000). I derive the domestic trade variables ($X_{iD_{-i}}$,$X_{D_{-i}i}$) in the same way as these studies by subtracting international imports and exports from total inflows and outflows, respectively, to obtain domestic imports and domestic exports.[10]

The international trade data for provinces are taken from China Statistical Yearbooks, which is available on University of Michigan's China Data Online. Local trade (X_{ii}) is derived by subtracting total outflow from gross production. I verify that the data calculated thus match the results of the absorption shares published in a table in Poncet (2003) as well as data available in the input-output tables I have for two provinces for 1997[11]. The "local" purchase of the rest of China ($X_{D_{-i}D_{-i}}$) is calculated as gross value of output minus international exports and exports to region i. For the period 2002, I have access to the entirety of input-output tables of all 31 provinces, which provide direct data on domestic imports ($X_{iD_{-i}}$) and exports ($X_{D_{-i}i}$), international imports (X_{iF}) and exports (X_{Fi}), gross output (Y_i), and gross absorption (X_i).[12] Local purchases is then derived from subtracting domestic and international exports from gross output, $X_{ii} = Y_i - X_{Fi} - X_{D_{-i}i}$. The change in the measured trade barriers are calculated for the 20 Chinese provinces for which both 1992 and 1997 data are available, and 23 Chinese provinces for which both 1997 and 2002 data are available. The level of barriers are calculated for all 29 provinces for the year 2002. The following section presents the results.

4.1 Levels of Domestic Trade Barriers

Table 6 reports the tariff-equivalent levels of domestic trade barriers in all goods and services for each province for the years 1992, 1997, and 2002. I also report the results for a range of parameter values for γ found in the literature.[13] The national average of domestic trade

[10] I am grateful to Sandra Poncet for providing data on the total inflows and outflows for the 1992 and 1997 data used in this paper.

[11] I have the input-output tables for Beijing and Shanghai for 1997

[12] I thank Zhi Wang for providing this data.

[13] Eaton and Kortum (2002) reports 8.3 for γ. Anderson and Van Wincoop (2003) reports a range of 5 to 10 for σ, while Arkolakis and Muendler (2011) find it to range from 5.13 to 7.61. Lu (2011) fits a Frechet

barriers, interpreted as tariff-equivalent, ranges from 28 to 54 percent in 1992, 30 to 56 percent in 1997, and 32 to 61 percent in 2002. The provinces in the west clearly indicate a higher level of barriers than those located in the center or the coast.

How do these numbers compared to previous studies? I compare the level of barriers for each province calculated under my method to the tariff-equivalent levels of border effects in Poncet (2005), the closest comparable study to mine.[14] Converted into tariff equivalent using the three γ values that I use, her estimates yield an average level of domestic barrier ranging from 29 percent to 55 percent in 1992 and 29 to 61 percent in 1997, which are slightly higher than the Head and Ries method. The high correlation between the results, 0.83 in 1992 and 0.74 in 1997, suggest that the relative provincial pattern of trade barriers are similar between the two methods.[15] The standard deviation of the tariff-equivalent border effects across provinces for both years, at 22 and 24 percentage points, however, is higher than that of my measured trade barriers, which is 14 and 16 percentage points.

Although the difference between the tariff-equivalent of border effects and the tariff-equivalent barriers from the Head and Ries method is small, it is important to keep in mind that the way that the border effects are estimated should have ensured that geographic distances are not contained in the tariff-equivalent border effects.[16] On the other hand, the trade barriers produced by the Head and Ries method include natural geographic barriers, which are significant and positively correlated to the measured trade barriers (this will be discussed in more details in the next section). That the tariff-equivalent level of barriers resulted from both methods are similar when the Head and Ries method has not controlled for geographic barriers implies that the portion of its trade barriers that are attributable to local government policies is substantially lower than those computed by the border effects method.

There are reasons to suspect that the trade barriers for manufacture goods, which account for the bulk of internal trade, are even lower than the range found in Table 3, which is based on trade data of all goods and services. The inclusion of services into the calculation of trade barriers may tilt the average barriers upwards as many services items are nontradable; a region that has a large service industrial base, possibly for reasons due to development

distribution for the total sales of Chinese manufacturing firms and finds $\frac{\gamma}{\sigma-1}$ to be 1.05. Arkolakis and Muendler (2011) finds 1.21 for the same parameter, whereas Chaney (2008) it to be 2.

[14] In that study, Poncet needs to specify the parameter value for $\sigma - 1$ in order to convert her estimates into tariff-equivalent. The equivalent parameter in the model underlying the trade barrier calculation of this paper to $\sigma - 1$ in Poncet is γ. She used $\sigma = 9$, which gives a tariff-equivalent average border effect of 53 percent in 1997.

[15] There does not appear to be a systematic way in that our results differ; the provinces which indicate a higher domestic barriers calculated under Poncet's border effects method are: Tianjin, Beijing, Henan, Xinjiang, Gansu, Shanxi, Sichuan, Zhejian, and Qinghai.

[16] This is because distance is controlled for in the regression estimation of border effects.

stage or idiosyncratic historical reasons, might indicate a higher level of domestic trade barriers relative to those regions that have a smaller service industry. Therefore, it is useful to examine trade barriers computed using only manufacture goods trade data. Previous studies use data that combined goods and services because a more disaggregate version of the input-output table that makes the distinction is not available for the earlier years. However, the domestic trade data for manufacture goods is available for the year 2002, which allows for the calculation of trade barriers separately for agricultural goods, manufacture goods, and services for that year.

The trade barriers for manufacture goods are reported in Table 4. A striking pattern emerges: the tariff-equivalent level of trade barriers for manufacture goods is smaller than the barriers for agricultural goods and services across all provinces. The national average domestic trade barriers for manufacture goods is 49 percent–substantially smaller than the 61 percent calculated under the same parameter value and using trade data that include all goods and services. Trade barriers are found to be 86 percent for agricultural goods and 88 percent for services. The province with the lowest manufacture trade barrier at 31 percent is Anhui, a relatively poor region with small manufacture base and relies on importing manufacture from the rest of China.

The hierarchy of openness to domestic trade still hold across the three broad geographic regions for manufacture goods trade, with the coastal region on average being more open than the inland regions. This likely reflects the concentration of the manufacture sector in the coastal region and the rest of China's reliance on trade to obtain manufacture goods. The new observation, however, is that all of the inland provinces in the center have lower barriers than the coastal region in agricultural goods trade. In the coastal region, trade barriers for agricultural goods is the highest among the three sectors; at 86.6 percent tariff-equivalent level it is twice as high as manufacture goods and 11 percentage points higher than barriers on services. For all the regions located in the center, their agricultural trade barriers are on average 1.5 times higher than barriers in manufacture goods, and barriers in services are more than twice of manufacture levels. With an average of 49 percent, domestic trade barriers in manufacture goods within China are substantially lower than the goods and services combined average.

While a 49 percent tariff-equivalent of domestic trade barriers does not seem to indicate strikingly high domestic market fragmentation, it remains questionable what should be considered a "high" level of domestic trade barrier in the absence of a comparable benchmark of what is considered normal. Unfortunately, there are few studies of domestic trade barriers that are directly comparable to China, due to the limitation on domestic trade data and the uniquely large size of the Chinese provinces. Coughlin and Novy (2011) examine domestic and international trade for the states in the United States.[17] Using a similar border effects method as Poncet (2001), they estimate that intrastate trade is 7.8 times of interstate trade. Mapping this estimate into tariff-equivalent terms comparable to the Head and Ries results, this border effect corresponds to an average domestic trade barrier of 34 percent.[18] This number is sizably smaller than the 49 percent found for manufacturing trade barriers among Chinese provinces. However, there are two caveats about making direct comparison between the US and Chinese results: (1) Chinese provinces are on average much larger than US states, in both population and geographic area. Therefore, home market effects could make it seem as as Chinese provinces are more autarkic than US states. (2) The tariff-equivalent level of the border effect estimates has already excluded geographic barriers, whereas the Head and Ries estimates do not. The domestic barriers in China could be lower than the 34 percent in US if the geographic barriers netted out included; in fact, in a later section, I investigate the variation of Chinese domestic trade barriers that could be explained by geographic barriers. Taking away the part of trade barriers that are attributable to geographic barriers, the average domestic trade barriers for manufacture goods ranges from 27 percent to 45 percent.[19] Therefore, it is not clear it all that domestic trade barriers in China are greater than in US.

Another way to place the domestic trade barriers into perspective is to compare them with the international trade barriers of the Chinese provinces. Because of the availability of provincial level bilateral international manufacture trade data for the year 2002, I can calculate the trade barriers for each province in the period against one of their major trade partners, the United States. Table 5 shows these results. Domestic barriers are much smaller than international barriers, which is on average almost 4 times larger than domestic barriers. Across all the provinces, international trade barriers are larger than domestic barriers. As a factor of domestic barriers, they range from twice as large (Shanghai) to 6.3 times as large (Jilin). Note that the gap between international and domestic barriers is on average smaller in the coastal region than the inland regions.

The observations from this exercise dispel the image of China being a more foreign-friendly country than to within itself, as implied by Young (2000). Far from being a country that are more hostile to internal trade than foreign trade, domestic trade barriers in China are not strikingly high, and they are far lower than provincial international barriers against the United States, one of China's largest trading partners. One would think that domestic

[17] The sectors included in their trade data are: manufacturing, mining, wholesale trade, and selected retail establishments.

[18] This number is taken from column 2 of Table 2 in Coughlin and Novy (2011): $exp(2.05) = 7.8$, and $exp(\frac{7.8}{\gamma}) - 1 = 0.34$, using $\gamma = 7$.

[19] Poncet (2005) and Coughlin and Novy (2011) are also not directly comparable as their data cover different sectors of the economy.

trade in a country should be more accessible than international trade due to the proximity between regions and the sharing of political institutions and languages. In this sense, China is not unique; domestic trade is plentiful and large, and much larger than international trade. The state of domestic trade protectionism that emerges from the analysis of this section seems to corroborate better with Naughton's depiction–that domestic trade is high and the domestic market is not seriously fragmented.

4.2 Changes in Domestic Trade Barriers

The evidence based on the levels of domestic trade barriers provides sparse support for the first part of Young's claim that domestic trade protectionism in China is high. In this section, I turn to examine the second part of his claim: had domestic trade barriers risen? Because geographic factors of provinces are time-invariant, the source of the changes in trade barriers can be interpreted as mostly attributable to government policies.

Table 6 shows the changes in the trade barriers and the components which contribute to their calculations for the period for the period 1992-1997, the same time period that Young (2000) and Poncet (2003) examined. During this period, trade barriers broadly increased across the provinces. Note that the increase in trade barriers occurs along with an overall growth in domestic trade flows across all provinces, as indicated by the first two columns in Table 6. Trade barriers increased because the growth in local trade had been larger than the growth in domestic trade. Four regions, however, indicate a decrease in trade barriers. They are Tianjin from the coastal area, and Yunnan, Gansu, and Qinghai, all three being located in the Western region. The highest increase is found to be in the center and west, led by Jilin, Hubei, Sichuan, and Shanxi. To see the source of this change, one can look to Table 6. Both Tianjin's and Yunnan's domestic imports and exports had been growing relatively much faster than the increase in its local trade and the rest of China's trade, whereas the decrease in domestic barriers found in Gansu and Qinghai is driven by the increase in its exports to the rest of China.

My results also confirm the changes estimated in Poncet (2005). Both the average and direction of change are similar to the border effects estimated in Poncet (2005). Using a paremeter value comparable to $\gamma = 7$, the corresponding increase in Poncet's tariff-equivalent border effects is 4 percent, which is the same as my method.[20]

Table 7 shows the results for the period 1997-2002. Overall, average domestic trade barriers continued the increase from the previous period, but with an average in the coastal

[20] The average change in the barriers is captured by the time dummy for 1997 in Poncet's regression. She finds a coefficient of 0.26, which is equivalent to 4 percent change when using parameter value $\gamma = 7$, calculated by $exp(\frac{0.26}{7}) - 1 = 0.04$

region that is smaller than the rest of China. I find a drop in domestic trade barriers for 5 provinces, 3 of which are located in the coastal region. The percentage decrease is the largest for Zhejiang, a province which had been mentioned in previous studies to have high domestic barriers in the earlier period.

This continuation in the buildup of domestic trade barriers stands in contrast to claims that the central government has actively clamped down on local protectionism during this period. [21] However, the fact that the decline in trade barriers are mostly found in the coastal provinces, which are highly open to international trade, also points to a possible effect from the increased competition from international imports during the period leading up to China's accession into the WTO. With increased market competition due to China's move toward adherence to WTO's regulations, local protectionist measures became less effective and provincial authorities had less incentives to use them (Li, Qiu, Sun, 2003).[22]

4.3 Determinants of Domestic and International Trade Barriers

In this section, I exploit the variation in provincial characteristics and trade barriers to empirically investigate the source of the domestic and international trade barriers found in the previous section. Using OLS regression analysis, I investigate the extent to which geographic barriers or government-created barriers explain the pattern of barriers across provinces. A key motivation for this examination is such that we can qualify whether the tariff-equivalent levels found in the previous section is considered "high". Geographic barriers are not distortive, while government-related barriers are and result in economic inefficiencies. The domestic market fragmentation argument made by Young (2000) and Poncet (2003) implies that local trade impeding policies employed by government are primarily responsible for the level of barriers. Furthermore, the sources of barriers have different implications

[21] As Naughton (2000) explains, since 1996 local governments have eased their protection of local employment levels. This led to widespread layoffs for state-owned enterprises, and lessened the incentives for state-owned enterprises to resort to protectionists measures against outside goods. Furthermore, in 2001 the State Council formally announced a list of laws prohibiting different forms of local trade barriers. They include: "1. Obliging companies or individuals to use only local goods and services. 2. Imposing customs tariffs on roads, at railway stations, ports, airports and at borders to prevent the entry of external goods. 3. Introducing differentiation in the pricing system. 4. Applying differential techniques and criteria for evaluating external goods. 5. Introducing discrimination in the allocation of entry permits for the local market. 6. Adopting a discriminatory policy in the tender process or concerning the investments of outside companies." (Poncet, 2004; translated from State Council No. 303 *Stipulation of the State Council to Forbid Regional Blockage in Market Economic Activities*, 2001)

[22] I also calculated the changes in the measured trade barriers for the provinces vis-a-vis US and Japan for the period 1997-2002 due to the availability of bilateral province-country trade data. For the calculation of international trade barriers vis-a-vis the United States and Japan, I draw the gross output data for each of the country from United Nations National Accounts Database and their bilateral trade data with Chinese provinces from the Chinese Customs. I find that international trade barriers with the United States and Japan had dropped by an average of 1.1 percent and 1.3 percent, respectively, during this period.

for policies, therefore it is important to distinguish between the two. The main results of this section are: (1) unlike international barriers, domestic barriers are not well explained by geographical characteristics (2) the size of SOE has significant explanatory power of the level of barriers, more so than geographic variable (3) geographic variables become better predictors of trade barriers across provinces over the progression of the sample period.

The explanatory variables in the regression reflect provincial geographic characteristics and the economic influence of the local government. I consider three types of geographic characteristics of provinces. First, I compute the physical distance from the central point of each province to the eastern coast of China. Second, I compute an output weighted average distance from the central point of each province to all other provinces in China. Third, I assign dummies to provinces according to their location in each of the three commonly accepted broad geographic regions: coast, center, and west.

To capture government incentives to erect barriers, I include as explanatory variable the share of state-owned enterprises (SOE) in output. A large presence of SOE in the local economy might lead to an increase in domestic trade barriers because of increased incentives of local government to retain revenues via protectionism policies. Unlike the pre-reform period where the central government pooled and reallocated revenues to all provinces, fiscal decentralization since 1980 has led to system where provincial governments had to increasingly rely on local revenues for expenditure.[23] This hardened the budget constraint of local government and created incentives for local authorities to grow their revenues, either by protectionist measures or market activities. As SOE are typically saddled with inefficiencies and employment mandate, authorities in a province with high SOE presence might more likely resort to protectionist measures to preserve revenues. Therefore, this variable captures the government policies-related reasons that explain the level of trade barriers.

The share of primary sector in output is also included in the regression in order to account for the higher protectionist tendency of the agriculture sector. As the agricultural sector is labor intensive, a region that is more reliant on the sector will experience higher unemployment pressure with trade liberalization; therefore, local government might more likely erect barriers.

Table 8 presents the regression results. The dependent variable in Panel A is the measured international barriers of each province against the United States for manufacture goods in 2002; the dependent variable in Panel B is the measured domestic barriers of each province for manufacture goods in 2002. Column 1-3 considers each of the three types of geographic

[23] More information about the history of fiscal decentralization in China can be found in Yang (1997), Young (2000), Lin and Liu (2000), Jin, Qian, and Weingast (2005), and Cai and Treisman (2006). The last three papers also empirically investigate if fiscal decentralization contributed to economic growth in China.

variables, and Column 4-6 augment these regression with government and industry variables. The positive and significant coefficients on the distance variables in Column 1-3 of Panel A conforms to intuition that geographical remoteness represents higher barriers to international trade. Column 3 indicates that a coastal province has a tariff-equivalent international trade barrier level that is 77.4 percent lower than a province in the landlocked west. The high explanatory power of the distance from coast measure and coastal dummy for international trade barriers, with 0.61 and 0.57 adjusted R-squared, confirms the common knowledge that coastal provinces have easier access to international trade.

The counterpart results for domestic trade barriers are shown in Panel B. The signs on the three geographic variables are the same as the signs for the international barrier, but they are not able to explain the pattern of domestic barriers as well. The distance from coast and coastal dummy again have the higher explanatory power than the weighted distance from rest of China variable, but the adjusted R-squared is only 0.22 and 0.23 respectively. One might expect that the proximity measure to rest-of-China would be more important in explaining domestic trade barriers that the distance from coast, but the results from Column 1 and 2 show that in fact it is also regions that are closer to the coast that have lower domestic trade barriers; proximity to rest of China is found to be statistically insignificant.

It is expected that coastal regions have lower international trade barriers vis-a-vis the US due to their proximity to seaports and sea routes, but the reasons for why they also have lower domestic trade barriers are less straightforward. Column 4-6 examines the role of government and industry in international and domestic trade barriers. Column 6 in Panel A indicates a positive and significant coefficient on the output share of primary sector, suggesting that the favorable condition of coastal regions to international trade is likely due to a higher manufacture share in their economies. The share of state owned enterprise in output, a proxy for local government presence, has a positive and significant coefficient in Column 5, but is not statistically important in the other specifications. An OLS regression of the three geographic variables augmented with these two government and industry variables can explain up to 76 percent of the variation seen in the international barriers of the provinces. These two variables also raise the adjusted R-squared for the domestic barriers regressions. However, once these new explanatory variables are included in the regressions for domestic trade barriers, the positive significance on the geographical variables disappears and the only significant variable is the SOE share. As indicated in Column 5 and 6, the coefficient on SOE share is positive and significant, suggesting that provinces with a larger SOE presence in its economy has higher domestic trade barriers. This relationship between the trade barriers and state-owned share of output supports the use of state-owned share of output as a proxy of domestic trade barriers, as suggested in Bai, Du, Tao, Tong (2004).

The comparison of the sources of international and domestic manufacture trade barriers is informative, but it is only available for the year 2002 due to limitations in industry disaggregation of the data in the earlier years of 1992 and 1997. I pool the available time series information for the domestic barriers in goods and services, which is available for 1992, 1997, and 2002, to enlarge the regression sample size. Table 9 shows the results for the domestic barriers for the period 1992-2002. Column 1-3 shows similar results in the geographical variables, as Column 1-3 in Table 8. The positive and significant time dummy for year 2002 suggests that on average that year has higher domestic trade barriers. The positive significance on the SOE share variable remain in the specification in Column (5), but not in the other specifications.

Finally, it would be interesting to trace the explanatory power of the geographic variables in the measured domestic barriers in each of the three years. Table 10 shows regressions estimated separately for each year on the geographical variables. One can see by a comparison of the results for 1992 and 2002, in Column 1 and 3 in each of the panel, that geographical reasons have become more important in explaining for the domestic trade barriers over the decade.

The analysis in this section reveals some new information about China's international and domestic trade barriers. First, international trade barriers are more reflective of natural geographic advantages than domestic trade barriers. Second, tentative evidence suggests that domestic trade barriers, more so than international trade barriers, are influenced by local politics. And third, domestic barriers are increasingly better explained by geographic rather than local government policy-related factors.

4.4 Determinants of the Changes in Domestic Barriers

One explanation that can account for the variation of changes in the measured trade barriers across provinces is the size of state-owned production in each location. In Figure 2, I plot the changes in the measured provincial domestic trade barriers from 1997 to 2002 against the provincial share of state and collectively-owned gross industrial output in 1997. This figure leads to two observations: (1) the coastal region of China is different from the rest of China in a key aspect— state-owned production has a smaller share in its output, compared to the center and the west. (2) provinces with a higher share of industrial output produced by state and collective enterprises experience a higher increase in domestic trade barriers in the subsequent years. This pattern broadly holds across all provinces, but is particularly stark when viewed within each of the three geographic regions. Among the coastal provinces, Jiangsu experienced the highest increase in trade barriers over the period, and it also had the largest share of state-owned output in 1997 among these coastal provinces. Henan and Xinjiang, both provinces with largest increase in trade barriers in their respective regions of center and west, also had the largest share of state-owned output among their region in 1997.

I empirically test this relationship using an OLS regression. The results are shown in Table 11. The dependent variable in Panel A is the percentage changes in the domestic trade barriers in the period 1997-2002. Controlling for the initial level of trade barriers, I find that a province with an initially higher SOE share in gross output experiences higher increase in its trade barriers in the subsequent years. Together, the initial level of trade barrier and share of SOE can explain 72 percent of the variation in the changes of the trade barriers. Therefore, I conclude there is evidence pointing to the path dependency of trade barriers in the size of state-owned enterprises in the local economy.

4.5 Change in Fixed Trade Barriers

In the previous section, I find that domestic trade barriers had increased throughout the period 1992 to 2002. But we have seen that the measured trade barriers in fact capture a mix of variable and fixed trade barrier costs, and the measured trade barriers is not linear in the fixed trade barriers, as can be seen in equation (4). The fixed barriers has an exponent of $\frac{1}{2}\left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)$. Therefore, the measured trade barriers capture fixed trade barriers elevated to this factor. In this subsection I calculate the change in the underlying fixed barriers, making a simplifying assumption that all changes in trade barriers are derived from the fixed barriers.[24] The changes in the barriers are immediately magnified when doing so. Admittedly, variable trade barriers might have contributed to the change in the measured trade barriers as well. But anecdotal stories of Chinese domestic trade barriers suggest that they primarily take the form of nontariff barriers, which are suitably modeled as fixed trade costs. The theoretical importance of fixed trade barriers is that their changes lead to the adjustment in the extensive margin of trade. When the fixed costs of exporting fall, new firms or new varieties enter into the market. Thus, the magnitude in the change of the fixed

[24]Distinguishing between variable and fixed trade barriers has been recognized to be difficult. Thus this paper opts for making a simplifying assumption rather than trying to untangle the two. The measured trade costs applied in this paper actually give us a clue as to how to make such a separation. By taking the ratio of local trade flows over bilateral trade flows, Head and Reis (2001) and Novy (2009) give us an expression of variable and fixed trade barriers elevated to some parameters. Similarly, we could take such a ratio for another moment of the data which is also a function of variable and fixed barriers. For example, the ratio of the average bilateral demand attribute in my extended model (explained in the later part of this paper) will be an expression of variable and fixed trade barriers. By combining this and the Head and Ries trade barriers, we can solve for the variable and fixed barriers individually. However, there are challenges to the availability of data for this approach, which is why it is not pursued in this paper.

barriers give us a sense of the potential contribution of this margin of adjustment. The simplifying assumption enables us to back out the actual underlying fixed barrier from the measured trade barriers, which is a function of parameters. The calculation of the changes in fixed barriers is as follows:

$$\hat{\hat{F}}_{ir} = \left(\hat{F}_{ri}\hat{F}_{ir}\right)^{\frac{1}{2}} = \left(\hat{\hat{t}}^{M}_{ir}\right)^{\frac{1}{\left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)}}$$

Table 13 and 14 show the resulted change in barriers for the periods 1992 to 197 and 1997 to 2002, shown alongside the previous results without this simplifying assumption. One can see that a decrease or increase in trade barriers are both magnified. It also sharpens average increase of the barriers in the 1997-2002 period compare to the 1992-1997 period. The observation serves to illustrate the point that in the presence of fixed trade barriers, the changes in the fixed barriers that underly the measured trade barriers are more drastic.

4.6 Economic Significance of the Changes in Trade Barriers

How do the changes in the measured trade barriers impact trade flows? In this subsection I show that the changes in trade barriers found in the previous section are quantitatively important. By combining the information calculated in the previous section with additional data, we can calculate the impact of the changes in trade barriers on trade flows. The gravity equation in equation (1) tells us that trade flows are positively related to economic sizes of the two trading partners, negatively related to their bilateral trade barriers, and positively related to a variable termed multilateral resistance by Anderson and Van Wincoop (2003).[25] In order to calculate the contribution of each of these three components to changes in trade flows, we need data on each of them. From the previous section, we have obtained measures for the trade barriers, the second component. The data for the first component, economic size, is obtained by our absorption data for the provinces. After calculating the contribution of these two components to changes in trade flows based on available data, I then attribute to the rest to the multilateral resistance component. This decomposition is described in Novy (2009), which is derived by combining equation (2) and (1). Formally, I relate the geometric average of the change in trade flows between a province and the rest of China into the three

[25] The multilateral resistance captures the degree of competition the exporter country faces in the importer country.

components in the following manner[26] :

$$\underbrace{\frac{1}{2}ln\left(\hat{X}_{iD_{-i}}\hat{X}_{D_{-i}i}\right)}_{\text{trade flows}} = \underbrace{ln\left(\frac{\hat{Y}_i\hat{Y}_{D_{-i}}}{\hat{Y}_{China}}\right)}_{\text{(a) income growth}} + \underbrace{-\gamma ln\left(\hat{\bar{t}}^M_{iD_{-i}}\right)}_{\text{(b) domestic trade barriers}} + \underbrace{\gamma ln\left(\hat{\Phi}_i\hat{\Phi}_{D_{-i}}\right)}_{\text{(c) intl trade diversion}}$$

A positive value in (a) means that income growth positively contributed to the growth in trade. A positive value for (b) means that a decline in trade barriers have contributed to the growth in trade. A negative value for (c) can be interpreted as international imports having diverted domestic imports from a Chinese province. I apply this decomposition to the changes in domestic trade flows between each province and the rest of China. Table 12 shows the averages by region and for the whole country for the periods 1992-1997 and 1997-2002.[27] In the period 1992-1997, average domestic trade flows increased by 90 percent, and in 1997-2002, by 70 percent. The increase in domestic trade barriers in the period 1992-1997 led to a decrease of 24.5 percent in the domestic trade flows, and 13.4 percent in 1997-2002. This means that, had the domestic trade barriers remained unchanged during these two periods, domestic trade flows driven by growth in income and international trade alone would have increased by 113.9 percent in the earlier period, and 82.8 percent in the later period. As a percentage of China's GDP in 1997, domestic trade in 1997 would increase by 10.5 percentage points, from 82.4 percent of GDP to 92.9 percent. As a percentage of GDP in 2002, domestic trade in 2002 would increase by 7.4 percentage points, from 93.3 percent of GDP to 100.7 percent. If we assume that local purchases are replaced by the increase in domestic trade share, then the share of local purchases in absorption would decrease by 2.9 percentage points in 1997, from 71.9 percent to 68.9, and 1.7 percentage points in 2002, from 74.5 to 72.8. Given this assumed change, a broad class of trade trade models predict that real income in the period 1992 to 2002 would experience an increase ranging from 0.6 to 1.1 percent depending on the parameter γ.[28] In summary, the small changes in the measured trade barriers maps into significant numbers in trade flows.

[26] where $\hat{\Phi}_i = \left(\frac{constant^{\frac{1}{\gamma}}\theta_i}{w_i\tau_{ii}(F_{ii})^{\frac{1}{\sigma-1}-\frac{1}{\gamma}}}\right)^{\frac{1}{2}}$

[27] The calculations reported here use $\gamma = 7$, which is in the middle range of values commonly used.

[28] Arkolakis, Costinot, and Rodriguez-Clare (2010) show that several standard trade models (Eaton and Kortum (2002), Krugman (1980), extensions of Melitz, and Eaton, Kortum, Kramarz (2010)) would show that the sufficient statistic that can capture the welfare gains from trade is the share of goods purchased from itself and the elasticity of imports with respect to variable trade cost (γ). This sufficient statistic is also used in Donaldson (2010). This class of trade models capture the welfare gains from trade through prices and and wages, and do not consider technological transfers or dynamic gains. Change in real income here is calculated as $\hat{W} = \hat{\pi}_{ii}^{-\frac{1}{\gamma}}$, where π_{ii} is share of local purchases in total absorption, and $\hat{\pi}_{ii} = \frac{\pi'_{ii}}{\pi_{ii}}$. The values of γ used are 5 and 10, which are the values reported to be commonly used in Arkolakis, Costinot, and Rodriguez-Clare (2010) and Anderson and Van Wincoop (2004).

5 Beyond the Benchmark Gravity Equation

In the previous sections, I calculate the domestic trade barriers for each province based on a measure of trade costs that is derived from a benchmark gravity model. An implicit assumption in the calculations above is that all industries all identical and firms only differ by their productivities, whose distribution is governed by γ.[29] But industries also differ by other dimensions, such as in their propensity for product upgrading. Recent studies in trade has found that exporting firms increase investment in response to a decrease in trade costs (Antoniades, 2008; Bustos, 2010; Ferguson 2010) These studies predict that firms in industries that differ in product upgrading intensity will have a different response to fall in trade costs. In this section, I incorporate this particular feature of firms into the benchmark model. Firms reacts to a change in trade barriers with the additional margin of adjusting their product's sophistication. This dampens the sensitivity of trade flows to the changes in trade barriers. As a consequence, the true change in fixed trade barriers would be larger than the one inferred from the measured trade barriers of the Chaney (2008) benchmark model.

In the context of calculating domestic trade barriers for Chinese province, this model is relevant because of the particular industrial policies in favor of high tech sectors that Chinese government undertook in the late 1990s, prior to entry into the WTO. The 1996-2000 Ninth Five year Plan identifies a list of priority industries, top on the list are high-tech industries. Automobiles is identified as top priority industry for 19 out of 30 provinces, and electronics and machinery are both listed as priority industries for 15 provinces (Naughton, 2000). In hindsight, the growth of these industries in Chinese exports in the subsequent years shows that such industry targeting might have indeed been effective. Almost half of the export growth of China following its accession into the WTO in the years 2000 to 2007 are accounted for by machinery exports (Berger and Martin, 2011). Because of official endorsement, these targeted industries now have large presence in Chinese provinces. Given the technological dependence of these industries, one would think that endogenous fixed costs investment to upgrade quality would play an important role in the domestic trade in China as well.

In this section, I take into account this particular characteristic of these industries which are the target of promotion across Chinese provinces. Firms in this extended version of Chaney (2008) can increase the demand they face by making an investment decision via fixed cost in every period. By incurring this fixed cost, they increase the attractiveness of

[29] If we allow industries to differ in the benchmark gravity model, σ will be industry specific. A lower σ indicates an industry where firms are more differentiated. Trade becomes more sensitive to changes in trade barriers with σ decreases, as the impact of the extensive margin is bigger as the entering firms have a bigger sales than in lower σ industry.

their good before the consumer's eyes. My model is related to the strand of trade literature that examines the quality component of trade and endogenous fixed costs. Recent firm level studies find that exporting firms increase investment in response to a decrease in trade costs (Antoniades, 2008; Bustos, 2010; Ferguson 2010). These investments, in the form of fixed costs, which were initially unprofitable prior to trade liberalization, become profitable as revenues increase from an expanded market. Unlike the exogenous country-specific fixed cost of selling (i.e. F_{ir} in the notation of the previous section), these fixed costs are endogenous. Examples of these fixed costs are, the cost for marketing (Archolakais, 2010), R&D for product upgrading (Bustos, 2010), for quality improvement (Ferguson, 2010). I show that once this endogenous product upgrading of firms is included in the model, the interpretation of what we can infer from the measured trade costs will differ from the benchmark model. Specifically, I will show that this extension will attenuate the relationship between the measured and true trade costs, and in a special case, could even reverse the relationship between the measured and true trade costs. The intuition is as follows: when firms in an industry differ in the sophistication of their product, changes in the fixed trade barriers will not induce as much changes in trade as the benchmark model, as firms that enter the industry have lower revenues due to the relative unsophistication of their products. The results in this section are directly comparable to the benchmark gravity equation (1).

5.1 Model Setup

Individuals in all regions derive utility from consuming a homogeneous good and each variety of goods from H manufacture sectors:

$$U = x_0^{\mu_0} \prod_{h=1}^{H} \left(\int_{\omega \in \Omega} \left(a^h(\omega)^{\frac{1}{\sigma^h}} x(\omega) \right)^{\frac{\sigma^h - 1}{\sigma^h}} d\omega \right)^{\frac{\mu_h \sigma^h}{\sigma^h - 1}}$$

where $\sigma^h > 1$ is the elasticity of substitution for industry h. The lower is σ^h, the higher product differentiation across the goods in the industry. x_0 is a homogeneous good that is used as the numeraire. μ is the share of income spent in each sector, with $\sum_h^H \mu_h = 1$. Each product ω in the set Ω is associated with an attribute $a^h(\omega)$. This product attribute acts as a demand shifter and is chosen by the firm, which will be specify later. The higher is this attribute, the larger is the consumer demand for the good. This setup closely resembles Chaney (2008), but is augmented with the product attribute, $a(\omega)$, which can be alternatively interpreted as product quality, as in Ferguson (2010). Henceforth, I will drop the industry superscript h to prevent clutter.

To sell one unit of a good from region r to region i, a firm located in region r needs to ship $\tau_{ir} > 1$ of the good, where $1/\tau_{ir}$ of the good is lost during transport. The higher is τ_{ir}, the greater the variable trade barrier. This is the standard iceberg costs of international trade. Furthermore, to produce a good of attribute a, a firm has to pay a fixed cost $f(a)$ in each period. This fixed cost increases with the product attribute a that the firm chooses from its profit maximization process. Finally, the firm has to pay an exogenous fixed cost, F_{ir}, in order to sell from region r to i. Every firm from different countries have access to the same distribution of productivity draws, and gets a static productivity draw ρ. The only input to production is labor and costs w_r in region r. The variable cost per unit of output for a firm is therefore $\frac{\tau_{ir}w_r}{\rho}$. Given this cost structure, the cost function of a firm with productivity draw ρ from region r selling x units to region i is :

$$c_{ir}(\rho) = \frac{\tau_{ir}w_r}{\rho}x(\rho) + f(a(\rho)) + F_{ir}$$

I assume a market structure of monopolistic competition, as in Chaney (2008). Given the consumer demand, the optimal decision for each firm is to each produces a single variety. This allows us to index each good ω by the firm productivity ρ. The first order condition from the consumer problem means that a firm ρ from region r selling to i faces the following demand:

$$x_{ir}(\rho) = \mu a(\rho)\, p_{ir}(\rho)^{-\sigma} P_i^{\sigma-1} X_i \tag{5}$$

where $P_i = \int \left(p(\rho)^{1-\sigma} a(\rho)\right)^{\frac{1}{1-\sigma}} d\rho$, and X_i is the total absorption of region i.

The firm makes the decision to set a and p by maximizing its profits for each exporting location:

$$\max_{a,p} \pi_{ir}(\rho) = p_{ir}(\rho)\, x_{ir}(\rho) - \frac{\tau_{ir}w_r}{\rho}x(\rho) - f(a(\rho)) - F_{ir} \tag{6}$$

Maximizing the profit function, the optimal price for firms selling from r to i is to charge a constant markup over marginal cost:

$$p_{ir}(\rho) = \frac{\sigma}{\sigma-1}\frac{\tau_{ir}w_r}{\rho} \tag{7}$$

which is a standard result given the monopolistic competitive market structure and consumer preferences. Next, I turn to the choice of a.

5.2 Optimal Fixed Costs

The key feature of this extended model is that firms must pay a fixed cost to buy their product attribute a in each period. The amount of fixed costs increases in their product attribute. An example of an industry that exhibits these two features is integrated electronic circuits, which is widely produced across Chinese provinces. This industry experiences rapid technological changes, undergoing four different production processes in a matter of eight years; furthermore, each successive generation of microprocessors require new manufacturing processes with new capital requirements (Berger and Martin, 2011). I parametrize the endogenous fixed cost as increasing and convex in a:

$$f(a) = a^{\alpha} \tag{8}$$

where $\alpha > 1$. This assumption means that it becomes increasingly difficult to upgrade the product. α can be interpreted as the elasticity of endogenous fixed cost with respect to product attribute. This convexity assumption is the same as Ferguson (2010). The decreasing return to upgrading is also similar in nature to Arkolakis (2010), where the marketing fixed cost of reaching additional consumers become extremely high. Given this functional form of fixed costs, firms choose an a for each location they sell to by maximizing the profits in that location. Substituting equation (7) into (6), the firm problem becomes:

$$\max_{a} \pi_{ir}(\rho) = aB_{ir}\rho^{\sigma-1} - a^{\alpha} - F_{ir}$$

where $B_{ir} = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\left(\frac{\mu}{\sigma}\right)P_i^{\sigma-1}X_i\left(w_r\tau_{ir}\right)^{1-\sigma}$. The optimal a for each firm is set by equating the marginal benefit of an additional a to the marginal cost, $B_{ir}\rho^{\sigma-1} = \alpha a^{\alpha-1}$. By paying to increase a, a firm obtains additional revenues because consumers are willing to buy more of it. The marginal gain from upgrading also increases in the size of the destination market and decreases in variable trade costs. The product attribute that the firm chooses to sell to consumers and the associated fixed cost are then:

$$a_{ir}(\rho) = \left(\frac{B_{ir}\rho^{\sigma-1}}{\alpha}\right)^{\frac{1}{\alpha-1}} \tag{9}$$

$$f_{ir}(\rho) = \left(\frac{B_{ir}\rho^{\sigma-1}}{\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{10}$$

There is empirical evidence that more productive firms tend to produce higher quality products (Kugler and Verhoogen, 2008). In order for a to increase in ρ, the restriction I need on the parameters are that $\sigma > 1$, $\sigma - 1 < \gamma$. The optimum choice in product attribute and fixed costs tell us that these two endogenous variables increase in the market size of i and the productivity of the firm, and decreases in the variable trade barrier τ_{ir} and labor cost of region r, w_r.

5.3 The Cutoff Firm

Because of the exogenous fixed cost of exporting, F_{ir}, only the more productive firms from region r can sell to i. The firm that earns a zero net profit is the least productive firm that is able to sell to i. Denote the productivity of this firm as ρ^*_{ir}, it is pinned down by the zero profit condition $a\left(\rho^*_{ir}\right) B_{ir} \rho^{*\sigma-1}_{ir} - f\left(a\left(\rho^*_{ir}\right)\right) - F_{ir} = 0$, where only firms with $\rho > \rho^*_{ir}$ will sell to i. Substituting equation (10) into it solves the cutoff productivity in terms of exogenous variables, wages, and price index:

$$\rho^*_{ir} = \left(\frac{\alpha}{B_{ir}} \left(\frac{F_{ir}}{(\alpha - 1)} \right)^{\frac{\alpha-1}{\alpha}} \right)^{\frac{1}{\sigma-1}} \tag{11}$$

Note that as $\alpha \to \infty, \rho^*_{ir} = \left(\frac{F_{ir}}{B_{ir}}\right)^{\frac{1}{\sigma-1}}$, which would be the same as Chaney (2008). Finally, we follow the same simplifying assumptions as Chaney (2008) to solve for the equilibrium. First, firm productivities follow a Pareto distribution, $P(\rho < \bar{\rho}) = 1 - \bar{\rho}^{-\gamma}$, with the shape parameter γ. A lower γ means more firm heterogeneity. This assumption allows us to solve the model in closed form. Second, the mass of potential firms in each exporting country r is proportional to $w_r L_r$. Third, there is no free entry, and profits are collected in a global fund that redistributes them to each person in units of the numeraire good. The following propositions follows in general equilibrium:

Proposition 1 (Aggregate Trade Flow): *The sales from region r to i is related by the region pairs' economic size (Y_r, Y_i), negatively related to variable trade costs (τ_{ir}) and cost of production (w_r) in the exporting country r, and negatively related to the exogenous fixed cost of exporting (F_{ir}), and positively related to the remoteness measure of the importing region (θ_i) :*

$$X_{ir} = Constant \times \frac{Y_r \times Y_i}{Y} \times \left(\frac{w_r \tau_{ir}}{\theta_i} \right)^{-\gamma} \times \left(F_{ir}\right)^{1-\frac{\gamma}{\sigma-1}\left(\frac{\alpha-1}{\alpha}\right)} \tag{12}$$

where $\left(\theta_i\right)^{-\gamma} = \sum_k \left(\frac{Y_k}{Y}\right) \left(w_k \tau_{ik}\right)^{-\gamma} \left(F_{ik}\right)^{1-\frac{\gamma}{\sigma-1}\left(\frac{\alpha-1}{\alpha}\right)}$. See Proof in Appendix 2A. This equation is similar as the one derived in Chaney (2008), with the addition of $\left(\frac{\alpha-1}{\alpha}\right)$ in the exponent for exogenous fixed costs.

Proposition 2 (Elasticity of trade barriers): *The elasticity of trade flow with respect to fixed trade barriers is smaller than in Chaney (2008), while the elasticity of trade flow with respect to variable trade barriers is the same:*

$$\xi_\tau \equiv -\frac{dlnX_{ir}}{dln\tau_{ir}}=\gamma \text{ and } \xi_F \equiv -\frac{dlnX_{ir}}{dlnF_{ir}} = \frac{\gamma}{\sigma-1}\left(\frac{\alpha-1}{\alpha}\right)-1$$

Then

$$\xi_\tau = \xi_\tau^{Chaney} \text{ and } \xi_F < \xi_F^{Chaney}$$

See Proof in Appendix 2B. The model assumption states that $\alpha > 1$, which means that $\frac{\alpha-1}{\alpha} < 1$. The elasticity of trade to fixed costs in Chaney (2008) is $\frac{\gamma}{\sigma-1} - 1$–also interpreted as the extensive margin adjustment to changes in our exogenous fixed barrier and is now dampened by $\frac{\alpha-1}{\alpha}$. In other words, the predicted increase in trade in response to a fall in fixed trade barriers is now smaller. The intuition is the following: when trade barriers fall, the productivity cutoff for the exporting firms would be lowered as in the benchmark model. But because the new firms that export have lower productivity, they choose a lower a and therefore face smaller demands than the firms that are already exporting. So the increase in trade would be less than Chaney (2008), when the new firms that enter exporting would sell more than the firms in this model.

If $\frac{\alpha-1}{\alpha}$ is small enough, the elasticity of trade to the fixed barrier could become positive. This occurs when $\alpha < \frac{\gamma}{\gamma-(\sigma-1)}$. The story for this special case is as follows: when the fixed costs of entering market i increases, low productivity firms that produce unsophisticated goods exit the market. The increase in the fixed barrier leads to an increase in the price index of region i , making it easier for the firms that continue to export to sell to them. These firms will also upgrade their product and increase sales. Because the industry as a whole exhibits high propensity to upgrade, their increase fixed cost investment and raises the total demand for the products, increasing the aggregate trade to region i. This positive response in trade flows to fixed barriers is interesting, but it is difficult to find an empirical example to support it.

Proposition 3 (Elasticity of trade barriers for different industries): *The elasticity of endogenous fixed cost with respect to product attribute (α) is positively related to the elasticity of trade flows with respect to the fixed trade barrier (ξ_F), but has no effect on the elasticity of trade flows with respect to the variable trade cost (ξ_τ):*

$$\frac{\partial \xi_\tau}{\partial \alpha} = 0 \text{ and } \frac{\partial \xi_F}{\partial \alpha} > 0$$

Proof in Appendix 2C. According to this proposition, industries with higher α manifest a higher sensitivity in trade flows to fixed cost barriers (F_{ir}). The intuition is the following: a high α industry means that it is difficult for firms to raise the demand of their product through endogenous fixed cost investment. When the exogenous trade barriers decrease, the new firms that enter the market, though with lower productivity, do not sell goods that are substantially lower in product sophistication than the existing firms. Therefore, their sales are also similar to the firms that are already selling. In comparison, in an industry with a lower α, new firms that enter the market following a decline in fixed trade barriers have lower productivity than then incumbent exporters. They choose to produce goods with lower sophistication and face smaller demands. Therefore, the addition in revenues they generate from trade are smaller than would be for new firms in a higher α industry.

Proposition 4 (Measured Trade Costs vs. Underlying Trade Costs): The sensitivity of fixed barriers to the measured trade barriers is now adjusted by α:

$$\hat{\bar{t}}_{ir}^M = \left(\frac{\hat{X}_{ii} \hat{X}_{rr}}{\hat{X}_{ir} \hat{X}_{ri}} \right)^{\frac{1}{2\gamma}} = \left(\hat{\tau}_{ri} \hat{\tau}_{ir}\right)^{\frac{1}{2}} \left(\hat{F}_{ri} \hat{F}_{ir}\right)^{\frac{1}{2}\left(\frac{1}{\sigma-1}\frac{\alpha-1}{\alpha} - \frac{1}{\gamma}\right)} \tag{13}$$

Compare to the benchmark measured trade cost equation (3), the measured trade cost from this model is less sensitive to the fixed trade barriers, as $\frac{\partial ln \bar{t}_{ir}^M}{\partial ln F_{ri} F_{ir}} = \frac{1}{2}\left(\frac{1}{\sigma-1}\frac{\alpha-1}{\alpha} - \frac{1}{\gamma}\right) < \frac{1}{2}\left(\frac{1}{\sigma-1} - \frac{1}{\gamma}\right)$. The increase (decrease) in fixed barriers implied by this model would be greater (smaller) than under the benchmark Chaney (2008). Intuitively, this happens because the responsiveness of trade flows to fixed barriers are smaller. Given the same ratio of own purchases relative to trade flows, it must be that the fixed barriers have increased or decreased more than in the benchmark model. Furthermore, if $\alpha < \frac{\gamma}{\gamma-(\sigma-1)}$, an increase in measured trade cost will mask the actual decrease in the fixed trade cost.

5.4 Empirical Test of Model

The model predicts a relationship between firm fixed costs investment behavior and destination market size and trade costs. It suggests that firms upgrade to increase their sales in the presence of a larger market and when they face lower trade costs. I test this relationship at the industry level using international trade data for Chinese provinces. I estimate a cross-section OLS regression implied by the optimal product attribute choice equation. The following is the my estimation equation:

$$lna_{ir}^{h} = \text{constant } + \beta lnX_i + \zeta ln\tau + \delta_i + \delta_r + \delta_h + \vartheta_{ir} \tag{14}$$

where δ_i, δ_r, and δ_h are importer, exporter, and industry fixed effects. τ_{ir} is the trade costs, and X_i is the destination market size. ϑ_{ir} is a random error term. a_{ir}^{h} is the average product attribute of industry h. If it were true that firms upgrade their product in response to a larger market, we would expect $\beta > 0$. Also, if firms upgrade in response to lower trade costs, we would expect $\zeta < 0$. a_{ir}^{h} is proxied by measures that capture value enhancing attributes of the products, which I interpret as quality and the number of varieties. I follow other studies in using unit costs to proxy for quality (Hummels and Klenow, 2002), and I use the number of products at HS8 level for each HS2 industries as proxy for the number of varieties in an industry. I use GDP data for X_i, and proxy trade costs by distance, common language, and contiguous border. I estimate this equation for HS2 level data. Bilateral international trade data between a province and a country is available for all 31 Chinese provinces and 132 unique destinations. The unit values are calculated for 32 HS2 level industries, where the quantity unit (kg) is comparable. Table (15) shows the results.

The signs on the explanatory variables are mostly as predicted, with positive and significant sign on GDP and negative signs on distance. The estimates on the first two columns are for all 32 HS2 industries, ranging from chemical, apparel, electronics and machinery, to transportation. Table 16 ranks the industry fixed effects in descending order. I interpret an industry that ranks higher as having a lower α. For example, we see that transportation and machinery are low α industries. The industry fixed effects show that the sectors that are sensitive to upgrading are also capital sensitive sectors. What is the exposure of each province to these industries? Only 6 provinces export airplanes and spacecraft (HS 88), to a total of 5 foreign countries. In comparison, 28 provinces export some products in industry nuclear reactors, boilers, machinery and mechanical appliances and computers (HS 84) to a total of 129 destinations. All 31 provinces export some products in electrical machinery (HS 85) to a total of 202 destinations. In fact, sectors 84 and 85 are popular export industries across provinces in China.[30] In column 3-6 of the OLS regression, I show estimation of equation (14) for these two industries. The observation here is that the sensitivity of the destination market size and distance are higher for both HS 84 and HS 85 industries than for the average of all industries. This is in agreement with our intuition that these two capital

[30] The complete description for HS 84 is "Nuclear reactors, boilers, machinery & mechanical appliances, computers", and the description for HS85 is "Electrical machinery & equipments and parts, telecommunications equipments, sound recorders, television records."

intensive sectors are more sensitive to upgrading than other sectors. Also, these sectors are where we would think the α, elasticity of upgrading to endogenous fixed costs, would be low. And therefore, regions that are most exposed to these sectors would be where the sensitivity of fixed barriers to the measured trade barrier is attenuated.

Which regions are most impacted by this change in the sensitivity of the measured trade costs to underlying fixed costs? Since the international trade data for provinces are available at relatively disaggregated industry level, I exploit it to infer information about the industry base of each province. In Table 17, I show the international exports of each province in 2002 to electronics and machinery, the two industries which I find above to have relatively low α. The representativeness of international trade to domestic trade might be questioned on the basis that much exports in China is due to foreign processing trade, which are not intended to be sold domestically. Therefore, I subtract from total exports the exports that are dubitably traded domestically. These exports include those classified by Chinese Customs as process and assembling, process with imported materials, equipment for processing trade, outward processing, equipments invested by foreign enterprises, and equipments imported into the export processing zone. As can be seen in the table, these two industries are the drivers for China's export boom across several provinces, whether one looks at total exports or just ordinary exports. On average, the coastal regions are more exposed to these two sectors, with a combined average of 30 percent of total exports. Foreign processing is important in the coastal region, and after substracting exports that contain foreign components, these two sectors account for 13 percent of the value of ordinary exports. More than half of Tianjin's total exports is in these electronics and machinery (57 percent), but much of it has processing components in it. After subtracting out the processing components, these two industries account for 17 percent of Tianjin's ordinary exports. It is still larger than most other provinces, though not the largest. The provinces which have the highest share of electronics and machinery based on ordinary exports are Guangdong (20%), Sichuan (20%), and Zhejiang (18%). The table also shows that the growth in the value of international exports of these two sectors combined is large in absolute terms (an average of 165% (total exports) and 155% (ordinary exports) across provinces). If the size and growth of these industries in international trade is indicative of their presence in domestic trade, then the measured trade cost as interpreted in the benchmark model would understate the underlying change in fixed barriers.

5.5 Implication of the Extended Model for Measured Trade Costs

To quantify the magnitude of the understatement in the fixed barriers by the measured barriers, we first need to separate the variable trade barriers from the fixed barriers. Secondly, we need values of α, the elasticity of fixed cost to product upgrading in each industry. Both tasks are challenging and require additional data that is not available to this study.[31] However, in order to give a sense of the magnitude of this issue, I illustrate an example here with the aid of some simplifying assumptions to circumvent these two problems. First, I assume that only the fixed trade barriers changed, as in a previous section. With this simplification, the average change in bilateral fixed barriers in the benchmark and extended model can be backed out from the measured trade costs as follows:

$$\hat{\hat{F}}_{ir}^{benchmark} = \left(\hat{F}_{ri}^{bm}\hat{F}_{ir}^{bm}\right)^{\frac{1}{2}} = \left(\hat{\hat{t}}_{ir}^{M}\right)^{\frac{1}{\left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)}}$$

$$\hat{\hat{F}}_{ir}^{extended} = \left(\hat{F}_{ri}^{e}\hat{F}_{ir}^{e}\right)^{\frac{1}{2}} = \left(\hat{\hat{t}}_{ir}^{M}\right)^{\frac{1}{\left(\frac{1}{\sigma-1}\frac{\alpha-1}{\alpha}-\frac{1}{\gamma}\right)}}$$

The implied change in the fixed barriers by the extended model is more pronounced in both directions than the benchmark model because of the additional effect of $\frac{\alpha-1}{\alpha} < 1$. In this example, I compare these two objects and demonstrate the size of their difference. To do so, the second simplifying assumption I make is on the value of α. If I take the estimates in Table 15 seriously as indicative of the firm's optimal choice equation in equation (9), then the coefficient on GDP would be interpreted as $\left(\frac{\sigma-1}{\gamma}\right)\left(\frac{1}{\alpha-1}\right)$, from which we can back out values for α. This is a simplifying assumption because the results in Table 15 are estimated from industry level data, which has aggregated across firm productivities and therefore the estimate on GDP are not interpreted strictly as in the firm's optimal choice equation[32]. However, the coefficient will give us a ballpark value for α. Using $\gamma = 7$ and $\sigma = 5$ (to be consistent with the calculation of trade barriers in the earlier sections), the estimation for all industries in column (1) gives us an implied α of 3.89 and an elasticity of fixed trade barrier with respect to trade flows of $1 - \frac{\gamma}{\sigma-1}\left(\frac{\alpha-1}{\alpha}\right) = -0.3$, compared to the $1 - \frac{\gamma}{\sigma-1} = -0.75$ in the benchmark.[33] By accounting for the average of industry product upgrading intensity, a 1 percent increase in fixed trade barriers would lead to 0.3 percent drop in trade flows, which

[31] To obtain precise values for α of each industry, one needs a firm level dataset with observations on firm productivity and a measure of quality or endogenous fixed cost of the firm's output. From there, estimate equation (14), and α can be backed out by the coefficient on market size in the estimation of equation.

[32] The size of the coefficient on GDP would be bigger than if estimated by firm level data.

[33] The implied α for the estimates of industry HS 84 (nuclear reactors) in column (3) and (4) of the table are 2.3 and 1.99; for industry HS 85 (electrical machinery), the implied α in column (5) and (6) are 3.86 and 2.00. The elasticity of trade flows to the fixed trade barrier is 0.01 and 0.13 for HS 84, and -0.3 and 0.12 for HS 85, respectively.

is less than half of the 0.75 percent decline predicted by the benchmark.

Using this industry average value of α, I now calculate the change in the fixed barriers for the benchmark and extended model. Table 18 shows the results. The first three columns show the fixed trade barriers implied by the benchmark model as already presented in Table 14. The last three columns show the change in the fixed barriers by the extended model with product upgrading. The main observation from this table is that the magnitude of changes in fixed barriers implied by the extended product upgrading model is even bigger than that in the benchmark model. The adjustment of the extensive margin is therefore starker in the extended model.

6 Concluding Remarks

China's impressive global integration in the last two decades has been accompanied by many domestic changes, some of which less visible to the world. In this paper, I examine the claim that domestic trade protectionism had worsened by directly calculating domestic trade barriers from interprovincial trade data. I apply a measure of trade barriers that is both theoretically founded on trade models and that bypasses indirect inferences or estimation problems. The application of this measure to Chinese domestic trade is new. I find that ad valorem tarriff-equivalent level of domestic trade barriers of goods and services average to be 54 percent, 56 percent, and 61 percent in 1992, 1997, and 2002, respectively. They are much lower than the international trade barriers for all provinces. When looking at only manufacture goods, the average trade barrier is 49 percent, which is substantially lower than that for all goods and services. I also verify that domestic trade barriers in the period 1992-1997 increased, as broadly found in the literature. With an updated time series for the period 1997-2002, I find that the increase in domestic trade barriers continued, and is positively associated with the presence of State-Owned Enterprises in the local economy.

I also examine the interpretation of the measured trade costs in a trade model that adds to the benchmark model features of industries that experienced significant growth in China. In my extended version of Chaney (2008), firms can choose to upgrade their product via investment in fixed costs. I find that the change in fixed trade costs implied by the measured trade barriers would be even more amplified than the benchmark model. As high tech industries have become the driving force for Chinese international trade in recent years, they also likely have an increase presence in domestic trade. Therefore, my finding in the extended model provides a more nuanced interpretation of the measured trade barriers for Chinese provinces.

This paper also leaves a few questions open for further research in the area of international trade as well as Chinese domestic trade protectionism. First, related to the international trade literature is the estimation of the elasticity of endogenous fixed costs to product upgrading, the α in my extended model. An empirical estimation of this parameter from firm level data would contribute toward quantifying the responsiveness of trade flows to fixed barriers. Second, it would be informative to consider alternative market-based explanation for the rise of the share of local purchases. As the primary focus of this paper is to measure domestic trade barriers based on standard trade models, it does not delve into models that consider structural change in the economy. A direction for further research is to consider models consisting of non-traded goods (or services, as interpreted in the data) and where preferences are not homothetic in non-traded goods. This class of models might suggest that trade barriers did not rise as much as it is suggested in standard models. Third, it will be interesting to see if the measured domestic trade barriers continue their decline in the successive years after China's entry into the WTO, once new time series data become available.

Finally, the findings of this paper have an important policy implication. Recently, China has been criticized for its exchange rate policy that has arguably led to an excessive reliance on external demand. Chinese leaders subsequently announced their intention to pursue a policy of boosting domestic demand.[34] As this paper has found, domestic trade barriers in China had increased from a tariff-equivalent level of 54% in 1992 to 61% in 2002. The gains from trade to be had from domestic trade liberalization appear to be large. Since domestic trade is almost twice as large as international trade in the Chinese economy, it could overtake international trade as the more important driver of China's growth if the decline in domestic trade barriers were to hasten.

[34] China's President Hu Jintao said, "China pursues a policy of boosting domestic demand, meaning we'll mainly rely upon domestic demand expansion to further promote growth." (April 19-20, 2006) Premier Wen Jiabao also said, "We must [expand] domestic demand, a long term strategic policy that we must stick to." (October 8, 2005)

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Appendix 1: Aggregation of Domestic Trade

A limitation to the domestic trade data for Chinese provinces from the regional input-out tables is that they aggregate the bilateral trade data across all outside provinces. Therefore, my analysis is based on the trade data between a province and an aggregate of purchases from the rest of China. In this section, I explain the interpretation of the observed measures I calculated in the text.

Denote D_{-i} as the set of provinces in the rest of China from the perspective of province i. I take a geometric average that will approximate the arithmetic mean of province i's purchase from the rest of China, $\frac{X_{iD_{-i}}}{D} = \frac{\sum_{d \in D_{-i}} X_{id}}{D} \approx \left(\prod_{d \in D_{-i}} X_{id} \right)^{\frac{1}{D}}$. With this, the observed data of province i imports from the rest of China can be approximated by:

$$X_{iD_{-i}} \approx D \times \left(\prod_{d \in D_{-i}} \frac{Y_i \cdot Y_d}{Y} \left(\frac{w_d \tau_{id}}{\theta_i} \right)^{-\gamma} F_{id}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \right)^{\frac{1}{D}}$$

The purchase of the rest of China from itself, $X_{D_{-i}D_{-i}}$, is denoted by $X_{D_{-i}D_{-i}} = \sum_{d \in D_{-i}} X_{dd} + \sum_{b \in D_{-i}} \sum_{k \neq b, k \in D_{-i}} X_{bk}$. The geometric average approximation of the arithmetic mean of $X_{D_{-i}D_{-i}}$ is then $\frac{X_{D_{-i}D_{-i}}}{D \times D} = \frac{\sum_{d \in D_{-i}} X_{dd} + \sum_{b \in D_{-i}} \sum_{k \neq b, k \in D_{-i}} X_{bk}}{D \times D} \approx \left(\prod_{b \in D_{-i}} \prod_{k \in D_{-i}} X_{bk} \right)^{\frac{1}{D \times D}}$, so

$$X_{D_{-i}D_{-i}} \approx D \times D \times \left(\prod_{b \in D_{-i}} \prod_{k \in D_{-i}} X_{bk} \frac{Y_b \cdot Y_k}{Y} \left(\frac{w_b \tau_{bk}}{\theta_b} \right)^{-\gamma} F_{bk}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \right)^{\frac{1}{D \times D}}$$

The Head and Ries (2001) ratio of the trade flows would become:

$$\frac{X_{iD_{-i}} X_{D_{-i}i}}{X_{ii} X_{D_{-i}D_{-i}}} \approx \frac{\left(\left(\prod_{d \in D_{-i}} \tau_{id}^{-\gamma} F_{id}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \right)^{\frac{1}{D}} \left(\prod_{d \in D_{-i}} \tau_{di}^{-\gamma} F_{di}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \right) \right)^{\frac{1}{D}}}{\left(\frac{\prod_{b \in D_{-i}} \prod_{k \in D_{-i}} \tau_{bk}^{-\gamma} F_{bk}^{-\left(\frac{\gamma}{\sigma-1}-1\right)}}{\prod_{b \in D_{-i}} Y_b \left(\frac{w_b}{\theta_b} \right)^{-\gamma}} \right)^{\frac{1}{D \times D}} \left((\tau_{ii})^{-\gamma} F_{ii}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \right)}$$

Assume that variable barriers are independent of fixed barriers, then:

$$\frac{X_{iD_{-i}} X_{D_{-i}i}}{X_{ii} X_{D_{-i}D_{-i}}} \approx \frac{\left(\left(\prod_{d \in D_{-i}} \tau_{id}^{-\gamma} \prod_{d \in D_{-i}} F_{id}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \right)^{\frac{1}{D}} \left(\prod_{d \in D_{-i}} \tau_{di}^{-\gamma} \prod_{d \in D_{-i}} F_{di}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \right) \right)^{\frac{1}{D}}}{\left(\frac{\prod_{b \in D_{-i}} \prod_{k \in D_{-i}} \tau_{bk}^{-\gamma} F_{bk}^{-\left(\frac{\gamma}{\sigma-1}-1\right)}}{\prod_{b \in D_{-i}} Y_b \left(\frac{w_b}{\theta_b} \right)^{-\gamma}} \right)^{\frac{1}{D \times D}} \left((\tau_{ii})^{-\gamma} F_{ii}^{-\left(\frac{\gamma}{\sigma-1}-1\right)} \right)}$$

Define $\bar{\tau}_{iD_{-i}}= \left(\prod_{d\in D_{-i}} \tau_{id}\right)^{\frac{1}{D}}$, $\bar{F}_{iD_{-i}} = \left(\prod_{d\in D_{-i}} F_{id}\right)^{\frac{1}{D}}$,$\bar{\tau}_{bD_{-i}} = \left(\prod_{k\in D_{-i}} \tau_{bk}\right)^{\frac{1}{D}}$, $\bar{F}_{bD_{-i}} = \prod_{k\in D_{-i}} F_{bk}^{-\left(\frac{\gamma}{\sigma-1}-1\right)}$,$\bar{\tau}_{D_{-i}D_{-i}} = \frac{\left(\prod_{b\in D_{-i}} \bar{\tau}_{bD_{-i}}\right)^{\frac{1}{D}}}{\left(\prod_{b\in D_{-i}} Y_b^{-\frac{1}{\gamma}}\left(\frac{w_b}{\theta_b}\right)\right)^{\frac{1}{D\times D}}}$, and $\bar{F}_{D_{-i}D_{-i}} = \left(\prod_{b\in D_{-i}} \bar{F}_{bD_{-i}}\right)^{\frac{1}{D}}$, then we can rewrite the measured trade barrier based on the Head and Ries ratio is:

$$\hat{t}^M_{iD_{-i}} = \left(\frac{X_{iD_{-i}}X_{D_{-i}i}}{X_{ii}X_{D_{-i}D_{-i}}}\right)^{-\frac{1}{2\gamma}} = \left(\frac{\bar{\tau}_{iD_{-i}}\bar{\tau}_{D_{-i}i}}{\bar{\tau}_{D_{-i}D_{-i}}\tau_{ii}}\right)^{\frac{1}{2}} \left(\frac{\bar{F}_{iD_{-i}}\bar{F}_{D_{-i}i}}{\bar{F}_{D_{-i}D_{-i}}F_{ii}}\right)^{\frac{1}{2}\left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)}$$

Therefore the interpretation of the measured trade barriers is the geometric average of the barriers across outside provinces from the perspective of province i.

Appendix 2: Proofs for Proposition 1-3

Appendix 2A: Proof for Proposition 1

Proposition 1 states that the gravity equation in the extended model. I restate it here:

$$X_{ir} = Constant \times \frac{Y_r \times Y_i}{Y} \times \left(\frac{w_r \tau_{ir}}{\theta_i}\right)^{-\gamma} \times F_{ir}^{1-\frac{\gamma}{\sigma-1}\left(\frac{\alpha-1}{\alpha}\right)}$$

The total sales from region r to i is related by the region pairs' economic size (Y_r, Y_i), *negatively related to variable trade costs* (τ_{ir}) *and cost of production* (w_r) *in the exporting country r, and negatively related to the exogenous fixed cost of exporting* (F_{ir}), *and positively related to the remoteness measure of the importing region* (θ_i), *where* $\theta_i^{-\gamma} = \sum_k \left(\frac{Y_k}{Y}\right)(w_k \tau_{ik})^{-\gamma} F_{ik}^{1-\frac{\gamma}{(\sigma-1)}\frac{(\alpha-1)}{\alpha}}$.

Proof:

The total imports of i from r is:

$$X_{ir} = w_r L_r \int_{\rho_{ir}^*} p_{ir}(\rho)\, x_{ir}(\rho)\, dG(\rho)$$

Firm optimization and equilibrium conditions give us the following equations:

(Price index[35]) $P_i = Y_i^{\frac{1}{\gamma}-\frac{1}{\sigma-1}} \times K \times \theta_i$

(Firm sales[36]) $p_{ir}(\rho)\, x_{ir}(\rho) = \left(\frac{1}{\alpha}\right)^{\frac{1}{\alpha-1}} \left(\lambda_1 \left(\frac{Y_i}{Y}\right)^{\frac{\sigma-1}{\gamma}} \left(\frac{\theta_i}{w_r \tau_{ir}}\right)^{\sigma-1}\right)^{\frac{\alpha}{\alpha-1}} \rho^{\frac{(\sigma-1)\alpha}{\alpha-1}}$ if $\rho > \rho_{ir}^*$

(Cutoff firm) $\rho_{ir}^* = \left(\alpha \left(\frac{F_{ir}}{(\alpha-1)}\right)^{\frac{\alpha-1}{\alpha}}\right)^{\frac{1}{\sigma-1}} \left(\frac{\sigma}{\sigma-1}\right)\left(\frac{1}{\sigma}\right)^{\frac{1}{1-\sigma}} P_i X_i^{\frac{1}{1-\sigma}} (w_r \tau_{ir})$

(Aggregate output) $Y_i = (1 + K_4) \cdot w_i L_i$

(Profits) $\pi = K_4$

Substituting these equations into total imports and using the assumption that the distribution of productivities across firms is Pareto ($G(\rho) = 1 - \rho^{-\gamma}$), we can rewrite total imports as:

$$X_{ir} = Constant \times \frac{Y_r \times Y_i}{Y} \times \left(\frac{w_r \tau_{ir}}{\theta_i}\right)^{-\gamma} \times F_{ir}^{1-\frac{\gamma}{\sigma-1}\left(\frac{\alpha-1}{\alpha}\right)}$$

Which is what we want to show.

[35] where $K = (K_1 K_2 K_3)^{-\frac{1}{\gamma}}$, $K_1 = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{\frac{1-\sigma}{\alpha-1}}\left(\frac{1}{\sigma}\right)^{\frac{1}{\alpha-1}}\left(\frac{1}{\alpha}\right)^{\frac{1}{\alpha-1}} \frac{\gamma}{\gamma+1-\sigma-\frac{\sigma-1}{\alpha-1}}$, $K_2 = \left(\frac{\alpha}{(\alpha-1)^{\frac{\alpha-1}{\alpha}}}\right)^{1-\frac{\gamma}{\sigma-1}+\frac{1}{\alpha-1}}$, $K_3 = \left(\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\left(\frac{1}{\sigma}\right)\right)^{-1+\frac{\gamma}{\sigma-1}-\frac{1}{\alpha-1}}$

[36] where $\lambda_1 = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\left(\frac{1}{\sigma}\right) K^{\sigma-1}$

Appendix 2B: Proof for Proposition 2

Restating Proposition 2: *The elasticity of trade flow with respect to fixed trade barriers is smaller than in Chaney (2008), while the elasticity of trade flow with respect to variable trade barriers is the same:*

$$\xi_\tau \equiv -\frac{dlnX_{ir}}{dln\tau_{ir}}=\gamma \text{ and } \xi_F \equiv -\frac{dlnX_{ir}}{dlnF_{ir}} = \frac{\gamma}{\sigma-1}\left(\frac{\alpha-1}{\alpha}\right)-1$$

Then

$$\xi_\tau = \xi_\tau^{Chaney} \text{ and } \xi_F < \xi_F^{Chaney}$$

Proof:

The trade elasticity with respect to variable and fixed trade costs can be decomposed into the intensive and extensive margin elasticities, as in Chaney (2008):

$$\xi_\tau \equiv -\frac{dlnX_{ir}}{dln\tau_{ir}} = \underbrace{-\frac{\tau_{ir}}{X_{ir}}\left(w_r L_r \int_{\rho^*_{ir}} \frac{\partial p_{ir}(\rho)\, x_{ir}(\rho)}{\partial \tau_{ir}} dG(\rho)\right)}_{\text{intensive margin}} + \underbrace{\frac{\tau_{ir}}{X_{ir}}\left(w_r L_r p_{ir}(\rho^*_{ir})\, x_{ir}(\rho^*_{ir})\, G'(\rho^*_{ir})\, \frac{\partial \rho^*_{ir}}{\partial \tau_{ir}}\right)}_{\text{extensive margin}}$$

$$\xi_F \equiv -\frac{dlnX_{ir}}{dlnF_{ir}} = \underbrace{-\frac{F_{ir}}{X_{ir}}\left(w_r L_r \int_{\rho^*_{ir}} \frac{\partial p_{ir}(\rho)\, x_{ir}(\rho)}{\partial F_{ir}} dG(\rho)\right)}_{\text{intensive margin}} + \underbrace{\frac{F_{ir}}{X_{ir}}\left(w_r L_r p_{ir}(\rho^*_{ir})\, x_{ir}(\rho^*_{ir})\, G'(\rho^*_{ir})\, \frac{\partial \rho^*_{ir}}{\partial F_{ir}}\right)}_{\text{extensive margin}}$$

Elasticity of Trade with respect to Variable Trade Costs

The elasticity of the intensive margin with respect to variable cost can be calculated by using the firm sales equation:

$$\frac{\partial p_{ir}(\rho)\, x_{ir}(\rho)}{\partial \tau_{ir}} = \left(\frac{1}{\alpha}\right)^{\frac{1}{\alpha-1}} \left(\lambda_1 \left(\frac{Y_i}{Y}\right)^{\frac{\sigma-1}{\gamma}} \left(\frac{\theta_i}{w_r}\right)^{\sigma-1}\right)^{\frac{\alpha}{\alpha-1}} \rho^{\frac{(\sigma-1)\alpha}{\alpha-1}} \tau_{ir}^{\frac{\alpha(1-\sigma)}{\alpha-1}-1} \frac{\alpha(1-\sigma)}{\alpha-1}$$

$$= \frac{p_{ir}(\rho)\, x_{ir}(\rho)}{\tau_{ir}} \frac{\alpha(1-\sigma)}{\alpha-1}$$

Integrating over the distribution of productivities gives us the intensive margin elasticity:

$$-\frac{\tau_{ir}}{X_{ir}}\left(w_r L_r \int_{\rho^*_{ir}} \frac{\partial p_{ir}(\rho)\, x_{ir}(\rho)}{\partial \tau_{ir}} dG(\rho)\right) = \frac{\alpha(\sigma-1)}{\alpha-1}$$

To calculate the elasticity of extensive margin, use the definition of the equilibrium productivity threshold, $\rho_{ir}^{*}=\left(\frac{\alpha}{B_{ir}}\left(\frac{F_{ir}}{(\alpha-1)}\right)^{\frac{\alpha-1}{\alpha}}\right)^{\frac{1}{\sigma-1}}$:

$$\frac{\partial\rho_{ir}^{*}}{\partial\tau_{ir}}=\frac{\rho_{ir}^{*}}{\tau_{ir}}$$

Substitute it into the definition of the extensive margin:

$$\frac{\tau_{ir}}{X_{ir}}\left(w_{r}L_{r}p_{ir}\left(\rho_{ir}^{*}\right)x_{ir}\left(\rho_{ir}^{*}\right)G'\left(\rho_{ir}^{*}\right)\frac{\partial\rho_{ir}^{*}}{\partial\tau_{ir}}\right)$$

$$=\frac{\tau_{ir}}{X_{ir}}\left(\frac{X_{ir}\left(\gamma-\frac{(\sigma-1)\alpha}{\alpha-1}\right)}{\rho_{ir}^{*}}\frac{\rho_{ir}^{*}}{\tau_{ir}}\right)=\left(\gamma-\frac{(\sigma-1)\,\alpha}{\alpha-1}\right)$$

The elasticity of trade with respect to variable cost is obtained by summing the extensive and intensive margin of the variable trade costs elasticity:

$$\xi_{\tau}=\left(\gamma-\frac{(\sigma-1)\,\alpha}{\alpha-1}\right)+\frac{\alpha\,(\sigma-1)}{\alpha-1}=\gamma$$

Thus $\xi_{\tau}=\xi_{\tau}^{Chaney}=\gamma$.

Elasticity of Trade with respect to Fixed Trade Costs

The procedure for calculating it is similar as for the variable trade costs. First, the intensive margin of trade with respect to fixed trade costs is 0, since $\frac{\partial x_{ir}(\rho)}{\partial F_{ir}}=0$. To calculate the extensive margin of trade with respect to trade costs, first we use the following expression:

$$\frac{\partial\rho_{ir}^{*}}{\partial F_{ir}}=\left(\frac{\alpha}{B_{ir}}\left(\frac{F_{ir}}{(\alpha-1)}\right)^{\frac{\alpha-1}{\alpha}}\right)^{\frac{1}{\sigma-1}}\frac{\alpha-1}{\alpha}\frac{1}{\sigma-1}F_{ir}^{-1}=\frac{\alpha-1}{\alpha}\frac{1}{\sigma-1}\frac{\rho_{ir}^{*}}{F_{ir}}$$

Plug it into the expression for the elasticity of the extensive margin with respect to fixed cost:

$$\frac{F_{ir}}{X_{ir}}\left(w_{r}L_{r}p_{ir}\left(\rho_{ir}^{*}\right)x_{ir}\left(\rho_{ir}^{*}\right)G'\left(\rho_{ir}^{*}\right)\frac{\partial\rho_{ir}^{*}}{\partial F_{ir}}\right)=\frac{F_{ir}}{X_{ir}}\left(\frac{X_{ir}\left(\gamma-\frac{(\sigma-1)\alpha}{\alpha-1}\right)}{\rho_{ir}^{*}}\frac{\alpha-1}{\alpha}\frac{1}{\sigma-1}\frac{\rho_{ir}^{*}}{F_{ir}}\right)$$

$$= \left(\frac{\alpha - 1}{\alpha} \frac{\gamma}{\sigma - 1} - 1 \right)$$

Summing the extensive and intensive margin of the fixed trade costs elasticity gives us the elasticity of trade with respect to fixed trade cost:

$$\xi_F = 0 + \left(\frac{\alpha - 1}{\alpha} \frac{\gamma}{\sigma - 1} - 1 \right) = \frac{\alpha - 1}{\alpha} \frac{\gamma}{\sigma - 1} - 1$$

Since $\alpha > 1$, $\xi_F < \xi_F^{Chaney} = \frac{\gamma}{\sigma - 1} - 1$.

Appendix 2C: Proof for Proposition 3

Restating Proposition 3: *The elasticity of endogenous fixed cost with respect to product attribute (α) is positively related to the elasticity of trade flows with respect to the fixed trade barrier (ξ_F), but has no effect on the elasticity of trade flows with respect to the variable trade cost (ξ_τ):*

$$\frac{\partial \xi_\tau}{\partial \alpha} = 0 \text{ and } \frac{\partial \xi_F}{\partial \alpha} > 0$$

Proof.

It is clear that $\frac{\partial \xi_\tau}{\partial \alpha} = 0$ since the elasticity of trade with respect to variable trade cost is independent of α. However, the elasticity of trade with respect to fixed trade cost is increasing in α:

$$\frac{\partial \xi_F}{\partial \alpha} = \alpha^{-1} (\alpha - 1) \frac{\gamma}{\sigma - 1} = \left(\frac{\gamma}{\sigma - 1} \right) \frac{1}{\alpha} \left(1 - \frac{(\alpha - 1)}{\alpha} \right) > 0$$

Since $\alpha > 1$ and $\sigma > 1$, $\frac{(\alpha - 1)}{\alpha} < 1$, and therefore $\frac{\partial \xi_F}{\partial \alpha} > 0$.

Table 1: Chinese Domestic and International Trade (percentage of GDP[a])

Domestic	1997	2002	97-02 Growth[b]
Exports	39.6	46.6	82.2
Imports	42.7	46.7	69.4
Combined	82.3	93.3	75.6

International	1997	2002	97-02 Growth[b]
Exports	23.0	27.3	82.0
Imports	16.0	24.3	126.0
Combined	39.0	51.6	100.1

	1997	2002
Ratio of Domestic to Foreign Trade[c]	2.11	1.81

a. Except where noted. The data for this table is based on aggregating across 21 provinces where complete data are available for both 1997 and 2002.

b. Percentage growth of levels.

c. Trade refers to exports plus imports.

Table 2: Domestic and International Trade, By Province (percentage of GDP, 2002)

	Domestic Trade				International Trade				Ratio of Domes/Foreign Trade
	Exports	Imports	Exports + Imports	Net	Exports	Imports	Exports + Imports	Net	
Coast									
Beijing	105.6	108.3	213.9	-2.7	25.4	25.5	50.9	-0.1	4.2
Tianjin	100.8	99.7	200.5	1.1	50.9	47.9	98.8	3.0	2.0
Hebei	77.6	65.6	143.2	12.0	5.8	2.8	8.6	3.0	16.6
Shanghai	62.0	42.7	104.7	19.2	59.0	71.6	130.6	-12.7	0.8
Jiangsu	34.7	31.6	66.3	3.2	30.6	27.9	58.5	2.8	1.1
Zhejiang	65.7	70.4	136.1	-4.7	32.1	13.6	45.7	18.5	3.0
Fujian	20.7	31.2	51.9	-10.5	28.4	14.8	43.3	13.6	1.2
Shandong	32.8	30.9	63.7	1.9	15.9	13.9	29.8	2.0	2.1
Guangdong	42.5	42.2	84.7	0.3	78.2	70.6	148.8	7.6	0.6
Guangxi	56.1	67.7	123.8	-11.6	6.1	3.2	9.3	2.9	13.3
Liaoning	43.4	33.6	77.0	9.8	18.2	14.3	32.5	3.9	2.4
Average	58.4	56.7	115.1	1.6	31.9	27.8	59.7	4.1	4.3
Center									
Shanxi	32.2	34.7	66.9	-2.5	9.8	3.1	12.8	6.7	5.2
Jilin	108.9	114.9	223.8	-6.1	6.9	9.4	16.3	-2.5	13.7
Anhui	83.6	84.4	168.0	-0.8	5.5	4.4	9.9	1.2	17.0
Heilongjiang	41.5	33.5	75.1	8.0	5.1	5.1	10.3	0.0	7.3
Jiangxi	38.3	47.2	85.5	-8.8	3.5	2.8	6.2	0.7	13.7
Henan	28.6	28.3	56.9	0.3	3.1	2.0	5.1	1.1	11.2
Hubei	23.8	25.1	48.9	-1.2	3.3	4.3	7.5	-1.0	6.5
Hunan	31.4	27.8	59.2	3.5	3.4	3.0	6.4	0.3	9.3
Inner Mongolia	48.4	42.3	90.7	6.0	4.5	8.3	12.8	-3.8	7.1
Average	48.5	48.7	97.2	-0.2	5.0	4.7	9.7	0.3	10.1
West									
Sichuan	20.2	23.8	44.0	-3.5	4.5	3.4	7.9	1.0	5.6
Guizhou	49.8	64.6	114.4	-14.7	3.9	3.1	7.0	0.9	16.3
Yunnan	31.3	43.2	74.5	-11.9	3.8	3.0	6.8	0.8	10.9
Shaanxi	56.6	64.0	120.6	-7.5	0.3	5.4	5.7	-5.1	21.2
Gansu	39.3	59.0	98.3	-19.7	10.5	3.8	14.3	6.7	6.9
Qinghai	55.8	96.0	151.9	-40.2	9.1	1.8	10.9	7.3	13.9
Ningxia	62.4	111.8	174.2	-49.4	3.8	3.5	7.3	0.3	24.0
Xinjiang	45.5	52.7	98.2	-7.2	5.9	6.6	12.4	-0.7	7.9
Average	45.1	64.4	109.5	-19.3	5.2	3.8	9.0	1.4	13.3
Sum	47.1	46.8	94.0	0.3	23.0	20.0	43.0	3.0	2.2
Average	51.4	56.3	107.7	-4.9	15.6	13.5	29.2	2.1	3.7

Figure 1: Decomposition of China's Final Demand (average across provinces), 1987-2002

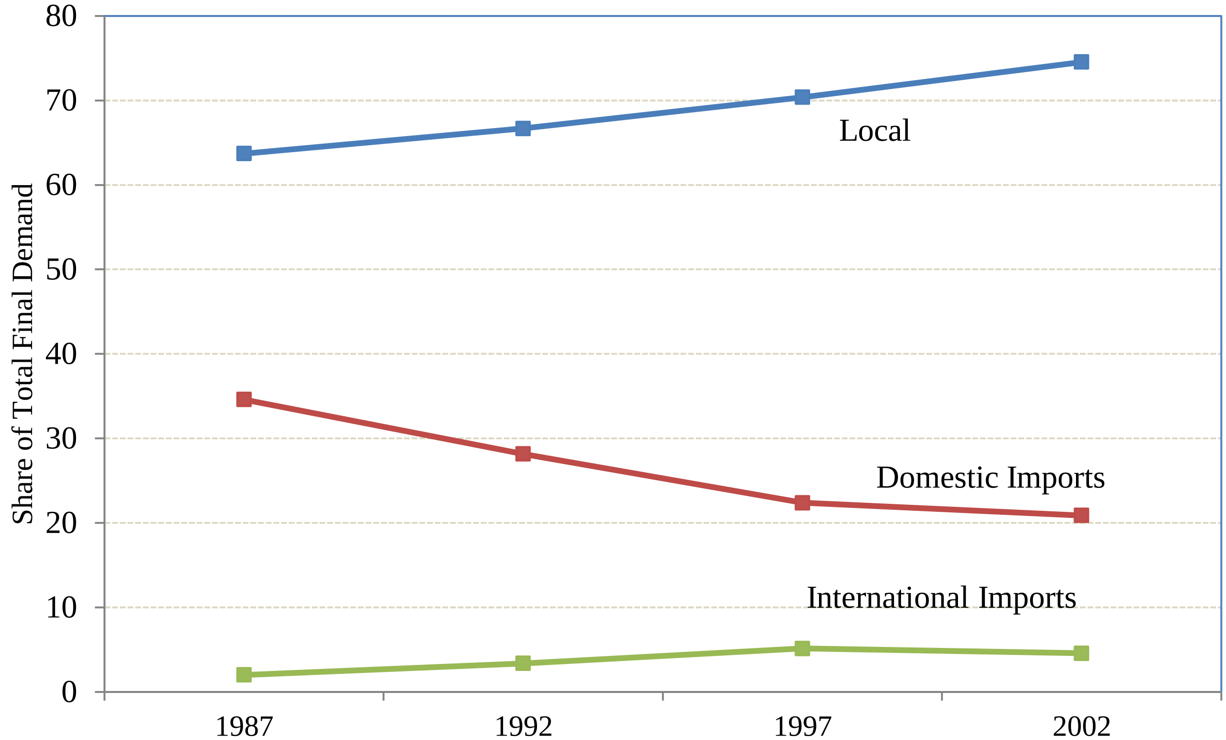

Table 3: Domestic Trade Barriers in Goods and Services (Ad Valorem Tariff-equivalent, %)

	1992			1997			2002		
Province	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$
Coast									
Beijing	46.0	30.3	24.7	48.1	31.6	25.7	45.9	30.3	24.6
Tianjin	41.6	27.6	22.5	39.0	25.9	21.2	48.4	31.8	25.9
Hebei	-	-	-	-	-	-	43.2	28.6	23.3
Shanghai	31.7	21.3	17.4	39.7	26.3	21.5	53.4	34.9	28.4
Jiangsu	25.2	17.0	14.0	27.9	18.8	15.4	56.7	37.0	30.0
Zhejiang	62.7	40.6	32.8	63.2	40.9	33.1	44.8	29.6	24.1
Fujian	77.2	49.3	39.6	-	-	-	70.8	45.5	36.7
Shandong	36.9	24.6	20.1	-	-	-	56.7	37.0	30.0
Guangdong	-	-	-	35.5	23.7	19.4	48.5	31.9	25.9
Guangxi	47.3	31.1	25.3	48.0	31.6	25.7	55.7	36.4	29.5
Liaoning	60.8	39.4	31.9	63.3	41.0	33.1	61.2	39.7	32.1
Average	**47.7**	**31.2**	**25.4**	**45.6**	**30.0**	**24.4**	**53.2**	**34.8**	**28.2**
Center									
Shanxi	54.9	35.8	29.1	70.9	45.5	36.7	76.8	49.0	39.4
Jilin	27.7	18.7	15.3	47.0	31.0	25.2	43.5	28.8	23.4
Anhui	-	-	-	-	-	-	43.8	29.0	23.6
Heilongjiang	-	-	-	-	-	-	61.2	39.7	32.1
Jiangxi	59.0	38.3	31.1	58.7	38.2	30.9	66.1	42.7	34.5
Henan	46.0	30.3	24.7	50.3	33.0	26.8	65.7	42.4	34.2
Hubei	42.1	27.9	22.8	60.5	39.3	31.8	69.9	45.0	36.3
Hunan	52.4	34.3	27.9	66.4	42.8	34.6	66.9	43.1	34.8
Inner Mongolia		-	-	48.7	32.0	26.0	67.9	43.7	35.3
Chongqing							45.4	30.0	24.4
Average	**47.0**	**30.9**	**25.1**	**57.5**	**37.4**	**30.3**	**60.7**	**39.3**	**31.8**
West									
Sichuan	61.7	40.0	32.3	80.6	51.2	41.2	74.4	47.6	38.3
Guizhou	64.3	41.6	33.6	-	-	-	67.0	43.2	34.9
Yunnan	85.8	54.3	43.5	64.4	41.6	33.6	71.1	45.6	36.8
Shaanxi	-	-	-	-	-	-	61.9	40.1	32.4
Gansu	62.8	40.6	32.9	60.7	39.4	31.9	74.1	47.4	38.2
Qinghai	76.4	48.8	39.3	74.4	47.6	38.3	76.2	48.7	39.2
Ningxia	66.5	42.9	34.6	74.3	47.5	38.3	75.0	48.0	38.6
Xinjiang	48.2	31.7	25.8	54.5	35.6	28.9	67.7	43.6	35.2
Average	**66.5**	**42.8**	**34.6**	**68.2**	**43.8**	**35.4**	**70.9**	**45.5**	**36.7**
National Average	**53.5**	**34.8**	**28.2**	**56.0**	**36.4**	**29.5**	**60.7**	**39.3**	**31.8**

Table 4: Domestic Barriers in 2002, (Ad Valorem Tariff-equivalent, %, γ =7)

Province	Goods & Services	Agricultural	Manufacture	Services
Coastal				
Beijing	45.9	103.4	34.7	56.2
Tianjin	48.4	64.4	43.3	53.6
Hebei	43.2	53.1	31.7	74.4
Shanghai	53.4	97.7	44.0	72.5
Jiangsu	56.7	100.0	46.4	87.1
Zhejiang	44.8	65.8	36.6	66.2
Fujian	70.8	109.9	58.9	95.7
Shandong	56.7	90.9	49.0	69.5
Guangdong	48.5	91.3	35.6	86.9
Guangxi	55.7	85.2	50.5	58.1
Liaoning	61.2	90.5	47.6	112.0
Average	53.2	86.6	43.5	75.7
Center				
Shanxi	76.8	-	62.9	109.7
Jilin	43.5	43.3	33.1	62.5
Anhui	43.8	40.6	31.2	72.3
Heilongjiang	61.2	93.6	47.0	96.0
Jiangxi	66.1	66.1	54.8	90.8
Henan	65.7	106.5	53.5	106.5
Hubei	69.9	70.5	58.0	101.1
Hunan	66.9	82.5	49.0	148.4
Inner Mongolia	67.9	73.1	50.3	140.3
Average	62.4	72.0	48.9	103.1
West				
Chongqing	45.4	62.8	42.8	52.3
Sichuan	74.4	81.4	63.3	100.8
Guizhou	67.0	112.5	53.6	82.1
Yunnan	71.1	98.1	55.5	97.2
Shaanxi	61.9	86.1	49.8	85.8
Gansu	74.1	115.3	58.3	110.1
Qinghai	76.2	132.0	70.0	75.4
Ningxia	75.0	97.1	64.7	88.4
Xinjiang	67.7	110.9	50.6	94.5
Average	68.1	99.6	56.5	87.4
National Average	60.5	86.1	49.0	87.9

Table 5: A Comparison of Domestic and International Barriers (Ad Valorem Tariff-equivalent, %)[a]

Province	Intl	Domestic	Intl/Domes
Coast			
Beijing	106.0	34.7	3.1
Tianjin	101.5	43.3	2.3
Hebei	179.1	31.7	5.7
Shanghai	86.5	44.0	2.0
Jiangsu	111.8	46.4	2.4
Zhejiang	126.0	36.6	3.4
Fujian	125.6	58.9	2.1
Shandong	132.0	49.0	2.7
Guangdong	102.1	35.6	2.9
Guangxi	239.6	50.5	4.7
Liaoning	149.8	47.6	3.1
Average	**132.7**	**43.5**	**3.1**
Center			
Shanxi	210.4	62.9	3.3
Jilin	207.6	33.1	6.3
Anhui	181.3	31.2	5.8
Heilongjiang	229.7	47.0	4.9
Jiangxi	217.8	54.8	4.0
Henan	201.3	53.5	3.8
Hubei	198.1	58.0	3.4
Hunan	212.0	49.0	4.3
Inner Mongolia	205.4	50.3	4.1
Chongqing	188.2	42.8	4.4
Average	**205.2**	**48.3**	**4.4**
West			
Sichuan	170.5	63.3	2.7
Guizhou	234.6	53.6	4.4
Yunnan	209.6	55.5	3.8
Shaanxi	189.2	49.8	3.8
Gansu	245.9	58.3	4.2
Qinghai	231.4	70.0	3.3
Ningxia	222.1	64.7	3.4
Xinjiang	199.4	50.6	3.9
Average	**212.8**	**58.2**	**3.7**
National Average	**179.8**	**49.2**	**3.7**

a. Trade barriers are calculated based on trade data that includes only manufacture goods.

Table 6: Changes in Domestic Trade Barriers, 1992-1997[a]

Province	X_{iD}	X_{Di}	X_{ii}	X_{DD}	X_{ii}/X_{iD}	X_{DD}/X_{Di}	$X_{iD}X_{Di}/X_{ii}X_{DD}$ (H&R)	Measured Trade Barriers[b]		
								$\gamma = 7$	$\gamma = 10$	$\gamma = 12$
Coast										
Beijing	2.93	2.47	3.04	2.99	1.23	1.02	0.80	1.02	1.01	1.01
Tianjin	3.13	3.60	3.01	2.99	0.83	0.96	1.25	0.98	0.99	0.99
Shanghai	2.61	2.36	4.92	2.90	2.09	1.11	0.43	1.06	1.04	1.04
Jiangsu	2.48	2.45	2.75	3.02	1.12	1.22	0.73	1.02	1.02	1.01
Zhejiang	2.89	3.97	4.32	2.86	1.09	0.99	0.93	1.01	1.00	1.00
Guangxi	2.64	3.06	2.99	2.99	0.97	1.13	0.91	1.01	1.00	1.00
Liaoning	1.78	3.90	2.98	2.99	0.76	1.68	0.78	1.02	1.01	1.01
Average	**2.64**	**3.12**	**3.43**	**2.96**	**1.16**	**1.16**	**0.83**	**1.02**	**1.01**	**1.01**
Center										
Shanxi	1.32	1.53	2.73	3.00	1.79	2.28	0.25	1.11	1.07	1.06
Jilin	1.37	1.36	4.56	2.97	3.35	2.17	0.14	1.15	1.10	1.09
Jiangxi	2.53	3.13	2.68	3.00	0.85	1.18	0.99	1.00	1.00	1.00
Henan	2.54	2.94	3.93	2.93	1.34	1.15	0.65	1.03	1.02	1.02
Hubei	1.78	1.44	4.92	2.90	3.42	1.63	0.18	1.13	1.09	1.07
Hunan	1.87	1.98	4.40	2.93	2.22	1.57	0.29	1.09	1.06	1.05
Average	**1.90**	**2.06**	**3.87**	**2.96**	**2.16**	**1.66**	**0.41**	**1.09**	**1.06**	**1.05**
West										
Sichuan	1.19	1.32	2.52	3.03	1.90	2.54	0.21	1.12	1.08	1.07
Yunnan	4.88	8.86	2.70	3.00	0.30	0.61	5.34	0.89	0.92	0.93
Gansu	2.99	3.47	2.99	2.99	0.86	1.00	1.16	0.99	0.99	0.99
Qinghai	2.25	3.50	2.32	2.99	0.66	1.33	1.14	0.99	0.99	0.99
Ningxia	1.82	2.44	2.91	2.99	1.19	1.64	0.51	1.05	1.03	1.03
Xinjiang	2.38	2.39	3.52	2.99	1.47	1.25	0.54	1.04	1.03	1.03
Average	**2.59**	**3.66**	**2.83**	**3.00**	**1.07**	**1.40**	**1.48**	**1.01**	**1.01**	**1.01**
National Average	**2.39**	**2.96**	**3.38**	**2.97**	**1.45**	**1.39**	**0.91**	**1.04**	**1.03**	**1.02**

a. All numbers in this table are expressed as a ratio of 2002 value over 1997 value.

b. Measured trade barriers are converted from the Head and Ries ratio by $(H\&R)^{-1/2\gamma}$

Table 7: Changes in Domestic Trade Barriers, 1997-2002[a]

Province	X_{iD}	X_{Di}	X_{ii}	X_{DD}	X_{ii}/X_{iD}	X_{DD}/X_{Di}	$X_{iD}X_{Di}/X_{ii}X_{DD}$ (H&R)	Measured Trade Barriers[b]		
								$\gamma = 7$	$\gamma = 10$	$\gamma = 12$
Coast										
Beijing	3.13	3.05	2.97	2.23	0.95	0.73	1.44	0.97	0.98	0.98
Tianjin	1.64	1.66	2.31	2.25	1.40	1.36	0.52	1.05	1.03	1.03
Shanghai	0.94	1.37	1.86	2.29	1.97	1.68	0.30	1.09	1.06	1.05
Jiangsu	0.71	0.78	2.94	2.17	4.12	2.77	0.09	1.19	1.13	1.11
Zhejiang	5.24	4.89	1.85	2.31	0.35	0.47	6.00	0.88	0.91	0.93
Fujian	9.75	6.48	2.15	2.26	0.22	0.35	12.98	0.83	0.88	0.90
Guangdong	1.43	1.44	3.72	2.13	2.61	1.48	0.26	1.10	1.07	1.06
Guangxi	2.00	1.66	2.31	2.25	1.15	1.36	0.64	1.03	1.02	1.02
Liaoning	2.44	3.16	1.96	2.28	0.80	0.72	1.72	0.96	0.97	0.98
Average	**3.03**	**2.72**	**2.45**	**2.24**	**1.51**	**1.21**	**2.66**	**1.01**	**1.01**	**1.01**
Center										
Shanxi	1.86	1.72	2.19	2.26	1.18	1.31	0.65	1.03	1.02	1.02
Jilin	2.81	2.66	2.23	2.26	0.79	0.85	1.49	0.97	0.98	0.98
Jiangxi	1.96	1.59	2.36	2.25	1.21	1.42	0.58	1.04	1.03	1.02
Henan	1.35	1.37	2.10	2.27	1.55	1.66	0.39	1.07	1.05	1.04
Hubei	1.27	1.21	1.47	2.32	1.16	1.92	0.45	1.06	1.04	1.03
Hunan	1.78	2.00	1.53	2.30	0.86	1.15	1.01	1.00	1.00	1.00
Inner Mongolia	1.53	1.75	2.82	2.25	1.84	1.29	0.42	1.06	1.04	1.04
Average	**1.79**	**1.76**	**2.10**	**2.27**	**1.23**	**1.37**	**0.71**	**1.03**	**1.02**	**1.02**
West										
Sichuan	3.44	2.93	1.91	2.28	0.56	0.78	2.31	0.94	0.96	0.97
Yunnan	2.01	1.45	2.48	2.25	1.24	1.55	0.52	1.05	1.03	1.03
Gansu	1.75	1.16	2.42	2.25	1.39	1.94	0.37	1.07	1.05	1.04
Qinghai	3.73	2.17	3.69	2.25	0.99	1.04	0.97	1.00	1.00	1.00
Ningxia	3.34	1.86	2.97	2.25	0.89	1.21	0.93	1.01	1.00	1.00
Xinjiang	1.47	1.27	2.91	2.25	1.98	1.78	0.28	1.09	1.06	1.05
Average	**2.62**	**1.81**	**2.73**	**2.26**	**1.17**	**1.38**	**0.90**	**1.03**	**1.02**	**1.02**
National Average	**2.53**	**2.16**	**2.42**	**2.26**	**1.33**	**1.31**	**1.56**	**1.02**	**1.02**	**1.01**

a. All numbers in this table are expressed as a ratio of 2002 value over 1997 value.

b. Measured trade barriers are converted from the Head and Ries ratio by $(H\&R)^{-1/2\gamma}$

Table 8: Explanations for International and Domestic Trade Barriers, 2002[a]

Independent Variable	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Dependent Variable: International Trade Barriers						
Ln (Distance from Coast)	29.29***			17.16**		
	(4.444)			(4.665)		
Ln (Wtg. Distance from Rest of China)		171.29**			108.96**	
		(59.518)			(36.085)	
Coast Dummy			-77.37***			-38.44
			(14.123)			(19.150)
Center Dummy			-3.04			2.65
			(14.812)			(14.449)
SOE Share				0.39	0.76**	0.44
				(0.232)	(0.216)	(0.299)
Primary Sector Share				3.46***	4.47***	3.44**
				(0.856)	(0.812)	(1.029)
Constant	149.06***	30.86	210.10***	94.59***	-11.78	125.12***
	(7.399)	(52.301)	(10.474)	(14.376)	(31.329)	(29.690)
Observations	28	28	29	28	28	28
Adj. R-squared	0.61	0.21	0.57	0.76	0.73	0.70
Panel B. Dependent Variable: Domestic Trade Barriers						
Ln (Distance from Coast)	3.92**			1.95		
	(1.343)			(1.675)		
Ln (Wtg. Distance from Rest of China)		25.58			19.60	
		(13.670)			(11.856)	
Coast Dummy			-13.03**			-8.21
			(4.085)			(6.178)
Center Dummy			-7.64			-5.99
			(4.284)			(4.661)
SOE Share				0.20*	0.24**	0.16
				(0.083)	(0.071)	(0.097)
Primary Sector Share				0.07	0.15	0.08
				(0.307)	(0.267)	(0.332)
Constant	45.35***	27.23*	56.51***	38.42***	20.72	46.98***
	(2.236)	(12.013)	(3.030)	(5.162)	(10.293)	(9.578)
Observations	28	28	29	28	28	28
Adj. R-squared	0.22	0.08	0.23	0.32	0.35	0.31

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

a. Trade barriers are calculated based on trade data of only manufacture sector.

Table 9: Panel Regression of Domestic Trade Barriers, 1992-2002[a]

Independent Variable	(1)	(2)	(3)	(4)[b]	(5)[b]	(6)[b]
Ln (Distance from Coast)	4.90***			4.55**		
	(1.075)			(1.569)		
Ln (Wtg. Distance from Rest of China)		37.20**			20.31	
		(10.831)			(11.813)	
Coast Dummy			-19.50***			-19.87***
			(3.195)			(5.514)
Center Dummy			-12.32***			-9.25*
			(3.381)			(4.162)
SOE Share				0.11	0.22**	0.01
				(0.088)	(0.080)	(0.099)
Primary Sector Share				0.06	0.34	-0.03
				(0.244)	(0.223)	(0.250)
1997 Dummy	2.22	2.01	2.69			
	(3.666)	(3.871)	(3.381)			
2002 Dummy	7.44*	7.55*	7.83*	7.71*	11.50**	5.16
	(3.423)	(3.612)	(3.156)	(3.702)	(3.562)	(3.797)
Constant	48.52***	21.22*	64.84***	43.48***	18.12	66.91***
	(2.785)	(9.781)	(3.071)	(7.021)	(10.230)	(11.183)
Observations	71	71	71	49	49	49
Adj. R-squared	0.25	0.16	0.36	0.36	0.29	0.40

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

a. Trade barriers are calculated based on trade data that includes all goods and services.

b. This sample period only contains 1997 and 2002 observations.

Table 10: Geographic Explanations for Trade Barriers, by year[a]

Independent Variable	(1) *1992*	(2) *1997*	(3) *2002*
Panel A.			
Ln (Distance from Coast)	3.40	6.21**	5.10***
	(2.499)	(1.839)	(1.315)
Constant	50.04***	49.33***	55.75***
	(4.210)	(3.163)	(2.189)
Observations	22	21	28
Adj. R-squared	0.04	0.34	0.34
Panel B.			
Ln (Wtg. Distance from Rest of China)	45.13	34.42	32.97*
	(23.020)	(21.000)	(14.138)
Constant	14.34	25.68	32.44*
	(20.235)	(18.727)	(12.423)
Observations	22	21	28
Adj. R-squared	0.12	0.08	0.14
Panel C.			
Coast Dummy	-18.82*	-22.59**	-17.70***
	(7.001)	(5.871)	(4.039)
Center Dummy	-19.50*	-10.65	-8.50
	(7.729)	(6.048)	(4.224)
Constant	66.53***	68.16***	70.74***
	(5.251)	(4.438)	(3.073)
Observations	22	21	28
Adj. R-squared	0.25	0.39	0.39

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

a. Trade barriers are calculated based on trade data that includes all goods and services.

Figure 2: Change in Domestic Trade Barriers and State Share of Output, 1997-2002

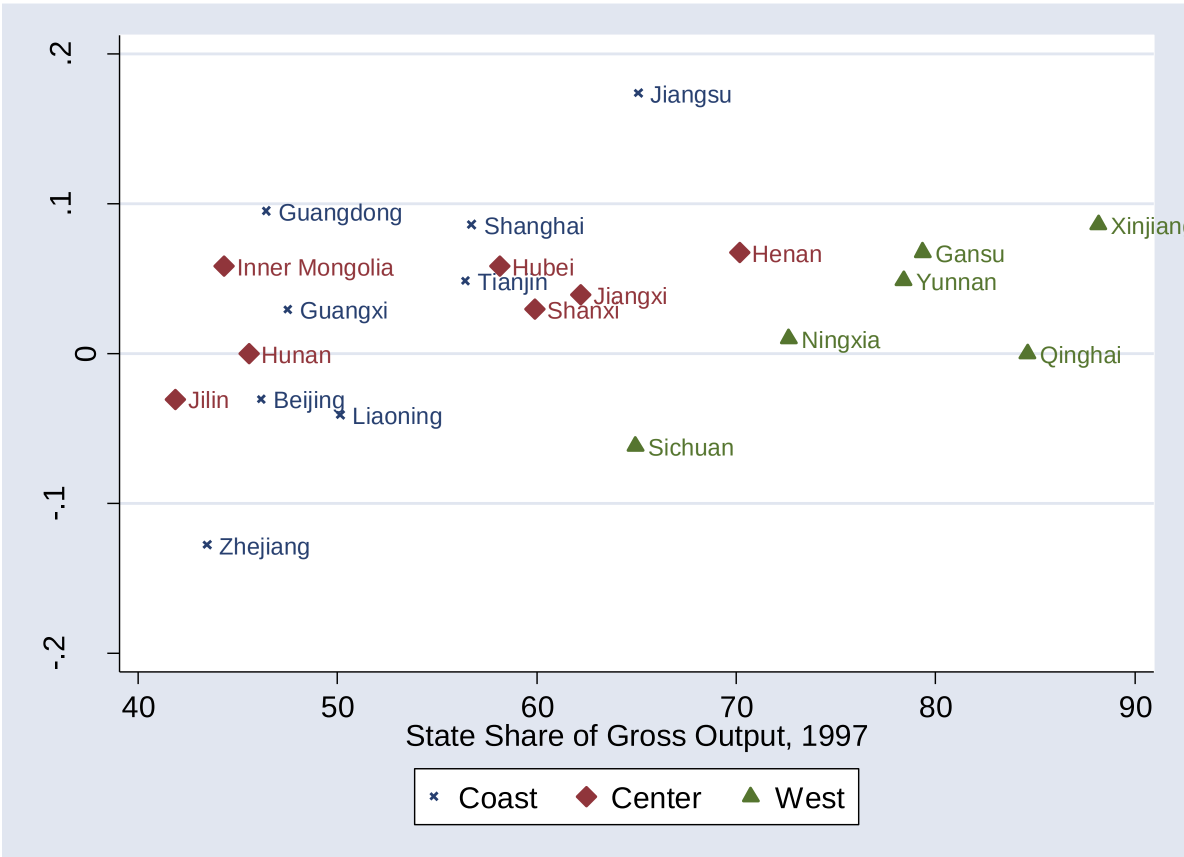

Table 11: Explaining Changes in Domestic Trade Barriers

Independent Variable	(1)	(2)
Panel A: Dependent Variable: Percentage Change in Domestic Trade Barriers, 1997-2002		
Ln(initial trade barrier)[a]	-72.42***	-85.33***
	(14.883)	(12.063)
Ln(initial SOE)[a]		51.26**
		(13.908)
Constant	304.52***	147.45*
	(59.551)	(62.843)
Observations	21	21
Adj. R-squared	0.53	0.72
Panel B: Dependent Variable: Percentage Change in Domestic Trade Barriers, 1992-1997		
Ln(initial trade barrier)[b]	-36.87*	-61.62**
	(13.060)	(16.720)
Ln(initial SOE)[b]		134.54
		(63.801)
Constant	157.18**	-349.06
	(51.304)	(244.574)
Observations	19	19
Adj. R-squared	0.28	0.40

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

a. Initial level refers to the level of 1997.

b. Initial level refers to the level of 1992.

Table 12: Contribution to Growth in Domestic Trade (%)[a]

Province	Contribution of the growth in income[b]	Contribution of the decline in domestic trade barriers[c]	Contribution of the decline in international trade diversion[d]		Growth in Domestic Trade[e]
1992-1997					
Coast	109.1	-11.7	6.2	=	103.5
Center	103.0	-56.2	17.0	=	63.8
West	91.7	-7.5	14.6	=	98.8
National Avg	101.7	-24.5	12.3	=	89.5
1997-2002					
Coast	84.4	-3.8	-1.3	=	79.3
Center	75.0	-22.3	1.6	=	54.4
West	98.7	-17.6	-9.2	=	71.9
National Avg	85.3	-13.4	-2.5	=	69.4

a. This decomposition is based on data on provincial total absorption and the calculated changes in measured domestic trade barriers reported in Table 4 and 6.

b. Income refers to total absorption of provinces.

c. The domestic trade barriers are those calculated in the previous tables.

d. This contribution is calculated as a residual after taking account of changes due to income and domestic trade barriers.

e. This is a geometric average of the growth in domestic exports and domestic imports.

Table 13: Change in Trade Barriers, in 1992-1997 changes[a]

Province	Measured Trade Barriers[b]			Fixed Trade Barriers[c]		
	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$
Coast						
Beijing	1.016	1.011	1.010	1.163	1.058	1.046
Tianjin	0.984	0.989	0.991	0.860	0.945	0.956
Shanghai	1.062	1.043	1.036	1.751	1.234	1.183
Jiangsu	1.023	1.016	1.013	1.232	1.082	1.065
Zhejiang	1.005	1.004	1.003	1.052	1.019	1.015
Guangxi	1.007	1.005	1.004	1.068	1.025	1.020
Liaoning	1.018	1.013	1.011	1.184	1.065	1.052
Average	**1.017**	**1.011**	**1.010**	**1.187**	**1.061**	**1.048**
Center						
Shanxi	1.105	1.073	1.060	2.548	1.420	1.324
Jilin	1.152	1.104	1.086	3.756	1.642	1.487
Jiangxi	1.001	1.001	1.000	1.008	1.003	1.002
Henan	1.031	1.022	1.018	1.335	1.114	1.090
Hubei	1.130	1.090	1.074	3.142	1.536	1.410
Hunan	1.093	1.064	1.053	2.298	1.366	1.283
Average	**1.086**	**1.059**	**1.049**	**2.348**	**1.347**	**1.266**
West						
Sichuan	1.119	1.082	1.068	2.862	1.483	1.371
Yunnan	0.887	0.920	0.933	0.327	0.658	0.715
Gansu	0.989	0.993	0.994	0.906	0.964	0.971
Qinghai	0.991	0.994	0.995	0.918	0.968	0.975
Ningxia	1.049	1.034	1.028	1.567	1.183	1.144
Xinjiang	1.045	1.031	1.026	1.505	1.166	1.131
Average	**1.013**	**1.009**	**1.007**	**1.348**	**1.070**	**1.051**
National Average	**1.037**	**1.026**	**1.021**	**1.604**	**1.154**	**1.118**

a. All numbers in this table are expressed as a ratio of 2002 value over 1997 value.

b. Measured trade barriers are converted from the Head and Ries ratio by $(H\&R)^{-1/2\gamma}$

c. Fixed trade barriers are derived from the assumption that all sources of change came from fixed barriers. It is converted from the measured trade barriers by $t_M^{(1/(1/(\sigma-1)-(1/\gamma)))}$, where σ=5.

Table 14: Change in Trade Barriers, in 1997-2002 changes[a]

Province	Measured Trade Barriers[b]			Fixed Trade Barriers[c]		
	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$
Coast						
Beijing	0.974	0.982	0.985	0.784	0.913	0.930
Tianjin	1.047	1.033	1.027	1.537	1.175	1.138
Shanghai	1.089	1.062	1.051	2.219	1.348	1.270
Jiangsu	1.190	1.130	1.107	5.076	1.839	1.628
Zhejiang	0.880	0.914	0.928	0.303	0.639	0.699
Fujian	0.833	0.880	0.899	0.181	0.527	0.599
Guangdong	1.101	1.070	1.058	2.461	1.402	1.310
Guangxi	1.032	1.023	1.019	1.347	1.118	1.093
Liaoning	0.962	0.973	0.978	0.695	0.873	0.897
Average	**1.012**	**1.007**	**1.006**	**1.623**	**1.093**	**1.063**
Center						
Shanxi	1.031	1.022	1.018	1.333	1.114	1.090
Jilin	0.972	0.980	0.984	0.767	0.906	0.924
Jiangxi	1.039	1.027	1.023	1.430	1.144	1.113
Henan	1.070	1.048	1.040	1.879	1.267	1.208
Hubei	1.059	1.041	1.034	1.705	1.222	1.174
Hunan	1.000	1.000	1.000	0.996	0.998	0.999
Inner Mongolia	1.064	1.044	1.037	1.778	1.241	1.188
Average	**1.033**	**1.023**	**1.019**	**1.413**	**1.127**	**1.099**
West						
Sichuan	0.942	0.959	0.966	0.572	0.811	0.846
Yunnan	1.048	1.033	1.028	1.544	1.177	1.139
Gansu	1.073	1.051	1.042	1.932	1.280	1.218
Qinghai	1.002	1.001	1.001	1.019	1.007	1.006
Ningxia	1.005	1.004	1.003	1.051	1.019	1.015
Xinjiang	1.094	1.065	1.054	2.315	1.370	1.286
Average	**1.027**	**1.019**	**1.016**	**1.405**	**1.111**	**1.085**
National Average	**1.023**	**1.015**	**1.013**	**1.497**	**1.109**	**1.080**

a. All numbers in this table are expressed as a ratio of 2002 value over 1997 value.

b. Measured trade barriers are converted from the Head and Ries ratio by $(H\&R)^{-1/2\gamma}$

c. Fixed trade barriers are derived from the assumption that all sources of change came from fixed barriers. It is converted from the measured trade barriers by $t_M^{\ (1/(1/(\sigma-1)-(1/\gamma)))}$, where $\sigma=5$.

Table 15: Endogenous Fixed Costs Regression, 2002

	(1)	(2)	(3)	(4)	(5)	(6)
	All Industries[a]		Electronics (HS 84)[b]		Machinery (HS 85)[c]	
VARIABLES	ln(Unit Value)	ln(N in industry)	ln(Unit Value)	ln(N in industry)	ln(Unit Value)	ln(N in industry)
ln (GDP)	0.20***	0.40***	0.44***	0.58***	0.20	0.57***
	(0.023)	(0.011)	(0.097)	(0.031)	(0.114)	(0.035)
ln (Dist)	-0.51***	0.43***	-2.77***	-0.78***	-1.66**	-0.27
	(0.136)	(0.067)	(0.560)	(0.177)	(0.614)	(0.186)
Contiguous Border	0.62*	-1.05	0.75	-1.10***	1.27	1.08**
	(0.248)	(1.014)	(1.036)	(0.230)	(1.201)	(0.364)
Common Language	-0.30*	0.86***	0.50	0.16	0.03	0.99***
	(0.150)	(0.071)	(0.672)	(0.205)	(0.728)	(0.220)
Constant	7.41***	-5.51***	32.26***	8.20***	22.41***	3.16
	(1.244)	(0.615)	(4.995)	(1.580)	(5.481)	(1.659)
Exporter FE	yes	yes	yes	yes	yes	yes
Importer FE	yes	yes	yes	yes	yes	yes
HS2 Industry FE	yes	yes				
Observations	22,475	22,481	1,943	1,944	1,775	1,775
R-squared	0.59	0.60	0.38	0.78	0.41	0.79
Adj. R-squared	0.59	0.59	0.32	0.76	0.36	0.77

Standard errors in parentheses

*** p<0.001, ** p<0.01, * p<0.05

a. All industries include 32 sectors for which the unit values are comparable.

b. The complete description for HS 84 is "Nuclear reactors, boilers, machinery & mechanical appliances, computers".

c. The description for HS85 is "Electrical machinery & equipments and parts, telecommunications equipments, sound recorders, television records."

Table 16: Industry Fixed Effects (Ranked in Decreasing Order)[a]

HS2	HS2 Description	Industry Fixed Effect
89	Ships, boats, & floating structures	7.50***
88	Aircraft, spacecraft, & parts thereof	7.10***
84	Nuclear reactors, boilers, machinery & mechanical appliances, computers	4.40***
86	Railway or tramway locomotives, rolling stock, track fixtures & fittings, signals	4.28***
87	Vehicles other than railway or tramway rolling stock	2.88***
85	Electrical machinery & equip. & parts, telecommunications equip., sound recorders, television recorders	1.41***
40	Rubber and articles thereof	1.09***
92	Musical instruments, parts & accessories	1.04***
90	Optical, photographic, cinematographic, medical or surgical instruments & accessories	0.68*
94	Furniture, bedding, cushions, lamps & lighting fittings nesoi, illuminated signs	0.61*
69	Ceramic products	0.39
93	Arms & ammunition, parts & accessories	0.29
73	Articles of iron or steel	-0.13
97	Works of art. collectors' pieces, antiques	-0.62*
62	Articles of apparel & clothing accessories-not knitted or crocheted	-0.84**
37	Photographic or cinematographic goods	-1.07
42	Articles of leather, saddlery & harness, travel goods, handbags, articles of gut	-1.10***
44	Wood & articles of wood, wood charcoal	-1.16***
63	Made-up textile articles nesoi, needlecraft sets, worn clothing, rags	-1.20***
61	Articles of apparel & clothing accessories-knitted or crocheted	-1.26***
91	Clocks & watches & parts thereof	-1.39***
66	Umbrellas, sun umbrellas, walking-sticks, whips, riding-crops & parts	-1.52***
95	Toys, games & sports equip, parts & acces.	-1.80***
65	Headgear & other parts	-2.54***
70	Glass & glassware	-2.87***
6	Live trees and other plants	-3.26***
82	Tools, spoons & forks of base metal	-3.33***
96	Miscellaneous manufactured articles	-3.64***
3	Fish and crustaceans	-4.42***
4	Dairy, eggs, honey, and edible products	-5.14***

Standard errors in parentheses

*** $p<0.001$, ** $p<0.01$, * $p<0.05$

a. The industry fixed effects listed here are estimated from the OLS regression for the first column in Table 8.

Table 17: Importance of Machinery and Electronics Sector in Provincial Exports[a], 2002

Province	Electronics and Machinery (share of)		1997-2002 Growth in Combined Value	
	Total Exports[b]	Ordinary Exports[c]	Total Exports[b]	Ordinary Exports[c]
Coast				
Beijing	43.6	21.3	205.9	85.7
Tianjin	57.3	16.6	201.2	272.4
Hebei	7.8	6.1	93.9	114.7
Shanghai	39.5	15.2	160.0	231.2
Jiangsu	42.9	15.1	30.7	246.0
Zhejiang	19.3	18.1	128.9	376.0
Fujian	26.4	7.4	63.2	232.2
Shandong	14.1	7.8	-7.1	225.2
Guangdong	46.7	19.7	272.3	217.5
Guangxi	5.7	5.3	433.6	-12.2
Liaoning	30.2	8.3	299.2	76.4
Average	**30.3**	**12.8**	**171.1**	**187.7**
Center				
Shanxi	1.9	1.8	99.7	183.7
Jilin	6.1	3.5	224.9	18.7
Anhui	11.9	10.6	92.2	147.7
Heilongjiang	7.5	3.4	199.1	-11.8
Jiangxi	5.6	5.4	89.4	79.0
Henan	6.8	6.6	169.1	79.5
Hubei	14.0	7.9	80.8	84.5
Hunan	9.9	5.9	161.6	73.9
Inner Mongolia	1.5	1.4	-25.7	95.3
Average	**7.2**	**5.2**	**121.3**	**83.4**
West				
Sichuan	42.0	19.8	346.6	76.4
Guizhou	7.0	5.8	63.1	52.1
Yunnan	5.5	5.6	-8.0	-0.1
Shaanxi	21.4	15.7	61.7	52.1
Gansu	5.3	8.4	-5.0	-0.4
Qinghai	0.8	1.0	67.4	66.1
Ningxia	3.9	5.3	315.8	709.8
Xinjiang	9.0	8.8	798.5	553.9
Average	**11.9**	**8.8**	**205.0**	**188.7**
National Average	**17.6**	**9.2**	**164.8**	**154.5**

a. The complete description for HS 84 is "Nuclear reactors, boilers, machinery & mechanical appliances, computers", and the description for HS85 is "Electrical machinery & equipments and parts, telecommunications equipments, sound recorders, television records."

b. Total exports, which includes all forms of exports recorded by the Customs.

c. Ordinary trade refers to total exports minus all other forms of exports, which include process and assembling, process with imported materials, equipment for processing trade, outward processing, equipments invested by foreign enterprises, and equipments imported into the export processing zone.

Table 18: Change in Fixed Trade Barriers, 1997-2002[a]

Province	Fixed Trade Barriers[b] (Benchmark Model)			Fixed Trade Barriers[c] (Extended Model)		
Coast	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$	$\gamma = 7$	$\gamma = 10$	$\gamma = 12$
Beijing	0.784	0.913	0.930	0.545	0.874	0.900
Tianjin	1.537	1.175	1.138	2.928	1.268	1.205
Shanghai	2.219	1.348	1.270	7.328	1.553	1.413
Jiangsu	5.076	1.839	1.628	57.951	2.454	2.023
Zhejiang	0.303	0.639	0.699	0.051	0.517	0.596
Fujian	0.181	0.527	0.599	0.014	0.389	0.477
Guangdong	2.461	1.402	1.310	9.490	1.645	1.478
Guangxi	1.347	1.118	1.093	2.105	1.179	1.138
Liaoning	0.695	0.873	0.897	0.403	0.818	0.854
Average	**1.623**	**1.093**	**1.063**	**8.979**	**1.189**	**1.120**
Center						
Shanxi	1.333	1.114	1.090	2.051	1.172	1.133
Jilin	0.767	0.906	0.924	0.516	0.864	0.892
Jiangxi	1.430	1.144	1.113	2.445	1.219	1.168
Henan	1.879	1.267	1.208	4.834	1.417	1.315
Hubei	1.705	1.222	1.174	3.796	1.343	1.261
Hunan	0.996	0.998	0.999	0.989	0.998	0.998
Inner Mongolia	1.778	1.241	1.188	4.214	1.374	1.284
Average	**1.413**	**1.127**	**1.099**	**2.692**	**1.198**	**1.150**
West						
Sichuan	0.572	0.811	0.846	0.248	0.735	0.785
Yunnan	1.544	1.177	1.139	2.960	1.271	1.207
Gansu	1.932	1.280	1.218	5.185	1.439	1.331
Qinghai	1.019	1.007	1.006	1.049	1.011	1.008
Ningxia	1.051	1.019	1.015	1.131	1.028	1.022
Xinjiang	2.315	1.370	1.286	8.145	1.590	1.439
Average	**1.405**	**1.111**	**1.085**	**3.119**	**1.179**	**1.132**
National Average	**1.497**	**1.109**	**1.080**	**5.381**	**1.189**	**1.133**

a. All numbers in this table are expressed as a ratio of 2002 value over 1997 value.
b. Benchmark model refers to Chaney (2008). Fixed trade barriers are derived from the assumption that all sources of change came from fixed barriers.
It is converted from the measured trade barriers by $t_M^{(1/(1/(\sigma-1)-(1/\gamma)))}$, where $\sigma=5$.
c. Extended Model refers to Chaney (2008) with product upgrading. Fixed trade barriers are derived from the assumption that all sources of change came from fixed barriers.
It is converted from the measured trade barriers by $t_M^{(1/((\alpha-1)/(\alpha(\sigma-1))-(1/\gamma)))}$, where $\sigma=5$ and $\alpha = 3.89$