Trade Restrictiveness and Deadweight Loss in China's Imports※

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[**Abstract**] China is believed to have gained extensively from accession to the WTO in 2001. One of the direct gains is from the lessening of deadweight loss (DWL) due to tariff reduction. Conventional measures for DWL, however, are too aggregate to capture the trade policies, which are determined at a much higher disaggregated level, and ignore the interactions between tariff and corresponding import demand as suggested by theories. In this paper, we first systematically estimate the import demand elasticities at a highly disaggregated level and then match them with the most detailed lines of the applied tariff for Most Favored Nations reported by the WTO. Using the detailed matching data, we construct Feenstra's (1995) simplified trade restrictiveness index (TRI) which captures the covariance of tariff and the corresponding demand elasticity. Finally, we use the TRI to compute the DWL in 1997 to 2008 and find the gain from DWL reduction due to WTO amounts for as much as 0.38% GNI in 2008.

***Keywords*:** demand elasticities, non-processing imports, deadweight loss (DWL)

JEL classification: F12, F14, O47

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1. Introduction

Over the recent two decades, China has undergone salient growth and liberalization in its international trade sector. For example, China's level of openness, as measured by total value of trade (i.e., sum of import and export) divided by national GDP, amounts to about 60 percent, a drastic jump from nearly 25 percent in 1989. While the whole world marvels at China's uprising as the so-called "world factory", relatively little attention has been given to China's quickly increasing imports. Figure 1 shows that China's import growth is of the similar magnitude as its export growth. To meet WTO's requirements, China has effectively removed many protection barriers against foreign imports. For example, the simple average of China's import tariff has been decreased from 17.51 in 1997 to 9.86 percent in 2008. As a result, China now not only serves as one of the largest exporters in the world, but is also one of the most attractive markets for international producers. The annual import into China has increased from 55 billion US dollars in 1988 to over 1.1 trillion US dollars after 20 years (see Figure 1). This trend's growth is especially drastic after China's accession into the WTO in 2001.

Two related empirical question following this trend naturally are: how much of the tariff barrier has China effectively removed and consequently how much welfare has China directly gained from reducing deadweight loss due to lowered tariffs? [1] The first question needs to be answered by a scalar measure (referred to as "trade restrictiveness"), that is, a uniform tariff rate which can reasonably summarize

[1] The gains from trade liberalization include not only reduction in tariff scheme, but also removal of non-tariff barriers (NTBs), and other protective measures such as antidumping. Due to data limitation, we will focus on trade liberalization in the form of import tariff reduction.

the detailed changes across over 5000 tariff lines. The ideal answer to the second question relies on information of detailed demand structures for thousands of imported products.

To answer the first question, many studies often resort to using simple or weighted averages[2] of all tariff lines[3]. Such measures, however, are neither theoretically solid nor empirically convincing. First of all, simple average neglects the huge difference of import values among import goods, and therefore does not take into account the disperse degrees of importance of different goods. Secondly, even though the value-weighted average tariff rate does treat imported goods differently, it does so in a misleading way. Goods subject to higher tariffs will be imported less and thus receive lower weights. Therefore, value-weighted average tariff rates tend to underestimate the real restrictiveness. One extreme case is that a prohibitive tariff will not be counted in the weighted average tariff rate since the import volume is virtually zero. Furthermore, goods usually have different price elasticities of demand, that is, their responsiveness to price change (due to imposing tariff) varies vastly. Therefore, these types of measures, which are lacking solid theoretical support, are in general not satisfactory gauges of real trade restrictiveness as pointed out by Rodriguez and Rodrik (2001).

Cipolina and Salvatici (2008) and Coughlin (2010) also survey and discuss literature on measuring trade restrictiveness and support the idea that an ideal restrictiveness (tariff) indicator should leave the country or a representative agent

[2] One common way is to use actual import volumes as weights.
[3] See, for example, Edwards (1998).

indifferent between facing the uniform tariff and facing otherwise various tariffs of different industries. For example, Kreikemeier and Moller (2008) and Falvey and Kreikemeier (2009) use this idea to discuss the welfare impact of tariff reform.

Anderson and Neary's (1992, 1994, 1996, 2003, 2007) seminal work, in particular, provided trade restrictive indexes on a sound theoretical ground. Essentially, they define a trade restrictiveness index (TRI) as a uniform tariff which generates the same aggregation results (i.e. welfare distortion, profit, volume, etc.) as the existing tariff structure.[4] Furthermore, their application shows the empirical applicability of the TRI in CGE models. However, though the CGE based indexes can take into account the income and substitution effects due to tariff changes and the interaction between tariff policy and domestic policies (i.e. taxation policy and monetary policy), they suffer from a serious problem: due to the constraints in CGE models, tariff changes have to be studied at an aggregated industry level which can not capture the heterogeneity of levels of protection within these industries.

Based on a partial equilibrium, which ignores the feedback effects in general equilibrium, Feenstra (1995) provides a simplified version of TRI which only requires import demand elasticities, import shares, and the tariff schedules. The greatly simplified TRI can be conveniently applied in econometric intensive approaches which allows for tractability of highly disaggregated tariff lines. Kee et al. (2008, 2009) applied Feenstra's (1995) TRI and estimate TRI indexes (as well as their trade barrier indexes) for a number of countries including both developed countries and

[4] See Anderson and Neary (2005) for a thorough discussion.

developing ones. Furthermore, Kee et al. (2008) also show that TRI can be conveniently applied to calculate countries' DWL defined at a highly disaggregated tariff line level which can be used to answer our second question.

This paper aims to measure the evolution of China's trade restrictiveness over the past decade, and the reduction of China's DWL due to decreasing tariff schedules. To be more specific, we first estimate the price elasticities, following the method proposed by Feenstra (1994) and Broda and Weinstein (2006). In particular, we utilize the most disaggregated product category available (Harmonized System at 8 digit, HS8) to do the estimation for as long as it's possible. We end up with several thousands of elasticities. We then combine those estimates of elasticities with import shares and tariff data to construct a measure of trade restrictiveness index (TRI) as suggested by Feenstra's (1995) and Kee et al. (2008, 2009). Reduction in TRI during 1997 to 2008 is then used to compute the yearly DWL reduction in China's imports. Furthermore, since China regained its membership with the WTO in the end of 2001, which is covered by our data, we could also roughly gauge how much China gained directly from its WTO accession. We find tariff reduction due to WTO accession accounts for welfare gain as much as 0.38% of GNI.

The most relevant paper to ours is Kee *et al* (2008). However, these two papers differ substantially from the method of estimating import demand elasticties which are the keys for computing DWL in both papers. Kee *et al* (2008) develops a production-based semi-flexible GDP function from Kohli (1991) and Harrigan (1997) and uses a panel estimation method to estimate the parameters needed in computing elasticities at HS6 levels. In contrast, we estimate our elasticities at HS8 levels based on the widely applied CES welfare function developed by Feenstra (1994) and Broda and Weinstein (2006). Our method may be superior to theirs in the following three aspects. First, their elasticities are (indirectly) estimated from a GDP maximization problem and thus they are not in line with the theoretically suggested Hicksian demand elasticities as in Feenstra (1995). In contrast, ours are Hicksian which are directly estimated from the widely used CES utility. Second, their elasticities non-linearly depend on the estimates of own price elasticities of GDP which are estimated by a panel analysis. That is, they have to assume that their own price elasticities are the same across 88 countries in the panel. Apparently, it is a fairly strong assumption since their own price elasticities typically depend on production technology which are rather different across countries.[5] Nevertheless, ours are estimated only from China's import data and thus we do not rely on this assumption. Third, the variances of their elasticities depend on those of their own price elasticities inflated by the square of the inverse HS6 level import shares. Since the import shares are typically fairly small at this disaggregated level, the variance of the elasticities are thus significantly inflated which makes the elasticities less accurate.

We make contributions on the following two fronts. First, we provide systematic import demand elasticity estimates for more than 6,200 import industries at the HS8 level (the most disaggregated import industry level available in China). Such highly disaggregated elasticities allow us to more accurately obtain the elasticities at

[5] Note: import demand derived from GDP is factor demand which is partly determined by the production technology.

higher aggregate levels (i.e. HS6 level in this paper).[6] We weight these highly disaggregated import demand elasticities to HS6 levels to match the HS6 tariff lines recorded by WTO, which, to our knowledge, is the first detailed study in China. Following Feenstra (1995), we construct TRI for China which takes into account not only the conventional weighted tariff but also the effects of tariff variance and their covariance with elasticities. The TRI allows us to closely compute the change on DWL in China over time and thus reveal the alleviation of tariff distortion thanks to the WTO. Second, we calculate China's DWL with correcting the problem of "processing imports" which is ignored in most existing literature including in Kee *et al* (2008). More than half of China's total imports in the most recent decade are imported intermediates for processing. As discussed in Chen and Ma (2010), unlike the ordinary imports processing imports enjoy free duty and are mainly used for producing exports.[7] Therefore processing imports does not actually suffer from tariff distortion and including them will seriously overstate the DWL. Furthermore, the majority of processing imports in China are conducted by multinationals via FDI, which usually have the "transfer pricing" problem. This problem typically distorts the prices of imports which may seriously bias our estimation for elasticities of substitution between varieties (as is clear in section 3). After correcting the disturbance of processing imports, our estimates of elasticities, TRI, and

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[6] Since empirical research on estimating import demand elasticities have to use unit values to proximate prices, which unavoidably incur the measurement error problem as unit of measure may be different across industries even at highly disaggregated levels. Though careful econometric treatments such as are applied to obtain unbiased estimates, the variance of the estimates are, however, effectively smaller as the measurement error would be reduced if we estimate at the more disaggregate levels. (See, for example, Broda, Greenfield , and Weinstein, 2006)

[7] There are, however, cases that processing imports are used for producing goods which are later sold within China. The share of this type is small and is captured as imports from China to China in the customs data.

corresponding DWL are all concerned with “ordinary imports”.

The rest of the paper is organized as follows. Section 2 overviews China’s imports and tariffs in the most recent decade. Empirical strategy for estimating import demand elasticities is discussed in section 3. Section 4 constructs a TRI and computes the DWL in China’s imports from 1997 to 2008. Section 5 concludes.

2. Data Overview

Our import data consists of import values and quantities as reported by the China Customs General at highly disaggregate level of HS 8 digit. However, since HS-8 was introduced by the Customs after 1996, our dataset covers only the most recent 12 years, from 1997 to 2008. Another notable feature for China’s import is that a significant share of imported products is imported intermediate inputs, which will be processed in China’s factories and then exported as finished goods. Because imports labeled as “for processing” are exempted from import tax or VAT[8], including processing imports in our empirical investigation will bias up the measure of the trade restrictiveness. Thus we will only consider non-processing trade in this paper. Figure 2 shows the basic trend of total imports and non-processing imports over the past two decades. And over time, share of non-processing trade initially decreases from over 70% to nearly 50%, and then eventually increases to two-thirds of the total imports. On average, we have more than 6,000 imported products, and each product has been sourced from over 10 countries. With this dataset, we could compute import shares,

[8] To be more precise, there are two subcategories within “processing” trade: processing and assembly, and processing with imported inputs. Under the first category, firms do not pay import tax or VAT, while for the second category, firms pay the taxes first and claim rebates when the finished goods are exported.

and estimate elasticities of imports as well.

Our tariff data comes from the WITS, which is at HS 6 digit level. An overlook of the data tells that the trade restrictiveness is eventually released over our sample period. This is shown in Figure 3, where we depict the simple and weighted average tariff rate, as well as the TRI which we will estimate in section 5. But even at the first glance, we could see that import-weighted average tariff tends to underestimate the restrictiveness than the other two measures. Measured with TRI instead of simple average tariff, we also see a sharp drop around 2001, when China formally regained its WTO membership.

3. Empirical Strategy

As is widely applied in trade and many other fields in economics, we assume a country's welfare on imports can be summarized by a constant elasticity of substitution (CES) function initially introduced by Dixit and Stiglitz (1997). That is, we assume that the elasticity of substitution between varieties, σ (sigma), within the same goods, g , is constant.[9] A remarkable feature of such CES functional form is that the elasticity of substitution between varieties, the sigma, can also be interpreted as the price elasticity of demand for a given imported goods.

As is standard in macro-level studies, a variety as defined by Armington (1969) is a country-goods pair. Particularly, a good in this paper is a HS-8 category and varieties of it are its exporting countries. For instance, "safety headgear" is a typical

[9] Intuitively, the elasticities, which reflect productivity or tastes, should not significantly change in a short period. For example, Broda, Greenfield, and Weinstein (2006) find that the elasticities of 77 countries do not significantly change during the two sub-periods: 1994-1998 and 1999-2003.

HS-8 product ("HS 65061000"). Suppose China imports this product from 6 different countries, then we shall treat "safety headgear" as a good with six imported varieties. A typical import demand function derived from the CES welfare maximization problem is shown as,

(1) $\Delta \ln s_{gvt} = \varphi_{gt} - (\sigma_g - 1)\Delta \ln p_{gvt} + \varepsilon_{gvt}$

where s_{gvt} is the imports share of variety v of goods g;[10] φ_{gt} acts as a random effect to capture the special characters of demand on goods g overtime; p_{gvt} is the price of variety v of goods g; ε_{gvt} is the error term; σ_g is the time invariant elasticity of substitution between varieties of good g and it is assumed bigger than unity to ensure a convex welfare. Finally, the difference operator "Δ" is applied between years to phase out goods-fixed effects.

However, equation (1) has two problems which result in biased estimation for the sgimas. First, there is a simultaneity problem. That is, supply curves facing the importing countries may be upward-sloping, which result in importing prices to increase with imports demands increase. Second, there is a measurement error problem. Since the prices of imports are usually not available, they are approximated by unit prices. Therefore, prices and demand may still be correlated.

To solve the simultaneity problem, we follow Broda and Weinstein (2006) and assume an up-ward sloping supply curve as equation (2).

(2) $\Delta \ln p_{gvt} = \psi_{gt} + \dfrac{\omega_g}{1+\omega_g}\Delta \ln s_{gvt} + \delta_{gvt}$

where ψ_{gt} is a random effect to capture the special characters of supply on goods g

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[10] Demand is expressed in terms of expenditure shares rather than quantities to avoid the potential measurement error imparted from the use of unit values. (See, Kemp, 1962)

overtime; $\omega_g \geq 0$ the inverse supply elasticity and δ_{gvt} is the error term which captures any random changes in the production technology.

Since both φ_{gt} and ψ_{gt} are unobserved random effects, we further difference equation (1) and (2) with a base country "b".[11] Then the "difference in difference" of the demand and supply equations is respectively given by equation (3) and (4):

(3) $\Delta^b \ln s_{gvt} = -(\sigma_g - 1)\Delta^b \ln p_{gvt} + \varepsilon^b_{gvt}$

(4) $\Delta^b \ln p_{gvt} = \dfrac{\omega_g}{1+\omega_g}\Delta^b \ln s_{gvt} + \delta^b_{gvt}$

where $\Delta^b x_{gvt} = \Delta x_{gvt} - \Delta x_{gbt}$. For the sake of identification, we assume that $E(\varepsilon^b_{gvt}\delta^b_{gvt}) = 0$. That is, demand and supply errors are uncorrelated once good and time specific effects are controlled for.

Multiplying (3) and (4), we obtain a "reduced form" as equation (5)

(5) $(\Delta^b \ln p_{gvt})^2 = \theta_1(\Delta^b \ln s_{gvt})^2 + \theta_2(\Delta^b \ln p_{gvt}\Delta^b \ln s_{gvt}) + u_{gvt}$

where $\theta_1 = \dfrac{\omega_g}{(1+\omega_g)(\sigma_g - 1)}$, $\theta_2 = \dfrac{1-\omega_g(\sigma_g - 2)}{(1+\omega_g)(\sigma_g - 1)}$, and $u_{gvt} = \varepsilon^b_{gvt}\delta^b_{gvt}$.

Note that equation (5) provides the relation between equilibrium prices (measured by unit prices) and quantities (measured by share) without the simultaneity problem as we assume $E(u_{gvt}) = E(\varepsilon^b_{gvt}\delta^b_{gvt}) = 0$. However, equation (5) still suffers from the measurement error problems which results in OLS estimates of $\beta_g = \begin{pmatrix} \sigma_g \\ \omega_g \end{pmatrix}$ inconsistent. Feenstra (1994) proposes that consistent estimates can still be obtained if we exploit the panel nature of the data set and assume constant supply and demand elasticities for the same good over time. Particularly, averaging equation (5)

[11] The base country is varied across goods. Basically, the based country of goods "g" just needs to be the country which exports "g" every year or most frequently during 1997 to 2008.

overtime, the error term $\overline{u_{gv}}$ is independent of the regressands given σ_g and ω_g is time invariant. Then the unbiased estimates can be obtained from equation (6).

$$(6) \qquad \overline{(\Delta^b \ln p_{gv})^2} = \theta_1 \overline{(\Delta^b \ln s_{gv})^2} + \theta_2 \overline{(\Delta^b \ln p_{gv} \Delta^b \ln s_{gv})} + \overline{u_{gv}}$$

where $\bar{x}$ denotes the time average.

We use GMM to exploit the independence of the unobserved demand and supply disturbances for each country over time. According to Feenstra (1994), we can define a set of moment conditions such that

$$(7) \qquad G(\beta_g) = E_t(u_{gvt}(\beta_g)) = 0 \ \forall \ v$$

as long as all countries exporting good *g* satisfy the following condition:

$$\chi^2_{\varepsilon^b_{gv}} / \chi^2_{\varepsilon^b_{gv}} \neq \chi^2_{\delta^b_{gv}} / \chi^2_{\delta^b_{gv}}$$

where χ^2_x is the variance of *x*. Equation (7), therefore, gives us V_g independent moment conditions for each good *g* to estimate the two parameters of interest. For each good *g*, the following objective function can be used to obtain Hansen's (1982) estimator:

$$(8) \qquad \hat{\beta}_g = \arg\min_{\beta \in B} G^*(\beta_g)' W G^*(\beta_g)$$

where $G^*(\beta_g)$ is the sample analog of $G(\beta)$; *W* is a positive definite weighting matrix; and *B* is the set of economically feasible β such that $\sigma_g > 1$ and $\omega_g \geq 0$. Specifically, the weighting matrix, *W*, is related to the time span and the inverse of lagged import quantities as in Broda and Weinstein (2006). We first estimate θ_1 and θ_2 and then solve for β_g. The standard errors for β_g are derived using the delta method. In the case that estimates are ill-defined, we use a grid search of β's over the space defined by *B*. In particular, we compute the minimized GMM objective function over $\sigma_g \in [1.05, 200.5]$ at intervals which are 5 percent apart. Standard errors of β_g in this case are obtained by bootstrapping the grid-searched parameters.

4. TRI and DWL

We use the following steps to calculate the deadweight loss due to tariff cuts during 1997 to 2008. First, we estimate the elasticity of substitution (among the varieties), σ_g , for thousands of HS 8-digit goods and aggregate them to HS-6 level to match with the tariff data. Next, we calculate the TRI by computing not only the import weighted tariff, but also the variance of the tariff and its covariance with elasticities. Finally we apply the TRI to compute the DWL in 1997 to 2008.

4.1 Elasticities of Substitution

We successfully estimate the sigmas for 6243 HS-8 import goods.[12] It is impossible to report all the sigmas. Instead, we report in Table 1 the means of estimated sigmas for 16 HS-2 aggregation categories.

[Insert Table 1 here]

In column (3), Table 1 shows that the most important imports are mineral products and electrical products, which account for 33.46% and 26.87% of the total imports respectively. Column (4) reports the number of HS-8 goods in each industry that have estimated sigmas. Relatively much more differentiated goods are in Machinery/Electrical and Textiles industries than others, which allow us to obtain 1435 and 1009 sigmas respectively. Column (5) reports the median varieties per HS-8

[12] We abandon 6 outliers with sigmas range in 206 to 947. They only account for 0.03% of the imports. Including them would seriously affect the variance of sigmas and covariance between sigmas and tariffs, which are the key parameters for DWL calculation as in section 4.2.

goods, which ranges from the lowest of 3.70 in transportation to the highest of 5.83 in Rubbers, Raw Hides, Shins, Leather. The most important results, the sigmas, are reported in column (6) and (7). The simple average of sigmas ranked from the smallest of 1.56 in mineral products to the largest of 3.03 in wood products. The overall rank of simgas is preserved when weighted by imports value. However, except Electrical Products, the weighted average of sigmas are much smaller than the unweighted ones. Besides the reports in table 1, we also compute the overall weighted average of sigmas which is about 1.46.

As a comparison, Broda, Greefield, and Weinstein (2006, hereafter, BGW) estimate the import demand elasticities for 73 countries in the world including China. They employ the HS-6 digit data from COMTRADE database from 1994-2003 and aggregate the elasticities at the HS-3 digit level. Based on similar estimation method, they report that the median import elasticities of China about 3.4 and simple average is about 6.2, which seems a little bit larger than our estimates but in the same magnitude. Except the time coverage difference (we contain more post-WTO data), the small discrepancy between our findings and BGW's (2006) is mainly due to the fact that goods at the HS2 level are in general less substitutable than at HS-3 level. As stated in the empirical strategy, sigma is the elasticity of substitution between varieties. A lower sigma implies less substitutable variety. Since goods in more aggregated level are intuitively less substitutable, we are expected to find smaller sigma's than those in BGW (2006). Another comparison is with Kee *et al.* (2008). They employ HS-6 data during 1988 to 2001 and use a rather different estimating strategy. They report that the simple average of the China's import elasticities (HS-6 level) is 7.26 but the weighted one is only 1.44. That is, our weighted average sigma, which is 1.46, is surprisingly very close to theirs. Though it is hard to argue which estimation is more precise, ours is at least in line with the relevant works in general.

Next, we aggregate the sigmas at HS-8 level to HS-6 level to match the tariff data. That is, the HS-6 sigmas are the weighted ones at the HS-8 level in the same HS-6 category where the weights are the corresponding HS-8 imports values. Though we eventually also have sigmas at HS-6 level as in Kee et al. (2008), ours have two advantages to theirs. First, the HS-6 level sigmas are obtained from HS-8 level which are based on finer/more disaggregated data and thus have better quality. Second, we can effectively obtain more sigmas at the HS-6 level. Unlike Kee et al (2008), we do not drop any HS-6 lines due to missing sigmas whereas they drop 15% of the HS-6 lines which cover 13% of the imports. Based on sigmas at HS-8 level, we can naturally obtain more HS-6 level sigmas in the first place. Of course, mainly due to data availability, it is not possible to match all the tariff line at HS-6 level.[13] However, since consumers usually have similar tastes on similar goods, we assume a missing sigma can be extrapolated based on sigmas of similar goods (i.e. the HS-6 goods under the same HS-4 category). Thus we approximate a missing HS-6 sigma by the weighted average of the sigmas in the rest of the HS-6 industries that are under the same HS-4 category.

4.2. Constructing TRI and Calculating DWL

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[13] For example, to estimate equation (6), we need at least four supplying countries in each HS-8 goods that survive at least two years.

We directly apply our elasticities estimates to the Feenstra (1995) TRI, as specified below,

$$(9) \qquad TRI_t = \left[\frac{\sum_n s_{nt}\sigma_n t_{nt}^2}{\sum_n s_{nt}\sigma_n}\right]^{1/2}$$

where s_n is the import share of goods *n* (defined at HS-6 level), σ_n is the corresponding elasticity of substitution which is time invariant and t_n is the corresponding tariff, the subscript *t* denotes year.

Kee *et al.* (2008) show that the Feenstra's (1995) TRI as in equation (9) can be simply expressed as a function of weighted tariffs ($\bar{t}$), variance of the tariffs (δ^2), and the covariance between tariffs and the corresponding import demand elasticities (ρ). The relevant variables are defined as follows:

import weighted tariff: $\bar{t}_t = \sum_n s_{nt}t_{nt}$; variance of tariffs: $\delta_t^2 = \sum_n s_{nt}(t_{nt} - \bar{t}_t)^2$;

import weighted elasticity of substitution: $\bar{\sigma}_t = \sum_n s_{nt}\sigma_n$;

adjusted elasticities: $\tilde{\sigma}_{nt} \equiv \dfrac{\sigma_n}{\bar{\sigma}_t}$; and the covariance: $\rho_t = Cov(\tilde{\sigma}_{nt}, t_{nt}^2)$.

Note that though individual elasticity is time invariant, their average and the adjusted ones are time variant since the weights change overtime. TRI can be rewritten as equation (10):

$$(10) \qquad TRI_t = \left[\sum_n s_{nt}\tilde{\sigma}_{nt}t_{nt}^2\right]^{1/2} = [E(\tilde{\sigma}_{nt}t_{nt}^2)]^{1/2} = [\bar{t}_t^2 + \delta_t^2 + \rho_t]^{1/2}$$

Eqaution (10) clearly reveals that TRI is theoretically consistent: as suggested by TRI, trade restriction should be higher than otherwise suggested by the weighted average tariff if the tariffs have big variance and the tariffs are positively related to the import demand elasticities. Intuitively, higher variance of tariffs implies a higher probability of highly distortionary or even prohibitive tariffs on some specific industries. Furthermore, the restriction would be more severe if higher tariffs are imposed on goods with higher demand elasticities (i.e. more sensitive to price changes).

Table 2 reports the TRI in China in 1997 to 2008. The second column reports the weighted average of elasticities. The variation after 2001 is fairly small: it ranges from the lowest of 1.44 in 2002 to the highest of 1.52 in 2005. What's amazing is that the weighted average elasticity in our paper, though estimated from a different method and weighted by only ordinary (i.e. non-processing) imports, is very close to 1.44, which is the weighted average elasticity reported in Kee *et al.* (2008). The 3rd and 4th Columns report simple average tariff and TRI. Both measures reveal that China effectively reduce its tariff barrier after 2001, the year China ascended to WTO. But such WTO effect seems gradually fades away in 2007 and 2008. The trade restrictiveness indicated by TRI is higher than otherwise suggested by the simple average tariff except 2007 and 2008. The reason can be uncovered from the decomposition of TRI as reported in the 5th to the 7th column. Compared to the simple average tariff, TRI is higher in early years mainly due to the high variation of tariffs. Faster decrease in TRI can be attributed to the great reduction of the variation. This reduction indicates that China not only reduces overall tariff but also reduces more on the relatively higher tariff. As a result, tariff rates are more harmonized and variance is significantly smaller. Though the covariance turns from negative during 1997 to 2001 to positive in later years, it does not effectively offset the fast reduction in average tariff and its variance.

Finally, following Kee *et al.* (2008), the DWL given TRI and its decomposition can be calculated from equation (11):

$$DWL_t = \frac{1}{2} IMP_t \sum_n s_{nt}\sigma_n t_{nt}^2 = \frac{1}{2}(TRI_t)^2 \sum_n s_{nt}\sigma_n$$
$$= \frac{1}{2} \underbrace{\bar{t}_t^{\,2} IMP_t \overline{\sigma}_t}_{\text{weighted average tariff}} + \frac{1}{2} \underbrace{\sigma_t^2 IMP_t \overline{\sigma}_t}_{\text{tariff variance}} + \frac{1}{2} \underbrace{\rho_t IMP_t \overline{\sigma}_t}_{\text{tariff-elasticity covariance}} \tag{11}$$

where *IMP* denotes the total import value.

Equation (11) shows that the total DWL can be further decomposed into the losses from weighted average tariff, tariff variance and tariff-elasticity covariance, respectively.

Table 3 reports the DWL in China's imports in 1997 to 2008. It reveals that the DWL peaks in 2001 with the largest loss of USD 6406 million, followed with a sharp drop in 2002 with a loss of USD 2157 million, then the loss modestly grows with some variations till 2008.[14] Considering the decreasing TRI after 2001, the growing loss is mainly owing to the fact the China's imports after 2001 has increased rapidly. That is, the base for calculating DWL has significantly expanded. Similar dynamic patterns are reported in the decomposed DWL due to average tariff and tariff variance. Though the loss pattern due to covariance seems different, it has a rather small impact on the overall loss pattern since the impact of covariance is dominated by the other two factors. The alleviation of DWL due to tariff reduction, however, can be better measured by the DWL-GNI ratio as reported in the 3rd column. Compared to 2001, China's income/welfare loss due to the existence of tariff barrier is significantly

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[14] The currency unit is current dollar. But the dynamic pattern will not change even if we use real dollar.

reduced from 0.49% to 0.11%. In other word, we have save about 0.38% of income from tariff distortion mainly thanks to the WTO's effective removal of tariff barrier.

5. Conclusion

The past decades have seen enormous liberalization in China's foreign trade. Though the literature discusses intensively on the surge in China's exports, relatively few studies focus on its imports, which is of similar magnitude in recent years. This paper aims to measure how restrictive China is regarding foreign imports. The reduction in trade restrictiveness helps us to understand the welfare gain from reducing DWL due to less distortionary tariff schedules.

To make this goal, we use extremely disaggregated import data from 1997 to 2008 in order to estimate the demand elasticities for 6243 import goods. Such detailed elasticities then allow us to construct a good measure of trade restrictiveness index (TRI), following the methodology proposed in Feenstra (1994) and Kee, *et al.* (2008). We find the movement of TRI over our sample period, 1997-2008, is much more dramatic compared with the conventional measure of protection such as the simple or weighted average of tariff schedules. Moreover, given our estimates of TRIs, we predict that the direct reduction of DWL from WTO accession amounts to more than one third of a percentage point of GNI.

Reference

Anderson, James, and Peter Neary, 1992. "Trade reforms with quotas, partial rent retention and tariffs", Econometrica, vol. 60(1): 57–76.

___, 1994, "Measuring the restrictiveness of trade policies", *World Bank Economic Review,* 8 (2): 151-169.

___, 1996, "A New Approach to Evaluating Trade Policy," *Review of Economic Studies*, 63, February, 107-125.

___, 2003, "The Mercantilist index of trade policy", *International Economic Review,* 44(2): 627-649.

___, 2005, *Measuring the Restrictiveness of Trade Policy*. Cambridge, MA: MIT Press.

___, 2007, "Welfare Versus Market Access: The Implications of Tariff Structure for Tariff Reform", *International Economic Review*, 44(2): 627-649.

Armington, Paul, 1969, "A Theory of Demand for Products Distinguished by Place of Production," *International Monetary Fund Staff Papers*, XVI (1969): 159-78.

Broda, C., and D. Weinstein 2006, "Globalization and the Gain from Variety," *Quarterly Journal of Economics* 121(2):541-585.

Broda, C., J. Greenfield, and D. Weinstein, 2006, "From Groundnuts to Globalization: Structural Estimate of Trade and Growth." *NBER Working Paper 12512*.

Chen, Bo, and Hong Ma, 2010, "Import Variety and Welfare Gain in China", SHUFE and Tsinghua Univeristy, mimeo.

Cipollina, Maria and Luca Salvatici, 2008. "Measuring Protection: Mission Impossible?" *Journal of Economic Surveys*, Vol. 22(3): 577–616.

Coughlin, Cletus C., 2010. "Measuring International Trade Policy: A Primer on Trade Restrictiveness Indices", *Federal Reserve Bank of ST. Louis Review*, September/October, *92*(5): 381-94.,

Dixit, Avinash K. and Joseph E. Stiglitz, 1977, "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, 67, 297-308.

Edwards, S., 1998, "Openness, Productivity and Growth: What Do We Really Know?" *Economic Journal*, 108: 383-398.

Falvey, Rod and Udo Kreickemeier, 2009. "Tariff reforms with rigid wages", *Economic Theory*, 41:23–39.

Feenstra, Robert. 1994, "New Product Varieties and the Measurement of International Prices," *American Economic Review*, 84(1), March: 157-177.

Feenstra, Robert, 1995 "Estimating the Effects of Trade Policy," in Gene Grossman and Kenneth Rogoff (Eds.), *Handbook of International Economics*, vol. 3 Amsterdam: Elsevier.

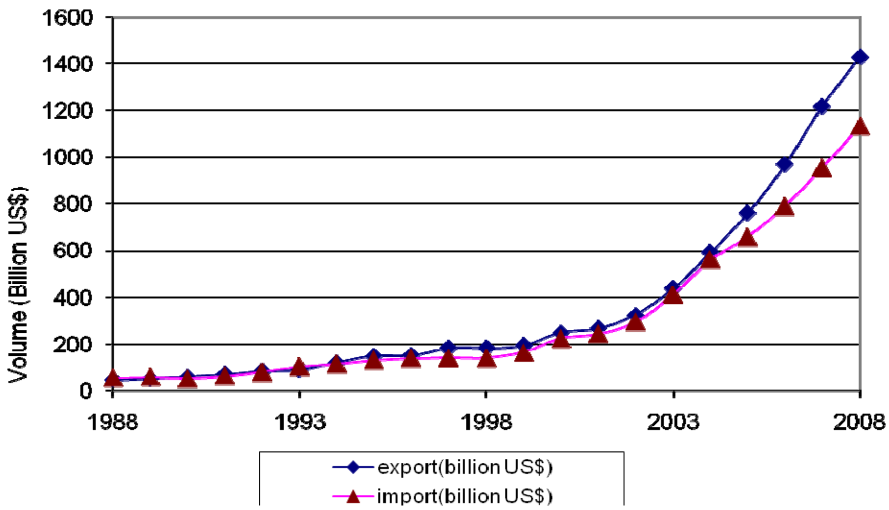
Hansen, Lars.P. (1982), "Large Sample Properties of Generalized Method of Moments Estimators." *Econometrica* 50(4), 1029-54.

Harrigan, James, "Technology, Factor Supplies, and International Specialization: Estimating the Neoclassical Model," *American Economic Review* 87 (September 1997), 475–494.

Kee, H.-L., A. Nicita, and M. Olarreaga, 2008, "Import Demand Elasticities and Trade

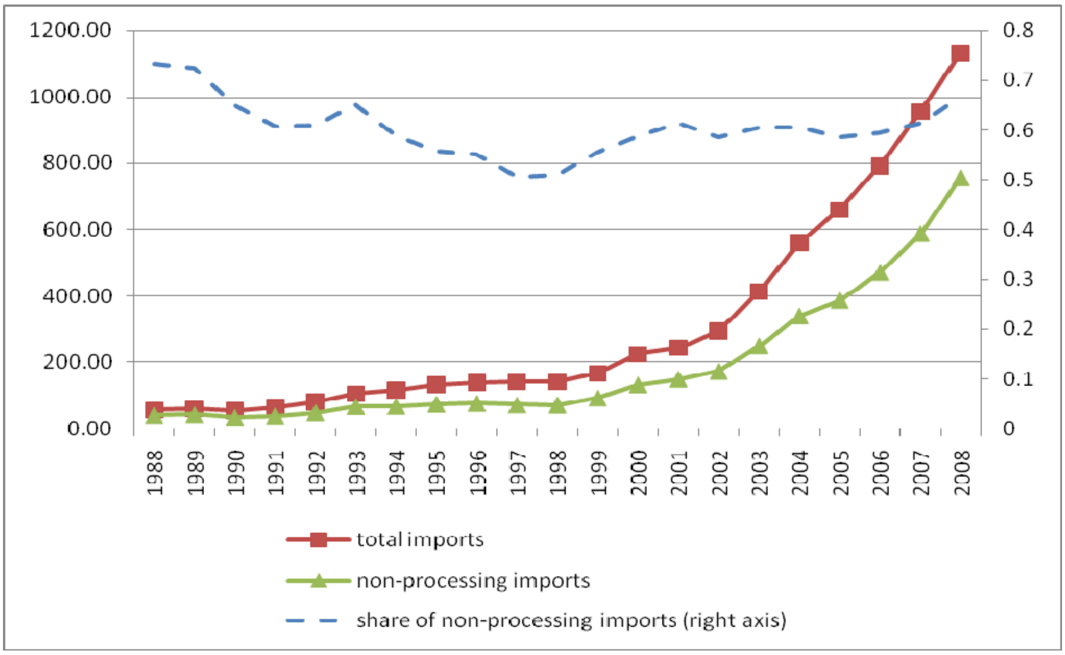
Distortions", *Review of Economics and Statistics*, Vol. 90(4): 666-682.
___, "Estimating Trade Restrictiveness Indices", *EconomicJournal*, January 2009, *119*(534):172-99.
Kohli, Ulrich, "*Technology, Duality, and Foreign Trade: The GNP Function Approach to Modeling Imports and Exports"* Ann Arbor: University of Michigan Press, 1991.
Kreickemeier, Udo and Pascalis Raimondos-Møller, 2008. "Tariff–tax reforms and market access", Journal of Development Economics 87: 85–91.
Rodriguez, F. and Rodrik, D., 2001. "Trade policy and growth: a skeptic's guide to the cross national evidence", in Ben Bernanke and Kenneth S. Rogoff (eds), Macroeconomics Annual 2000: 261–324.
Spence, Michael, 1976, "Product Selection, Fixed Costs, and Monopolistic Competition," *Review of Economic Studies*, 43(2): 217-235.

Figure 1: China's Export and Import, 1988-2008



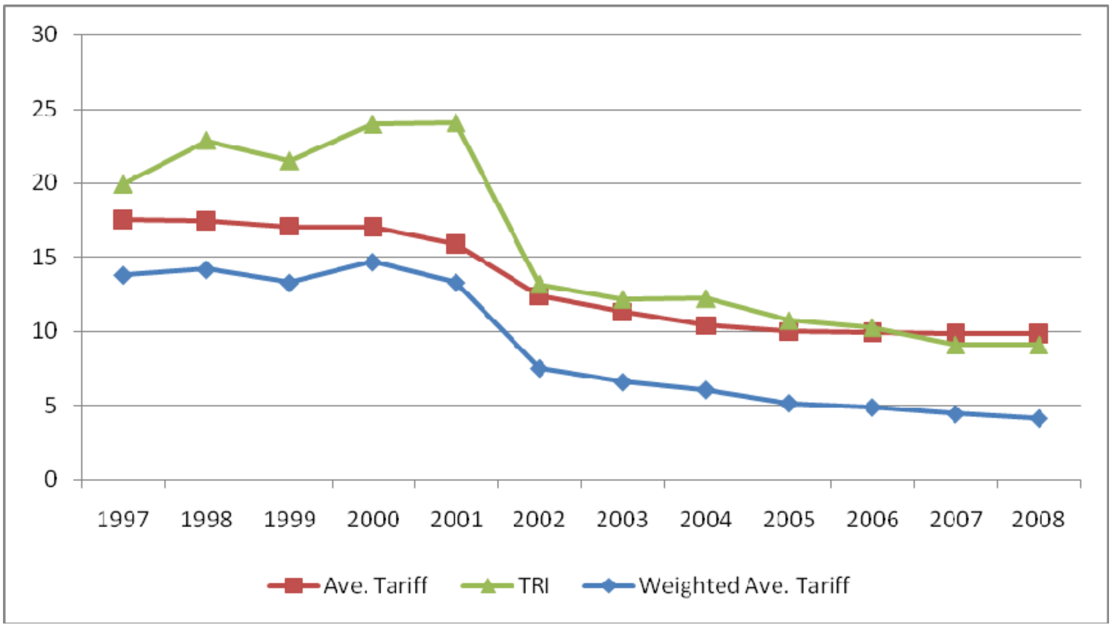
Source: Customs General, PRC.

Figure 2: Total Imports and Non-Processing Imports



Source: Customs General, PRC.

Figure 3: Simple and Weighted Average Tariff Versus TRI



Source: Customs General, PRC. and Authors' own calculation based on data from the WITS Tariff Database and China Customs General.

TABLE 1 SIGMA'S FOR HS-2 AGGREGATION LEVEL

HS-2 Code	Industry	Average import share* (%)	Number of HS-8 goods	Varieties per HS-8 goods	Sigma Simple Average	Sigma Weighted Average	Standard error**
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
01-05	Animal & Animal Products	0.64	132	3.71	2.250	1.566	0.385
06-15	Vegetable Products	4.76	210	3.81	2.747	1.058	0.379
16-24	Foodstuffs	0.78	184	3.84	1.946	1.080	0.360
25-27	Mineral Products	33.46	141	3.52	1.561	1.017	0.501
28-38	Chemicals & Allied Industries	7.81	739	5.24	1.814	1.764	0.220
39-40	Plastics / Rubbers	4.20	249	5.83	1.665	1.065	0.465
41-43	Raw Hides, Skins, Leather, Furs	0.35	115	3.69	1.972	1.173	0.334
44-49	Wood & Wood Products	2.65	336	4.28	3.033	2.138	0.508
50-63	Textiles	1.25	1009	4.55	2.116	1.238	0.380
64-67	Footwear / Headgear	0.10	53	4.69	1.825	1.913	0.205
68-71	Stone / Glass	0.75	223	4.65	2.404	1.944	0.318
72-83	Metals	6.55	656	5.11	2.070	1.458	0.435
84-85	Machinery / Electrical	26.87	1435	5.08	1.916	1.553	0.074
86-89	Transportation	5.13	238	3.70	2.233	1.637	0.131
90-97	Miscellaneous	4.38	484	5.06	2.660	1.351	0.156

(*) It is the average import share throughout 1997 to 2008.

(**) Estimates of the mean sigmas and standard errors are adjusted for parameter censoring.

Source: Authors' calculation.

Table 2 Trade Restrictiveness Indexes in China: 1997-2008

Year	Simple Average Tariff	Trade Restrictiveness Index (TRI)	Decomposition of TRI		
			Average	Variance	Covariance
1997	17.51	19.91	13.70	213.95	-5.17
1998	17.43	22.85	14.88	301.81	-1.17
1999	17.04	21.48	14.14	265.62	-4.25
2000	16.98	23.95	14.97	357.93	-8.58
2001	15.88	24.05	14.98	363.24	-9.43
2002	12.37	13.17	8.37	90.26	13.01
2003	11.30	12.16	7.50	77.54	13.99
2004	10.41	12.21	7.08	75.53	23.47
2005	9.99	10.71	6.27	56.40	19.01
2006	9.95	10.26	5.80	53.92	17.69
2007	9.86	9.08	5.16	43.18	12.68
2008	9.86	9.08	5.04	41.57	15.58

Source: Authors' own calculation based on data from the WITS Tariff Database and China Customs General.

Table 3 Deadweight Loss Due to Import Tariff in China: 1997-2008

Year	Total Deadweight Loss [a] (DWL)	DWL as Percentage of GNI	Decomposition of DWL		
			Average	Variance	Covariance
1997	2325.63	0.25	1101.13	1254.80	-30.30
1998	3022.16	0.30	1281.55	1747.36	-6.75
1999	3336.09	0.31	1446.31	1920.49	-30.70
2000	5673.39	0.48	2217.51	3540.75	-84.87
2001	6406.06	0.49	2486.52	4024.04	-104.50
2002	2156.61	0.15	871.74	1123.02	161.85
2003	2699.67	0.17	1027.12	1416.91	255.65
2004	3747.59	0.19	1259.16	1898.56	589.87
2005	3359.61	0.15	1150.06	1652.54	557.02
2006	3700.83	0.14	1183.60	1895.44	621.80
2007	3595.38	0.11	1160.92	1881.73	552.73
2008	4590.16	0.11	1410.56	2312.84	866.76

Note: a. Losses are measured in current million US dollars.

Source: Authors' own calculation.