Appendix A
The Computable Partial Equilibrium Model

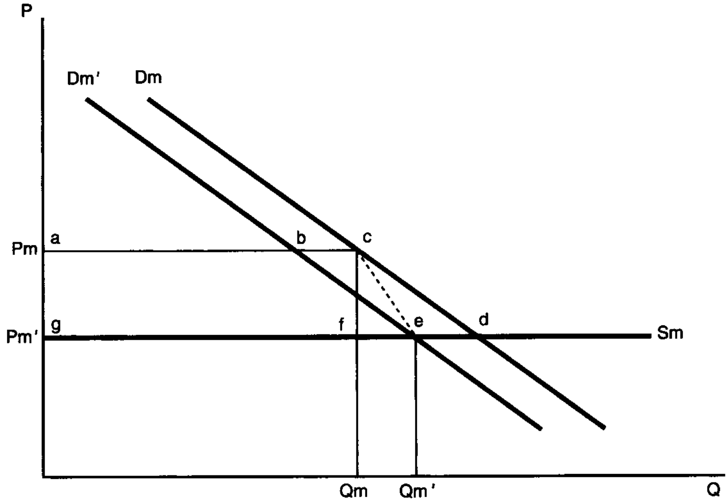
To facilitate international comparison, the same computable partial equilibrium model that was used to compute the costs of protection in the United States, Japan, and South Korea is used for China.[1] Compared with the computable general equilibrium approach, this partial equilibrium model is simple and easy to use. However, the methodology has several limitations. For example, it does not capture relationships between sectors, which a general equilibrium approach would capture. A further limitation of the partial equilibrium approach, which is also applicable to the general equilibrium approach, is that various aspects of China's reform process—the step-by-step nature of liberalization, the coexistence and resulting conflicts between central authority and increasingly independent local authorities, and rampant rent seeking—are hard to quantify. Moreover, it is not feasible for us to assess the dynamic gains of trade liberalization. Nevertheless, we believe that this study and its methodology serve as a preliminary investigation into the costs of protection in China. We hope that our work will lay a foundation for further investigation of the benefits of trade liberalization that takes into account the limitations of this study.

The four key assumptions of the computable partial equilibrium model are:

- Domestic and imported goods are not perfect substitutes.
- The supply schedule for imported goods is flat (perfectly elastic).

1. The computable partial equilibrium model was devised by Peter Uimonen (see Hufbauer and Elliot 1994).

Figure A.1 Effects in the import market of removing a trade barrier



With the trade barrier in place, the price of the import in the protected market is *Pm*, and the quantity imported is *Qm*. Following liberalization, the price falls to *Pm*′, the world price. Then, responding to a lower price in the domestic market (see figure A.2), the demand schedule for the import shifts from *Dm* to *Dm*′, and the quantity imported settles at *Qm*′.

- The supply schedule for domestic goods slopes upward (less than perfectly elastic).
- All markets are perfectly competitive.

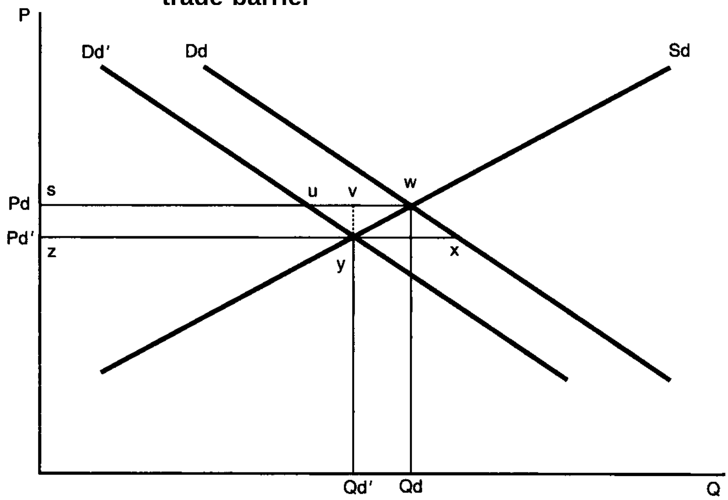
The static effects of removing a trade barrier (either a tariff or a quota) are illustrated in figures A.1 and A.2. In figure A.1, the supply curve for imports (*Sm*) is flat, corresponding to a ''small country'' with an open economy. According to a fundamental assumption of this model, a small country is a ''taker'' of world market prices and does not influence their level.[2] *Pm*′ is the world market CIF price (expressed in yuan); with the trade barrier in place, the landed price of imported goods in the protected home market is *Pm* (expressed in yuan):

$$Pm = Pm' (1 + t + n), \qquad \text{(A.1)}$$

where t is the tariff rate (percent ad valorem) and n is the tariff equivalent of nontariff barriers (percent ad valorem). After liberalization (assuming the removal of all trade barriers), the landed price falls to *Pm*′. Then, responding to the lower price in the domestic market (see figure A.2),

2. Obviously, China is not a ''small country.'' But, at this stage, China's foreign trade does not have a decisive impact on world market prices.

Figure A.2 Effects in the domestic market of removing a trade barrier



With the trade barrier in place, the price of the import-competing domestic product is *Pd*, and the quantity demanded is *Qd*. Following liberalization and the decline in the import price (see figure A.1), demand for the domestic substitute falls, shifting the demand curve from *Dd* to *Dd'*, the quantity consumed falls to *Qd'*, and the price drops to *Pd'*.

the demand curve for imports shifts from *Dm* to *Dm'*, and the quantity imported settles at *Qm'*, which is higher than the initial quantity imported, *Qm*.

Trade liberalization will have a series of welfare effects. The consumer surplus gain from liberalization in the import market is approximated by the area *aceg* (figure A.1). Area *acfg* represents transfers from the government to consumers in the form of lost tariff revenues and transfers from those who controlled quotas to consumers in the form of lost quota rent. The import market will also experience an efficiency gain because resources will be better utilized. Before liberalization, the wedge between the landed price of the imports and the world market price lured resources toward the production of import substitutes and away from other sectors that could have made more efficient use of those resources. After liberalization, the process is reversed. The efficiency gain following liberalization is represented by the area *cef*.[3] Area *acfg* plus *cef* add up to area *aceg*, the total gains realized by consumers.

In figure A.2, the supply curve for the import-competing domestic product (*Sd*) slopes upward. With the trade barrier in place, the price of the domestic product is *Pd* (expressed in yuan), and the quantity demanded is *Qd*. Following liberalization and the decline in the import price (figure A.1), the demand curve for the domestic substitute shifts from *Dd* to

3. See Jones (1993) for mathematical proof that this method is valid.

Dd', the quantity consumed falls to Qd', and the price drops to Pd'. The consumer surplus gain from lower domestic prices may be approximated by the area marked *swyz*, which is just offset by the producer surplus loss.

To summarize the welfare effects on the two markets following liberalization, the efficiency gain is the area *cef*, and the total consumer surplus gain is the area *aceg* + *swyz*. Of this total, area *acfg* is the transfer to consumers from the government and quota rent collectors, and area *swyz* is the transfer to consumers from domestic producers.[4] Because the model only calculates static welfare, it might substantially underestimate the contribution that trade expansion makes to economic growth.

To derive solutions for individual industries, a computable partial equilibrium model corresponding to figures A.1 and A.2 was devised. The model assumes that supply and demand relationships are not linear in their absolute terms, but rather that they are linear in their logarithmic terms. This assumption enables the parameters associated with the price terms to be interpreted as elasticities.

The underlying domestic supply and demand functions are specified according to the following equations:

$$Qd = aPd^{Edd}Pm^{Edm} \tag{A.2}$$

and

$$Qs = bPd^{Es}. \tag{A.3}$$

In equation A.2, *Edd* is the own-price elasticity of demand for the domestic good, while *Edm* is the cross-price elasticity of demand for the domestic good with respect to the price of the imported good. In equation A.3, *Es* is the own-price elasticity of supply of the domestic good. Because the domestic good and the imported good are imperfect substitutes in this model, equilibrium in the domestic market requires that domestic demand equal domestic supply (i.e., $Qd = Qs$).

Assuming that the supply of the import is perfectly elastic, the demand and supply equations in the import market are:

$$Qd = aPd^{Edd}Pm^{Edm} \tag{A.4}$$

and

$$Pm = Pm'(1 + t + n)(1 + Rv)/(1 - Rc). \tag{A.5}$$

In equation A.4, *Emd* is the cross-price elasticity of demand for the

4. The tariff revenue plus quota rent (area *acfg*) may be estimated as $Qm(Pm - Pm')$. The efficiency loss due to protection (area *cef*) may be estimated as $(1/2)\,[(Pm - Pm')\,(Qm' - Qm)]$. And the consumer surplus loss in the domestic market due to protection (area *swyz)* may be estimated as $Qd'(Pd - Pd') + (1/2)\,[(Pd - Pd')(Qd - Qd')]$.

imported commodity with respect to the price of the domestic commodity, while *Emm* is the own-price elasticity of demand for the imported commodity. Equation A.5 represents the assumption that the supply of the imported commodity is perfectly elastic, and that the world market CIF price, Pm', is therefore the same regardless of import quantity. In equation A.5, *Rv* represents the value-added tax rate for imports, and *Rc* represents the consumer tax rate.[5]

This system of supply and demand functions may be converted into a system of linear relationships by taking the logarithms to the base *e* (shown by ln) of equations A.2, A.3, A.4, and A.5:

$$\ln Qd = \ln a + Edd \ln Pd + Edm \ln Pm \quad \text{(A.6)}$$

$$\ln Qs = \ln b + Es \ln Pd \quad \text{(A.7)}$$

$$\ln Qm = \ln c + Emd \ln Pd + Emm \ln Pm \quad \text{(A.8)}$$

$$\ln Pm = \ln[Pm'(1 + t + n)(1 + Rv)/(1 - Rc)] \quad \text{(A.9)}$$

Equations A.6, A.7, A.8, and A.9 are used to calculate the welfare effects of liberalization. The calculation involves three basic steps: first, we estimate the elasticity parameters required for each product; second, we estimate the protective price premium $(t + n)$ for each product and substitute all values of the parameters and data into equations A.6 through A.9, together with the equilibrium condition $Qd = Qs$, to find the postliberalization quantities and welfare effects; third, we analyze the model's results and derive realistic conclusions on China's trade system efficiency and the impact of liberalization.

5. Both value-added and consumer taxes are levied by the State General Administration of Taxation. See appendix B for the tax formulas.

Appendix B
Calculating Tariff and Nontariff Barriers ($t + n$)

According to the Chinese tariff and tax regulations effective in January 1994, import charges include the following: tariffs, value-added taxes for imports (two rates, 13 and 17 percent), and consumer taxes (14 rates).[1] When nontariff barriers exist (quotas, etc.), their tariff equivalent can be added to the tariff, following the methodology in Hufbauer and Elliot (1994) and Sazanami, Urata, and Kawai (1995).

Let:

T	=	tariff (yuan)
t	=	tariff rate (percentage ad valorem)
n	=	tariff equivalent of nontariff barrier (percentage ad valorem)
VAT	=	value-added tax rate for imports (yuan)
Rv	=	value-added tax rate for imports (percentage)
CT	=	consumer tax (yuan)
Rc	=	consumer tax rate (percentage)
GT	=	gross tax (yuan)
Pm'	=	CIF price of imported goods (dollars per unit); note that Pm' is the same as in appendix A, except that Pm' is expressed here in dollars.
Pm	=	landed price of imported goods in the protected domestic market, including all tariffs, taxes, and quota rents (dollars per unit)

1. According to China's Temporary Regulations on Consumer Tax, China levies consumer tax only on the following 11 imported goods: cigarettes, wine, cosmetics, shampoo, precious jewelry, gasoline, diesel oil, tire, fireworks, motorcycles, and sedans.

The calculation of the tax and tariff burden runs as follows. The tariff calculation is straightforward:

$$T = Pm' \times t. \tag{B.1}$$

In the Chinese system, the consumer tax is levied on a base that includes the tariff and the consumer tax but excludes the value-added tax:

$$CT = \left(\frac{Pm' + T}{1 - Rc}\right) \times Rc. \tag{B.2}$$

The VAT is imposed on a base that includes the consumer tax and the tariff:

$$VAT = (Pm' + T + CT) \times Rv. \tag{B.3}$$

Substituting B.1 into B.2:

$$CT = Pm' \times \left(\frac{1 + t}{1 - Rc}\right) \times R. \tag{B.4}$$

Substituting B.1 and B.4 into B.3:

$$VAT = Pm' \times \left(\frac{1 + t}{1 - Rc}\right) \times Rv. \tag{B.5}$$

By definition, the gross tax is defined as follows:

$$GT = T + CT + VAT. \tag{B.6}$$

Hence, the landed price of imports on the domestic market can be expressed as follows:

$$Pm = Pm' + GT = Pm' \times \left[\frac{(1 + t)(1 + Rv)}{1 - Rc}\right]. \tag{B.7}$$

When a nontariff barrier exists, we replace t with $(t + n)$, giving:

$$Pm = Pm' \times \left[\frac{(1 + t + n)(1 + Rv)}{1 - Rc}\right]. \tag{B.8}$$

To derive $t + n$, we have to find Pm. Now we introduce an empirical coefficient K, the price of an imported good (in yuan) in the protected market divided by the CIF price (in dollars) of an imported good. Let E = the foreign exchange rate (normally \$1 = 8.6 yuan; differences in this exchange rate, resulting from government rules, are treated as a nontariff barrier). Therefore, we have:

$$K = \frac{E \times Pm}{Pm'}. \tag{B.10}$$

The value of $E \times Pm$, the price of imported goods (expressed in yuan) in the protected domestic market, is approximately equal to the wholesale price of goods offered by the trading company. This approximation ignores the part of the trading company's profits that corresponds to a ''normal'' wholesale margin and not to quota rents. By conducting surveys of China's foreign trading companies, we obtained the various empirical values of K for the 25 imported goods included in this study. In fact, the K coefficients are used as rules of thumb by the trading companies for pricing imported goods sold to domestic users. Combining B.8 and B.10 we have:

$$K = \frac{E(1 + t + n)(1 + Rv)}{1 - Rc}. \tag{B.11}$$

Rearranging:

$$t + n = \frac{K(1 - Rc)}{E(1 + Rv} - 1. \tag{B.12}$$

Thus, we can calculate $(t + n)$ by using equation B.12.

Appendix C
Estimating Demand and Supply Elasticities

The Almost Ideal Demand System Model

The five elasticities incorporated into the computable partial equilibrium model are fundamental parameters. As mentioned in chapter 3, however, empirical work on Chinese elasticity parameters is in its infancy, and we calculated the required elasticities ourselves.

To arrive at these calculations, we adopted the Almost Ideal Demand System (AIDS) model, which was designed by Angus Deaton and John Muellbauer (1980). By adapting monthly time-series data for domestic and imported products to the AIDS model, we were able to estimate the elasticity parameters required for the Chinese context (see table 2.2 for the results of these calculations).

We adopt the following functional form:

$$Wi = \alpha i + \gamma ii \ln Pi + \sum_j \gamma ij \ln Pj + \beta i \ln(X/\hat{P}) \,, \tag{C.1}$$

where:

Wi = the share of the budget spent on commodity i, which equals $\frac{PiQi}{X}$;
Pi = the price of commodity i;
Pj = the price of commodity j;
X = total expenditures on all commodities, which equals $\sum_i PiQi$;
$\hat{P}$ = the price index;
αi = a constant;

γii = the own-price elasticity of the share of the budget spent on commodity i;
γij = (where $i \neq j$) the cross-price elasticity of the share of the budget spent on commodity i, when the price of commodity j changes; and
βi = the income elasticity of the share of the budget spent on commodity i.

The exact price index, $\hat{P}$, can be closely approximated by a function of the price index, P^*, which is defined by the expenditure shares of the different goods and the logarithms of their respective prices:

$$P^* = \sum_i Wi \ln Pi. \quad \text{(C.2)}$$

Then, $\hat{P}$ can be expressed as:

$$\hat{P} \approx \phi \times P^* . \quad \text{(C.3)}$$

Note that $X / \hat{P}$, which approximately equals $X / \phi\, P^*$, is an expression for real income. Substituting equation C.3 back into equation C.1, we have:

$$Wi = (\alpha i - \beta\, i\, 1n\, \phi) + \gamma ii\, 1n\, Pi + \sum_j \gamma ij \ln Pj + \beta i\, 1n(X / P^*).' \quad \text{(C.4)}$$

The next step is to define $\alpha^* i$, such that:

$$\alpha^* i = (\alpha i - \beta\, i \ln \phi)\,. \quad \text{(C.5)}$$

We can use equation C.4 as a regression equation to estimate $\alpha^* i$, γij, and βi. These parameters can be used to calculate *Edd*, *Edm*, *Emm*, and *Emd*. The equations required to make these calculations are summarized below. Readers interested in the derivation of these equations are referred to Deaton and Muellbauer (1980).

Application of the AIDS Model to the Statistical Data

The basic data used to estimate parameters $\alpha^* i$, γij, and βi for the 25 goods selected for study were price series for imported and domestic goods. We obtained the 25-month time-series data for the domestic goods from the National Bureau of Statistics for the period March 1992 to May 1995. The data begin March 1992 because the Chinese statistical system was revamped at that time. In the 1992-93 data, the factory prices (a weighted average of the market price and the planned price) and the quantities of domestic goods were only available for March, May, August, and November. In the 1994-95 data, the factory prices and quantities of domestic goods were available for the full 12 months. Nearly 800 kinds of producer and consumer goods (comprising more than 1,000 different items) were included in the calculation. The base period chosen was December 1994.

The 30-month time-series data for the prices and quantities of imported goods were obtained from the *Customs Statistics* published by the General Administration of Customs for January 1993 to June 1995. The import prices used were CIF prices.

Nearly 2,000 kinds of imported producer and consumer goods (identified by tariff lines) were included in the calculation. Based on the criteria discussed in chapter 3, the 25 product categories—such as rolled-steel final products, copper and copper products, aluminum and aluminum products, synthetic fiber, synthetic rubber, plastics, and soft drinks—were chosen. Three levels of aggregation were then applied within the 25 product categories, ranging from the specific to the general: ''items,'' ''commodities,'' and ''products.''

We started with domestic items, which correspond to the closest possible match between the eight-digit code of the Harmonized Commodity Description and Coding System (HS), as used in *Customs Statistics*, and six-digit code of the Standard Industrial Trade Classification (SITC), as used in *China's National Statistics*.

Then, by means of a value-weighted average (using domestic, or import, values to compute weights of domestic, or import, goods) we calculate the price of each commodity. The commodity level represents the match between the HS four-digit code and the SITC five-digit code.

Finally, by successive weighted merging of commodities (still using domestic or import values as weights), we obtain domestic prices for each of the 25 products. The product level represents the match between the HS two-digit code (or several four-digit codes) and the GB four-digit code.

In the classification and merging process, we paid close attention to the correspondence between domestic and imported goods. If data on either domestic or imported goods were lacking, those goods were not merged toward a higher level. The peculiarities of reconciling the Chinese classification system with international standards are briefly addressed in box C.1 and tables C.1, C.2, and C.3.

The Five Elasticities for 25 Commodities

Cross-Price Elasticities

Because available data sets are limited, the parameters α^*i, γij, and βi, which are then used to calculate *Edd*, *Edm*, *Emm*, and *Emd*, are estimated in two separate groups: a domestic-goods group and an imported-goods group. As a result, parameters used to calculate own-price elasticities and income elasticities are estimated, but those used to calculate the cross-

Box C.1 A Note on China's National Economic Statistics and Customs Statistics

The Chinese system for national economic statistics, sometimes referred to by the acronym GB, has two standards—GB4754-84, the old system, and GB4754-94, the new system. The new system follows the Standard Industry Trade Classification (SITC) system of the United Nations. The structures of the old and new GB systems are shown in table C.1.

Rolled-steel final products, for example, belong to section C (Manufacturing in the GB4754-94 system) or section 2 (Industry in the GB4754-84 system). The structure of the old code system is shown in table C.2.

''Rolled-steel final products'' represents the product level, indicated by the four-digit code 4832. ''Ordinary rolled-steel, large'' represents the commodity level, indicated by the five-digit code 48323. ''Round bar'' represents the item level, indicated by the six-digit code 483251. Within the ''Rolled-steel final products'' category, there are 14 commodities and 56 items. The unit value at the commodity level is derived by calculating a value-weighted average of the prices of the included items. The same method is then repeated, using a value-weighted average of commodity unit values, to derive a unit value at the product level (the rolled-steel final products).

For custom statistics, we have a different code structure, illustrated by table C.3. The ''rolled-steel'' category, at the product level, is made up of several four-digit codes (7208-7217, 7219-7223, 7225-7229, 7301-7302, 7304-7306). ''Angle bars, shape bars, and special section bars'' represent the commodity level, indicated by the four-digit code 7216. ''Channel bars and I-bars'' represent the item level, indicated by the eight-digit code 72161000. Within the ''rolled-steel'' product category there are 32 commodities and 90 items. The unit value at the commodity level is derived by calculating a value-weighted average of included items. The same method is then repeated, using unit values for commodities, to derive a unit value at the product level (the rolled-steel category).

price elasticities between domestic and imported goods are not. Instead, the properties of the demand function are applied to derive the cross-price elasticities.

The starting point is to use the ''adding up'' restriction. The adding up restriction can be interpreted as the proposition that people spend their entire budget on goods and services. In other words, the total of the individual budget shares for all goods and services should be one:

$$\sum_i Wi = 1. \tag{C.6}$$

This restriction translates into the following set of restrictions using equation C.1:

$$\sum_i \alpha^* i = 1, \tag{C.7a}$$

$$\sum_i \gamma\, ii + \sum_j \gamma\, ij = 0, \text{ and} \tag{C.8a}$$

Table C.1 China's Standard Industrial Classification (SIC) system

(a) General comparison

	Sectors	Large categories	Medium categories
Old SIC system (GB4754-84)	13	75	310
New SIC system (GB4754-94)	16	92	368

(b) Examples of old and new SIC systems

Old SIC system	New SIC system
I. Farming, forestry, animal husbandry, fishery, and water conservancy industry	A. Farming, forestry, animal husbandry, and fishery industry
	B. Excavation
08: Coal mining and processing	06: Coal mining and processing
09: Petroleum and natural gas extraction	07: Petroleum and natural gas extraction
	C. Manufacturing
(Large category)	(Large category)
48: Smelting and processing of ferrous metals	
(Medium categories)	(Medium categories)
481: Iron smelting	321: Iron smelting
482: Steel smelting	322: Steel smelting
483: Steel processing	324: Steel processing
488: Ferroalloy smelting	326: Ferroalloy smelting

$$\sum_i \beta i = 0. \qquad \text{(C.9a)}$$

Because γii approximately equals the own-price elasticity of demand and γij approximately equals the cross-price elasticity of demand, these restrictions can be rewritten as:

$$\sum_{ii} \alpha i = 0, \qquad \text{(C.7b)}$$

$$\sum_i Eii + \sum_j Eij = 0, \text{ and} \qquad \text{(C.8b)}$$

$$\sum_i \beta i = 0. \qquad \text{(C.9b)}$$

Table C.2 Illustrations of SIC system for domestic industrial products (GB4754-84)

48: Smelting and processing of ferrous metals (large category)
483: Steel processing (medium category)
4832: Rolled-steel final products (product level)
48321: Heavy rails (commodity level)
483211: Plain carbon steel (item level)
483212: Low-alloy steel (item level)

48322: Light rails

48323: Ordinary rolled steel, large
483231: Round bar
483232: Angle bar
483233: I-bar

48324: Ordinary rolled steel, medium
483241: Round bar
483242: Angle bar
483243: I-bar

48325: Ordinary rolled steel, small
483251: Round bar
483252: Angle bar
483253: I-bar
48326: Quality rolled steel

48335: Seamless steel pipe
483351: Hot rolled
483352: Cold drawn

Note:
"Rolled-steel final products" indicates the product level, with a four-digit code of 4832.
"Ordinary rolled steel, large" indicates the commodity level, with a five-digit code of 48323.
"Round bar" indicates the item level with a six-digit code of 483251.
Within "Rolled-steel final products" there are 14 commodities and 56 items. Value weights are applied to the prices of individual items to obtain a unit value at the commodity level. The same method is repeated on commodities to obtain a unit value at the product level (Rolled-steel final products).

Restriction C.8b states that the own- and cross-price elasticities sum to zero. This restriction can be applied to estimate cross-price elasticities. If the cross-price elasticities between domestic and imported goods are assumed to be significantly related, then the sum of the own-price elasticities equals the sum of the cross-price elasticities between domestic and imported goods:

$$(Edd + Emm) + (Edm + Emd) = 0 \text{ or} \tag{C.10}$$

Table C.3 Illustration of Harmonized Commodity Description and Coding System (HS) for imported goods

72: Iron and steel
7216: Angle bar, shape bar, and special section of bar made from iron and nonalloy steel
72161000: Channel bar and t-bar
72162100: Angle bar
73: Iron and steel products
7302: Rail and others
73021000: Rail
73022000: Coupled sleeper

Note: "Rolled steel" is a product level composed of items from the "iron and steel" sector and the "iron and steel products" sector. "Rolled-steel products" include several four-digit codes (7208-7217, 7219-7223, 7225-7229, 7301-7302, 7304-7306). "Angle bar, shape bar, and special section bar" indicates the commodity level with a four-digit code 7216. "Channel bar and t-bar" indicates the item level with an eight-digit code 72161000. Within "Rolled-steel," there are 32 commodities and 90 items. Value weights are applied to the prices of individual items to obtain a unit value at the commodity level. The same method is repeated on commodities to obtain a unit value at the product level (rolled-steel final products).

$$(Edd + Emm) = -(Edm + Emd). \qquad \text{(C.11)}$$

The next step is to divide the sum of these cross-price elasticities between *Edm*, the elasticity of demand for domestic goods with respect to a change in price of imported goods, and *Emd*, the elasticity of demand for imported goods with respect to a change in price of domestic goods. Because the average market shares of domestic and imported goods used in this study are roughly 50 percent each (see table 3.3 for the import ratios of each good), it is reasonable to assume that the two cross-price elasticities are about equal. Using equation C.11, we then roughly approximate the cross-price elasticities from the own-price elasticities.

$$Edm = -\frac{1}{2}(Edd + Emm) \qquad \text{(C.12)}$$

$$Emd = -\frac{1}{2}(Edd + Emm) \qquad \text{(C.13)}$$

Table 3.3 presents the approximated own- and cross-price elasticities, based on the foregoing discussion.

Supply Elasticities

In this study, the elasticity of domestic supply is defined as:[1]

$$Es = Edd + (Edm / \Gamma), \text{ where} \qquad \text{(C.14)}$$

1. This formulation was used in Sazanami, Urata, and Kawai (1995).

$$\Gamma = \partial(1n\ Pd) / \partial(1n\ Pm)\ . \qquad \text{(C.15)}$$

In these equations:

Edd	=	the own-price elasticity of demand for domestic goods;
Edm	=	the cross-price elasticity of demand for domestic goods with respect to the price of imported goods;
Emm	=	the own-price elasticity of demand for imported goods;
Emd	=	the cross-price elasticity of demand for imported goods with respect to the price of domestic goods;
Es	=	the own-price elasticity of supply of domestic goods;
Pd	=	the price of domestic goods;
Pm	=	the price of imported goods; and
Γ	=	the ratio of logarithms of price for imports and domestic goods.

Appendix D
Smuggling and Trade Barriers

If a trading system is operating smoothly with low import barriers, most importers will decide against smuggling and other illegal import activity. Because the majority of importers will be law-abiding, the import framework can be simple and inexpensive to administer. This scenario can be described as a mechanism for rational compliance: those informed of the law will choose to act in compliance with it.

As of 1994, rational compliance was far from the norm in China. Instead, smuggling and other illicit activity were widespread. China's failure to establish a system that promotes law-abiding trade has several causes.

First, excessively high tariff and nontariff barriers have stimulated smuggling and other illicit activities such as the abuse of import processing privileges. At the same time, the Chinese authorities have not caught enough smugglers to dissuade others. Second, it is difficult to penalize smuggling and related activities because local authorities often collude to protect those involved. Third, the low criminal penalties for those caught and convicted of smuggling and related activities have contributed to a high level of expected profits.

The model set forth in this appendix is designed to illuminate the interaction among profits from smuggling, the risk of capture, and the severity of punishment. In building the model, we assume that both smugglers and legitimate importers are ''risk neutral'' and that a given enterprise can shift from one category to the other, so that the expected profit from smuggling equals the expected profit from complying with the law. In most countries, the minimum capture rate required to establish rational compliance is determined by the height of trade barriers and taxes that can be evaded by smuggling, the normal profit rate from legal trade, and the penalty if caught. Higher trade barriers and taxes stimulate more smuggling. Higher normal profits from complying with the law make smuggling less attractive. Severe penalties increase the cost of getting caught. The minimum capture rates change accordingly—positively with the height of trade barriers and taxes and negatively with the severity of the penalty and the normal profit rates.

China's Customs Law mandates that authorities confiscate smuggled goods and levy stiff fines when lawbreakers are caught. In practice, smugglers are sometimes allowed to keep illegally imported goods and even make a profit after paying the fine, which is normally calculated as a multiple of the value of the tariff and tax evaded rather than as a multiple of the value of the goods smuggled. This "penalty function" contributes to the evasion problem.

Indeed, with this peculiar penalty function, the minimum required capture rate for rational compliance becomes independent of the tariff, the tax rate, and the normal profit. This can be seen as follows. Let:

- Q = the CIF value of imported goods;
- GT = the gross rate of tariff and nontariff barriers, plus value-added and consumption taxes;[1]
- Rn = the profit rate for law-abiding import activities;
- Rm = the profit rate for smuggling;
- P = the probability of capture of smuggled goods; and
- α = the degree of penalty, expressed as a multiple of the value of GT (more specifically, the tariff and tax component of GT).

Assuming that smugglers and importers are risk neutral and equate expected profits from smuggling with the profits from legal trade, then we arrive at the following equation:

$$(1\text{-}P)QRm + P(QRm - \alpha\, Q\, GT) = QRn. \qquad \text{(D.1)}$$

The left-hand side of equation D.1 represents the expected profits from smuggling. The first term is the profit from successful smuggling multiplied by the success rate $(1 - P)$ of smuggling. The second term on the left-hand side is the expected profit from smuggling when the smuggler is caught. The right-hand side of equation D.1 is the expected profit from legal trade.

Rm represents a combination of profit from legal trade plus the value of tariffs and taxes:

$$Rm = GT + Rn. \qquad \text{(D.2)}$$

1. $GT = (t + n) + VAT + CT$. See appendix B for an explanation of the Chinese tax system.

Table D.1 Capture rate for smuggled cigarettes, 1991-94

	1991	1992	1993	1994
Estimate of total cigarettes smuggled (thousands of boxes)	2,700	2,320	2,600	2,500
Cigarette smuggling captured (thousands of boxes)	570	440	510	700
Capture rate (percentage)	21.1	19.0	19.6	28.0

Source: Compiled by the Beijing Commercial Information Consultant Company, *The Abstract of Surveys*, no. 9 (1995) (Internal Material).

By substituting equation D.2 into D.1 and rearranging the result, we obtain:

$$P = 1 / \alpha. \tag{D.3}$$

As equation D.3 shows, under the peculiar Chinese penalty system, the minimum capture rate required to establish rational compliance depends only on the penalty rate and is independent of GT or Rn. When $\alpha = 2$, which is a common value in China, the required minimum capture rate is 50 percent. This high rate makes the cost of cracking down on smuggling practically infeasible.

Table D.1 illustrates the capture rate for smuggled cigarettes from 1991-1994. Clearly, the current Chinese system does not work and, in fact, it effectively encourages illicit trade. If Chinese authorities enforced the Customs Law strictly—confiscate illegally imported goods and fine or imprison smugglers—the authorities could effectively control the required minimum capture rate by changing the tariff-plus-tax rates.

Under a system of strict law enforcement, equation D.1 would become:

$$(1 - P)QRm - P(QRm + \alpha QGT) = QRn. \tag{D.4}$$

Substituting equation D.2 into D.4 and rearranging the result, we have:

$$P = \frac{1}{\frac{(1 + Rn)}{GT} + (\alpha + 1)}. \tag{D.5}$$

Using equation D.5, the minimum required capture rates under a system of strict law enforcement may be calculated. Table D.2 presents the result. Under this system, the Chinese authorities can lower the tariff and/or tax rates to deter smuggling, assuming that the capture rate remains constant. Alternatively, very severe penalties expressed in terms of high values could also work, because they would lower the minimum required

Table D.2 Capture rate required to deter new smuggling activity under a reformed penalty system (percentage)

	Capture rate needed to discourage new smuggling	
Gross tax rate	Harsh punishment[a]	Mild punishment[b]
100	33.3	100.0
40	13.3	40.0
20	6.7	20.0

a. Harsh punishment assumes that the fine rate equals three, meaning that smugglers who are caught have to pay three times the value of tariff and tax evaded.
b. Mild punishment assumes that the fine rate equals one, meaning that smugglers who are caught have to pay the exact value of tariff and tax evaded.

Source: Authors' calculations.

capture rate. However, very high statutory penalties might create secondary corruption as law breakers attempted to bribe their way out of penalties.

In summary, it is unreasonable to expect a mechanism for rational compliance to emerge from China's import system as implemented in 1994. Many factors stand in the way: excessively high tariff and tax rates, insufficient penalties for smuggling, and unattainably high minimum-required capture rates. These factors combine to create high expected profits for smugglers. In 1994, vast amounts of luxury commodities were smuggled into China, including automobiles, motorcycles, cigarettes, wine, cosmetics, and air conditioners. Illicit practices including false commodity classification and underinvoicing were also common.

Appendix E
Benefits of a Competitive Market Structure

Trade liberalization has an even larger impact when a previously monopolized market is made more competitive by liberalization. Table E.1 illustrates the trade barriers and market structures in China, as of 1994, for the sectors covered by this study. Although these sectors are protected from foreign competition, about half of them already operate under competitive conditions.

However, several sectors are dominated by monopoly or oligopoly structures. To illustrate the possible benefits of more competitive market structures within China, we will examine four sectors that have traditionally featured a monopoly or oligopoly. The sectors are sugar, ammonium phosphate, wool and wool tops, and synthetic fiber. Each sector is expected to become competitive within the next decade, partly as a consequence of trade and investment liberalization.

Investment liberalization can obviously lead to the entry of new firms and to more competitive markets. Trade and investment liberalization often go together, but trade liberalization alone can also force monopolistic firms to act more like competitive firms. In particular, if imports are a strong substitute for domestic goods, local firms are compelled (in their own interest) to equate marginal cost with price, rather than with marginal revenue. This change not only eliminates monopoly profits but also increases consumer welfare. In some cases, it can actually cause domestic production to rise, even as imports increase.

Our method for calculating the benefits of a more competitive market structure is based on Atje and Hufbauer (1996). We contrast a ''standard'' scenario, which assumes the existence of a competitive market structure

Table E.1 Trade barriers and market structures in China

Product category	Trade barriers[a]		Market structure[b]	
	Tariff	Quota	Starting	Ending
Rapeseed oil	✓✓	✓	pc	pc
Sugar	✓✓	✓	m	pc
Soft beverages	✓✓	✓	pc	pc
Plywood	✓✓	✓	pc	pc
Wool and wool tops	✓	✓	2f	pc
Color televisions		✓	pc	pc
Video cassette recorders	✓	✓	pc	pc
Motorcycles	✓✓	✓	pc	pc
Air conditioners	✓✓	✓	pc	pc
Rolled-steel final products	✓		pc	pc
Copper and copper products	✓		pc	pc
Aluminum and aluminum products	✓		pc	pc
Gasoline	✓	✓	3f	3f/4f
Diesel oil	✓	✓	3f	3f/4f
Ammonium phosphate		✓	m	pc
Synthetic fiber	✓	✓	2f	pc
Natural rubber	✓✓	✓	pc	pc
Synthetic rubber	✓✓	✓	pc	pc
Plastics	✓		pc	pc
Autos (sedans)	✓✓	✓	pc	pc
Crude oil	✓	✓	3f	3f/4f
Microcomputers	✓	✓	pc	pc
Color tubes	✓	✓	pc	pc
Wheat[c]	✓	✓	m/2f	2f/3f
Program-controlled switchboards	✓	✓	pc	pc

2f = 2-firm oligopoly
3f = 3-firm monopolistic competition
4f = 4-firm monopolistic competition
pc = perfect competition
m = monopoly

a. Products with a tariff rate of 20 percent or higher are indicated by a double check mark, ✓✓.

b. Market structure as of 1994.

c. The status of competition in the wheat market was changed from a monopoly to a 2-firm oligopoly in July 1994. Up to that time, the following grain markets were also monopolized: barley, maize, soybean, rice, mung bean, and flour.

Source: Based on this study and authors' evaluation.

both before and after liberalization, with a "more competitive market" scenario, which assumes that a monopoly market is opened to trade and investment and, as a consequence, becomes completely competitive after liberalization. The standard scenario calculations are the same as those presented in the main text.

Table E.2 illustrates the production and welfare changes in these two different scenarios. In customary models of trade liberalization, all sectors show a decline in domestic production in the "standard" scenario after

Table E.2 Production, import, and welfare effects as a function of the market structure scenario

Product category	Standard scenario: Domestic production: Value (millions of dollars)	Standard scenario: Domestic production: Price (index)	Standard scenario: CIF value of import (millions of dollars)	Standard scenario: Efficiency gain (percentage of imports)[a]	More competitive market scenario: Domestic production: Value (millions of dollars)	More competitive market scenario: Domestic production: Price (index)	More competitive market scenario: CIF value of import (millions of dollars)	More competitive market scenario: Efficiency gain (percentage of imports)[a]	Tariff and nontariff barriers (percentage)
Sugar									
Before liberalization	2,492	1.00	403	25.0	2,492	1.00	403	46.1	141.4
After liberalization	888	0.68	740		1,463	0.59	505		
(Percentage change)	–64.4	–32.0	83.4		–41.3	–37.0	25.2		
Ammonium phosphate									
Before liberalization	33	1.00	763	29.3	33	1.00	763	37.3	72.4
After liberalization	17	0.75	1,364		45	0.57	1,217		
(Percentage change)	–48.5	–25.0	78.6		36.4	–43.0	59.4		
Wool and wool tops									
Before liberalization	375	1.00	1,039	0.9	375	1.00	1,039	3.5	19.2
After liberalization	326	0.92	1,158		493	0.84	981		
(Percentage change)	–13.1	–8.0	11.4		31.5	–16.0	-5.6		
Synthetic fiber									
Before liberalization	3,538	1.00	1,138	1.2	3,538	1.00	1,138	45.4	22.0
After liberalization	3,186	0.91	1,291		5,526	0.74	1,081		
(Percentage change)	–9.9	–9.0	13.5		56.2	–26.0	–5.0		

a. The percentage of efficiency gain is derived by dividing the efficiency gain value by the preliberalization value of import.

Source: Authors' calculation.

the removal of trade barriers. By contrast, all sectors, except sugar, show an increase in domestic production when trade and investment liberalization leads to a more competitive market. The basic reason for the difference is that, once firms equate marginal cost with price, they expand output significantly.

The wool and wool tops and synthetic fiber sectors illustrate the difference between the two scenarios. Liberalization, accompanied by newly competitive markets, raises the value of domestic production and actually causes a small fall in imports. By comparison, the ''standard'' scenario shows the opposite.

Imports might fall in the ''more competitive market'' scenario because modest initial protection means that liberalization causes only a modest drop in the landed price of imports. Meanwhile, the change to a more competitive market causes a fairly large drop in the price of domestic goods: domestic production of wool and wool tops rises by 32 percent, and the domestic production of synthetic fiber rises by 56 percent. These production gains squeeze out imports, and more importantly, increase domestic output.

The efficiency gains from trade liberalization are of course greater in a sector previously protected by high tariff or nontariff barriers. For example, efficiency gains are higher in the highly protected sugar industry than the other three sectors in both scenarios. But the novel and interesting contrast is between efficiency gains in the standard scenario and the more-competitive-market scenario. In the more-competitive-market scenario, the efficiency gains are substantially larger in every sector than in the standard scenario.

The synthetic fiber sector displays the most striking difference in efficiency gains between two scenarios. With the more-competitive-markets scenario, efficiency gains are about 40 times larger than with the standard scenario. The main reason is that domestic synthetic fiber production has more than a 50 percent market share, while trade barriers are relatively modest. Hence, the efficiency gains from more competitive domestic production overwhelm the efficiency gains from lower trade barriers.

Beyond the individual aspects illustrated by these examples, the broad conclusion is clear: when trade and investment liberalization promotes a more competitive market structure, substantial new benefits are added to the standard gains from eliminating trade barriers.