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**Sebastián Claro**

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**VERTICAL AND HORIZONTAL  
DIMENSIONS OF TRADE  
LIBERALIZATION**

**Sebastián Claro\***

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# Vertical and Horizontal Dimensions of Trade Liberalization\*

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## Abstract

FDI introduces competition between foreign and domestic firms at the factor market level. If the latter are technology backward, cost pressures render them uncompetitive, and absolute advantage determine the pattern of foreign and domestic firms' production. To compensate for technology deficiencies, countries introduce distortions in product and factor markets. Trade liberalization, i.e., the removal of these distortions, have important implications for production and employment patterns, wages and capital flows. I provide evidence that China's policies to protect domestic —specially state-owned— firms match the model's prediction on the structure of interventions.

Key Words: Trade Integration, Tariffs, Capital Subsidies, FDI, Technology Transfers, China.

JEL: F1, F2.

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# 1 Introduction

Trade liberalization studies usually emphasize the effects of tariff changes in factor returns and in the reallocation of resources across sectors. This horizontal view ignores that in many cases tariff liberalization is accompanied by the liberalization of Foreign Direct Investment (FDI). The opening access of domestic markets to foreign producers introduce competition in factor markets, affecting the competitive position of technology-backward firms. If competition between technology-backward domestic firms and technology-advanced foreign firms were only in product markets, technology differences would be compensated with international factor price differences. However, this compensating mechanism vanishes if foreign firms are allowed to produce domestically. Competition in factor markets render technology-backward firms uncompetitive, as factors get employed in high-return firms. As a consequence, FDI liberalization generates a movement of resources across firms within sectors – vertical movement – that may dominate the resource allocation and factor return effects of pure tariff liberalization.

The experience of Germany in the 1990s highlights the relevance of these effects. Integration of eastern and western Germany in product and factor markets generated significant cost pressures to technology-backward eastern producers. The dramatic fall in industrial output and the rise in unemployment revealed that the cost pressures for eastern firms were dramatic (Sinn, 1995). Although wage increases were far beyond market-clearing levels due to unions pressures, there exists consensus that technology differences between eastern and western producers, the fall of the communist block that provided an artificially high demand for eastern products, and integration of capital markets were the main determinants of the price-cost squeeze faced by eastern producers<sup>1</sup>. To sustain eastern employment and investment, the newly unified government granted important capital subsidies to eastern firms (Sinn, 1995, 2002). Another example of the implications for domestic firms of technology-advanced foreign competition is the case of China, specially in the 1990s. Foreign firms have introduced important cost pressures to domestic producers –specially

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<sup>1</sup>See Akerlof et.al., (1991), Dornbusch and Wolf (1994), Fitzroy and Funke (1998). For evidence on technology differences between eastern and western producers at the moment of unification and afterwards see Akerlof et.al., (1991) and Funke and Jahn (2002).

state-owned enterprises—, which share in output and employment have decreased steadily in the last two decades<sup>2</sup> As I will argue below, the limits to foreign producers to access tariff-protected domestic markets together with a very restricted and controlled domestic capital market, have been the main mechanisms to compensate for the technology-backwardness of domestic producers.

In a more global context, the implications for the pattern of world production and trade of product and factor market integration in the presence of international technology differences are very broad. Indeed, factor markets' integration introduce cost pressures to firms on low-technology countries that render them uncompetitive. As a consequence, absolute advantage arises as the relevant concept in international specialization (Storper, 1992). Of course, as long as some factors remain internationally immobile, there is always scope for production of technology-backward firms. However, acknowledging the role that absolute technology differences play in a world of increasing integration in factor markets is fundamental to understand the policies that countries take in order to compensate for the cost pressures that globalization carries with.

The first objective of the paper is to develop a model to understand the impact on technology-backward domestic firms of tariff and FDI liberalizations. For that, I assume that in the pre-integration situation, coexistence of technology-backward domestic producers and technology-advanced foreign firms is supported by distortions in product and factor markets that compensate for the technology gap. At the product market level, only domestic firms can sell their products in tariff-protected domestic markets. This distortion is aimed to capture any policy that introduces a product-price advantage for domestic firms vis-à-vis foreign producers. The model does not explicitly analyze the determinants of foreign investment, but these assumptions imply that FDI is driven by international factor-price differences —determined by international technology differences—, rather than by tariff-jumping justification. In other words, foreign affiliate production is not intended for the local market, at least until FDI is liberalized.<sup>3</sup>

At the factor market level, I assume that the domestic capital market is segmented from international

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<sup>2</sup>See Branstetter and Feenstra (2002), Chow (2002), Feenstra (1998), Lardy (1992, 1998, 2002), Naughton (1996), and Sachs and Woo (1997).

<sup>3</sup>See Horstmann and Markusen (1992), Brainard (1993), and Markusen and Venables (2000) for models where FDI is intended for the domestic market.

markets, so that the return to domestic capital may differ from the international cost faced by foreign producers. In particular, it is lower due to technology-disadvantages of domestic firms. This assumption contrasts with the traditional literature on foreign investment, that suggest that FDI tends to equalize the rate of return on capital throughout a given industry in all countries and/or throughout all industries and countries. In this paper, foreign producers bring their technologies and capital to produce locally enjoying low labor costs. Together with capital market segmentation, this is consistent with equilibrium differences in the return to capital.

The lower cost of capital and the product-price premium compensate domestic producers for their technology backwardness. In this setting I analyze the effects on production, employment, wages and capital flows of tariff and FDI liberalizations. Tariff liberalization implies a change in tariffs and relative product prices without lifting the restricted access of foreign producers to domestic markets. Because wages are set according to foreign firms' competitiveness conditions, they are not affected by the tariff liberalization. Capital market segmentation assures that domestic production is competitive in at least one industry, and the structure of domestic production depends on the final tariff structure and the sectoral distribution of technology differences. If domestic production is only viable in capital-intensive industries, a rise in FDI is required to clear the labor market. Likewise, if domestic firms are viable in labor-intensive industries, capital outflows –a fall in the stock of foreign capital– are required to generate the equilibrium increase in domestic employment. Interestingly, the fall in relative product prices of domestic producers compared to foreign firms may be accompanied with an increase in domestic employment.

The liberalization of FDI represents a more radical step. In this case, the final tariff structure is also relevant for foreign producers, that are allowed to sell their products in tariff-protected domestic product markets, meaning that the product price advantage for domestic producers vanishes. Also, FDI liberalization comprises the integration of domestic capital markets to world markets. Therefore, the net return to domestic capital must be equal to the international cost faced by foreign producers, meaning that the pre-liberalization capital-cost advantage in favor of domestic firms also disappears. The absorption of all labor by foreign producers is necessarily accompanied by gross capital inflows. A net (of domestic capital outflows) increase

in capital takes place as long FDI rises relatively more in capital-intensive industries, while net capital outflows take place if the expanding foreign firms are labor intensive.

The disappearance of domestic producers reflects that the coexistence of technology-advanced foreign producers and technology-backward domestic firms can be only sustained by product and factor market distortions, unless full technological convergence takes place. Aside from the role of product-level distortions and capital market segmentation, I analyze a third possibility: capital subsidies. Granting capital subsidies for low-technology firms to compensate for the difference between gross capital return and its opportunity cost is consistent with domestic production. I therefore estimate the capital subsidies required to compensate for technology disadvantages of domestic producers.<sup>4</sup>

The second part of the paper is empirical. Based on the model's predictions, I analyze the experience of China in protecting their domestic —specially state-owned— firms. It has been well documented that the transition in China, specially since the beginning of the 1990s, has been characterized by important shrinkage in state-owned production and employment. Indeed, the production of state-owned enterprises (SOEs) represented nearly 78% of total industrial production in 1978 and less than 30% in 1996 (Chow, 2002). The fall in SOEs' share in total output has been driven by two forces. First, since the reforms started in the mid 1980s, SOEs have been subject to increasing competition from collectively-owned enterprises (COEs) —specially Township and Village enterprises— that are not subject to the tight controls of SOEs.<sup>5</sup> Greater productivity of COEs has introduced cost pressures on state-owned firms, undermining their competitive position. As Brandt and Zhu (2000) point out, the policy of granting SOEs credit at subsidized rates is fundamental to understand their survival in a context of increasing domestic competition.

At the same time, China's openness to FDI have attracted important amount of foreign capital to the

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<sup>4</sup>Neary (1978a) and others have studied the role of capital subsidies in employment and factor intensities. However, they focus on the implications of differences in the ratio of marginal productivity of factors on cross-sectoral factor reallocation, and not on cross-firm within-sector or vertical dimensions of capital subsidies.

<sup>5</sup>See Groves et. al., (1994, 1995) for discussions on the restrictions faced by SOEs, and the role of incentives and management in their performance.



mainland. Indeed, China was in 2001 the highest recipient of FDI among developing countries, by far.<sup>6</sup> In addition to this, the share of foreign-invested firms (FIEs) in industrial production rose from essentially zero in 1980 to 16.5% in 1996 (Chow, 2002), (21% in 1997 if only establishments with independent accounting systems –excluding Village enterprises– are considered). The presence of technology-advanced foreign producers have also introduced significant cost pressures to domestic producers, specially in labor markets. To smooth the impact of FDI on domestic costs, and to avoid a Germany-style shrinkage in SOEs’ production, the authorities have introduced two types of distortions. First, the degree of integration of the domestic capital market with the international market is negligible. Therefore, the return to domestic capital in China differs from the international return. In particular, it is lower due to technology differences, and hence it ameliorates the cost pressures on domestic firms. Also, China has introduced many policies to limit the access of foreign firms’ to tariff-protected domestic product markets. Although there are many FIEs selling their goods in mainland markets, legal and de facto restrictions as well as incentives for foreign firms to export their production are tended to introduce a product-price premium in favor of domestic producers.<sup>7</sup> The last section of the paper is devoted to provide evidence on the existence and relevance of these interventions to explain the coexistence of China’s state-owned firms with technology-advanced COEs and FIEs.

## 2 The Model

### 2.1 Homogeneous domestic firms

Consider a small open economy that produces  $i$  tradable goods with constant-returns-to-scale technologies and two factors of production: labor  $L$  and capital  $K$  (Jones, 1965, 1971). Within each industry, two types of firms coexist: technology-backward domestic firms ( $d$ ) and technology-advanced foreign firms ( $f$ ). Labor is completely mobile across sectors and firms, so the wage rate is unique in the economy. Capital markets are segmented, however. Foreign firms have access to international financial markets, where the cost of

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<sup>6</sup>United Nations World Investment Report, 2002.

<sup>7</sup>See footnote 2.

capital is  $r^*$ . Domestic capital is restricted to domestic firms, that do not have access to international capital markets, and full capital mobility across domestic firms assure a unique return to domestic capital in the long run, that can differ from  $r^*$ .

The zero-profit condition for firm type  $n = d, f$  in industry  $i$  is equal to

$$p_i^n = a_{Li}^n w + a_{Ki}^n r_i^n \quad (1)$$

where  $p_i^n$  is the price of good  $i$  faced by firm type  $n$ , and  $w$  and  $r_i^n$  are the returns to labor and sector-specific capital, respectively. Technology parameters  $a_{Fi}^n$  (inverse of average productivity) are functions of relative factor prices and exogenous technological conditions.

The long run equilibrium wage rate is determined by the set of zero-profit conditions of foreign firms. In particular,  $w$  satisfies

$$p_i^* = a_{Li}^f \left( \frac{w}{r^*} \right) \cdot w + a_{Ki}^f \left( \frac{w}{r^*} \right) \cdot r^* + c_i. \quad (2)$$

where  $p_i^*$  is the international price of good  $i$ , faced by the foreign producer, and  $c_i > 0$  is the unit cost for a foreign firm to produce domestically. The effective price of a foreign producer in the domestic country is  $p_i^* - c_i$ . The rationale for foreign investment is that, doted with better technologies, they are willing to produce abroad to enjoy lower wages. In equilibrium however, the return to capital is  $r^*$ .  $c_i$  may represent the native entrepreneurs' advantage over a foreign rival from its general accumulation of knowledge about his home market (Caves, 1971). A value of  $c_i$  greater than zero is consistent with international wage differences; otherwise, zero-profit conditions (2) hold in the foreign country too, and there is international wage equalization. For presentation purposes and without any loss of generality, I assume  $c_i = 0$ .

Given  $p_i^*$ , and  $r^*$ , the equilibrium wage rate  $w^*$  is such that (2) holds in all industries where foreign production takes place. I assume that there is a unique  $w^*$  that make (2) hold in all industries. Domestic producers face the wage rate consistent with foreign firms' production.<sup>8</sup> If domestic technologies were identical to those of foreign firms and there were international capital mobility, condition (2) would hold for

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<sup>8</sup>There exists ample evidence that foreign producers pay higher wages than their domestic counterparts (see Lipsey, 2002 for a survey). To the extent that these differences reflect differences in job or workers characteristics, their inclusion in the analysis is not relevant. If differences in wage payments reflect labor market regulations, they become an additional source of

domestic firms, too.<sup>9</sup> However, I assume that domestic and foreign production techniques –  $a_{Fi}^n$  – differ for two reasons. First, differences in relative factor prices affect the optimal factor intensity in each sector. This reflects the traditional movement along an isoquant. Also, technologies may differ even at similar factor intensities. In particular, I assume that after correcting for differences in factor intensities, there are Hicks-neutral technology differences  $-\delta_i$  between domestic and foreign firms, so that

$$a_{Li}^d = (1 + \delta_i) \left( 1 - \theta_{Ki}^f \sigma_i (R_i - 1) \right) a_{Li}^f \quad (3)$$

$$a_{Ki}^d = (1 + \delta_i) \left( 1 + \theta_{Li}^f \sigma_i (R_i - 1) \right) a_{Ki}^f. \quad (4)$$

where  $R_i = r^*/r_i$ ,  $\theta_{Fi}^f$  is the share of factor  $F = L, K$  in value-added in foreign firm in industry  $i$ , and  $\sigma_i$  is the elasticity of substitution between labor and capital in industry  $i$ .<sup>10</sup> Plugging (3) and (4) into (1), and assuming  $p_i = p_i^*$ , the return to domestic capital in industry  $i$  consistent with zero profits satisfies

$$1 = (1 + \delta_i) \left( \frac{R_i \theta_{Li}^f + \theta_{Ki}^f - \theta_{Li}^f \theta_{Ki}^f \sigma_i (R_i - 1)^2}{R_i} \right) \quad (5)$$

If  $\delta_i > 0$  (domestic firms are technology backward), equation (5) holds as long as  $R_i$  is greater than one, implying that  $r_i < r^*$ . In other words, domestic firms' technological backwardness are compensated with lower cost on capital. This is possible in a long run equilibrium as long as capital markets are segmented.

However, even with capital market segmentation, the long run return to domestic capital must be equalized across industries. And this does not necessarily follow from (5). To assure positive domestic production in all sectors in the long run, the government segments goods markets. Consider that domestic firms can sell their products in tariff-protected domestic markets, so that  $p_i = p_i^*(1 + \tau_i)$ , where  $p_i^*$  is the world price of good  $i$ . Foreign firms are restricted to access domestic markets, so they face a product price equal to  $p_i^*$ .

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technology-differences compensation. The model could be simply extended to allow for wage differences between domestic and foreign firms.

<sup>9</sup>If  $c_i > 0$ , domestic firms would have profits, implying that foreign production would not be viable. In other words, FDI will take place as long as there exist some technological advantage of foreign producers that more than compensates the net product price disadvantage.

<sup>10</sup>The elasticity of substitution is defined as  $\sigma_i = d \log(K/L) / d \log(w/r)$ . In a constant-returns-to-scale technology, it is possible to show that  $\widehat{a_{Li}} = -\theta_{Ki} \sigma_i (\widehat{w} - \widehat{r})$  and  $\widehat{a_{Ki}} = \theta_{Li} \sigma_i (\widehat{w} - \widehat{r})$ .

Therefore, the zero-profit condition for domestic firms in industry  $i$ , imposing cross-industry domestic rental rate equalization, is given by

$$(1 + \tau_i) = (1 + \delta_i) \left( \frac{R\theta_{Li}^f + \theta_{Ki}^f - \theta_{Li}^f \theta_{Ki}^f \sigma_i (R - 1)^2}{R} \right). \quad (6)$$

The sector-specific tariff rate is uniquely determined for any given level of  $R$ . Equation (6) defines a system of  $i$  equations and  $i + 1$  unknowns  $(\tau_i, R)$  which solution is the sector-specific tariff rate and the domestic return to capital consistent with zero profits in all industries. A unique solution could be determined imposing an additional restriction —i.e., on average tariffs—, but for the sake of the argument I assume that sector-specific tariff rates are exogenous. The tariff structure —computed as the ratio of  $(1 + \tau_i)$  in any two sectors  $x, y$ — is given by

$$\frac{1 + \tau_x}{1 + \tau_y} = \left( \frac{1 + \delta_x}{1 + \delta_y} \right) \cdot \left( \frac{R\theta_{Lx}^* + \theta_{Kx}^* - \theta_{Lx}^* \theta_{Kx}^* \sigma_x (R - 1)^2}{R\theta_{Ly}^* + \theta_{Ky}^* - \theta_{Ly}^* \theta_{Ky}^* \sigma_y (R - 1)^2} \right). \quad (7)$$

The intuition for (7) is the following. *Ceteris paribus*, tariffs must be greater in those sectors with greater technology backwardness. This is because wage pressures from foreign firms hurt most those sectors with worse technologies. Additionally, given technology differences, a higher cost of capital (a fall in  $R$ ) generates a shift in tariffs toward capital-intensive sectors, unless the second-order effects associated with changes in factor intensities dominate. I assume this is not the case. Higher capital costs benefit most labor-intensive industries, so that lower product-price compensations for these industries are required. As  $R$  tends to zero, tariffs may end up being higher in capital-intensive sectors even if the technology gap between domestic and foreign firms are lower in these sectors.

The initial equilibrium is therefore characterized by technology-advanced foreign firms producing in all industries. Production of technology backward domestic firms is supported through two mechanisms. First, the capital market is segmented, so the return to capital domestically differs from  $r^*$ . Abstracting from second-order effects of differences in relative factor prices<sup>11</sup>, the pre-liberalization domestic return to capital  $r_0$  expressed as percentage of the international return equals

$$\frac{r_0}{r^*} = \frac{v_{i0} - \theta_{Li}^*}{\theta_{Ki}^*} \quad (8)$$

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<sup>11</sup>  $(R - 1)^2 \approx 0$ .

where  $v_{i0} = (1 + \tau_{i0}) / (1 + \delta_i)$  is the technology-adjusted or net product-price ratio of domestic to foreign firms. I assume it is lower than one so that the domestic return to capital is lower than  $r^*$ . In general,  $\tau_{i0}$  refers to any distortion that introduces a gross (of productivity differences) product-price advantage for domestic firms vis-a-vis foreign producers. Capital market segmentation and the restricted access of foreign producers to tariff-protected domestic firms assure that there is a structure of sectoral tariffs and a unique return to domestic capital consistent with zero profits for domestic firms in all industries.

We are now ready to analyze the impact on employment and factor returns of tariff and FDI liberalization. The former comprises a change in the tariff structure relevant for domestic firms, keeping the capital market segmented and without opening domestic product markets to foreign firms. FDI liberalization implies the opening of tariff-protected domestic markets to foreign firms' production, as well as opening domestic financial markets. In equilibrium, the return to domestic capital must be equalized across domestic firms in the case of a pure tariff liberalization (although it may continue to differ from the international return to capital), and it must also be equal to  $r^*$  in the case of FDI liberalization.

### 2.1.1 Tariff Liberalization

Consider an exogenous fall in tariffs. Regardless of the final tariff structure, zero-profit conditions for foreign firms have not changed, and hence the wage rate is equal to its pre-liberalization level. Capital market segmentation assures that domestic production is viable in at least one industry. That will depend on the final tariff structure. If  $\tau_{i1}$  is such that (6) holds for all firms with a unique return to capital, all domestic firms remain competitive, and the domestic return to capital becomes

$$\frac{r_1}{r^*} = \frac{v_{i1} - \theta_{Li}^*}{\theta_{Ki}^*} < \frac{r_0}{r^*} \quad (9)$$

where  $v_{i1} = (1 + \tau_{i1}) / (1 + \delta_i) < v_{i0}$ . The lower return to capital is the market mechanism to adjust for the lower productivity-adjusted product price ratio of domestic to foreign products. The fall in the relative cost of capital implies that all domestic industries become more capital intensive. For a given domestic capital stock  $\overline{K}$ , and for a constant level of domestic employment ( $L^d = \overline{L} - L^f$ )<sup>12</sup>, this implies a shift

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<sup>12</sup> $\overline{L}$  ( $= L^d + L^f$ ) represents the aggregate labor force in the home economy, of which  $L^d$  is employed in domestic firms and

in domestic production toward labor-intensive industries.<sup>13</sup> This is consistent with the shift in the tariff structure in favor of labor-intensive industries required for all domestic industries to remain competitive. Indeed, from (7),  $\partial[(1 + \tau_x)/(1 + \tau_y)]/\partial R > 0$  if and only if  $x$  is labor-intensive. However, the total level of domestic employment depends on possible changes in foreign capital stock. Although the level of foreign capital stock is not determined in the model, consider for the sake of the argument that FDI increases. Because neither relative factor prices nor foreign firms' factor intensities changes, increases in foreign capital imply a movement of workers from domestic to foreign firms, shifting the domestic production structure toward capital-intensive industries. It is reasonable to think that FDI would not change –because foreign firms' conditions have not changed. However, the potential impact of the tariff reform on foreign investment have important implications for output and employment patterns.

Consider now that the final tariff structure is inconsistent with positive production of domestic producers in all industries. The return to domestic capital becomes

$$\frac{r_{m1}}{r^*} = \max_{\{i\}} \left[ \frac{v_{i1} - \theta_{Li}^*}{\theta_{Ki}^*} \right] \quad (10)$$

where  $r_{m1}$ , lower than  $r_0$ , represents the return to capital in sector  $m$  where domestic firms are competitive. In other words, zero profits are only attainable in industry  $m$ . Given  $w^*$  and  $r_m$ , domestic relative factor usage is given by  $k_m = K_m/L_m = a_{Km}(w/r_m)/a_{Lm}(w/r_m)$ , that may differ from  $k^d = \bar{K}/L^d$ . If  $k_m > k^d$ , domestic firms are not able to absorb  $L^d$ , and excess labor ( $L^d - L_m$ ) is employed by foreign firms. The increase in foreign firms' employment requires a rise in foreign capital, unlike the case when domestic producers can absorb  $L^d$ . The rationale for the rise in FDI is that unemployment is not an equilibrium, as long as a fall in wages would generate profits for foreign producers. It is not possible to establish in which industries the capital stock –and employment– increases, and therefore nothing can be said regarding the size of capital inflows. Likewise, if  $k_m < k^d$ , capital outflows take place, and post-integration domestic employment is greater than  $L^d$ . It is important to notice that complete specialization is not required to generate capital flows, but rather than competitive domestic industries are not able to absorb the domestic

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$L^f$  in foreign firms.

<sup>13</sup>Mussa (1974), Neary (1978b).

pre-liberalization factor availability  $k^d$ .

Even if the new tariff structure pushes for specialization, the government may choose to subsidize the return to capital in those industries  $i$  where  $r_i < r_m$  to make them viable. The subsidy required to equalize the net return to capital across industries, expressed as percentage of  $r^*$ , is given by

$$\frac{s_i}{r^*} = \frac{v_{m1} - \theta_{Lm}^*}{\theta_{Km}^*} - \frac{v_{i1} - \theta_{Li}^*}{\theta_{Ki}^*} > 0. \quad (11)$$

In this case, we are back to the scenario where the equilibrium is reached without international capital flows, as domestic firms are able to absorb  $k^d$ . Nevertheless, as firms choose their optimal factor intensities based on gross relative factor prices, all domestic industries except the one that is not granted subsidy become more capital intensive, shifting the production structure toward labor-intensive goods even more than the case where the final tariff structure was consistent with zero profits in all domestic firms.

### 2.1.2 FDI Liberalization

Consider now that foreign firms are allowed to sell their products locally, meaning that the new tariff vector is relevant for foreign firms. In other words, national treatment for FIEs yields product price equalization between domestic and foreign producers in each industry. Also, FDI liberalization is accompanied by domestic financial market liberalization, so that the net return to domestic capital must be equal to  $r^*$ .

The impact on wages will depend on the sector-bias of relative product-price changes for foreign firms, reflected in the sector bias of the final tariff structure. For simplicity, consider that the new tariff structure is such that foreign firms remain viable in all industries, meaning that  $\tau_{i1}/\theta_{Li}^* = \tau_{j1}/\theta_{Lj}^*$  for all  $i, j$ .<sup>14</sup> Consequently, the long run change in the wage rate is given by  $\tau_{i1}/\theta_{Li}^* \geq 0$ .

Regardless on the final tariff structure, domestic production is not viable with complete product and factor market integration. Unless full technological convergence of domestic firms takes place, foreign firms' and domestic firms' zero-profit conditions cannot hold at the same time. Therefore, all labor ends up employed in foreign firms. Because of the long run increase in the relative cost of labor, foreign firms become more

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<sup>14</sup>For foreign firms,  $\widehat{(1 + \tau_i)} = \tau_{i1}$ . Zero profits for foreign firms in all industries is possible if tariffs are greater in labor-intensive industries.

capital intensive in the post-liberalization equilibrium, meaning that labor market equilibrium is not possible without changes in foreign capital stock. If FDI increases in labor-intensive industries, small gross capital inflows are compatible with labor market equilibrium, but if FDI increases in capital-intensive industries, higher gross capital inflows are needed to absorb domestic labor. Overall, if the most expansionary foreign firms are those in capital-intensive industries, net (of domestic capital outflows) capital inflows will take place and a shift in aggregate production toward capital-intensive sectors follow. The opposite happens if FDI increases are greater in labor-intensive industries.

The absorption of pre-liberalization domestic employment by foreign firms could also follow from a reallocation of FDI across industries so that foreign capital increases in labor-intensive firms and falls in capital in capital-intensive industries, keeping the aggregate level of foreign capital constant. A shift of the production structure toward labor-intensive industries follows and net capital outflows amount for the level of domestic capital. In this case though, it is more difficult to argue in favor of a shrinkage in FDI stocks in capital-intensive industries, because of the increase in product prices.

If the final tariff structure is such that foreign production is viable in only one industry, it is still the case that domestic production is not viable in any sector. The absorption of labor originally employed in domestic firms by foreign firms is possible with gross capital inflows. If the capital-labor ratio of the competitive foreign producer —evaluated at post-liberalization relative factor prices— is greater than  $k^d$ , net capital outflows take place. Otherwise, full employment is reached with net capital inflows.

The disappearance of domestic production can be avoided with capital subsidies. The capital subsidy to domestic producer  $i$  required to equalize the net return to domestic capital to  $r^*$  is given by

$$\frac{s_i}{r^*} = \frac{1 - v'_{i1}}{\theta_{Ki}^*} \quad (12)$$

where  $v'_{i1} = 1/(1 + \delta_i) < v_{i1} < 1$ . The access of foreign firms to tariff-protected domestic product markets increases the productivity-adjusted product price ratio of foreign to domestic producers. The subsidy depends positively on the technology gap between foreign and domestic firms, and negatively on the share of capital in value-added. Wage pressures from foreign firms rise marginal costs more in labor-intensive



industries, and hence greater subsidies are needed in those industries. The subsidy is higher than under pure tariff liberalization (equation (11)), when it compensates for the difference between the sector-specific return to capital and the return set by the most competitive domestic industry  $r_m$ , that was lower than  $r^*$ . With capital market integration and the liberalization of FDI, the subsidy compensates for the difference between the sector-specific domestic return and  $r^*$ .

## 2.2 Heterogeneous domestic firms

Consider now that within the domestic economy, two types of firms coexist:  $s$  for state-owned enterprises and  $p$  for privately-owned enterprises. Following the notation in section 2.1, the Hicks-neutral technology gap between domestic firms type  $\alpha = s, p$  and foreign firms in industry  $i$  is  $\delta_i^\alpha$ , with  $\delta_i^s > \delta_i^p$  for all  $i$ . Initially, only firms type  $s$  and  $p$  have access to tariff-protected domestic product markets. Also, they hire capital from the domestic capital market, that is segmented from international financial markets. Finally, the wage rate is set according to foreign firms' competitiveness conditions. The zero-profit condition for firm type  $\alpha$  in industry  $i$  is given by

$$(1 + \tau_{i0}) = (1 + \delta_i^\alpha) \left( \frac{R_i^\alpha \theta_{Li}^* + \theta_{Ki}^* - \theta_{Li}^* \theta_{Ki}^* \sigma_i (R_i^\alpha - 1)^2}{R_i^\alpha} \right). \quad (13)$$

If  $\delta_i^s > \delta_i^p$ , (13) holds for all firms as long as  $R_i^s > R_i^p$ , that is, if the cost of capital for firms type  $s$  is lower than for firms type  $p$ . Assuming that the domestic capital market is competitive, the net return to capital is equal across firms and sectors. Therefore, production of  $s$ -type firms is possible if they are granted capital subsidies. Type  $p$  firms are not granted capital subsidies, and hence I assume that tariffs  $\tau_{i0}$  are such that (13) holds for all firms type  $p$  with a unique return to capital  $R^p$ . Given  $\tau_{i0}$  and  $R^p$ , nothing assures that the return to capital that make (13) hold for all firms type  $s$  is unique. In particular, the capital subsidy in industry  $i$  that equalizes the net return to capital to  $R^p$  —as percentage of the international return to capital—, is given by

$$\frac{s_i}{r^*} = \frac{v_{i0}^p - v_{i0}^s}{\theta_{Ki}^*} = \frac{(1 + \tau_{i0})}{\theta_{Ki}^*} \cdot \frac{(\delta_i^s - \delta_i^p)}{(1 + \delta_i^s)(1 + \delta_i^p)} > 0. \quad (14)$$

where  $v_{i0}^\alpha = (1 + \tau_{i0}) / (1 + \delta_i^\alpha)$ . For the capital subsidy to be equal across sectors, technology differences

between firms type  $s$  and  $p$  must be greater in labor-intensive industries. In general, it is increasing on the technology-adjusted product price of firms type  $p$  vis-a-vis firms type  $s$ . This is explained by the technology advantage of firms type  $s$  given by  $\delta_i^s - \delta_i^p > 0$ . Also, although both types of firms have access to tariff-protected domestic goods markets, the subsidy is increasing on  $\tau_{i0}$ . This is because the percentage increase in productivity-adjusted product price for a given tariff is greater in technology-advanced firms. This is a very important result. If restrictions to foreign firms' access to tariff-protected domestic goods markets are aimed to protect technology-backward firms type  $s$ , they introduce a product price advantage in favor of firms type  $p$  that has to be compensated with greater capital subsidies.

### 2.2.1 Tariff Liberalization

As in the case of homogeneous domestic firms, zero-profit conditions for foreign firms do not change, and wages stay constant. Also, capital market segmentation assures that domestic production is competitive, at least by one type of firm in one industry. If pre-liberalization capital subsidies do not change, the net return to capital in firms type  $p$  is lower than for  $s$ -type firms. Therefore, either subsidies fall or the former disappear.

If subsidies do not change, production of firms type  $s$  is viable in all industries as long as the new tariff structure assures net rental rate equalization across industries. In other words, if differences in the return to capital implicit in (13) are equal to pre-liberalization capital subsidies. In this case, labor market equilibrium is reached without capital flows. Otherwise, we are back in the case where domestic production is viable in only one industry, and capital inflows (outflows) will take place if the competitive industry is (capital) labor intensive.

### 2.2.2 FDI Liberalization

As in the case of homogeneous firms, the access of foreign producers to tariff-protected domestic markets imply a rise in wages. Unless full technology convergence takes place, both types of domestic firms become

uncompetitive. The subsidy that equalizes domestic net return to capital to  $r^*$  is

$$\frac{s_{i1}^\alpha}{r^*} = \frac{1 - v_{i1}^\alpha}{\theta_{Ki}^*} \quad (15)$$

where  $v_{i1}^\alpha = 1/(1 + \delta_i^\alpha) < 1$ . The absorption of all labor by foreign firms requires again gross capital inflows. Depending on whether they are greater on labor- or capital-intensive industries, net capital outflows or inflows are required to achieve labor market equilibrium.

### 3 An Application: China in the mid 1990s

The following section presents evidence on the relevance of the mechanisms emphasized in the model to protect domestic firms. In particular, I present evidence on the dual economic structure existent in China, and on how this structure is aimed to protect state-owned enterprises from collective and foreign firms' competition.

The starting point of the analysis is presented in figure 1, that plots 3-digit ISIC tariffs for 1996 from UNCTAD (Nicita and Olarreaga, 2001) against capital intensity, measured as capital per worker in the same industries in the United States. There is no reliable data on sectoral capital intensity in China, and the usage of U.S. figures is reasonable as long as differences in capital per worker are mainly technology driven and not very much affected by differences in relative factor prices.<sup>15</sup> It is evident that China protects labor-intensive industries most. Why does China protects those sectors where it is supposed to have comparative advantage? New trade theory would suggest economies of scale or the "import protection as export promotion" principle as an explanation for this puzzle. The model suggests a very different explanation; China protects industries with greater technology disadvantages of domestic vis-à-vis foreign producers, meaning that technology differences are greater in labor-intensive industries.

[Figure 1]

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<sup>15</sup>To check this, I proxy capital intensity in China dividing the nominal value of total assets in each industry on sectoral employment for state-, collectively-, and foreign-owned enterprises in 1996. The results are very similar.

Is there direct evidence on this? The Appendix presents a methodology to estimate sector-specific Hicks-neutral technology differences between domestic and foreign firms. The methodology has two steps. First, I estimate the ratio of domestic to foreign firms' return to capital, for collective and state-owned firms separately. For COEs I assume that the return to capital is equalized across industries and estimate the cost of capital that best fits the relative factor usage of collective and foreign firms within each sector. For SOEs, I estimate the average capital subsidy they are granted based on aggregate figures of fiscal subsidies to state-owned firms, and deduct it from collective firms' net return to capital to get a figure on state-owned firms' gross return of capital. The results show that the return to capital in COEs in 1996 was 47% of the return to capital for foreign firms' located in China. Given subsidies to SOEs of around 3% of aggregate GDP, the return to capital for SOEs was on average 17% of foreign firms' capital return, meaning that if the international return to capital is 10%, the return to capital in SOEs is 1.7%.<sup>16</sup>

Data on capital costs, relative wages (from Zhao, 2001), factor shares (China's Statistical Yearbook, 1997) and tariff rates (Nicita and Olarregaga, 2001) are combined to estimate the sector-specific Hicks-neutral technology parameter  $\delta_i^\alpha$  for  $\alpha$  =state- and collectively-owned that fits perfectly each zero-profit condition. The results are reported in Table 1, that shows two alternative measures of  $\delta_i$  for each type of firm.  $\delta_{i1}$  assumes differences in product prices of domestic firms vis-à-vis foreign firms based on tariffs. In other words, it assumes that domestic firms sell their products in tariff-protected domestic markets while foreign firms face international prices.  $\delta_{i2}$  assumes no differences in product prices. The last two columns reports sectoral nominal tariffs and capital per worker for U.S. firms.

[Table 1]

Several elements are worth noticing of Table 1. First, the technology gap is greater for state-owned enterprises. The productivity advantages of COEs has been widely documented, (i.e., Brandt and Zhu, 2000; and Jefferson et. al., 1999) and it is consistent with the declining share of SOEs production on hands of

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<sup>16</sup>Using data from China's Industrial Statistics Yearbook for 1998, the ratio of SOEs (COEs) to FIEs profits as percentage of value-added is .3 (.56) (Lemoine 2000). These numbers are not very different from the .17(.47) figures obtained in my estimations.

COEs. Second, the correlation coefficient of technology differences and capital per worker is not significantly different from zero of COEs, but it is significantly negative for SOEs, revealing that the technology gap of state-owned firms is greater in labor-intensive industries, exactly those with greatest tariffs. Third, the correlation between nominal tariff and  $\delta_{i2}$  is positive and significant for both types of firms, revealing the direct positive association between protection and technology differences (see Figure 2 for SOEs).<sup>17</sup> This is exactly the mechanism emphasized in the paper. According to the model, tariffs are greater in those industries with greater technology backwardness, that are labor-intensive industries.

[Figure 2]

The rationality of this explanation rests on two elements. First, that the domestic capital market is segmented from international markets. Otherwise, it would be difficult to explain differences in the return to capital. The restrictions of foreign financial institutions to penetrate the Chinese market has been widely documented (Lardy, 2002). For example, the share of domestic credit issued by foreign banks was only 0.01 percent of total domestic credit outstanding from all financial institutions in 1998.<sup>18</sup>

According to the model, capital market segmentation must be accompanied by capital subsidies to low-technology state-owned enterprises. Brandt and Zhu (2000) provide extensive evidence on the subsidies granted to state-owned firms by state-controlled banks in China. Lemoine (2000), using data from China's Statistical Yearbook of 1998, shows that sectoral profits of state-owned enterprises are positively and significantly correlated with SOEs' share in sectoral output in 1997, that is greater in capital-intensive industries are evident in Table 2. This suggests that capital subsidies —required to equalize the net return to capital across state-owned firms— are greater in labor-intensive industries.<sup>19</sup> This matches the predictions of the model, as long as technology differences are greater in labor-intensive industries. Indeed, the correlation

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<sup>17</sup>Recall that  $\delta_{i2}$  is computed without tariff data, and so there is no spurious correlation between technology differences and tariff rates.

<sup>18</sup>Xu Binglan "Wider Bank Access Mooted" China Daily Business Weekly, April 27, 1998 and People's Bank of China, Quarterly Statistical Bulletin (3), 1999.

<sup>19</sup>Lardy (2002) shows that the textile industry, a labor-intensive industry, was in 1996 the biggest money-losing sector in state-owned manufacturing. During the 1990s, the fall in state employment in textile production was greater than 35%.

coefficient between sectoral capital intensity and  $(\delta_{i2}^s - \delta_{i2}^c)$  is -.46 if all industries are considered, and -.26 excluding Petroleum industries.<sup>20</sup>

[Table 2]

Evidence on the limits of foreign firms' to access tariff-protected product markets is more indirect. Table 2 shows the distribution of employment and value-added between state, collective and foreign enterprises for 3-digit ISIC manufacturing sectors in 1996<sup>21</sup>, revealing a high dispersion of FIEs penetration. What explains the different rates of penetration of foreign firms across industries?<sup>22</sup> Figure 3 plots the share of foreign firms in total sectoral output against capital intensity. The negative and significant association reveals that foreign firms' penetration is greater in labor-intensive industries, suggesting that foreign investment is driven by factor-price differences. This point is emphasized by the positive and significant correlation between foreign firms' output penetration and technology differences in state-owned enterprises (.63 and .82, depending on the measure of technology difference). This suggests that FIEs penetration is greater in industries intensive in those factors with relative low cost if China's capital *and* labor markets were closed. If FDI were driven by other incentives rather than cost differences —like tariff-jumping—, a high correlation between foreign firms' penetration and factor intensity would not necessarily be found.

[Figure 3]

The share in production does not point out to the key aspect of the penetration of foreign firms in consumption. It is well documented that several restrictions apply for foreign firms selling in tariff-protected domestic markets. First, there are many incentives for foreign firms to export a considerable portion of their output. As part of the "Twenty-two Regulations" established in 1986 to define an export oriented

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<sup>20</sup>The estimation of technology differences for SOEs assumed a common subsidy across all industries. If we were to consider a sector-specific subsidy —greater in labor-intensive industries— the pattern of figure 2 would be even more dramatic.

<sup>21</sup>3-digit ISIC sectors are 28, but China's authorities keep records (at least public ones) for 23 aggregates, which are detailed in the table. Hereafter, all the analysis is done based on those 23 categories.

<sup>22</sup>The data in table 2 only refers to share in production, and says nothing with respect to where that production is sold.

firm, tariff exemptions and tax benefits are granted subject to export performance.<sup>23</sup> To some extent, these interventions create an export-promotion and an import-substitution regime at the same time, although the incentives to export somehow undermine the price advantage that tariff protection confer domestic firms. In 1994, only 31% of imports in China were on products to be sold to domestic firms or consumers.<sup>24</sup> Another 41% came in as processing trade, which is later exported, and a further 20% of imports were initial investment of joint ventures, revealing the export orientation of foreign invested firms. Indeed, in the late 1990s, FIEs' production represented almost 20% of manufacturing output and their share in total exports was higher than 50%.<sup>25</sup>

Although there are many FIEs selling in domestic markets and also many SOEs exporting, there are many restrictions—specially from local governments—that limit FIEs' access to domestic market and help introduce an artificial product-price premium to state-owned firms (See Rosen, 1998; Branstetter and Feenstra, 2002). For example, foreign companies must use a government-approved Chinese company that has trading rights in order to trade with China. In addition, they must use a Chinese distributor to distribute imports in the domestic market.<sup>26</sup> Also, legal restrictions and discrimination in legal procedures—specially from local governments—, de facto legal and illegal surcharges, local governments' control over distribution channels have significantly affected the ability of foreign firms' to access domestic markets. A different and more indirect evidence on this is provided by Young (2001). Restrictions to inter-regional trade of goods serve as product-level distortions to protect domestic firms in those regions with low foreign firms' production penetration. Table 3 shows that FIEs' consumption penetration in 1995 was very low except for in those regions with special incentives for foreign producers.<sup>27</sup> Even if foreign firms are eventually able to sell part

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<sup>23</sup>See Branstetter and Feenstra (2002).

<sup>24</sup>Survey of China's International Trade, International Trade Center, UNCTAD/WTO, 1995.

<sup>25</sup>See 2000 Statistical Communique of the People's Republic of China on the 2000 National Economic and Social Development Report.

<sup>26</sup>Indeed, one of the most important aspects of China's protocol accession into the WTO is related to the facilitation of distribution of foreign firms' products on domestic markets (Lardy, 2002).

<sup>27</sup>The share in apparent consumption for region  $r$  of firm type  $i$  is calculated as  $(Q_{ri} - X_{ri}) / (Q_r - X_r + M_r)$ , where  $Q_{ri} - X_{ri}$  is production net of exports, and  $Q_r - X_r + M_r$  is total (apparent) consumption.

of their products in domestic markets, these distortions introduce a gap in the net product price as perceived by FIEs vis-à-vis domestic firms.

[Table 3]

## 4 Conclusions

The traditional paradigm of international trade is the absolute technology differences do not matter; the comparative advantage principle suggests that the pattern of production is determined by relative productivity differences. The theoretical strength of this approach rests, among other things, on the assumption regarding international factor market segmentation. If factors cannot move internationally, absolute technology differences are compensated with factor price differences, with no effect on the pattern of production.

International integration of factor markets can take several forms, like lifting restrictions for workers' movements, or liberalizing the capital account. This paper argues that the liberalization of Foreign Direct Investment is equivalent to factor market integration. The access of technology-advanced foreign producers to domestic markets pressures factor prices up, rendering domestic firms uncompetitive. Absolute rather than relative technology differences determine the pattern of production between domestic and foreign producers. Rather than across-country factor movements, FDI liberalization generates across-firm factor reallocation. Moreover, this side of trade liberalization contrasts with traditional across-industry factor reallocation from tariff changes.

The cost pressures faced by domestic firms make governments react to avoid the collapse of domestic production. This reaction may not be optimal. Indeed, in the limit all factors end up employed in high-technology firms receiving high returns. However, pressures to protect domestic productions do exist, and countries may end up introducing distortions in product and factor markets to compensate for technology disadvantages. Evidence from China suggests that limits to foreign firms' access to tariff-protected domestic markets, a low degree of international financial integration, and capital subsidies to state-owned firms have played a role in sustaining domestic —specially SOEs— employment and production.



From a global perspective, the consequences of FDI liberalization are far-reaching. From a welfare point of view, it can push toward factor price convergence without need for factor flows, a very contentious issue in developed and developing countries alike (Rodrik, 1997). From a trade perspective, it can reinforce the role of factor abundance of the pattern of production. Finally, to the extent that technology differences are endogenous to the existence of domestic distortions (Parente and Prescott, 2000), it emphasizes the need for broad liberalization in less-developed countries.

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# Appendix

Following the notation in section 2, the zero-profit condition for any domestic firm  $d = s, c$  in sector  $i$  can be written as

$$p_i^d = a_{Li}^d w^d + a_{Ki}^d r^d \quad (\text{A1})$$

With this notation, we can compare the average productivity of labor and capital ( $1/a_{Li}$  and  $1/a_{Ki}$ ) in any industry between domestic and foreign firms. The ratio of labor requirements can be written as

$$\frac{a_{Li}^d}{a_{Li}^*} = \frac{\theta_{Li}^d}{\theta_{Li}^*} \frac{w^*}{w^d} (1 + \tau_i) \quad (\text{A2})$$

Similar for capital. Cross-country differences in average factor productivity are twofold. First, relative factor prices may differ across countries. Therefore, firms choose different factor intensities that result in differences in the average and marginal productivity of factors. The second source of difference in average productivity follows from genuine technology differences. For similar relative factor prices, average productivity may differ ( $a_{Fi}^d = a_{Fi}^* (1 + \delta_{Fi})$ ). If  $\delta_{Fi} > 0$ , technology in the foreign country is more advanced than in the home country.

Including both sources of differences in observed  $a_{Fi}$  we can rewrite (A2) for both factors as

$$(1 + \delta_{Li}) \left( 1 - \theta_{Ki}^* \sigma_i (\widehat{w^*} - \widehat{r^*}) \right) = \frac{\theta_{Li}^d}{\theta_{Li}^*} \frac{w^*}{w^d} (1 + \tau_i) \quad (\text{A3})$$

$$(1 + \delta_{Ki}) \left( 1 + \theta_{Li}^* \sigma_i (\widehat{w^*} - \widehat{r^*}) \right) = \frac{\theta_{Ki}^d}{\theta_{Ki}^*} \frac{r^*}{r^d} (1 + \tau_i) \quad (\text{A4})$$

where  $\sigma_i$  is the elasticity of substitution between labor and capital in industry  $i$ .<sup>28</sup> The term  $(\widehat{w} - \widehat{r})$  refers to the adjustment required to equalize relative factor prices in the home and foreign countries at the home's ratio.

Defining  $w = w^*$  and  $r^* = rR$ ,  $(\widehat{w^*} - \widehat{r^*})$  can be written as  $(R - 1)$ . Using data for factor shares, sectoral tariffs and the elasticity of substitution, equations (A3) and (A4) constitute a system with three unknowns;

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<sup>28</sup>The definition of the elasticity of substitution between labor and capital is  $\sigma_i = \text{dln}(K_i/L_i)/\text{dln}(w/r)$ . The percentage change in  $a_{Li}$  and  $a_{Ki}$  for changes in relative factor prices can be written as  $\widehat{a_{Li}} = -\theta_{Ki} \sigma_i (\widehat{w} - \widehat{r})$  and  $\widehat{a_{Ki}} = \theta_{Li} \sigma_i (\widehat{w} - \widehat{r})$ .

$\delta_{Li}, \delta_{Ki}$ , and  $R$ . However, assuming that technology differences are Hicks-neutral ( $\delta_{Li} = \delta_{Ki} = \delta_i$ ), and dividing (A3)/(A4) we get

$$\frac{1 - \theta_{Ki}^* \sigma_i (R - 1)}{1 + \theta_{Li}^* \sigma_i (R - 1)} = \frac{\Phi_i}{R} \quad (\text{A5})$$

where  $\Phi_i = (\theta_{Li} \theta_{Ki}^*) / (\theta_{Ki} \theta_{Li}^*)$ . Equation (A5) is a second-order equation on  $R$ . Assuming cross-industry equalization of relative factor-price ratios – $R$ – this condition is valid in all sectors. Therefore, we can use cross-sector data to estimate the (unobserved) value of  $R$  that best fits this equation in all industries.

With the estimation of  $R$  we can recover the value of  $\delta_i$  that makes each zero-profit condition fit perfectly. For that, consider rewriting equation (A1) as

$$p_i^w (1 + \tau_i) = (1 + \delta_i) [a_{Li}^* (1 - \theta_{Ki}^* \sigma_i (R - 1)) \cdot w + a_{Ki}^* (1 + \theta_{Li}^* \sigma_i (R - 1)) \cdot r]. \quad (\text{A6})$$

that can be rewritten as

$$(1 + \delta_i) = (1 + \tau_i) \cdot \left[ \frac{(1 - \theta_{Ki}^* \sigma_i (R - 1)) \theta_{Li}^* R + (1 + \theta_{Li}^* \sigma_i (R - 1)) \theta_{Ki}^*}{R} \right]^{-1}. \quad (\text{A7})$$

Two measures of  $\delta_i$  are computed:  $\delta_{i1}$  allows for differences in product prices due to tariffs. Strictly speaking,  $(1 + \tau_i)$  refers to relative value-added tariffs, that can be approximated as  $(1 + \tau_i) (1 - \theta_{Li}) / (1 - \theta_{Li}^*)$ , where  $\tau_i$  is the nominal tariff in sector  $i$ , and  $\theta_{Li}$  is the share in output of intermediate inputs, computed using sectoral data on output and value-added. The results are very similar if nominal tariffs are used. The second estimate,  $\delta_{i2}$ , considers  $(1 + \tau_i) = 1$ . Differences in product prices are more difficult to observe directly, and  $\delta_{i2}$  accounts for the part of technology differences that is not driven by differences in product prices.

The data required to estimate A5, reported in Table 4, are obtained from several sources. Factor shares are based on firms with independent accounting systems (that excludes Village enterprises), from China's Statistical Yearbook. Tariffs are obtained from Nicita and Olarreaga (2001). Finally, the elasticity of substitution is obtained from Claro (2003). The estimation of A5 for collectively-owned enterprises yields a value for  $R$  of 2.11, meaning that the estimated ratio of capital return in collective to foreign firms,  $r^c/r^*$ , is .47. If  $\sigma_i = 1$  for all  $i$ ,  $r^c/r^* = .51$ , revealing that the results are mainly driven by differences in factor intensities. The estimates of  $\delta_{i1}^c$  and  $\delta_{i2}^c$  are reported in columns 1 and 2 of table 1.

For state-owned enterprises, estimating  $r^s/r^*$  is more complex because SOEs are subject to credit subsidies. While factor intensities are decided on the basis of gross factor costs, factor shares are computed using net factor prices. Therefore, measures of  $\theta_K$  and  $\theta_L$  are not reliable in order to compute factor price differences. Nevertheless, we can recover an estimate of  $r^s/r^*$  by deducting from  $r^c/r^*$  an estimate of the average subsidy given to SOEs ( $r^s/r^* = r^c/r^* - s^s/r^*$ ), as a percentage of the international return to capital. The subsidy is computed as

$$\frac{s^s}{r^*} = S \cdot \left( \frac{1}{\theta_K^*} \frac{K^*}{K^s} \frac{1}{\phi_m^*} \frac{1}{\phi^m} \right) \quad (\text{A8})$$

where  $S = s^s K^s / Y^T$  stands for the total costs of capital subsidies as a percentage of aggregate GDP (estimated around 3% in 1993, according to Brandt and Zhu, 2000),  $\theta_K^* = .75$  is the average share of capital costs in foreign firms in manufacturing, obtained from China's Statistical Yearbook.  $K^*/K^s = .36$  is the ratio of foreign to state capital stock, from China's Statistical Yearbook, computed as  $(K_i^n / \sum_i K_i^n)$ , where  $K_i$  and  $L_i$  are nominal assets and employment levels in SOEs in 1996.  $\phi_m^* = .16$  and  $\phi^m = .3$  are the share of foreign production in manufacturing output and the share of manufacturing production in total GDP, respectively, also from China's Statistical Yearbook. This yields a value for  $s^s/r^*$  of .3, that deducted from the estimate of  $r^c/r^*$  yields a value for  $r^s/r^*$  of .17, that is used to compute  $\delta_i^s$  from A7.<sup>29</sup> The results are reported in columns 3 and 4 in table 2.

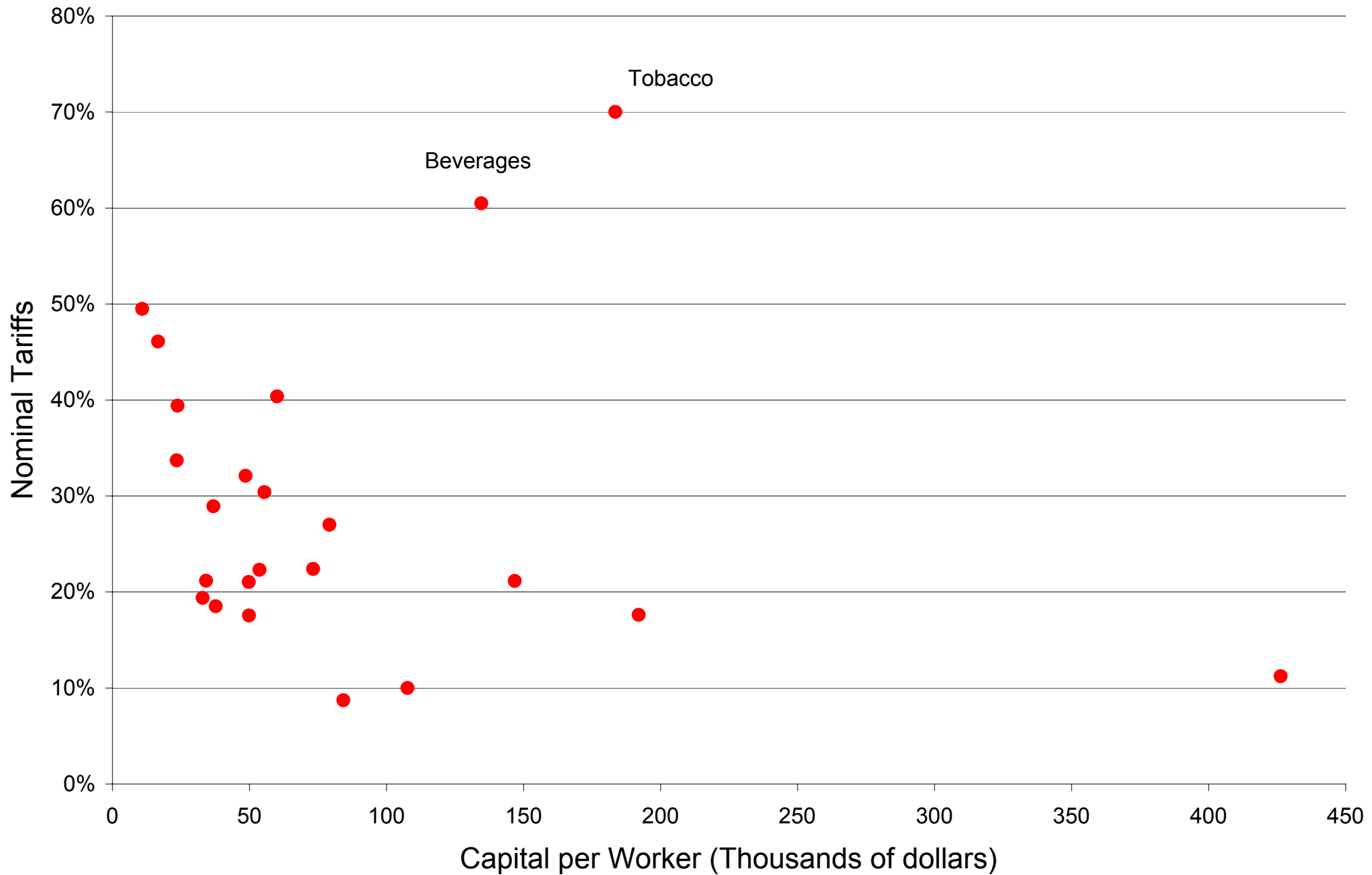
[Insert Table 4]

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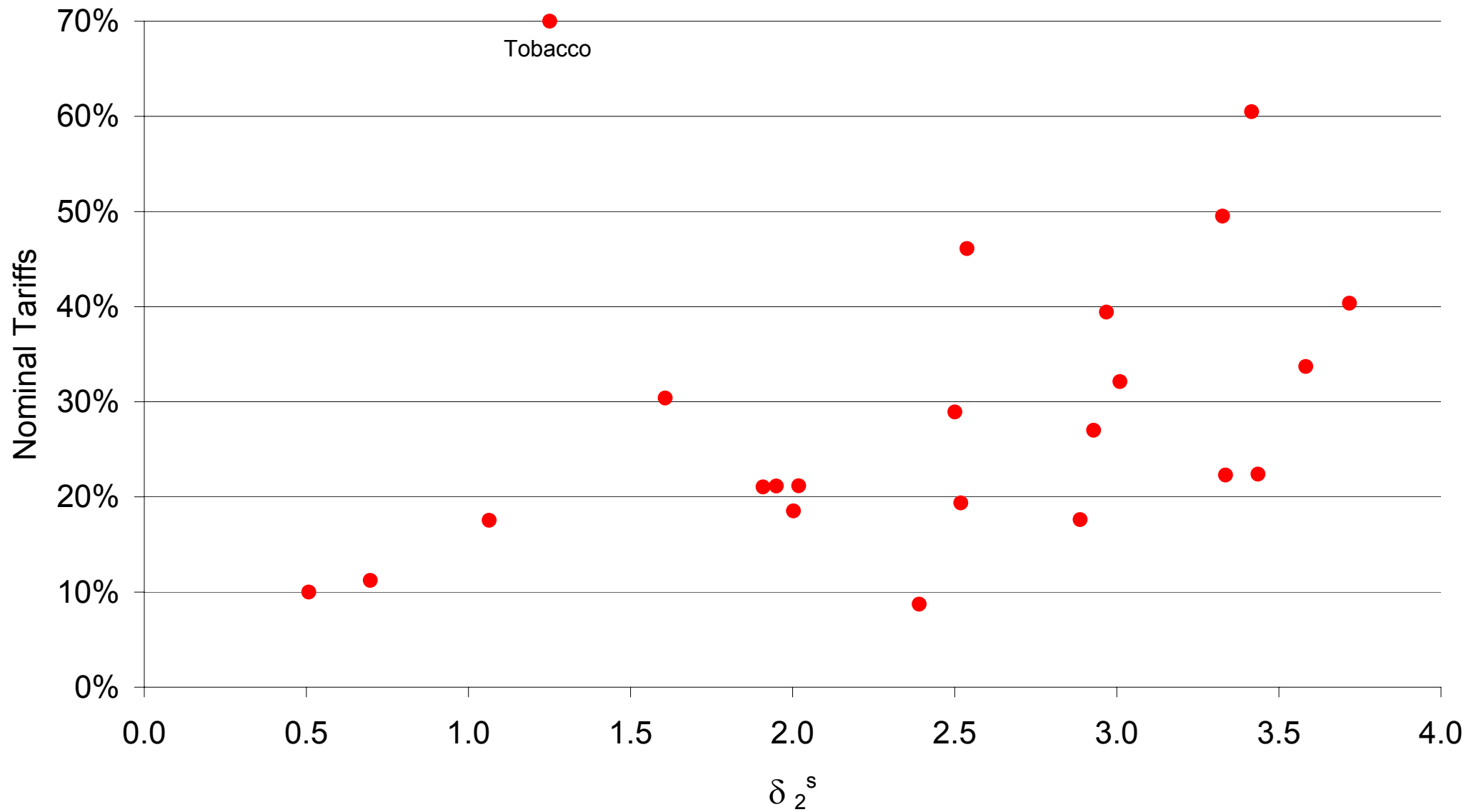
<sup>29</sup> According to (A8),  $s^s/r^* \approx 10 \cdot S$ . For other values of  $S$ , the resulting subsidy and technology differences between state- and foreign-owned enterprises change accordingly, but the sectorial distribution of  $\delta$  is hardly affected. In other words, the result that technology deficiencies are greater in labor-intensive industries is not affected by the value of  $S$  considered.



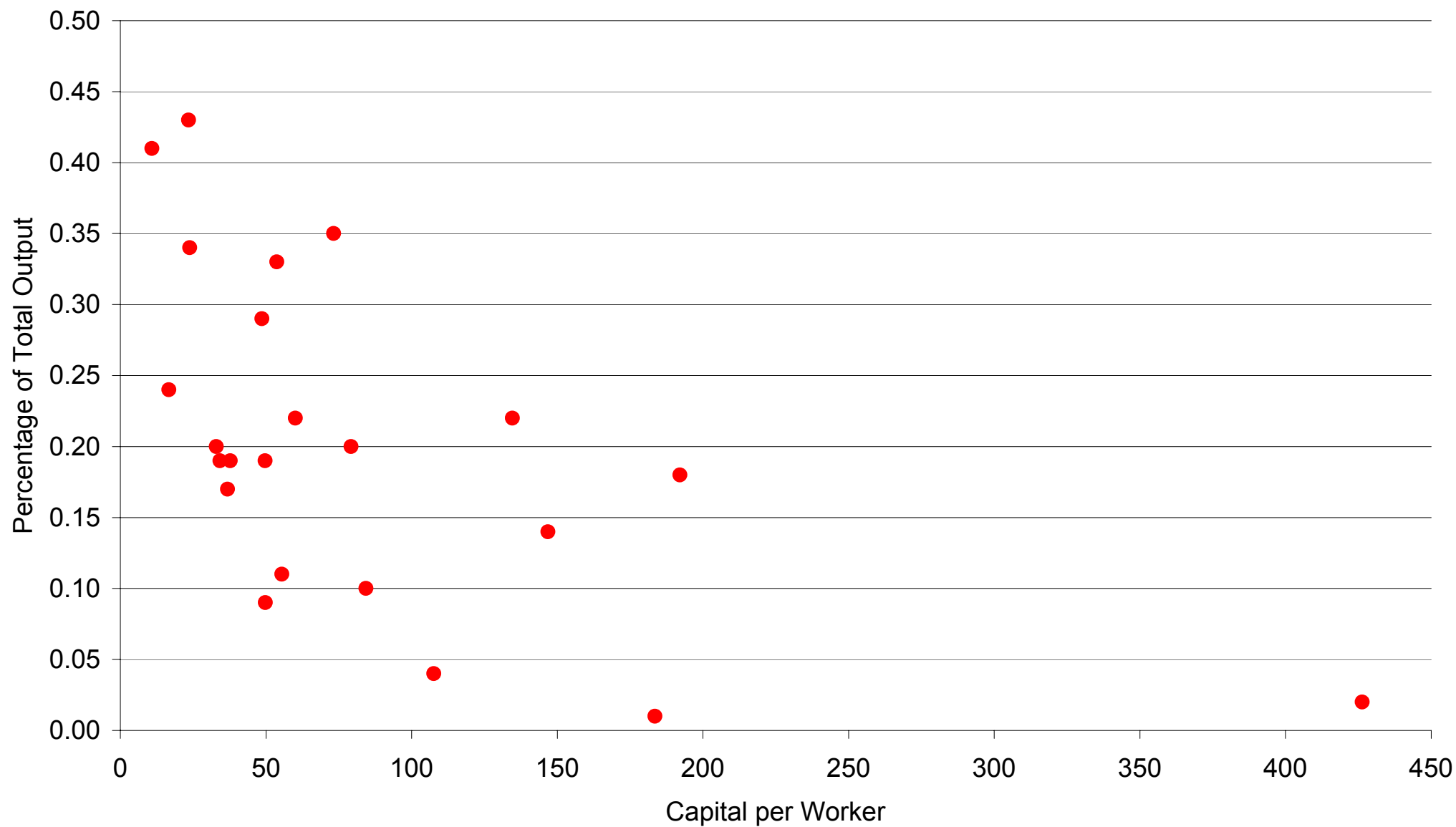
**Figure 1**  
**Tariff and Factor Intensity - China 1996**



**Figure 2**  
**Tariffs and Technology Differences in SOEs - China 1996**



**Figure 3**  
**Foreign Firms' Penetration and Factor Intensity - China 1996**



**Table 1**  
**Technology Differences in China - 1996**

industry	1 $\delta_1^c$	2 $\delta_2^c$	3 $\delta_1^s$	4 $\delta_2^s$	5 $\tau_{96}$	6 (K/L)
Food	2.32	1.04	4.85	3.72	40.4%	60.1
Beverage	2.38	1.01	6.87	3.42	60.5%	134.6
Tobacco	2.35	1.24	4.65	1.25	70.0%	183.5
Textiles	1.73	1.02	3.10	2.50	28.9%	36.8
Apparel & Footwear	1.86	0.97	4.96	3.33	49.5%	10.9
Leather	1.77	0.97	5.06	3.58	33.7%	23.5
Wood	2.07	1.03	3.89	2.52	19.4%	33.0
Furniture	1.96	1.01	4.39	2.54	46.1%	16.7
Paper	1.63	1.01	2.84	1.95	21.2%	146.8
Printing	0.86	1.03	2.35	2.00	18.5%	37.7
Chemicals	0.95	1.02	2.38	2.89	17.6%	192.1
Petroleum	2.03	1.05	1.45	0.70	11.2%	426.3
Rubber	1.61	0.99	2.35	1.91	21.0%	49.7
Plastic	1.51	1.01	3.02	3.01	32.1%	48.6
Pottery and Glass	1.46	1.02	2.21	1.61	30.4%	55.5
Iron & Steel	1.32	0.93	1.21	0.51	10.0%	107.7
Non-ferrous Metals	1.59	1.03	2.94	2.39	8.7%	84.3
Fabricated Metal Products	2.12	1.02	3.67	2.02	21.2%	34.2
Machinery, except electrical	1.91	1.02	1.81	1.06	17.5%	49.8
Machinery, electrical	2.29	1.01	6.45	3.44	22.4%	73.3
Transport	1.93	1.01	3.94	2.93	27.0%	79.2
Professional & Scientific equipment	2.39	0.97	5.65	3.34	22.3%	53.7
Other	1.63	0.98	3.83	2.97	39.4%	23.8
Unweighted Average	1.81	1.02	3.65	2.42	29%	85.29

Note:

$\delta_1^n$  : Technology Difference with product-price premium for domestic firms (See appendix for details.)

$\delta_2^n$  : Technology Difference without product-price premium for domestic firms (See appendix for details.)

$\tau_{96}$  : Tariffs in 1999 from US-China Business Council

K/L : Capital per Workers (Thousands of US Dollars) in U.S. Manufacturing Industry.

**Table 2**  
China's Production Structure by Industry - 1996

Industry (ISIC Code)	Employment Share*	Output Share*	Share in Industry		
			State	Collective	Foreign
Food (311)	6%	7%	38%	41%	22%
Beverage (313)	2%	3%	52%	26%	22%
Tobacco (314)	0%	5%	98%	1%	1%
Textiles (321)	12%	7%	32%	51%	17%
Apparel & Footwear (322, 324)	4%	3%	6%	53%	41%
Leather (323)	2%	2%	7%	49%	43%
Wood (331)	1%	1%	15%	65%	20%
Furniture (332)	1%	1%	7%	69%	24%
Paper (341)	3%	2%	35%	51%	14%
Printing (342)	2%	1%	40%	41%	19%
Chemicals (351, 352)	10%	12%	44%	38%	18%
Petroleum (353, 354)	1%	4%	85%	13%	2%
Rubber (355)	1%	1%	35%	46%	19%
Plastic (356)	2%	2%	9%	61%	29%
Pottery and Glass (361, 362, 369)	11%	7%	28%	61%	11%
Iron & Steel (371)	5%	7%	75%	21%	4%
Non-ferrous Metals (372)	2%	2%	51%	38%	10%
Fabricated Metal Products (381)	4%	3%	13%	68%	19%
Machinery, except electrical (382)	12%	9%	39%	52%	9%
Machinery, electrical (383)	7%	10%	25%	40%	35%
Transport (384)	6%	6%	48%	33%	20%
Prof. & Sc. Equipment (385)	1%	1%	30%	37%	33%
Other (390)	3%	3%	7%	59%	34%

Source: China Statistical Yearbook 1997

\* Based on firms with Independent Account Systems.

State: State-Owned Enterprises

Collective: Collective-owned and Share-Holding Enterprises

Foreign: Foreign Funded and Enterprises funded by Overseas Chinese from Hong Kong, Macao and Taiwan

**Table 3****China's (apparent) Consumption Structure by Region - 1995**

Region	Output	Multinational Share	State-owned Share	Import Share
Beijing	1909	22%	56%	8%
Tianjin	2094	24%	28%	4%
Include OPC or SEZ				
Liaoning	4975	4%	39%	2%
Hebei	3996	7%	33%	1%
Shandong	8456	5%	27%	1%
Jianszu	11813	10%	18%	1%
Shanghai	5129	29%	29%	8%
Zhejiang	8088	8%	8%	1%
Fujian	2801	27%	7%	4%
Guangdong	9535	27%	0%	8%
Guangxi	1666	7%	36%	1%
Hainan	193	20%	5%	35%
Do not include OPC or SEZ				
Heilongjiang	2204	3%	65%	1%
Jilin	1429	6%	58%	5%
Inner Mongolia	782	5%	61%	2%
Shanxi	1754	2%	43%	1%
Henan	4715	4%	32%	1%
Anhui	3156	3%	29%	1%
Hubei	4103	4%	35%	1%
Jiangxi	1291	4%	50%	1%
Hunan	2451	3%	39%	1%
Guizhou	557	3%	64%	2%
Yunnan	1207	3%	64%	4%
Sichuan	4426	3%	37%	1%
Tibet	9	0%	73%	25%
Qinghai	149	1%	83%	1%
Shaanxi	1183	5%	56%	2%
Gansu	825	4%	65%	1%
Ningxia	198	9%	67%	1%
Xinjiang	803	2%	72%	1%

Source: Branstetter and Feenstra (2002)

Notes:

1. Output is measured in 100 million RMB, where 8 RMB ~ US\$ 1
2. Consumption shares estimated as in text, and do not sum to 100% because there are collective firms and other minor categories left out.
3. OPC stands for "Open Coastal Cities"

**Table 4**  
**Data to estimate Technology Differences in China - 1996**

industry	1 $\sigma_i$	2 $\tau_{96}$	3 $\theta_L^c$	4 $\theta_L^f$	5 $\theta_L^s$
Food	0.76	40.4%	0.14	0.08	0.28
Beverage	0.86	60.5%	0.24	0.08	0.16
Tobacco	2.12	70.0%	0.00	0.19	0.04
Textiles	0.93	28.9%	0.21	0.24	0.59
Apparel & Footwear	0.70	49.5%	0.36	0.15	0.57
Leather	0.86	33.7%	0.33	0.11	0.44
Wood	0.58	19.4%	0.11	0.25	0.69
Furniture	0.71	46.1%	0.19	0.28	0.83
Paper	0.81	21.2%	0.22	0.25	0.35
Printing	0.80	18.5%	0.18	0.28	0.48
Chemicals	0.68	17.6%	0.22	0.14	0.28
Petroleum	0.80	11.2%	0.09	0.52	0.12
Rubber	0.74	21.0%	0.29	0.25	0.26
Plastic	1.08	32.1%	0.23	0.17	0.51
Pottery and Glass	0.92	30.4%	0.22	0.39	0.65
Iron & Steel	0.66	10.0%	0.34	0.69	0.27
Non-ferrous Metals	0.59	8.7%	0.15	0.22	0.42
Fabricated Metal Products	0.83	21.2%	0.19	0.31	0.63
Machinery, except electrical	0.96	17.5%	0.24	0.48	0.51
Machinery, electrical	0.63	22.4%	0.28	0.10	0.30
Transport	0.94	27.0%	0.24	0.16	0.45
Professional & Scientific equipment	0.66	22.3%	0.38	0.15	0.58
Other	0.91	39.4%	0.30	0.19	0.61

Note:

$\sigma_i$ : Claro (2003)

$\tau_{96}$ : Nicita and Olarreaga (2001)

$\theta_L^k$ : Share of labor in value-added in firm type  $n=s,c,f$  (Firms with Independent Accounting Systems)