Trade, Technology, and Foreign Direct Investment

by

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Abstract

Chapter 1
Does Proximity to Foreign Firms Induce Technology Spillovers? Evidence from Panel Data (with Ann Harrison)

Many developing countries now actively solicit foreign investment, offering income tax holidays, import duty exemptions, and subsidies to foreign firms. One justification for subsidizing these firms is the so-called "spillover" of technology from foreign to domestic firms. Using plant-level data for Venezuela from 1976 to 1989, we test whether domestic firms located near foreign firms exhibit higher levels of productivity than comparable domestic firms located in regions without foreign investment. In contrast to previous studies, we generally find no impact or a negative impact of foreign presence on domestic (plant) productivity. The only exceptions are domestically owned plants which were previously foreign owned or become a target for foreign ownership in future years. For these firms, the observed spillovers from proximity to foreign firms are positive and significant.

Chapter 2
Human Capital, Labor Turnover, and Direct Foreign Investment: Wage Differences Between Foreign-Owned and Domestic Firms

In developing countries, wages are commonly observed to be higher within foreign-owned firms than within domestic firms. These wage differences persist even after controlling for characteristics such as size, industry, and capital-labor ratio. I confirm these wage differences for Venezuela. I then develop explanations for the wage differences, linking relative wages to human capital formation in foreign-owned firms and labor turnover. In particular, if foreign firms can reduce costly turnover by paying higher efficiency wages, an increase in the amount of specific human capital formed by workers at the foreign firm will result in an increase in the foreign/domestic wage differential, a decline in labor turnover from the foreign firm, and a decline in the stock of human capital spilled over to domestic firms. I test this explanation against other hypotheses of wage differences for a sample of Venezuelan manufacturing firms. The tests confirm the predictions of the efficiency wage turnover model; high foreign/domestic wage differences reduce the human capital spillover to domestic firms.

Chapter 3
Measuring Trade Policy Intervention: A Cross-Country Index of Relative Price Dispersion

In the debate about the relationship between trade policy and growth, various measures of trade intervention have been used. I present a new measure based on a country's relative price structure compared with the structure of world relative prices. This measure conforms more closely than existing measures to the concept of trade intervention.

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Chapter 1

Does Proximity to Foreign Firms Induce Technology Spillovers? Evidence from Panel Data (with Ann Harrison)

1.1 Background

In the 1960s and 1970s, many developing countries adopted policies to restrict the inflow of foreign investment. The rationale behind these policies was simple. As part of their overall strategy to promote infant industries, governments protected their less productive domestic firms from import competition. Since foreign multinationals could avoid these import restrictions by producing directly in the domestic country, host governments were forced to regulate foreign entry.

In the 1980s, the disappearance of non-equity sources of foreign capital created a resurgence of interest in direct foreign investment (DFI). The need for alternative sources of capital, combined with an increasing skepticism about import substituting trade strategies, led many developing countries to liberalize restrictions on incoming foreign investment. Some countries actually tilted the balance towards foreign firms by offering special incentives: in Mexico, the maquiladora firms pay no income taxes; in much of the Caribbean, foreign firms receive income tax holidays, import duty exemptions, and subsidies for infrastructure.

Can these subsidies be justified? Apart from the increase in employment and capital inflows accompanying foreign investment, the literature on the gains from DFI points to the transfer of knowledge or new technology from foreign to domestic firms as a potential benefit of foreign investment[1]. If foreign firms introduce new products or processes to the domestic market, domestic firms may benefit from the accelerated diffusion of new technology (Teece, 1977; Davies, 1977). In some cases, domestic firms may increase productivity simply by observing foreign firms in the region. In other cases, diffusion may occur from labor turnover as domestic employees move from foreign to domestic firms (Edfelt, 1975; Gonclaves, 1986; Watson, 1972). If this spillover benefit is not completely

[1] See Caves (1982), and Helleiner (1989) for surveys

internalized by the incoming firm, some type of subsidy could be justified. Case studies of Mauritius and Bangladesh, for example, suggest that the entry of several foreign firms led to the creation of a booming, domestically-owned export industry for textiles (Rhee and Belot, 1989). The expectation that foreign investment may serve as a catalyst for domestic production rationalizes policies in economies as diverse as Taiwan and Bulgaria, whose governments offer special treatment for foreign firms in high technology sectors.

Despite the voluminous literature on DFI in the 1960s and 1970s, the empirical evidence on technology spillovers from foreign sources of equity investment remains slim. Although a number of descriptive case studies document the importance of foreign investment for domestic technology development (see, for example, Rhee and Belot (1989)), few researchers have attempted to measure these effects empirically. In an early study, Caves (1974) tested for the impact of foreign presence on value-added per worker in Australian domestically-owned manufacturing sectors. Caves found that the disparity between (higher) foreign and domestic value- added disappears as the share of labor employed at foreign-owned firms in the sector rises, which is consistent with technology spillover hypothesis.

Globerman (1979) replicated Caves (1974) using sectoral, cross-section data for Canadian manufacturing industries in 1972. The results are consistent with a weak spillover effect. Yet spillovers from foreign investment are likely to be much larger in industrializing countries, where the gap between domestic and foreign productivity may be significant. Most of the empirical work on technology spillovers from foreign investment in developing countries has focused on Mexico, which gathers manufacturing data by ownership type. Blomstrom and Persson (1983), Blomstrom (1986), and Blomstrom and Wolff (1989) generally find that sectors with higher foreign ownership exhibited higher levels of productivity, faster productivity growth and faster convergence of productivity levels to US norms.[2].

None of the previous studies use firm-level data, restricting the authors' ability to examine domestic and foreign firm behavior separately. In this paper, we use annual census data on Venezuelan firms (averaging over 5,000 firms annually) to examine in detail the different behavior of foreign and domestic firms. Do foreign firms import more or less than their domestic counterparts? Are they more capital intensive? We are able to explicitly compare the behavior of foreign and domestic firms by sector. Instead of comparing partial productivity measures (such as labor productivity, which gives misleading results when firms differ in capital intensity), we construct a production function which allows us to examine the impact of foreign investment on multi-factor productivity.

All previous attempts to measure spillover effects from foreign investment also face a critical identification problem: if foreign investment gravitates towards more productive industries, then the positive impact of foreign presence on domestic firm productivity will be over-estimated. As a

[2]Blomstrom (1989) provides a synthesis of his previous work on the impact of foreign investment in Mexico.

result, one could find a positive spillover from foreign investment where no spillover occurs. This paper differs from previous studies by using the differences in foreign investment across regions to identify technology spillovers within each industry. Examining the differences in productivity for similar domestic firms within the same industry allows us to ignore factors which are likely to determine foreign investment at the industry level. We also control for the possibility that other factors, such as agglomeration economies, could lead to differences in productivity across regions; for example, easier access to information, better infrastructure, or better educational opportunities could make some areas more productive than others.

1.2 Foreign Investment and Spillovers: The Theoretical Framework

The so-called "industrial organization" approach to DFI in manufacturing suggests that multinationals can compete locally with more informed domestic firms because multinationals possess a nontangible productive asset, such as technological knowhow, marketing and managing skills, export contacts, coordinated relationships with suppliers and customers, reputation[3]. Since the assets are almost always gained through experience, they cannot be easily licensed to host country firms, but can be costlessly transferred to subsidiaries who locate in host countries either to circumvent trade barriers or produce with cheap local labor (Teece, 1977). With extensive production experience, multinationals may be in the best position to expand production to take advantage of low wages.

Although the intangible firm-specific asset may not be licensed, domestic industry might nonetheless benefit from the presence of foreign firms. Resource allocation is improved if foreign firms drive out the most inefficient domestic firms, raising average domestic productivity. The multinational may speed technology transfer if its firm-specific asset "spills over" to domestic industry through demonstration, labor mobility, or technical support to domestic suppliers. In addition, foreign firms may act as a stable source of demand for inputs in a industry, which can benefit upstream domestic firms by allowing them to train and maintain relationships with experienced employees.

We set up a framework for estimating the effects on domestic total factor productivity of foreign presence in the domestic firm's location[4]. Foreign firms exert an externality by increasing the stock of human capital in a given region. This stock becomes available to domestic firms as experienced workers leave the foreign firms and work at domestic firms; domestic productivity in the region increases with the increase in human capital accumulation. But foreign presence can also *reduce*

[3] See Rugman (1986), Caves (1971), Grieco (1986), Horstman and Markusen (1989), Helpman (1984), and Krugman (1983).

[4] In an appendix available from the authors we specify a more complete model which endogenizes foreign and domestic firm location decisions.

domestic productivity by reducing the demand for products produced by domestically owned firms, forcing them to spread their fixed costs over a smaller market. Domestic productivity can decline even if some of the firm-specific asset spills over, so long as the fall in perceived demand drives domestic firms back up their average cost curves.

1.2.1 Positive Technology Spillovers from Regional Foreign Presence

Production in the industry takes place in several regions. Foreign

firms in a region are assumed to "produce" industry-specific human capital as a byproduct of production. As experienced workers leave the foreign firm, they take their accumulated knowledge with them, and the foreign asset "spills over" into the region's human capital pool[5]. For region s, the net flow into the human capital stock h_s increases with the region's share of labor employed by foreign firms (fs_s); therefore, the stock of human capital is given by

$$h_s = h(fs_s) \qquad h' > 0 \tag{1.1}$$

The region's human capital stock is assumed to increase with increases in the region's share of workers employed by foreign-owned firms.

We allow for the possibility that foreign firms may be drawn to regions which exhibit higher domestic productivity. The foreign firm's location decision may be influenced by such factors as minimizing high search costs for domestic skilled labor, or retaining contact outside the country with suppliers, the parent company, and the broader market; foreign firms may be drawn to regions in which infrastructure is advanced or skilled labor markets are thick, such as urban areas. Better infrastructure and agglomeration effects caused by a high concentration of skilled labor may also raise productivity for domestic firms. To allow for the possibility that foreign share is influenced by factors related to domestic productivity, we assume foreign share in region s is characterized by

$$fs_s = fs(a_s) + \epsilon_s \tag{1.2}$$

where ϵ_s is exogenous, and a_s is an exogenous region-specific measure of labor productivity, and $fs' \geq 0$. The measure a_s can be interpreted as an effect of labor agglomeration, differences in infrastructure, or the existence of some regional fixed factor.

Total factor productivity for domestic firms is influenced both by region-specific human capital

[5] Even if the foreign firm were able to capture the full return on the asset by paying workers an "apprentice" wage lower than the market (in return, workers anticipate higher wages in the future), labor mobility insures the pool of human capital will increase; in this case, foreign firms induce workers to invest in acquiring job skills. However, there exists little or no evidence that foreign firms pay "apprentice" wages.

and by exogenous region-specific productivity characteristics

$$A_s = A(h_s, a_s) \tag{1.3}$$

From equation 1.1 domestic total factor productivity can be expressed

$$A_s = A(h(fs_s), a_s) \tag{1.4}$$

If region-specific productivity has no impact on foreign share ($fs' = 0$), then effects of foreign direct investment in a region on domestic total factor productivity can be estimated using the region's share of labor employed by foreign firms. If, however, foreign share is greater in regions with larger region-specific productivity effects ($fs' > 0$), then estimating total factor productivity using foreign share as an explanatory variable will over-state the productivity spillovers from foreign direct investment; foreign share would be correlated with the error term unless region-specific differences in productivity were controlled for. This can be accomplished using the regional skilled wage w_s. Provided the following holds

$$w_s = w(a_s) \qquad w' > 0 \tag{1.5}$$

Including the region's skilled wage (for all industries) in total factor productivity estimation will control for the missing variable bias which results if foreign share is related to region-specific productivity. Since the wage is for all industries in the region, it is unlikely to be influenced greatly by foreign presence in any one industry.

1.2.2 Spillovers from Foreign Investment at the National Level

If the industry sells the product in the national market, then the demand perceived by any one firm is independent of the firm's location of production. Demand for the product at the national level is given by

$$P = \alpha - \beta(Q + Q^*) \tag{1.6}$$

where Q is total output by domestic firms and Q^* is total output by foreign firms. Domestic output in the industry is produced by N firms and foreign output by N^* firms; domestic firms are assumed to be identical to one another, but may differ from foreign firms. Both N and N^* are assumed to be exogenously determined by entry and exit restrictions[6].

[6] The model can be extended to include free entry and exit into the industry. Free entry and exit do not change the impact of location-specific foreign investment so long as the market for the product is independent of the location of production

Each domestic firm produces with the cost function

$$C = F + mq \tag{1.7}$$

where q is the output of the firm, and m is the constant marginal cost of production. Foreign firms produce with no fixed costs and a marginal cost which differs from domestic marginal costs by the factor γ

$$m^{*} = \gamma m \qquad 0 < \gamma < 1 \tag{1.8}$$

We assume that domestically owned and foreign owned firms compete in a Cournot fashion; domestic firms maximize profits taking other firms' output in the industry as given

$$P - m + q(\frac{dP}{dq}) = 0 \tag{1.9}$$

This condition combined with demand in equation 3.19 gives the reaction function for domestic firms

$$q = \frac{\alpha - m}{\beta} - Q + Q^{*} \tag{1.10}$$

Imposing the symmetry condition $Q = Nq$ and solving for q, equation 1.10 becomes

$$q = \frac{\alpha - m}{\beta(N+1)} - (\frac{1}{N+1})Q^{*} \tag{1.11}$$

Equation 1.11 indicates that an increase in foreign output relative to domestic output will cause a decline in production by each domestic firm. Since domestic firms produce with declining average costs, this decline in production results in a fall in domestic total factor productivity.

The fall in productivity associated with an increase in foreign investment in the industry across all locations may be offset by the increase in productivity to those firms located in the same regions as the foreign firms. Because of these two offsetting spillovers, it is not clear ex ante that foreign investment over all regions should increase or decrease domestic total factor productivity.

1.3 Foreign and Domestic firms in Venezuela

Foreign ownership is restricted to minority participation only in some areas of manufacturing, such as basic industries (iron, steel, and aluminum) and is only excluded from investing in manufacturing enterprises in the petroleum sector. Although foreign investment in Venezuela has generally averaged less than 10 percent of total assets in Venezuela's manufacturing sector (Table 1.1), reforms initiated in 1986 and extended in 1990 are likely to increase its role.[7]

The dataset employed in this paper is taken from the Venezuelan industrial survey (*Enquesta Industrial*), which is conducted annually by the National Statistical Bureau (Oficina Central de Estadistica e Informatica, OCEI). The years covered include 1976 through 1989, with the exception of 1980 (the industrial survey is not taken in census years). The Enquesta Industrial covers all plants in the formal sector with more than 50 workers, as well as a large sample of smaller plants. For the smaller plants, OCEI calculates the sample weights, permitting aggregation of output and

other variables to estimate the total value for the entire manufacturing sector. The number of plants ranges from a low of 3,955 plants in 1982 to a high of 6,044 plants in 1978. The data contain information on foreign ownership, assets, employment, detailed cost information, location, and product destination (export/domestic). Respondents are guaranteed anonymity in responding to the survey.

Since the industrial census gives the percentage of subscribed capital owned by domestic investors, it is possible to derive the mean share of foreign investment by year, location, and sector. Table 1.1 shows the mean weighted share of FDI in manufacturing for selected years, using number of employees as the weight (since foreign firms tend to be more capital intensive than domestic firms, the share of foreign firms is significantly higher if weighted by physical capital). Table 3.36 shows that the majority of foreign investment over 1975-89 has been in autos (machinery, transport and metal products), basic metals (iron, steel, and aluminum), chemicals, and food and beverages.

Table 1.3 compares the performance of foreign and domestic firms in terms of their labor productivity, export and import behavior, and wages. On average, foreign owned firms exhibited higher labor productivity, a higher propensity to import as well as export, and paid higher wages than their domestic counterparts. These results are robust to corrections for size, capital intensity, and skill composition of foreign versus domestic firms. These differences in labor productivity, which persist even after controlling for differences in capital intensity, do suggest that foreign firms may exhibit some sort of technological superiority. The next section examines whether any of this technological

[7] Venezuelan firms are classified by degree of foreign ownership into three types: national, with less than 20 percent foreign ownership; mixed with 20 to 49.9 percent foreign ownership; and foreign firms, with majority foreign control. Until 1989, the Superintendencia de Inversiones Extranjeras (SIEX) exercised substantial discretion in regulating the inflow of foreign investment. Profit remittances were limited to 20 percent (plus LIBOR) of the investment (based on book value). Since purchasing equity in existing firms was prohibited, foreign investment could only be in the form of direct investment registered with SIEX. Payments by a firm for its foreign partner's technology were prohibited, and contracts that called for royalty or patent payments needed SIEX approval.

During the period from 1975 to 1989, foreign firms were discriminated against in a number of different ways. First, they faced higher tax rates on corporate income–50 percent versus 35 percent for domestic firms. They were also restricted from imposing

confidentiality and exclusive use of trade secrets in joint ventures. Finally, foreign firms were obliged to buy bolivares at the official exchange rate rather than the free market rate.

In 1989, the restriction on profit repatriation was eliminated. Bureaucratic discretion was eliminated and SIEX was authorized to reject foreign investment applications only if they did not comply with the sectoral restrictions discussed above. When exchange rates were unified following reforms, the discrepancy between official and free market exchange rates were eliminated. The restrictions on use of confidentiality and trade secret requirements are currently being negotiated as part of agreements on property rights, and the differential tax rates between foreign and domestic firms is addressed in pending tax legislation.

advantage "spills over" to domestic firms.

1.4 Evidence of Spillovers

To examine whether foreign presence affects productivity, we begin with a production function for domestic firms, with value-added Y a function of four inputs: skilled and unskilled labor, capital and material inputs. For firm i in sector j at time t, this can be written as

$$Y_{it} = A(j)_t F(SKL_{it}, UNSKL_{it}, M_{it}, K_{it}) \tag{1.12}$$

The level of productivity is given by $A(j)_t$, which is initially assumed to vary only across sectors and across time t. If we assume a general Cobb-Douglas production function, we can derive the log specification as

$$\begin{aligned} logY_{it} = logA(j)_t + \alpha_1 logSKL_{it} + \\ \alpha_2 logUNSKL_{it} + \alpha_3 logM_{it} + \alpha_4 logK_{it} \end{aligned} \tag{1.13}$$

To allow for imperfect competition, we do not impose the restriction that the coefficients on the inputs are equal to their factor shares, nor do we impose constant returns to scale. This general specification avoids some biases which may arise from calculating total factor productivity, captured here by the exogenous total factor productivity measure $A(j)_t$.

Production is computed as the value of sales less the change in inventories, deflated by a four-digit level production price deflator. Skilled and unskilled labor were measured as the number of skilled and unskilled employees. Material costs were adjusted for changes in inventories, then deflated by a production price deflator. Capital stock is the stock of capital reported by each firm at the beginning of the year, deflated by the GDP deflator.

1.4.1 The Impact of Foreign Investment: Reproducing Earlier Results

We begin the analysis by replicating tests performed by Globerman (1978) for Canadian data and Blomstrom and Persson (1983) for Mexican data. By assuming that the productivity term A varies with foreign presence in the sector, earlier researchers used output data at the sector level, with the dependent variable being total output by domestically-owned firms in the sector, to estimate essentially the following equation

$$\log Y_j = Constant + \alpha_1 \log SKL_j + \alpha_2 \log UNSKL_j +$$

$$\alpha_3 \log M_j + \alpha_4 \log K_j + \alpha_5 FS_j + \epsilon_j \quad (1.14)$$

where FS_j is the share of workers in sector j employed by foreign-owned firms. The coefficient α_5 is interpreted as a measure of spillovers from foreign presence onto domestic total factor productivity, and was generally found to be positive, although not always significant.

We extend previous studies by estimating equation 1.13 for a panel of plants between the years 1976 and 1989. We assume the productivity term $A(j)_t$ has an exogenous component ϵ_{it}, a mean-zero firm-specific component η_i, a time-varying component D_t, and varies with foreign presence in sector j:

$$\log A(j)_{it} = Constant + b_1 D_t + b_2 FS(j)_t + \eta_i + \epsilon_{it} \quad (1.15)$$

The foreign share $FS(j)_t$ is calculated annually as the share of the labor force employed by foreign owned firms in four-digit sector j. Combining this specification of $A(j)_{it}$ with equation 1.13 yields the following estimating equation

$$\begin{aligned}\log Y_{it} = Constant + \alpha_1 \log SKL_{it} + \alpha_2 \log UNSKL_{it} + \alpha_3 \log M_{it} + \\ \alpha_4 \log K_{it} + \alpha_5 FS(j)_t + \alpha_6 D_t + \eta_i + \epsilon_{it}\end{aligned} \quad (1.16)$$

This equation is estimated only for domestically-owned plants. Plants are defined as domestically owned if the plant is 100 percent domestically owned over the entire sample period. We refer to these types of firms as "Class 1" firms. Later in the paper, we examine the impact of foreign presence on firms which were wholly domestically-owned for only a subset of the sample period.

Estimation results are given in the first row of Table 1.4. The coefficients on the inputs are all positive and statistically significant, as expected. The coefficient on unskilled labor is three times as high as for skilled labor, indicating the higher share of unskilled labor in total labor payments in Venezuela. The coefficient on $FS(j)_t$ is positive and statistically significant, and is consistent with the evidence reported by earlier researchers. The coefficient, 0.061, suggests that if the share of labor employed by foreign-owned firms rose from 0 to 10 percent of the manufacturing sector, output would increase by 0.6 percent. Since the specification controls for the impact on increases in inputs on output, this .6 increase is a pure (total factor) productivity gain.

If foreign firms tend to locate in productive sectors, then estimates of the impact of foreign share will be biased upwards. One way to correct for this bias is to introduce sector dummy variables. This controls for unobserved productivity differences across industries, exploiting the time series to identify the impact of foreign investment. The second row in Table 1.4 reports the estimation results with the inclusion of industry dummies at the 2-digit level. With the inclusion of industry dummies, the coefficient on DFI switches from positive to negative and becomes statistically insignificant. This suggests that in our sample, the positive and statistically significant impact of foreign investment using cross-industry data is not robust; we cannot distinguish between the hypothesis that foreign investment has positive spillovers on domestic firm productivity from the possibility that foreign firms simply locate in productive industries.

The estimates for differences in productivity at the 2 digit industry level, however, may also be subject to the type of bias discussed above. Again, foreign investment may be more attracted to subsectors within each broad industry category which are most productive. For example, within food products, foreign firms may be attracted to the tobacco market, which may have achieved a higher level of productivity than beverages. Furthermore, firm-specific differences in productivity could also lead to biased estimates. We control for these potential biases by re-estimating equation 1.16, subtracting from each variable the firm's mean of that variable over the sample period. This *within estimation* approach eliminates any unobserved difference across firms or sectors which remain fixed over time, yielding the modified estimating equation

$$\log Y_{it} - \log Y_{i.} = \alpha_1(\log SKL_{it} - \log SKL_{i.}) + \alpha_2(\log UNSKL_{it} - \log UNSKL_{i.}) + \alpha_3(\log M_{it} - \log M_{i.}) + \alpha_4(\log K_{it} - \log K_{i.}) + \alpha_5(FS(j)_t - FS(j)_.) + (D_t - D_.) + \epsilon_{it} \quad (1.17)$$

where the subscript $i.$ indicates the mean over time for firm i.

Within estimates are reported in the third row of table 1.4. The results are dramatic; the coefficient on DFI becomes even more negative and is statistically significant at the 1 percent level. The coefficient, -0.174, suggests that an increase in the share of foreign investment from 0 to 10 percent of the manufacturing sector would be accompanied by a decline in total factor productivity of 1.7 percent.

1.4.2 The Impact of Foreign Investment: Exploiting Geographic Dispersion in Foreign Investment

As indicated in the model presented above, increasing foreign investment could be associated with an average decline in productivity for firms in the industry and at the same time provide positive benefits to those firms located near multinationals. We now broaden the analysis to examine the impact of locating in an area with a high share of foreign investment, allowing foreign share to vary both across industry j and region s. A, which will also vary across each region s and time period t, can be specified as

$$\log A(s,j)_{it} = Constant + b_1 D_t + b_2 FS(s,j)_t + a(s)_t + \eta_i + \epsilon_{it} \quad (1.18)$$

where $a(s)_t$ is a mean-zero factor which varies across regions and over time, but remains the same across all sectors. The "unadjusted" estimation will then be given by

$$\log Y_{it} = Constant + \alpha_0 Industry(j) + \alpha_1 \log SKL_{it} + \alpha_2 \log UNSKL_{it} + \alpha_3 \log M_{it} +$$

$$\alpha_4 \log K_{it} + \alpha_5 FS(s,j)_t + \alpha_6 D_t + \epsilon_{it} \tag{1.19}$$

where $Industry(j)$ is dummy variable indicating the firm's four-digit industry, and is included to control for any industry-level factor.

If the location-specific productivity term $a(s)_t$ is correlated with foreign share, $FS(s,j)_t$ would over-estimate the impact of location-specific foreign investment on productivity. For example, foreign firms may be more attracted to regions which benefit from agglomeration economies; we would observe a correlation between domestic productivity and foreign share in a location even in the absence of spillovers. Based on the model presented earlier in the paper, variations in productivity due to agglomeration economies or other region-specific effects may be captured by levels in the real skilled wage. Including the log of the skilled wage for *all* industries in region s ($\log Wage(s)_t$) in the estimation of equation 1.19 would control for these location-specific productivity effects. The resulting "adjusted" estimation equation is as follows

$$\log Y_{it} = Constant + \alpha_0 Industry(j) + \alpha_1 \log SKL_{it} + \alpha_2 \log UNSKL_{it} + \alpha_3 \log M_{it} + \\ \alpha_4 \log K_{it} + \alpha_5 FS(s,j)_t + \alpha_6 D_t + \alpha_7 \log Wage(s)_t + \epsilon_{it} \tag{1.20}$$

Since foreign investment in any one four-digit industry is unlikely to significantly affect the skilled wage for all industries in the region, the skilled wage will be independent of $FS(s,j)_t$.

Both foreign share and the skilled wage are calculated at the district level. Venezuela is divided into 23 regions, which in turn are subdivided into districts. Regions may have several or as many as 20 districts. In all, the total number of region-district locations adds up to 220 separate locations. In a country one-third larger than the state of Texas, this indicates that the average district size is 40 miles wide by 40 miles long (1600 square miles). Table 1.1 shows the average share of labor employed at foreign owned firms and the standard deviation of this measure across region-districts. The size of the standard deviations in table 1.1 indicates that foreign presence is not uniformly distributed across industries and across regions. Figure 1, which plots the dispersion of foreign investment across region-districts for each sector for 1985, shows foreign investment is not concentrated in a few locations, but is geographically scattered [8]. Most two-digit industries experienced an increase in foreign investment between 1975 and 1988, with the exception of textiles and clothing.

Estimates of the impact of regional foreign share on domestic firm productivity are given in Table 1.5. For both the adjusted and unadjusted estimates, the coefficient on foreign investment is statistically insignificant, and when the real skilled wage is included, the value of the coefficient falls to zero. The coefficient on foreign investment falls if the real wage is included, suggesting that foreign investment is likely to locate in areas with highly productive skilled workers. We also experimented with using other measures which might reflect location-specific productivity differences, such as the

[8] Although the table shows industry values at the two-digit level, the regressions were estimated with all industry variables calculated at the four-digit level.

number of firms in each location, rent prices, and the industry-specific skilled wage in the location, but the results were unchanged. Although not reported in the paper, we also find consistently positive and large location-specific effects (as proxied by the real skilled wage) on domestic factor productivity.

The within estimates, which control for firm-specific differences in productivity, are reported in the last row of Table 1.5. The within estimates support the results in the first and second rows, indicating no statistically significant impact of region-specific foreign investment on domestic firm productivity growth. The magnitude of the coefficient is also close to zero; an increase in foreign presence from 0 to 10 percent of the manufacturing sector would only increase TFP by 0.15 percent.

One way to interpret the negative impact of foreign share at the sector level and the essentially zero impact using regional foreign share is to recall the mixed results outlined in the theoretical model. The "competitive" effect suggests that domestic firms may be negatively affected by foreign entry. If foreign entry reduces the market for domestic firms and drives them back up their average cost curves (or reduces their revenues), this will appear at the aggregate, region-wide level. Estimation which uses region-specific foreign share, on the other hand, is more likely to capture spillovers. Particularly if demand shocks at the regional level can be diffused by selling on the national market, region- specific estimates are essentially capturing productivity spillovers. Yet both sets of estimates are a weighted average of competitive and productivity effects. Estimates at the sector level give greater weight to competitive effects, while region-specific estimates give greater weight to technology spillovers. This will become clearer later in the paper, when both the sector-wide and region-specific foreign share variables are included in the same estimation (see Table 1.12).

Table 1.6 decomposes the impact of foreign investment on domestic firm productivity by manufacturing sector. The third row of Table 1.4 and the second and third rows of Table 1.5 were re-estimated by allowing the coefficient on foreign share to vary across sectors. In the first column, which examines the impact of sector-level foreign share in a within estimation, the coefficient on foreign share is negative in 5 out of 7 sectors. However, the coefficient is only statistically significant (and negative) for food products. The second and third columns, which report the impact of foreign share at the district level, show that foreign investment generally had an insignificant impact on domestic firm productivity. The only exceptions are pottery and glass, where foreign investment had a large negative impact on productivity, and wood products, where its impact was large and positive.

1.4.3 The Impact of Foreign Investment on Domestic Plants which Experienced some Foreign Ownership During the Sample Period

To derive the impact of foreign investment on domestically owned plants in Tables 1.4 and 1.5, a number of observations were discarded. Plants which had a history of foreign ownership but were no longer foreign owned, as well as plants that would become the targets for foreign ownership in future periods were eliminated from the previous sample (some 27 percent of the total domestically-owned sample observations). These plants will be referred to as "Class 2" plants. This section explores the impact of foreign share on Class 2 plants during the period when they were 100 percent domestically owned.

Table 1.7 compares Class 2 domestic firms with domestic firms which had no foreign ownership over the entire sample period (Class 1 firms). Class 1 and Class 2 firms exhibit similar characteristics in a number of respects, including labor productivity, the share of skilled workers in their labor force, the capital- labor ratio, and the share of foreign investment in the region where they are located. A value of 0.99 for labor productivity, for example, suggests that labor productivity in Class 2 firms was only 1 percent lower than in Class 1 firms.

Table 1.8 shows the impact of sectoral foreign share on the productivity of Class 2 firms. Unlike the results presented earlier for Class 1 firms, foreign share exerts a large and statistically significant, positive impact on the productivity of these firms during the period when they were 100 percent domestically owned. Table 1.9 show the impact of each district's foreign share on plant productivity. When controls are included for region-specific productivity effects, the coefficient on foreign share falls from 0.28 to 0.23. The within estimate is slightly lower, at 0.21, which probably indicates that unobserved differences in firm-level and district-level productivity biased the coefficient slightly upward. These results indicate that an increase in foreign share from 0 to 10 percent would raise total factor productivity by 2.1 percent.

Why do we get such different results across the two sets of plants? One possibility, raised in the older literature on technology transfer, is that the gap between the technology used by foreign firms and their domestic counterparts, may be too wide. The "special" Class 2 domestic firms may be at a higher technology frontier, more capable of exploiting their proximity to their foreign counterparts. Another possibility is that the informal linkages between foreign firms and previously foreign firms may be more important–managers and workers may be in closer contact between these two types of firms. Yet another possibility is that there are special types of agglomeration economies between foreign (or previously foreign) firms. This could be why multinationals may all locate in the same areas (the macquiladoras in Mexico, for example), and could also explain why foreign firms are receptive to the establishment of special industrial parks for multinationals or joint ventures–such as the free trade zones in the Caribbean or foreign investment zones in China.

The impact of foreign share on Class 2 firms, disaggregated by manufacturing sector, is presented in Table 1.10. The results suggest that the positive spillovers are not driven by unusually strong effects in only one sector. The positive impact of foreign presence is most significant in basic metals (steel, aluminum) and machinery and equipment. These two sectors are also the most technology-intensive of all the manufacturing sectors in the sample.

Table 1.11 decomposes Class 2 plants into two types: (1) plants which are included in the sample prior to becoming foreign owned and (2) plants which were foreign owned, but are now fully domestically owned. It could be the case that foreign firms simply locate in a region, identify the most productive plants, and subsequently acquire them. If this were the case, then we would get the spurious result that foreign investment positively affects domestic plant productivity. Table 1.11 shows that this is not the case. Almost all the plants in the sample fall into the second category: plants with a history of foreign ownership. In addition, it is clear from the estimated coefficients that the aggregate results for Class 2 plants are driven by the impact of foreign presence on plants which were previously foreign owned. Those plants which subsequently acquired foreign investment did not exhibit any statistically significant benefits from foreign presence during their "domestic" phase.

1.4.4 Combining Sector-level and Regional Foreign Share in the Same Estimation

The theoretical model and the results presented earlier point to two, very different effects of foreign investment on domestic plant productivity: a negative competitive effect, which could be due either to domestic plant contraction; and a positive spillover effect, which occurs at the regional level. Table 1.12 reports the results of including both the sectoral and regional foreign share in the same estimating equation to separately identify the two effects. The aggregate results in the last row show that for both Class 1 and Class 2 plants, aggregate (sectoral) increases in foreign investment were associated with productivity declines, while region-specific increases in foreign presence were associated with productivity increases. However, as discussed earlier, the magnitude of the effects are very different for the two types of plants. For Class 1 plants, the negative sector effect is statistically significant and negative, while the positive spillover is small and insignificant. For Class 2 plants, the negative sector effect is small and insignificant; the positive impact of foreign presence at the regional level, however, is very large and statistically significant.

1.5 Conclusion

Using detailed panel data following more than 4000 firms from 1975 through 1989, this paper tests for technology spillovers from foreign investment. Facing fewer data limitations than any of the previous studies, we reproduce earlier studies which estimated spillovers from foreign investment and show that the results are sensitive to the inclusion of industry-specific effects. We then estimate a model which identifies the impact of foreign investment on domestic productivity by exploiting the regional variations in foreign presence.

We first replicate Caves (1974), Globerman (1978), and Blomstrom and Persson (1983), who found positive spillovers from foreign investment. Using a similar specification, we find that domestic firms exhibit higher productivity growth in sectors with a larger foreign share. After controlling for industry-specific effects, however, the results suggest that foreign investment negatively affects productivity growth of domestic firms. The difference between the two sets of estimates suggests that foreign investors locate in more productive industries, biasing the coefficients on foreign share. The negative spillover is consistent with our model, which posits that foreign entry reduces demand for domestically-owned production, driving domestic firms back up their average cost curves.

We then examine the possibility that within each sector, domestic firms located near foreign firms exhibit higher (or lower) productivity. The results suggest that foreign investment generally has no positive spillovers on most types of types of domestic firms located nearby. The only exceptions are those domestic firms which were foreign owned in the past or will become foreign owned in future periods. For these firms, the positive impact of foreign presence is large and statistically significant, even after controlling for differences in region-specific productivity effects. The effects are large: a ten percentage point increase in foreign investment in a location raises total factor productivity by 2 percent.

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Table 1.1: The Share of Foreign Direct Investment in Manufacturing
(percent weighted by number of employees)

Sector	1976	1981	1989
Food Products	8	5	6
Textiles & Clothing	6	6	3
Wood Products	0	0	2
Paper & Publishing	10	11	9
Chemicals, Petrol	6	8	7
Pottery, Glass	6	8	7
Basic Metals	7	6	12
Machinery	9	9	13
Professional Equip	8	10	4

Table 1.2: The Distribution of Foreign Ownership Across Sectors

Sector	1976	1981	1989
Food Products	24	15	19
Textiles & Clothing	16	14	6
Wood Products	0	0	1
Paper & Publishing	9	12	8
Chemicals, Petrol	11	17	14
Pottery, Glass	6	7	6
Basic Metals	6	7	15
Machinery	26	28	31
Professional Equip	1	1	1
Total	100	100	100

Table 1.3: Comparison of Productivity, Export Performance, and Wages Between Domestic and Foreign-owned Enterprises in Manufacturing

	Sector	Output per worker	Exports as percent of sales	Imported Inputs as percent of sales	Real wages
31	Food, beverages	2.3*	0.5	4.4*	2.2*
32	Textiles	2.0*	2.8	1.2	1.6*
33	Wood products	1.1	0.0	4.3*	1.0
34	Paper products	2.8*	2.9	0.8	1.6*
35	Chemicals	1.7*	3.9*	1.9*	1.5*
36	Non-metal	1.6*	6.5*	4.0*	1.7*
37	Basic metals	1.4	17.0*	2.0*	1.2
38	Machinery	1.7*	14.2*	3.1*	1.5*
39	Other mfg	1.5*	1.3	3.8*	1.4*
	All sectors	1.8*	10.0*	2.7*	1.7*

Ratio of enterprise performance for firms with foreign ownership to domestically owned firms. A firm is defined as foreign if more than 5 percent of total assets are foreign-owned. An "*" indicates that the difference is statistically significant at the 5 percent level.

Table 1.4: Impact of Sectoral Foreign Investment on Productivity of Domestic Firms

Dependent Variable - Log Output Produced by Domestically-Owned Firms

Sample	Independent Variables				
	Materials	Capital	Unskl Labor	Skl Labor	Foreign Presence
Without Industry Dummies	0.569	0.084	0.296	0.110	0.061
obs=35514	(327.0)	(59.2)	(103.7)	(44.7)	(1.9)
With 2-digit Dummies	0.573	0.076	0.293	0.114	-0.028
obs=35514	(272.9)	(44.7)	(84.8)	(39.4)	(0.9)
Within Estimation	0.525	0.041	0.221	0.094	-0.174
obs=35514	(189.3)	(19.8)	(45.3)	(24.0)	(3.5)

T-statistics in parentheses. Domestically-owned firms defined as firms which had no foreign ownership over the entire sample period. All regressions include annual time dummy variables.

Table 1.5: Impact of Regional Foreign Investment on Productivity of Domestic Firms

Dependent Variable - Log Output Produced by Domestically-Owned Firms

Sample	Independent Variables				
	Materials	Capital	Unskl Labor	Skl Labor	Foreign Presence
Unadjusted	0.587	0.060	0.292	0.107	0.039
obs=34564	(277.6)	(36.1)	(86.3)	(38.2)	(1.4)
Adjusted	0.585	0.060	0.290	0.106	-0.001
obs=34236	(275.5)	(36.2)	(85.7)	(37.9)	(0.0)
Within Estimation	0.526	0.044	0.227	0.093	0.015
obs=34236	(185.5)	(18.2)	(46.0)	(22.8)	(0.4)

T-statistics in parentheses. Domestically-owned firms defined as firms which had no foreign ownership over the entire sample period. All regressions include annual time dummy variables. Adjusted and Unadjusted regressions include 4-digit industry dummy variables. Regionally Adjusted and Within regressions include the overall skilled wage in the region and electricity prices.

Table 1.6: Impact of Foreign Investment on Domestic Productivity by Sector

Dependent Variable - Log Output Produced by Domestically-Owned Firms

Sector	Coefficient on Foreign Share		
	Sectoral Foreign Share	Regional Foreign Share	
	Within Estimates	Adjusted	Within
Food Products	-0.277	0.048	0.055
	(3.6)	(1.0)	(0.9)
Textiles & Clothing	0.176	-0.198	0.037
	(0.8)	(1.9)	(0.2)
Wood Products	-0.363	0.588	0.662
	(0.6)	(2.7)	(3.9)
Paper & Publishing	00.089	0.146	-0.138
	(0.3)	(1.5)	(1.2)
Pottery & Glass	-0.050	-0.296	-0.252
	(0.3)	(3.2)	(1.9)
Basic Metals	-0.225	0.102	0.051
	(1.2)	(0.7)	(0.3)
Machines & Equipment	-0.128	-0.005	-0.013
	(1.6)	(0.1)	(0.2)

T-statistics in parentheses. Domestically-owned firms defined as firms which had no foreign ownership over the entire sample period. All regressions include annual time dummy variables. Adjusted and Unadjusted regressions include 4-digit industry dummy variables. Regionally Adjusted and Within regressions include the overall skilled wage in the region and electricity prices.

Table 1.7: Comparison of Class 1 and Class 2 Domestic Firms

Class 1 = Domestic firms experiencing no foreign ownership over the entire sample period
Class 2 = Firms entirely domestically-owned this year but experiencing some foreign ownership within the sample period

Ratio of values for Class 2 firms relative to values for Class 1 firms

Sector	Ratio			
	Labor Productivity	Percent Skilled	Capital-Labor Ratio	Regional Foreign Presence
Food Products	0.99	0.95	1.00	1.02
Textiles & Clothing	0.99	0.97	0.99	1.49
Wood Products	0.99	0.91	1.05	0.96
Paper & Publishing	1.00	0.99	0.99	1.10
Pottery & Glass	1.00	0.94	1.02	0.99
Basic Metals	1.00	0.94	1.07	1.11
Machines & Equipment	1.00	0.96	1.03	1.06

Table 1.8: Impact of Sectoral Foreign Investment on Productivity of Class 2 Domestic Firms

Dependent Variable - Log Output Produced by Domestically-Owned Firms

Sample	Independent Variables				
	Materials	Capital	Unskl Labor	Skl Labor	Foreign Presence
Without Industry Dummies	0.574	0.089	0.295	0.115	0.072
obs=13425	(172.9)	(32.3)	(52.5)	(23.1)	(1.3)
With 2-digit Dummies	0.581	0.084	0.290	0.119	0.025
obs=13425	(170.9)	(29.5)	(49.9)	(23.5)	(0.4)
Within Estimation	0.578	0.085	0.288	0.119	0.146
obs=13425	(173.9)	(30.9)	(50.5)	(23.0)	(2.6)

T-statistics in parentheses. Class 2 firms are defined as firms which are entirely domestically-owned this period but experience some foreign ownership within the sample period. All regressions include annual time dummy variables.

Table 1.9: Impact of Regional Foreign Investment on Productivity of Class 2 Domestic Firms

Dependent Variable - Log Output Produced by Domestically-Owned Firms

Sample	Independent Variables				
	Materials	Capital	Unskl Labor	Skl Labor	Foreign Presence
Unadjusted	0.601	0.067	0.280	0.105	0.277
obs=9968	(152.0)	(20.8)	(42.4)	(18.6)	(5.4)
Adjusted	0.600	0.067	0.279	0.106	0.229
obs=9968	(149.2)	(20.8)	(42.1)	(18.8)	(4.5)
Within Estimation	0.587	0.081	0.272	0.120	0.207
obs=9968	(150.5)	(25.5)	(40.9)	(19.8)	(3.7)

T-statistics in parentheses. Class 2 firms are defined as firms which are entirely domestically-owned this period but experience some foreign ownership within the sample period. All regressions include annual time dummy variables. Adjusted and Unadjusted regressions include 4-digit industry dummy variables. Regionally Adjusted and Within regressions include the overall skilled wage in the region and electricity prices.

Table 1.10: Impact of Foreign Investment on the Productivity of Class 2 Domestic Firms by Sector

Dependent Variable - Log Output Produced by Domestically-Owned Firms

Sector	Coefficient on Foreign Share		
	Sectoral Foreign Share	Regional Foreign Share	
	Within Estimates	Adjusted	Within
Food Products	-0.092	0.057	0.062
	(0.8)	(0.6)	(0.6)
Textiles & Clothing	0.703	0.072	0.272
	(4.5)	(0.4)	(1.2)
Wood Products	-0.561	0.219	-0.308
	(2.3)	(0.4)	(0.7)
Paper & Publishing	0.436	0.208	0.346
	(2.0)	(1.4)	(2.3)
Pottery & Glass	-0.096	0.354	-0.370
	(0.4)	(2.0)	(1.7)
Basic Metals	1.685	0.892	1.032
	(6.1)	(3.7)	(4.2)
Machines & Equipment	0.044	0.298	0.264
	(0.5)	(3.6)	(3.0)

T-statistics in parentheses. Class 2 firms are defined as firms which are entirely domestically-owned this period but experience some foreign ownership within the sample period. All regressions include annual time dummy variables. Adjusted and Unadjusted regressions include 4-digit industry dummy variables. Regionally Adjusted and Within regressions include the overall skilled wage in the region and electricity prices.

Table 1.11: Impact of Foreign Investment on the Productivity of Class 2 Domestic Firms by Sector: Within Estimates

Dependent Variable - Log Output Produced by Domestically-Owned Firms

Sector	Coefficient on Foreign Share			
	Prior to Foreign Ownership (obs=470)		After Foreign Ownership (obs=12955)	
	Sectoral Foreign Share	Regional Foreign Share	Sectoral Foreign Share	Regional Foreign Share
Food Products	-0.125	1.611	-0.089	0.058
	(0.2)	(1.2)	(0.8)	(0.5)
Textiles & Clothing	1.941	-12.729	0.707	0.297
	(0.6)	(4.0)	(4.5)	(1.3)
Wood Products	-0.231	-118.331	-0.544	-0.274
	(0.0)	(0.7)	(2.2)	(0.6)
Paper & Publishing	-1.302	0.907	0.433	0.334
	(0.8)	(1.4)	(2.0)	(2.2)
Pottery & Glass	0.706	-0.554	-0.088	-0.352
	(0.8)	(0.7)	(0.4)	(1.6)
Basic Metals	7.276	4.863	1.665	1.002
	(1.6)	(2.3)	(6.0)	(4.0)
Machines & Equipment	-0.203	0.378	0.839	0.251
	(0.3)	(1.2)	(0.4)	(2.8)
All Sectors	-0.252	0.370	0.148	0.201
	(0.6)	(1.4)	(2.5)	(3.5)

T-statistics in parentheses. Class 2 firms are defined as firms which are entirely domestically-owned this period but experience some foreign ownership within the sample period. All regressions include annual time dummy variables. Regional regressions include the overall skilled wage in the region and electricity prices.

Table 1.12: Combined Regressions of Sector and Regional Foreign Share: Within Estimates

Class 1 = Domestic firms experiencing no foreign ownership over the entire sample period
Class 2 = Firms entirely domestically-owned this year but experiencing some foreign ownership within the sample period

Dependent Variable - Log Output Produced by Domestically-Owned Firms

Sector	Coefficient on Foreign Share			
	Class 1 (obs=34236)		Class 2 (obs=9828)	
	Sectoral Foreign Share	Regional Foreign Share	Sectoral Foreign Share	Regional Foreign Share
Food Products	-0.349	0.082	-0.022	0.062
	(4.3)	(1.3)	(0.2)	(0.6)
Textiles & Clothing	0.028	0.037	-0.127	0.285
	(0.1)	(0.2)	(0.7)	(1.2)
Wood Products	-0.622	0.681	0.235	-0.320
	(1.1)	(4.0)	(1.4)	(0.7)
Paper & Publishing	0.159	-0.149	-0.305	0.344
	(0.5)	(1.3)	(1.3)	(2.3)
Pottery & Glass	-0.046	-0.252	0.174	-0.370
	(0.3)	(1.9)	(0.9)	(1.7)
Basic Metals	-0.174	0.059	-0.204	1.027
	(1.0)	(0.3)	(0.6)	(4.2)
Machines & Equipment	-0.131	0.005	-0.248	0.265
	(1.6)	(0.1)	(1.9)	(3.0)
All Sectors	-0.205	0.033	-0.063	0.208
	(4.1)	(0.9)	(1.0)	(3.7)

T-statistics in parentheses. All regressions include annual time dummy variables, the overall skilled wage in the region and electricity prices.

Chapter 2

Human Capital, Labor Turnover, and Direct Foreign Investment: Wage Differences Between Foreign-Owned and Domestic Firms

The industrial organization motivation for direct foreign investment in manufacturing suggests that through experience, multinational corporations gain possession of intangible "assets" which allow the firm to produce more efficiently[1]. The asset may be a specific patent or technology, or it may be more elusive such as marketing or managerial skills, upstream and downstream linkages, and reputation. Since the asset is embodied in the labor force of the firm, markets for such intangible assets are likely to be imperfect. To capture the full rate of return on the asset through international arbitrage, the multinational must invest directly in countries in which the asset is most valued, since the firm is unable to sell the asset to domestic firms who may be better informed about local market conditions. Direct foreign investment (DFI) is a channel through which firm-specific knowledge combines with low-wage labor to obtain the highest international rate of return in the face of market imperfections for intangible assets.

If an intangible asset accompanies physical capital when DFI takes place, value is created above the return to the physical capital alone; gains from trade are realized, with DFI representing trade of the intangible asset between the asset's owners, the multinational, and the asset's users, domestic labor. In considering the welfare effects of DFI on a host economy, one important aspect is how the surplus from DFI is divided between foreign capital owners and domestic workers. Does the host economy retain some of the surplus in the form of higher wages, or is the surplus captured by foreign capital owners through repatriated profits?

There are two primary channels through which surplus is potentially captured by domestic labor; either directly through higher wages paid by foreign-owned firms to their employees, or indirectly by DFI's increasing labor demand and raising domestic wages for all workers. I focus on the direct

[1] Hymer (1960), Kindleberger (1969), Caves (1971); see Greico (1986) and Helleiner (1989) for surveys.

channel, comparing wage behavior in foreign-owned firms relative to their domestic counterparts. In particular, I examine the fact that foreign-owned firms pay substantially higher wages to their employees than similar domestic firms

Several reasons have been suggested for higher wages observed in foreign firms. The first relates to the manner in which the intangible asset of a foreign firm spills over onto the workers it employs. As workers at the foreign firm become more productive with experience, their wages rise relative to workers at domestic firms. A second explanation relies on labor turnover being more costly to the foreign firm than for the domestic firm; foreign firms pay higher "efficiency" wages to reduce costly turnover. A final explanation is that foreign firms may employ better workers than the domestic firms. If worker quality is observable to the firm but not to the econometrician, and foreign firms have a technological preference for more experienced workers, wage differences may appear even if there is no difference in firms' wage behavior. I test among these explanations for observed wage differences, finding evidence supporting differences arising from human capital formation within foreign firms, and that foreign firms limit human capital spillovers through efficiency wages.

2.1 The Importance of Direct Foreign Investment in Employment

Are the effects of DFI likely to be large? Aggregate employment numbers suggest that the impact of multinationals worldwide are likely to be small; in 1985, only 65 million workers were employed directly by multinationals, or about 3 percent of the work force (UNCTC, 1988). This foreign presence is concentrated in developed countries, as only 1 percent of developing country workers were employed by multinationals. These numbers could understate the impact of DFI on domestic labor in developing countries for two reasons; DFI is not uniformly distributed across countries or regions, but tends to concentrate in particular countries, and in particular regions within a country; and partial foreign ownership is often accompanied by substantial foreign control.

Direct foreign investment is mostly concentrated in a few countries. In 1982, a third of the entire stock of DFI in developing countries was located in the three countries Brazil, Mexico, and Singapore (IMF, 1985). The share of labor in these countries employed by foreign firms is quite high; around 20 percent for Mexico and Brazil (United Nations, 1983). The impact of DFI will be of more interest in Indonesia, where the average ratio of DFI to GDP from 1971-81 was 1.09, than in Ecuador, where the ratio is 0.02 (Edwards, 1990).

Within countries, DFI is not uniformly distributed across districts, but is nonexistent in many regions and highly concentrated in others. This is observed in the distribution of foreign relative to total manufacturing employment across regions in Venezuela in the mid 1980's. Foreign firms account for a significant portion of the district's employment in a number of districts; the standard deviation of foreign share over districts is 20 percent compared to a mean of 4.6 percent. The impact of DFI on these regions surely exceeds the impact suggested by the foreign presence in the country as a whole.

If the intangible asset being transferred through ownership is managerial skills, production technologies, etc., the relevant measure of a firm's "nationality" is the degree to which its activities are controlled by foreigners. The share of foreign ownership is likely to underestimate the impact of DFI, since in practice control by foreigners is believed to exceed foreign equity ownership where assistance in risk-sharing or information concerning the local environment is required by the multinational (Caves 1982, p.88-89)[2]. Table 2.1 shows shares of sales and inputs for foreign-owned firms in manufacturing in Venezuela. Foreign capital represents only 10 percent of the manufacturing capital stock and employs only 10 percent of the skilled labor in 1976-78. However, firms with some foreign ownership account for 28 percent of the capital stock and employ 24 percent of the skilled labor force. If substantial foreign control accompanies foreign capital, the share of foreign ownership will significantly understate the degree to which the foreign asset effects the domestic labor force.

2.2 Evidence of Wage Differences Between Foreign-Owned and Domestic Firms

One of the channels through which the gains from DFI are transferred to domestic workers is wages paid by foreign-owned firms relative to those paid by domestic firms. It is a well established fact that in developing countries the average wage at the multinational is higher than at domestic firms. Jenkins (1984) reports average wages for multinationals in Latin America to be 40 to 80 percent higher than wages paid at domestic firms (p.169). There is some question as to whether wage differences owe themselves to nationality of ownership or whether multinationals simply exhibit characteristics of high-wage firms; they tend to exist in high wage industries, have higher white-blue collar labor ratios, and are larger than domestic firms. Do multinationals pay higher wages once accounting for these characteristics?

A number of studies suggest that foreign ownership does result in higher wages paid to domestic employees in developing countries. Willmore (1986) compares foreign and domestic firms in Brazil matched by size within four-digit manufacturing SIC industrial classifications. His findings suggest that wages paid by foreign firms are 31 percent higher for management workers and 19 percent higher for production workers. These results are confirmed statistically by Lim (1977), who finds higher total benefits extended by foreign firms in Malaysian manufacturing. In surveys of firm behavior, Reuber (1973, p.175) reports that a small majority of multinationals in LDCs pay the prevailing

[2]The US Department of Commerce considers an investment direct if foreign ownership exceeds 10 percent by a single investor.

wage, but that almost half pay wages considerably higher than the market wage. Markensten estimates Swedish multinationals in India pay roughly 25 percent higher wages than comparable domestic firms (p.126). Mason (1973) also finds higher wages for foreign firms in the Philippines and in Mexico.

Using plant-level manufacturing data for Venezuela, I estimate wages for skilled labor as a function of foreign ownership over the years 1975 through 1989. The results, presented in Table 2.2, confirm the majority of previous studies that foreign-owned firms pay higher wages. Wage differences between foreign and domestic firms are roughly 50 percent. These differences remain even after controlling for industry, size, and capital-labor ratio; foreign firms pay 18 percent higher skilled wages than domestic firms of the same four- digit industry, size, and technology. It does not seem to matter whether the firm has a majority or minority foreign ownership share; wages differences are comparable for majority-owned foreign firms and those with only partial foreign ownership. Higher wages for foreign firms are observed across all but a couple industries, as Table 2.3 demonstrates.

There are exceptions to the finding that foreign firms pay higher wages. Jenkins (1984) argues that higher wages by foreign firms in Peru are attributable entirely to their larger size (pp. 169-70). Cohen (1975) finds that for a small number of firms surveyed in Singapore, domestic wages also exceeded those paid by multinationals (p. 115). Cohen attributes his findings to these firms producing primarily for export.

2.3 Evidence of Human Capital Formation in Foreign-Owned Firms

One of the suggested benefits of multinational firms in developing countries is the "externality arising from training received by employees who later leave the firm.." (Lall and Streeten, 1977, p.57). There is ample evidence that multinationals engage in substantial amounts of human capital formation. Reuber finds that multinational accounting and cost control systems and marketing skills accompanied physical capital in about half the foreign investment projects he examines in developing countries (p.198-9). He also finds that foreign firms were strongly committed to technical training within the firm, training for local suppliers, and training in marketing, distribution, and service, primarily in an effort to reduce reliance on more expensive expatriate employees (p.202). This is especially true for highly skilled workers. Firms typically engaged in the practice of training using expatriates and gradually replacing them with less expensive domestic workers; in the projects reviewed by Reuber, the share of domestic skilled employees used by foreign firms went from 56 percent to 73 percent in three years. Stewart cites evidence supporting foreign firms' use of trained domestic skilled labor to replace expensive expatriate personnel in Indonesia (p.80). Goncalves (1986) compares foreign and domestic training behavior in Brazil, finding that foreign firms provide significantly more training and technical support than domestic firms, even after controlling for industry. Training in foreign firms need not be formal; Rhee and Belot (1989) provide numerous case studies of industry growth in developing countries in which domestic employees learn during employment at foreign-owned firms. These workers then go on to work for competing domestic firms or start their own firms.

Human capital formation at domestic firms is consistent with rough total factor productivity calculations. If human capital accumulation is important, either through training or through learning by doing, there should be observable differences in total factor productivity growth between foreign and domestic firms; human capital is being accumulated at a faster rate within the foreign firm will cause total factor productivity growth to be higher for foreign firms than for comparable domestic firms. This is observed for TFP calculations for Venezuela over various periods. The results of these TFP calculations are displayed in Table 2.4 . Table 2.4 reports the rate of total factor productivity growth both for the ten year period from 1978 to 1987, and for average TFP growth from 1976 to 1984. TFP growth was over twice as high for output produced by foreign owned firms than for domestic output. These observations are consistent with human capital formation (whether specific or general) within foreign firms.

Is training or learning by doing an explanation of wage differentials observed between foreign and domestic firms? While workers may become more productive through being exposed to the foreign firm's intangible asset, this will not necessarily result in higher wages paid by the foreign firm. If the productive knowledge is specific to the firm, foreign firms need not pay wages different than the going market wage. In the benchmark case (competitive labor markets, flexible wages, perfect information), foreign firms could retain the entire surplus produced by specific human capital and still fulfill their demands for labor. If, on the other hand, the training raises the worker's value outside the foreign firm, a single multinational in a competitive labor market could require workers to pay for the general component of training in the form of lower "apprentice" wages during the training period. Wage differences depend on the degree of labor turnover from foreign firms; if turnover is high following the apprentice period, wages observed within foreign firms would actually be *lower* than those observed in domestic firms. The following framework considers more explicitly the interaction between human capital formation, turnover and wage differences.

2.4 A Model of Human Capital Formation, Turnover, and Wages

2.4.1 Wage Behavior with Exogenous Turnover

Here I develop a framework analyzing training benefits from multinationals, turnover, and relative wages. To focus attention to factor markets, I restrict analysis to partial equilibrium, in which firms' existence is exogenous. Domestic firms produce using only labor with a constant marginal product. Labor markets are competitive, with wages determined by the marginal product of labor at domestic firms.

Labor demands of both domestic and foreign firms are exogenous and are assumed to have no impact on wages; I postpone discussion of the effects of DFI in general equilibrium until section 2.5. Foreign firms take wages as given and set their wage in reference to the market wage; it is assumed that all foreign labor demands can be satisfied provided workers are paid a wage such that they are indifferent between working at the foreign firm and a domestic firm.

Each worker lives for two periods. In the first period, workers produce m_1 per labor unit whether working for the foreign firm or the domestic firm. If the worker works at the domestic firm, his product in the second period is m_2, while if he works for the foreign firm, his second period marginal product is M_2 at the foreign firm and

$$\gamma M_2 + (1 - \gamma) m_2 \qquad 0 \geq \gamma \leq 1 \tag{2.1}$$

at the domestic firm, such that $M_2 > m_2$. The higher marginal product reflects the "training" benefits of foreign firms; workers learn from their access to the foreign firm's intangible asset. The coefficient γ measure the transferability of learning to domestic firms; human capital is entirely general when $\gamma = 1$ and is entirely specific to the foreign firm when $\gamma = 0$. Training is assumed to take the form of learning by doing, and is costless to the firm; however the results do not change if training is costly to the firm.

Outside the foreign firm, the worker is always paid his marginal product; employed at domestic firm he receives m_1 the first period, m_2 the second period if he spent his first term at a domestic firm, and $\gamma M_2 + (1 - \gamma) m_2$ if he spent his first learning at the foreign firm and is "experienced". Employed at the foreign firm, the worker is paid $m_1 - \rho$ the first period, where ρ will be determined endogenously. In the second period, the foreign firm has no choice but to pay the worker, who will die after period two, his full marginal product m_2 if the worker is "inexperienced" and $\gamma M_2 + (1 - \gamma) m_2$ if he is "experienced".

The variable ρ is determined such that workers are indifferent between spending their first period at a domestic firm receiving lower wages in period two, and learning at the foreign firm in period one enjoying higher wages in period two. The risk neutral worker is indifferent between the two choices when

$$m_1 - \rho + \beta(\gamma M_2 + (1-\gamma)m_2) = m_1 + \beta m_2 \tag{2.2}$$

where $\beta < 1$ determines the rate at which the worker discounts future income. Elastic labor supply insures that

$$\rho = \beta\gamma(M_2 - m_2) \qquad > 0 \tag{2.3}$$

In this simple framework, workers "purchase" the foreign firm's intangible asset at its full net present value by accepting a lower wage in the first period. The accumulation of human capital is entirely financed by the worker through the lower "apprentice" wage. The implication that learning at foreign firms does not raise worker welfare should not be taken too seriously, since an artifact of the model setup is that workers always bid away welfare gains to the point of indifference. A richer framework is needed to isolate the factors which affect how the surplus of DFI is divided.

Foreign and Domestic Wage Differences

"Apprentice" wages do not imply observed wages should be lower at foreign firms. Foreign firms could choose to hire relatively more "experienced" workers than domestic firms. But even with similar composition of workers, wages may still be greater at foreign firms. Let both foreign and domestic firms employ the same fraction of "young" and "old" workers. Wages at the domestic firm w and at the foreign firm w^* are given by

$$\begin{aligned} w^* &= m_1 - \beta\gamma(M_2 - m_2)) + \alpha m_2 + (1-\alpha)(\gamma M_2 + (1-\gamma)m_2) \\ w &= m_1 + \alpha\theta(\gamma M_2 + (1-\gamma)m_2) + (1-\alpha\theta)m_2 \end{aligned} \tag{2.4}$$

where α is a measure of labor turnover, representing the probability that an experienced employee exits the foreign firm, and θ is the ratio of foreign to domestic labor demand. For now α is assumed to be exogenous. From equation 2.4, the observed wage at the foreign firm is greater than at the domestic firm if

$$\alpha < \frac{1-\beta}{1+\theta} \tag{2.5}$$

From Equation 2.5, higher rates of turnover reduce the chance of seeing higher wages at foreign firms; workers learn at foreign firms, receiving the lower apprentice wage, and then leave to work for domestic firms, where they receive their higher marginal product. Likewise, large foreign presence (given a rate of turnover α) increases wages at domestic firms, as experienced labor spills over into the domestic sector. High discount rates (low β) increase the wages at foreign firms, since high discount rates result in a lower asset price ρ for human capital; an increase in the discount rate would raise actual wage payments by foreign firms relative to the net present value of wages foregone by employees.

Note that relative wages are independent of whether human capital is specific or general. The exception is if human capital is entirely specific ($\gamma = 0$), in which case wages must be equal. As general human capital increases, both the price of the "asset" of working at the foreign firm (ρ) and the payoff of the asset ($\beta\gamma(M_2 - m_2)$) increase; whether wages at the foreign firm are larger depends only on the rate of mobility relative to the discount rate and the foreign presence expressed in equation 2.5.

Human Capital Spillovers from Foreign-Owned Firms

The impact of foreign firms on domestic wages given constant labor demand (domestic wages relative to wages in the absence of DFI) is defined as the wage "spillover" from DFI, and is given by

$$\Delta = w - (m_1 + m_2) \tag{2.6}$$

and from equation 2.4, is given by

$$\Delta = \alpha\theta\gamma(M_2 - m_2) \tag{2.7}$$

The spillover increases with turnover, with the foreign presence θ, and with the amount of *general* capital accumulation. This spillover represents an increase in the average level of human capital employed by domestic firms.

Wage Behavior with Uncertain Transferability of Human Capital

Foreign entry often occurs in industries in which domestic firms have no productive experience. In these industries, whether human capital gained at the foreign firm can be transferred to domestic firms may be uncertain. If workers are risk averse, they will not be willing to entirely finance human capital accumulation which is expected to be general but for which the transferability is uncertain. In response to uncertainty, wages will rise at foreign firms relative to domestic firms.

Using the same model as above, the effects of working at a foreign firm are assumed unknown to the worker; if workers are employed at the foreign firm in the first period, their marginal product in the second period outside the foreign firm is

$$\tilde{\gamma}M_2 + (1 - \tilde{\gamma})m_2 \tag{2.8}$$

where $\tilde{\gamma}$ is a random variable with a mean $\bar{\gamma}$ and a variance σ^2. The indifference condition for workers is now

$$m_1 - \rho + \beta Eu(\tilde{\gamma}M_2 + (1 - \tilde{\gamma})m_2) = m_1 + \beta m_2 \tag{2.9}$$

where $Eu(.)$ is the expected utility of period two income, and is given by

$$Eu(\tilde{\gamma}M_2 + (1-\tilde{\gamma})m_2) = \bar{\gamma}M_2 + (1-\bar{\gamma})m_2 - r(\sigma^2) \tag{2.10}$$

with $r(\sigma^2)$ reflecting the risk premium required by the worker. The indifference condition yields the asset price for working in the foreign firm

$$\rho = \beta(\bar{\gamma}(M_2 - m_2) - r(\sigma^2)) \tag{2.11}$$

which is non-negative since the distribution of $\tilde{\gamma}$ is bounded below by 0.

The mean wages observed at the foreign and domestic firms, again assuming equal shares of old and young workers, are

$$w^* = m_1 - \beta(\bar{\gamma}(M_2 - m_2) - r(\sigma^2)) + \alpha m_2 + (1-\alpha)(\bar{\gamma}M_2 + (1-\bar{\gamma})m_2) \tag{2.12}$$

$$w = m_1 + (1-\alpha\theta)m_2 + \alpha\theta(\bar{\gamma}M_2 + (1-\bar{\gamma})m_2)$$

Wages are observed to be greater at foreign firms if and only if

$$\alpha < \frac{1 - \beta(1 - \frac{r(\sigma^2)}{\bar{\gamma}(M_2 - m_2)})}{1+\theta} \tag{2.13}$$

Increasing the variance of the wage distribution relative to the expected difference in wages increases the foreign wage relative to the domestic wage. Foreign firms can be induced to finance part of general training if there is uncertainty in the outcome, since the asset price for the foreign firm's human capital will be driven down by uncertainty until the rate of return equals the risky rate of return in capital markets. The expected wage spillover, however, does not change with uncertainty; the amount of human capital which reaches domestic firms is the same on average.

2.4.2 Wage Behavior with Human Capital Formation and Endogenous Turnover

I now consider the interaction of human capital formation in the foreign firm and labor turnover when turnover depends on the wage paid by foreign firms. If turnover is costly to foreign firms, and they can reduce turnover by raising their wage, they may be induced to pay "efficiency wages" such that the cost of increasing wages is offset by the benefits in terms of reduced turnover (Stiglitz (1974); Salop and Salop (1976)). I will show that an increase in specific capital formation will prompt foreign firms to offer a higher wage, reducing turnover and general human capital spillovers, and increase the wage differential between foreign and domestic firms.

Assume the same model as in section 2.4.1, but with risk neutral workers; a worker who spends his first term at the foreign firm has a marginal product of M_2 in his second term within the foreign firm. If he leaves the foreign firm in period two, his marginal product at the domestic firm is

$$\tilde{\gamma}M_2 + (1 - \tilde{\gamma})m_2 \tag{2.14}$$

where $\tilde{\gamma}$ is a random variable with mean $\bar{\gamma}$ and variance σ^2, with the resulting mean wage given by

$$\mu = \bar{\gamma}M_2 + (1 - \bar{\gamma})m_2 \tag{2.15}$$

Worker mobility from the foreign firm is determined by competing opportunities at domestic firms. Following the completion of the first term at a foreign firm, the foreign firm offers the worker a wage for the second term. Workers stay at the foreign firm if the realization of the workers wage outside the firm, determined by $\tilde{\gamma}$, is less than the foreign firm's offer.

The foreign firm offers a wage $\hat{w}$ in period two that balances the costs of the higher wage bill with the benefits of reduced mobility. Workers are assumed to leave if their outside wage exceeds the foreign firm's wage offer. The probability of a worker leaving the foreign firm determines average mobility, and is given by

$$\alpha = \alpha(\hat{w} - \mu) \qquad \alpha' < 0 \tag{2.16}$$

The benefit to the firm of reduced turnover is the specific human capital which is preserved. The firm chooses $\hat{w}$ to solve

$$max_{\hat{w}} \quad (1 - \alpha(\hat{w} - \mu))(M_2 - \hat{w}) \tag{2.17}$$

The wage which solves equation 2.17 is implicitly defined by

$$\alpha'(M_2 - \hat{w}) + (1 - \alpha(\hat{w} - \mu)) = 0 \tag{2.18}$$

and is the wage such that the preserved specific human capital from lower mobility is offset by the cost of higher wages for the remaining workers.

Now consider the effects on wages and mobility of an increase in specific capital, holding general capital constant. This is expressed as an increase in M_2 holding μ constant. From equation 2.18, the implicit function theorem yields

$$\frac{d\hat{w}}{dM_2} = -\frac{\alpha'}{(M_2 - \hat{w})\alpha'' - 2\alpha'} \qquad < \frac{1}{2} \tag{2.19}$$

provided the probability of turnover is declining at a decreasing rate. Equation 2.19 indicates that firms are willing to raise wages partially to prevent specific human capital from being lost. The result is a fall in labor mobility away from foreign firms.

Foreign and Domestic Wage Differences

Equation 2.19 implies that foreign wages relative to domestic wages must rise in response to an increase in specific human capital. The difference in wages with endogenous mobility will be

$$w^* - w = -\rho + \alpha m_2 + (1-\alpha)\hat{w} - (1-\alpha\theta)m_2 - \alpha\theta w_2 \tag{2.20}$$

where w_2 is the second period wage outside the foreign firm and is given by the conditional expectation

$$w_2 = E(\bar{\gamma} M_2 + (1-\bar{\gamma})m_2 \mid \hat{w} < \bar{\gamma} M_2 + (1-\bar{\gamma})m_2) \tag{2.21}$$

and increases with an increase in $\hat{w}$. The asset price ρ with endogenous mobility is

$$\rho = \beta(\alpha w_2 + (1-\alpha)\hat{w}) \tag{2.22}$$

To focus on the unique wage effects of an increase in specific capital on wages when mobility is endogenous, assume the net present value of working at the foreign firm equals the actual value of wages paid to the higher human capital, so that $\beta = 1$. Equation 2.20 simplifies to

$$w^* - w = -m_2 + \alpha(1+\theta)(m_2 - w_2) \tag{2.23}$$

Differentiating equation 2.22 gives

$$\frac{d(w^* - w)}{dM_2} = (1+\theta)(\alpha' \frac{d\hat{w}}{dM_2}(m_2 - w_2) + \alpha \frac{dw_2}{d\hat{w}} \frac{d\hat{w}}{dM_2}) \qquad > 0 \tag{2.24}$$

Wages at the foreign firm increase relative to the domestic firm since the increase in specific human capital induces foreign firms to reduce the spillover by raising wages. This increase depends on the size of the spillover, which in turn depends on foreign presence θ.

Human Capital Spillovers from Foreign-Owned Firms

An increase in specific human capital, holding constant the amount of general capital produced within foreign firms, *reduces* the average amount of the human capital which spills over to domestic firms if mobility is endogenous. Spillovers are given by

$$\Delta = \theta\alpha(w_2 - m_2) \tag{2.25}$$

While w_2 rises when specific capital is increased, mobility from foreign firms falls. It can be shown that this fall in mobility from a decline in α more than offsets the wage increase, resulting in a decline in human capital spillovers to domestic firms. This is because although the total stock of specific capital produced by foreign firms increases, the total stock of general capital is constant. Since the number of employees retained by the foreign firm rises with $\hat{w}$, as does the general capital per employee retained (an increasing function of $\hat{w} - \mu$), the general human capital per employee arriving at the domestic firm must fall with an increase in specific capital.

2.4.3 Limited Evidence on Human Capital Formation, Wages and Turnover

As previously discussed in section 2.3, there is ample evidence that foreign firms engage in training and human capital accumulation. Are the effects of this accumulation significant? The prediction that increasingly specific human capital results in lower turnover rates and higher wage differentials is consistent with findings on turnover. There is evidence that turnover of skilled labor is very costly to foreign firms; several studies confirm that foreign firms routinely import skilled expatriates (at an estimated eight times the cost for a comparably skilled domestic employee) to train domestic employees for skilled positions; firms try very hard to prevent those workers from subsequently leaving (Reuber, Stewart). Consistent with the endogenous turnover model, spillover from foreign firms is observed to be much lower for skilled workers than for unskilled (Reuber, 1973), and wage differentials between foreign and domestic firms are substantially larger for skilled workers than for unskilled (Willmore, 1986). If a foreign firm's intangible asset is more transferable to other foreign firms than to domestic firms, mobility should be high between foreign firms relative to mobility from foreign firms to domestic firms. Stewart finds this to be the case for Indonesia, where turnover among multinationals is very high, but turnover from foreign firms to domestic firms is comparatively low (p.95). Cohen cites evidence of moderate turnover from foreign firms to domestic firms, observing that a third of Korean firms and a fifth of Taiwanese firms surveyed employ 10 to 50 percent employees with former experience at a multinational.

2.5 Wage Differences from Unobserved Worker Heterogeneity

One explanation for observed higher wages at foreign firms suggests they are caused entirely by a foreign preference for "better" workers, where differences in wages owe nothing to human capital accumulation within foreign firms. If workers are paid according to their abilities and foreign firms have a preference for better workers, foreign firms will pay a higher wage per worker than domestic firms. Foreign firms have generally employed a higher proportion of skilled to unskilled workers

(Willmore, 1986), part of which may be related to technological choice by foreign firms (Goncalves, 1986). If foreign firms also have a preference for better workers within skill categories, and these differences were observable to firms but not to the econometrician, then higher wages in foreign firms will reflect foreign firms bidding away the "best" workers from domestic firms. If worker ability or experience were accounted for, the wage discrepancy would disappear.

To illustrate this, the difference in relative wages between foreign and domestic firms can be characterized as

$$w^* - w = (\delta^* - \delta)(w_s - w_n) + \Sigma \tag{2.26}$$

where w_s is the wage paid to more productive workers, w_n the wage for less productive workers, δ and δ^* are the share of domestic and foreign's workers who are more productive, and Σ is any of the explanations for higher wages discussed earlier such as human capital accumulation at foreign firms. Differences in shares of good workers can lead to wage differences even if $\Sigma = 0$.

One can examine the impact of DFI on domestic wages to determine the importance of unobserved worker heterogeneity in explaining differences in wages between domestic and foreign firms. In particular, if domestic wages fall with an increase in foreign presence, foreign firms must be bidding away better workers from domestic firms. Using the definitions in equation 2.26, changes in the level of domestic wages are given by

$$dw = (1 - \delta)dw_n + \delta dw_s + (w_s - w_n)d\delta + d\Delta \tag{2.27}$$

where Δ represents the human capital "spillover" from DFI discussed in the previous sections; if the number of workers who obtain human capital and leave the foreign firm to work for domestic firms increases, $d\Delta$ will be positive. Direct foreign investment will affect domestic wages by affecting the partial derivatives in equation 2.27.

Suppose an alternative technology to that used by foreign firms exists for domestic firms. If this technology is less intensive than the foreign technology in the use of "good" labor and more intensive in the use of less productive labor, foreign investment is comparable to a shift in technology towards more productive labor for the good produced by foreign firms, resulting in a reorganization of factors and a shift in equilibrium wages. Accompanying this shift might also be an increase in total factor productivity either from the firm's intangible asset or from the higher capital-labor ratios characteristic of foreign firms. The wage response in equation 2.27 to foreign entry can be characterized as

$$dw = (1 - \delta)(\frac{dw_n}{da_n}da_n + \frac{dw_n}{db_n}db_n) + \delta(\frac{dw_s}{da_s}da_s + \frac{dw_s}{db_s}db_s) + (w_s - w_n)d\delta + d\Delta \tag{2.28}$$

where da_n and da_s are relative demand shifts for less and more productive workers, and db_n and db_s

are increases in demand from total factor productivity increases accompanying foreign firms. The derivatives in equation 2.28 from the shift in technology towards more productive labor have the following signs

$$\frac{dw_n}{da_n}da_n \leq 0 \tag{2.29}$$
$$\frac{dw_n}{db_n}db_n \geq 0$$
$$\frac{dw_s}{da_s}da_s \geq 0$$
$$\frac{dw_s}{db_s}db_s \geq 0$$
$$(w_s - w_n)d\delta \leq 0$$
$$d\Delta \geq 0$$

Relative demand shifts away from less productive to more productive labor reduces wages for less productive labor and raises wages for more productive labor in general equilibrium ($da_n \leq 0$). At the same time, higher productivity may raise all labor demand ($db_n \geq 0$ and $db_s \geq 0$). Foreign entry means less of domestic firms' labor will be "productive" ($d\delta \leq 0$). As discussed in earlier sections, DFI could result in a human capital spillover for labor employed by domestic firms ($d\Delta \geq 0$), which depends on the amount of human capital formation and turnover.

It would be useful to know what is the net effect of foreign entry on wages. In particular, if the impact of foreign firms is mainly to bid away workers from domestic firms, dw in equation 2.28 would be negative as DFI increases. Assuming the increase in demand for productive labor roughly offsets the fall in demand for less productive labor, so that

$$(1-\delta)\frac{dw_n}{da_n}da_n = -\delta\frac{dw_s}{da_s}da_s \tag{2.30}$$

the reaction of domestic wages to foreign investment will reveal whether the increased labor demand combined with the human capital spillovers exceeds the fall in wages from a shift in skill composition; high wages correlated with large foreign presence would suggest that a large exodus of productive workers from domestic firms in the face of DFI is not an important concern.

Jenkins (p.170) reports that in Brazil, average wages are significantly higher in industries with high foreign investment. This is also true in Mexico, in which industries where foreign presence exceeds 75 percent of production pay average wages over twice as high as in industries with less than 25 percent foreign presence. However, the variation in wages across industries is very high, and these correlations may simply reflect the propensity of DFI to take place in high-wage industries. Ideally, one would want to control for cross-industry wage differences unrelated to foreign investment.

Table 2.5, which reports wage differences across industries for domestic skilled wages reported by Venezuelan firms, confirms that DFI locates in high-wage industries. Domestic skilled wages are significantly higher in 4-digit industries with high foreign shares. This correlation is substantially diminished if controls are introduced for firm size and 3-digit industry. However, within a 3-digit industry, domestic firms producing in 4-digit industries with high foreign presence pay substantially higher wages than firms in industries with low foreign share. Although it is possible that DFI may gravitate to high wage 4-digit industries, the results in Table 2.5 are consistent with large total factor productivity and human capital spillover effects relative to a shift in productive labor away from domestic firms.

2.6 A Test for the Source of Wage Differences Between Foreign-Owned and Domestic Firms

In this section, I use the impact of direct foreign investment on domestic total factor productivity (TFP) to test among the competing hypotheses of wage differences between foreign-owned and domestic firms. The hypotheses can be distinguished based on the both the impact of foreign investment on domestic productivity and the interaction between this impact and wage differences. As mentioned above, the unobserved heterogeneity hypothesis attributes high wage differentials to the draining of productive labor from domestic firms. Increases in DFI should cause a decline in domestic total factor productivity. Moreover, this decline should increase with the difference in the foreign/domestic wage, as larger wage differences merely reflect a greater difference between the two types of firms in their shares of productive labor (see equation 2.26).

In contrast to the worker heterogeneity hypothesis, the human capital accumulation hypothesis predicts increases in DFI should *increase* the human capital spillover to domestic firms, resulting in an increase in domestic total factor productivity; equations 2.7 and 2.25 confirm the size of the human capital spillover per domestically-employed worker increases with θ, foreign employment relative to domestic employment.

I can further distinguish between cases of exogenous turnover and endogenous turnover by the impact of the interaction between DFI and wage differences on domestic TFP. If mobility were endogenous, human capital spillovers would decline with increases in the wage differential, as higher efficiency wages would result in less spillover. If wage differentials simply reflect the amount of general human capital accumulation ($\gamma(M_2 - m_2)$ in equation 2.7), spillovers should *increase* with wage differentials.

2.6.1 The Nature of the Test

To demonstrate this, I consider the model in section 2.4.1. The wage differences can be derived from equation 2.4 to be

$$w^* - w = ((1-\beta) - \alpha(1+\theta))\gamma(M_2 - m_2) \tag{2.31}$$

Combining equation 2.31 with the human capital spillover in equation 2.7 gives the relationship between human capital spillovers and observed wage differences

$$\Delta = (\frac{\theta\alpha}{(1-\beta) - \alpha(1+\theta)})(w^* - w) = f(\theta)(w^* - w) \tag{2.32}$$

where $f'(\theta) > 0$, and $f(\theta)$ depends on industry-specific characteristics. Equation 2.32 suggests that if turnover is exogenous, larger wage differences reflect greater human capital spillovers to domestic firms for a given foreign presence θ. This is because large wage differences indicate large amounts of general human capital formation within foreign firms. With turnover, this results in larger spillovers to domestic firms. To the extent domestic TFP increases are proportional to increases in human capital, high wage differences should be correlated with large TFP spillovers given foreign presence.

I derive the opposite result from the endogenous turnover model in section 2.4.2. Combining equation 2.23 with the human capital spillover given in equation 2.25, I derive the following relationship

$$\Delta = -m_2 - \frac{\theta}{1+\theta}(w^* - w) = A - f(\theta)(w^* - w) \tag{2.33}$$

where $f'(\theta) > 0$. Equation 2.33 shows that for a given foreign presence θ, large wage differences reflect *lower* the human spillovers to domestic firms. Foreign firms have the ability to reduce turnover by raising the wages they pay relative to domestic firms. If turnover is endogenous, high wage differences given foreign presence should be correlated with lower TFP spillovers from foreign investment.

2.6.2 Results of the Test

To test among the competing hypotheses, I estimate the following production function for output by domestically-owned firms at time t for firm i, industry j and region s

$$\log Y_{it} = X(j)_{it} \cdot \beta + \delta_1 DFI(j,s)_t + \delta_2(DFI(j,s)_t * WAGE(j,s)_{it}) + \epsilon_{it} \tag{2.34}$$

where $DFI(j,s)_t$ is the share of four-digit industry j's labor in region s employed by foreign-owned firms at time t, and $WAGE(j,s)_{it}$ is the difference between the skilled wage paid at foreign-owned firms in four-digit industry j in region s and the skilled wage paid by domestic firm i. The vector $X(j)_{it}$ contains the domestic firm's material inputs, capital stock, skilled labor, unskilled labor, and four-digit industry and time dummy variables.

I estimate equation 2.34 using firm-level Venezuelan manufacturing data over the years 1976 to 1989 for over 200 geographical regions. Knowing the firm's location allows me to exploit the geographical variation of foreign investment; I can control for unobserved inter-industry differences in factors which may be correlated with the explanatory variables, such as different rates of turnover, by comparing firms within an industry across different regions. To allow for the possibility that DFI may be attracted to regions with productivity advantages, I estimate an "adjusted" equation, which includes measures of location-specific productivity measures[3].

A positive coefficient δ_1 is consistent with human capital spillovers from foreign firms, while a negative δ_1 is consistent with the unobserved heterogeneity hypothesis. If δ_1 is non-negative, a positive δ_2 indicates exogenous turnover, while a negative δ_2 will result if turnover is endogenous. The signs of the coefficients for equation 2.34 predicted by the three hypotheses are given in Table 2.6.

The results of the estimation of equation 2.34 are given in Table 2.7. The results for estimation over the entire sample are consistent with the endogenous mobility hypothesis; increases in foreign presence increase the TFP of domestic firms, and this increase is lower the greater the deviation in foreign and domestic wages[4]. These results suggest human capital spills over to domestic firms, but that foreign firms limit the spillover by paying higher wages than are earned at domestic firms.

More can be learned about turnover by isolating the sample of domestic firms which have previously experienced some foreign ownership. When these firms are considered separately, the spillover from foreign presence is estimated to be much larger than for the sample as a whole. However, the interaction between the foreign/domestic wage difference and the size of the spillover disappears. This result is consistent with that predicted by the model in section 2.4.2, if human capital is more transferable from foreign firms to domestic firms which had some foreign ownership than to domestic firms which have always been entirely domestically-owned. The model predicts that as human capital formation in foreign firms becomes more general, the incentive to pay efficiency wages declines and spillovers increase.

When domestic firms with no previous foreign ownership are isolated, the estimated coefficients change significantly. Average spillovers from foreign firms are small and insignificant for this sample. However, the spillover is larger to firms for which the foreign/domestic wage difference is smaller. This result is again consistent with the model of endogenous turnover; foreign firms are estimated to be able to reduce the human capital spillover to domestic firms by paying their workers higher wages inducing them to stay.

[3] see Aitken and Harrison (Chapter 1) for a more complete analysis of TFP effects of foreign investment in Venezuela.

[4] Note this is the opposite result expected if it is believed that the size of the spillover is a function of the potential for domestic firms to learn, where the foreign/domestic wage difference measures this potential.

2.7 Conclusion

Wages paid by foreign-owned firms are higher than those observed in domestically-owned firms, even controlling for industry, size, and technology. One explanation for the wage differences links human capital formation within foreign firms with labor turnover. Another attributes higher wages to unobserved skill differences between labor employed by foreign and domestic firms. I present evidence that direct foreign investment does not result in a redistribution of productive labor from domestic firms to foreign firms. I find support for wage differences resulting from the attempt of foreign firms to reduce costly turnover; total factor productivity spillovers from foreign-owned to domestic firms are reduced by increases in foreign/domestic wage differences.

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Table 2.1: Shares of Sales and Inputs Employed by Foreign-owned Manufacturing Firms in Venezuela

	Years 1976-78	Years 1985-87
Shares Weighted by Percent of the Firm's Capital Owned by Foreigners		
Sales	9 %	9 %
Capital	10 %	9 %
Skilled Labor	10 %	9 %
Unskilled Labor	7 %	6 %
Materials	9 %	8 %
Shares by Firms with Some Foreign Ownership		
Sales	22 %	22 %
Capital	28 %	31 %
Skilled Labor	24 %	21 %
Unskilled Labor	16 %	14 %
Materials	20 %	20 %

Table 2.2: Comparison of Wages Paid by Foreign-Owned and Domestic Manufacturing Firms in Venezuela

Dependent variable is the log wage of skilled workers (Obs=41121)

	Coefficient on Foreign-Owned Dummy Variables		R^2
	Foreign Share ≥ 50%	0 < Foreign Share < 50%	
No Controls	0.489 (23.2)	0.513 (34.3)	0.09
Controlling for 2-digit SIC	0.465 (22.5)	0.474 (32.3)	0.14
Controlling for 4-digit SIC	0.377 (18.7)	0.387 (26.8)	0.19
Controlling for Size and 4-digit SIC	0.179 (9.8)	0.158 (11.6)	0.35
Controlling for Size, Capital-Labor Ratio, & 4-digit SIC	0.179 (9.8)	0.157 (11.7)	0.35

T-statistics in parentheses. All regressions include annual time dummy variables.

Table 2.3: Comparison of Wages Paid by Foreign-Owned and Domestic Manufacturing Firms in Venezuela - By Industry

Dependent variable is the log wage of skilled workers (Obs=41121)

	Coefficient on Foreign-Owned Dummy Variables	
	Foreign Share $\geq$ 50%	0 < Foreign Share < 50%
Food Products	0.209	0.271
	(5.3)	(6.2)
Textiles	0.071	0.053
	(1.5)	(0.6)
Wood Products	0.336	-0.021
	(2.9)	(0.2)
Paper Products	0.172	0.165
	(3.2)	(3.5)
Petrol & Chemicals	0.093	0.130
	(3.3)	(3.4)
Non-Metal	0.300	0.345
	(7.1)	(4.8)
Basic Metals	0.045	0.247
	(0.9)	(2.1)
Machines & Equipment	0.167	0.157
	(7.5)	(4.5)

T-statistics in parentheses. All regressions include annual time dummy variables, 4-digit SIC dummy variables, and Capital-Labor Ratio.

Table 2.4: Total Factor Productivity Growth for Foreign and Domestic Manufacturing Firms in Venezuela

	Domestically-owned Firms		Foreign-owned Firms
	TFP 1	TFP 2	TFP 1
TFP Growth per year from 1978 to 1987			
All Industries	0.18 %	0.42 %	1.06 %
Without Petroleum	-0.07 %	0.10 %	0.92 %
Average TFP Growth per year from 1976 to 1984			
All Industries	0.74 %	0.70 %	1.96 %
Without Petroleum	0.42 %	0.34 %	1.88 %

TFP 1 indicates Total Factor Productivity derived from estimated coefficients of firm-level regressions of log sales on logs of materials, skilled labor, unskilled labor, capital, year and 4-digit SIC dummy variables.

TFP 2 indicates Total Factor Productivity derived from estimated fixed effects coefficients of the same regressions as in TFP 1. Firms are defined to be "Foreign-owned" if some part of the firm's capital stock is owned by foreigners.

Table 2.5: Impact of Direct Foreign Investment on Domestic Wages in Venezuela

Dependent Variable is log wage for skilled domestic workers

	Coefficient on Foreign Share of Labor	
	DFI 1	DFI 2
No Controls	0.693 (26.2)	1.20 (22.6)
Controlling for Size	0.869 (35.8)	1.50 (30.7)
Controlling for Size & 2-digit SIC	0.944 (34.4)	1.46 (28.6)
Controlling for Size & 3-digit SIC	0.858 (25.5)	1.24 (18.8)

T-statistics in parentheses. All regressions include annual time dummy variables.

Table 2.6: Coefficients Predicted By Wage-Difference Hypotheses

Hypothesis	Predicted Coefficient	
	DFI	DFI*WAGE
Unobserved Heterogeneity	< 0	< 0
Human Capital Formation with Exogenous Turnover	> 0	> 0
Human Capital Formation with Endogenous Turnover	> 0	< 0

Table 2.7: Test of Human Capital Spillover and Turnover from Direct Foreign Investment

Dependent Variable is log Sales by Domestic firms

	Coefficient on Independent Variables	
	DFI	DFI*WAGE
	All Domestic Firms ($obs = 30515$)	
Unadjusted	0.089	-0.057
	(3.2)	(3.5)
Adjusted	0.047	-0.058
	(1.7)	(3.6)
	Domestic Firms with Previous Foreign Ownership ($obs = 5607$)	
Unadjusted	0.230	0.002
	(3.6)	(0.1)
Adjusted	0.193	0.002
	(3.0)	(0.1)
	Domestic Firms with No Previous Foreign Ownership ($obs = 24472$)	
Unadjusted	0.049	-0.073
	(1.6)	(3.8)
Adjusted	0.007	-0.075
	(0.2)	(3.9)

T-statistics in parentheses.

The variable DFI is the foreign share of total employment in the region for the four-digit industry. The variable $DFI * WAGE$ is the variable DFI interacted with the difference between the skilled wage paid by foreign-owned firms in the region in the four-digit industry and the domestic firm's skilled wage.

All regressions include logs of firms' capital stock, materials, skilled and unskilled workers, and time and four-digit industry dummy variables. Adjusted regressions also include the log of the region's skilled wage for all industries and the log of electricity prices in the region.

Chapter 3

Measuring Trade Policy Intervention: A Cross-country Index of Relative Price Dispersion

Trade policy debate has been confused by the failure to distinguish outward orientation from trade intervention. Trade intervention implies policies which distort the flow or pattern of trade (Edwards, 1989), while outward orientation implies that the incentives to export are greater than the incentives to import substitute (Kreuger, 1978). Trade intervention is often associated with outward orientation because the two may in fact be correlated: a restrictively interventionist trade regime can bias production against exports through an appreciated exchange rate (see Appendix). However, a highly interventionist trade policy that balances import restrictions with export incentives may be as "outwardly oriented" as completely liberalized economy. Also, A country may impose trade policies which raise the *average* incentive to export relative to import substitute while increasing the *dispersion* of incentives within the import and export sectors. When such a country liberalizes, trade may return to its original pattern but with incentives inwardly oriented.

Since intervention and outward orientation are theoretically distinct, an empirical relationship between outward orientation and growth does not imply the same relationship exists between trade intervention and growth. To test the effects of trade intervention on growth separate from the effects of outward orientation, one needs a satisfactory cross-country measure of trade intervention. The four most widely used measures of trade policy have been trade intensity, average tariffs and coverage ratio of NTB's, deviations in a country's trade pattern from that predicted by its factor endowments, and distortions in the real price level. In this paper, I present a new measure based on differences between a country's relative price structure and the structure of world relative prices, and argue that this measure conforms more closely than existing measures to the concept of trade intervention.

3.1 Problems with Commonly Used Trade Policy Measures

3.1.1 Trade Intensity

Trade intensity, defined for country j as

$$L_j = \frac{X_j + M_j}{GDP_j} \tag{3.1}$$

(with X_j being exports and M_j imports) is used as an indication of trade policy. A related measure, import penetration, is defined

$$\hat{L}_j = \frac{M_j}{GDP_j} \tag{3.2}$$

These measures are often adjusted for "structural" factors by regressing the numerator of equation 3.1 or 3.2 on country specific variables such as area, income level, and CIF/FOB ratios, and redefining the measure as

$$\tilde{L}_j = \frac{\hat{r}_j}{GDP_j} \tag{3.3}$$

with $\hat{r}_j$ being the residual from the regression.

Trade intensities and import penetration ratios, whether adjusted for "structural" factors or not, are simply not measures of trade intervention. A high trade share or import share may characterize either a liberal regime or an interventionist regime in trade balance with significant export subsidies (see the model in the appendix). Trade share is even unconvincing as a measure of outward orientation; it is notoriously unstable across time as well as across countries, more so than can believably be attributed to trade policy[1].

3.1.2 Adjusted Price Level

A second trade policy measure interprets the deviation of

the aggregate price level of country j (p_j expressed in dollars) relative to the United States (p_{us}) from the level predicted by the "structural" relationship (with y_j being income per capita also in dollars)

$$\frac{p_j}{p_{us}} = 1 + \beta y_j + \epsilon_j \tag{3.4}$$

as a distortion reflecting trade policy (Dollar, 1990). A country's price level contains a nontraded price which differs systematically across countries with income, and a traded price, which differs from world prices only through trade policy restrictions. Increases in import restrictions can raise the price level of the economy by raising both the price of imported goods and of nontraded goods, biasing production against exports (see Appendix). But the resulting index does not measure intervention

[1] Helleiner (1990) finds that Korea, for example, went from an export share of GDP of 9% to 36% over a twenty year period.

directly for the same reason as the trade share; interventions designed to keep the *average* tariff low while increasing the *variance* of traded goods prices will *lower* the price level. A low price level can be maintained even with a high average import tariff if exports are taxed. In this case the "adjusted" price level would fail as a measure of outward orientation as well; a low price level would be associated with a trade regime biased toward producing import substituting goods.

3.1.3 Administrative Measures

Administrative measures of trade regime include average tariffs and the percent of traded products covered by NTB's. While reflecting import restrictions, these measures reveal nothing about intervention in the export sector, and neither are precise measures of the *effect* of policy intervention on the flow of trade. For example, the most important trade restriction for developing countries is import licensing, a restriction which is highly discretionary; a strictly enforced licensing requirement on one good could be more restrictive yet result in a lower coverage ratio than several goods with unenforced requirements. Average tariffs for imported goods fail as intervention measures by ignoring the dispersion of tariffs within a category of goods.

3.1.4 Quantity Measures

One can determine the seriousness of policy intervention by measuring the degree to which trade patterns are distorted from those occurring in the absence of intervention. Such a measure has the advantage of determining the *effects* of intervention, thus avoiding many of the problems with administrative measures. But the "normal" pattern of trade which would occur in the absence of intervention is not observable, and some theoretical assumptions must be imposed to recover this pattern.

Leamer (1989) measures deviations of actual trade patterns from those predicted by the country's endowment using a Hecksher-Ohlin factor intensity model. Although the most theoretically grounded of the measures of intervention, this index suffers from its reliance on a theory which has had questionable empirical success. In practice, the three intervention measures calculated by Leamer are only mildly correlated with one other (having rank correlations between 20 and 30 percent), suggesting the index should be treated with caution.

Since all these measures are emphasizing different aspects of trade strategy, it would be surprising if they were correlated with one another. Indeed they are not. In a recent paper, Pritchet (1991) searches for correlations between the measures described above, and finds a "complete absence of correlation among them". While Harrison (1991) finds that the relationship improves when trade policy measures are observed over time, the correlation remains weak. Measures commonly used to describe trade regime cannot all be characterizing the same aspect of trade policy intervention.

If intervention is defined in terms of its effects on trade flows, one can measure intervention either by observing trade patterns deviating from non-intervention patterns, as was discussed above, or by measuring deviations of relative prices from world relative prices; in the absence of price controls, any "distortion" in the pattern of trade will also result in a deviation of relative prices from the non-intervention price structure. While measures based on relative price distortions share the advantage quantity measures have of focusing on the effects of intervention, relative price-based measures have the added advantage that prices in the absence of trade distortions are directly observed in the world economy; provided there are no other major barriers to price arbitrage across countries (such as transportation costs and monopolies in the distribution of goods), and after allowing for systematic differences across countries in the cost of distributing goods, the prices for traded goods observed in an economy in the absence of trade barriers will equal the world prices.

Helleiner argues "there is usually no escape from difficult and costly product-by-product comparisons of domestic and world prices in search of 'tariff equivalents"' (1990). In this paper I perform such a comparison, measuring directly the degree to which policy intervention distorts the incentives *within* the traded sector. I will not be measuring the effects of intervention on the *average* price of traded goods relative to nontraded goods, as these effects are captured in measures of deviations of the price level; an import tariff on some goods which does not change the average tariff will distort relative prices from world prices but will not raise the price *level*, while a uniform tariff on imports matched by a uniform subsidy on exports will not distort incentives within the traded sector but will raise the price level (see Dollar, 1990, and the appendix).

3.2 A Model of Relative Price Dispersion

Consumption in the economy is divided between one nontraded and n traded goods. Price arbitrage in traded goods assures that the domestic price of a traded good can deviate from the world price only through trade intervention. The log domestic dollar price of traded good i in country j is

$$P_{ij} = P_i^* + \epsilon_{ij} \tag{3.5}$$

where P_i^* is the international price of the produced good and ϵ_{ij} represents the impact of the policy intervention (an import restriction or an export subsidy).

Traded goods, whether produced at home or imported, are not consumed in their produced form, but can only be consumed after being "distributed". Goods are transformed into "distributed goods" using nontraded domestic services, where the inputs are the produced good and a fixed service requirement (the nontraded good) per unit of the distributed good. If goods are distributed with a constant marginal product in nontraded services, and if distribution is perfectly competitive, then the log of the dollar price of distributed good i in country j will be

$$p_{ij} = P_i^* + \epsilon_{ij} + a_i \log P_{Nj} \tag{3.6}$$

where P_{Nj} is the domestic nontraded goods price in dollars and a_i is the unit service requirement. I assume the service requirement in the distribution of goods can vary across goods, but not across countries. The last assumption is for exposition; the results of this section hold provided the service requirement in distribution moves monotonically with the service price. To allow for the possibility of nominal stickiness in the face on a nominal exchange rate fluctuations, equation 3.6 can be expressed

$$p_{ij} = P_i^* + \epsilon_{ij} + a_i(\log \hat{P}_{Nj} - \log e_j) \tag{3.7}$$

where $\hat{P}_{Nj}$ is the domestic currency price of nontraded goods and e is the nominal exchange rate expressed in dollars per unit of domestic currency.

According to equation 3.7, differences in prices of distributed goods from world production prices (P_i^*) are caused by the nontraded service component required to distribute the good, changes in the exchange rate (to the extent of nominal price stickiness), and trade distortions ϵ_{ij}[2].

The effect of policy on prices can be isolated by subtracting the average distributed price over all goods from the distributed price p_{ij} in equation 3.7, and comparing this difference to the world price. Subtracting the mean distributed price gives the *relative* distributed price

$$p_{ij} - \bar{p}_j = P_i^* - \bar{P}_i^* + \epsilon_{ij} - \ eps\bar{i}lon_j + (a_i - \bar{a})(\log \hat{P}_{Nj} - \log e_j) \tag{3.8}$$

where $\bar{p}_j$, $\bar{P}_i^*$, $\bar{\epsilon}_j$ and $\bar{a}$ are average values across goods within a country. The relative distributed price will be influenced by the exchange rate if nontraded prices adjust slowly and the nontraded service requirement of the good differs from the average.

Since world prices for "produced" goods are not directly observable, I subtract the relative distributed price defined in equation 3.8 for the United States from the relative price for country j[3]

$$\begin{aligned} \rho_{ij} = p_{ij} - \bar{p}_j - (p_{iUS} - \bar{p}_{US} = \epsilon_{ij} - \bar{\epsilon}_j - (\epsilon_{iUS} - \bar{\epsilon}_{US}) + \\ (a_i - \bar{a})(\log \hat{P}_{Nj} - \log e_j - \log P_{NUS}) \end{aligned} \tag{3.9}$$

or rearranging terms

$$\rho_{ij} = A_i + (a_i - \bar{a}) \log \frac{\hat{P}_{Nj}}{e_j} + \epsilon_{ij} - \bar{\epsilon}_j \tag{3.10}$$

[2] Other possible differences, such as are caused by monopolies in the distribution of goods will not be considered here. If distribution monopolies are not natural monopolies, but are caused by trade polices, the resulting price distortions can be safely attributed to intervention ϵ_{ij}.

[3] In the estimation, the weighted average of relative prices in OECD countries was substituted for the price in the United States, but the results were not changed.

where A_i is defined

$$A_i = \epsilon_{iUS} - \bar{\epsilon}_{US} - (a_i - \bar{a}) \log P_{NUS}$$

If A_i and $a_i - \bar{a}$ could be identified, the effects of intervention on price (the term $\epsilon_{ij} - \bar{\epsilon}_j$ in equation 3.10) could be isolated. This term represents the deviation of the *relative production* price of good i in country j from world *relative production* prices.

3.3 Relative Price Estimation

Although I do not observe A_i and $a_i - \bar{a}$ directly, I can estimate them with cross-country regressions performed for each good i. The data used for estimation are drawn from the last phase of the Incomes Comparison Project, which consists of goods prices relative to the United States for 151 traded and nontraded goods based on detailed price and expenditure data from a cross section of 57 countries in 1980 (Kravis, Heston and Summers, 1982; United Nations, 1986). In order to ensure the plausibility of the assumption that a_i is the same across countries, I aggregate the original 151 traded and nontraded goods to a sample of 16 traded goods and one nontraded good (see table 3.1)[4]. Prices were computed for these 16 traded goods and two nontraded goods (rent and services/construction) as the expenditure-weighted averages of the original 151 prices. Extensive efforts have been made in producing these data to control for cross-country differences in quality such that prices are compared for the same good across countries.

3.3.1 Bias from the Impact of Intervention on Prices of Nontraded Goods

If the dollar price of nontraded goods in country j is influenced by the average policy distortion $\bar{\epsilon}_j$, then estimating equation 3.10 using nontraded prices as an explanatory variable will bias the estimates of $a_i - \bar{a}$. The relationship between nontraded prices and average tariffs and subsidies in long run equilibrium is described in a detailed model in the appendix, but will be summarized here. An increase in the average import tariff or export subsidy shifts production towards the traded (import competing or exporting) sector while at the same time increasing the demand for and decreasing the production of nontraded goods. The excess demand for nontraded goods must be rationed with an increase in the price of nontraded goods. The increase is less than the increase in the policy measure since both supply and demand respond to an increase in nontraded prices.

This relationship introduces a potential bias into the estimation of equation 3.10. If the average distortion $\bar{\epsilon}_j$ increases from a uniform increase in ϵ_{ij} across goods, then $\epsilon_{ij} - \bar{\epsilon}_j$ remains orthogonal to P_{Ni}. If however distortions are concentrated on some goods, then $a_i - \bar{a}$ would be overestimated

[4] education and health care were dropped from estimation to avoid the difficulties of cross-country quality comparisons in these goods.

for those goods for which $\epsilon_{ij} - \bar{\epsilon_j}$ increased and underestimated for the goods for which $\epsilon_{ij} - \bar{\epsilon_j}$ decreased.

Estimation bias can be avoided by estimating in two stages; since service costs (mostly labor) are predicted to vary systematically with wages across countries, I first regress each of the two nontraded prices (in dollars) on income and income squared per worker (also in dollars) derived from Summers and Heston. The predicted values of these prices are now independent of the error term, and can be used to estimate $a_i - \bar{a}$ in equation 3.10.

3.3.2 Comparing Price Distortion between Countries with Different Income Levels

While it is not likely that the average level of distortion $\bar{\epsilon_j}$ greatly affects income per capita, if countries with low income levels are more likely to have high average distortion levels, then using income per worker as an instrument for nontraded prices may bias estimates of $a_i - \bar{a}$. Erzan et al find that in 1985 average tariffs were between 50 and 66 percent for countries with GDP per capita less then $500 and between 3 and 5 percent for countries with GDP per capita greater than $5000. NTB's coverage ratios were found to be highest among middle income countries[5].

If indeed low and middle income countries have higher average distortion levels than upper income countries, then the measured distortions in low and middle income countries will understate the true price distortions, and estimates of $a_i - \bar{a}$ will be biased[6].

The importance of this bias in comparing price distortions for two countries will increase with the difference in the countries' income levels. Let $\hat{\epsilon_{ij}}$ be the estimated error $\epsilon_{ij} - \bar{\epsilon_j}$, let $\hat{\beta}_i$ be the estimated $a_i - \bar{a}$ and β_0 be the true $a_i - \bar{a}$. Comparisons of the relative distortion for good i between countries j and k can be expressed as the difference

$$\hat{\epsilon}_{ij} - \hat{\epsilon}_{ik} = [(\epsilon_{ij} - \bar{\epsilon}_j) - (\epsilon_{ik} - \bar{\epsilon}_k)] - (\hat{\beta} - \beta_0)(y_j - y_k) \tag{3.11}$$

where y_j is the nontraded price predicted by per capita income in country j and y_k is the same in country k. According to equation 3.11, the estimated difference between two countries of price distortion equals the true difference plus a bias which increases with the difference in nontraded prices predicted by income. While estimated price distortions in Paraguay may be comparable with estimated price distortions in Peru, caution should be used in comparing these estimated price distortions with those of Denmark. For this reason, comparisons are made within three broad income

[5] Average tariff levels understate the importance of trade barriers in developed countries; tariffs are among the least important barriers to trade within the EC, next to administrative barriers, technical regulations, and frontier delays (see Emerson et al, 1988).

[6] Unless the higher average distortion $\bar{\epsilon_j}$ is caused by uniformly higher distortions ϵ_{ij} for all goods, leaving $\epsilon_{ij} - \bar{\epsilon_j}$ constant (see above). Ezran et al (1987), for example, found that for developing countries average tariff levels were roughly the same for food and for manufactures.

categories. As a further precaution, price dispersion was measured both over the entire sample of countries, and over a restricted sample which only considers countries in the high and middle income groups (eliminating India and most of Africa).

3.3.3 Estimation of the Service Component of Traded Goods

Since population density and urbanization are likely inputs in the distribution of goods and may affect relative prices, I include these variables in the price regressions. As indicated in equation 3.10, changes in the exchange rate can influence relative prices if nontraded prices are sticky. To control for this I include the log of the exchange rate in the year 1980 (the year of the ICP sample) minus the log of the average exchange rate over the previous ten years (defined as ex_rate_j). With no nominal stickiness the coefficient on the exchange rate should be zero.

Deviations from world production prices are estimated using the following equation for each good i

$$\rho_{ij} = A_i + \beta_1 rent\_\hat{p}_j + \beta_2 service\_\hat{p}_j + \beta_3 \log urban_j + \beta_4 \log density_j + \beta_5 ex\_rate_j + \eta_{ij} \quad (3.12)$$

where $rent\_\hat{p}_j$ is the log rent price predicted by log income per worker, $service\_\hat{p}_j$ is the log service and construction price predicted by log income per worker, and ex_rate_j is described above. I use the residual $\hat{\eta}_{ij}$ from the estimation of equation 3.12 as an estimate of $\epsilon_{ij} - \bar{\epsilon_j}$, the deviation of the relative price of good i in country j from the world relative price.

3.3.4 Relative Price Estimation Results

The results of the estimation of equation 3.12 on the restricted sample (low income countries excluded) are given in table 3.2. Including Low income countries reduces the percentage variation of relative prices explained by the dependent variables, but does not change the magnitude of the coefficients significantly. High nontraded goods prices substantially increase the price of consumer nondurables relative to capital goods and consumer durables; a 1 percent increase in service prices increases the *relative* price of clothing by 0.7 percent while decreasing the *relative* price of electrical equipment by 0.95 percent. This suggests the distribution of consumer nondurables is much more labor intensive than the distribution of capital goods. Capital goods are also relatively cheaper in areas of high population density, a result suggesting lower distribution costs in these areas.

High rent prices have a tendency to decrease prices for capital and consumer nondurable goods relative to consumer durables, but the effects are not uniform across all goods; the effect of rent prices may reflect higher inventory requirements in the distribution of consumer durables. A temporary depreciation of the exchange rate lowers the price of consumer nondurables relative to consumer durables and capital goods. This is the predicted response if nontraded prices adjust slowly to changes in the exchange rate, since nondurable consumption goods have a larger service component in their distribution.

3.4 Computing Relative Price Dispersion

As indicated above, the residual from the estimation of equation 3.12 for good i represents the deviation of the relative price of good i for country j from the world relative price. To derive a single measure (V_j) of the degree to which relative prices in country j differ from world prices, I square the deviations for each good i and country j and sum the magnitudes across all goods

$$V_j = \sum_i \alpha_{ij}\hat{\eta}_{ij}^2 = \sum_i \alpha_{ij}(\epsilon_{ij} - \bar{\epsilon}_j)^2 \tag{3.13}$$

where α_{ij} is the expenditure share predicted by a cross country regression of expenditure on income and income squared[7]. The index V_j represents the degree to which *relative* prices in country j differ from world *relative* prices.

3.4.1 Relative Price Dispersion Across Countries

Country rankings of intervention according to the price dispersion measure are listed in table 3.3 by income category. The dispersion categories in the table 3.3 are defined such that a country in the "low dispersion" category, for example, has a dispersion which is low *relative* to those in its income category. Among the middle income countries with high dispersion are Sri Lanka, Bolivia, and Portugal. Low dispersion economies include Pakistan, the Dominican Republic, and Costa Rica. In the high income group, Japan, Israel, and Spain have high dispersion, while Austria and Italy have relatively low dispersion. For the low income countries, Nigeria, Zambia, and India are high, while Madagascar and Kenya are low.

The results listed in table 3.3 are separated by income categories for reasons given in section 3.3.2: the bias in comparing dispersion in different countries increases with the difference in the countries' income per capita (see equation 3.11). The numbers given are the calculated index values V_j, and represent the variance across goods of differences in relative prices from world relative prices; for example Brazil, showing "medium high" dispersion in the middle income sample, has a variance of relative prices equal to 5.5 percent of the mean relative price.

The results for the middle and upper income groups were estimated using the restricted sample, in which the low income countries were not included[8]. Including low income countries does not change

[7] Actual expenditure shares were also used. Peru and Portugal show somewhat less price dispersion if their actual expenditure shares are used. An index was also calculated using the sum of the *absolute values* of the residuals. The resulting index was highly correlated (96% raw, 94% rank) with the sum of the squares of the residuals.

[8] The rankings in table 3.3 for Botswana, Morocco, and Tunisia are based on estimation over the unrestricted sample.

the hierarchy much for the upper income countries, but changes the hierarchy considerably for the middle income countries. Capital goods prices are relatively low for low and high income groups, and relatively high for middle income groups. The predicted relative price of capital declines with income in the restricted sample. Including low income groups in the estimation flattens the price-income relationship. Since almost all middle income countries have high capital prices, relatively poor countries within the middle income group show more price dispersion in the unrestricted sample; particularly Honduras, Indonesia, Pakistan, and Bolivia (the estimation results for the restricted and unrestricted samples are given in tables 3.8 and 3.9.

Within middle income countries, Asia is slightly more interventionist than Latin America; Asia has a median dispersion index of 0.051 versus Latin America with a median of 0.047. Perhaps more significant is the high variance of dispersion measures across Asia (Japan and Sri Lanka with very high dispersion, Pakistan with very low dispersion), while the variance in Latin America is relatively low.

3.4.2 Equipment Price Distortions

Whether a country intervenes may not be as important to growth as *how* the country intervenes. Delong and Summers (1991) have emphasized the relationship between equipment investment and growth, arguing that a one percent increase in equipment investment increases growth by one third of one percent. Intervention which subsidizes prices of capital goods in general or equipment in particular would encourage this type of investment. Subsidies of capital inputs may also encourage production and export growth of manufactures which use these inputs.

The relative price regressions estimating equation 3.12 allow cross-country comparisons of equipment price distortions from the world relative equipment price. Equipment price distortions are defined

$$D_j = \sum_k \alpha_{jk} \hat{\eta}_{jk} \tag{3.14}$$

where k indexes equipment goods (machines, agricultural machines, and electrical equipment), α_{jk} is the expenditure share for each good, and $\hat{\eta}_{jk}$ is the residual from regression in equation 3.12. Equipment price distortions can be used as measures of the relative incentives to engage in equipment investment: unusually high relative prices would discourage investment in equipment. Categorizations by relative price dispersion and equipment price distortion are listed in table 3.4, and equipment price distortion measures are given in table 3.10. Relative equipment price distortions vary substantially across countries within each income category; Korea, for example shows high intervention and

The countries' rankings are preserved if grouped with their African peers in the low income category; Botswana and Tunisia show high dispersion, and Morocco shows low dispersion.

Canada is considerably more distorted when estimated using the unrestricted sample. This is primarily caused by a stronger estimated effect of exchange rate appreciation in the unrestricted estimation, combined with Canada having a significantly more depreciated exchange rate in 1980 than in previous years.

relative equipment prices 5.3 percent below the predicted level, while Peru, having comparable levels of intervention, shows relative equipment prices 2.2 percent above the predicted level.

Within middle income countries, Asia has significantly lower median equipment prices than Latin America, although the variance of relative equipment prices is much higher in Asia mostly because of high prices in Sri Lanka and Philippines and low prices in Korea, Japan, Pakistan, and Indonesia[9].

3.5 Comparing Relative Price Dispersion and Measures of Outward Orientation

Combining intervention (the distortion of trade patterns) and outward orientation (the incentives to produce for export relative to import substitution) into a single measure of trade policy is often justified on the grounds that intervention in the form of import restrictions taxes exports, biasing incentives toward the production of import substitutes; import restrictions shift resources towards the import production, raising the prices of nontraded goods relative to the prices of exports, which are generally determined by world supply and demand (see Appendix). Export producers now face higher input and labor costs. If there are no export subsidies to offset the anti-export bias of the import restrictions, then intervention will produce an inwardly oriented trade regime.

3.5.1 Trade Intensity and Relative Price Dispersion

Outward orientation is usually measured as the ratio of trade to GDP (see equations 3.1 and 3.2); a higher share is thought to indicate an outwardly oriented regime. Often trade share is adjusted by using the portion of trade not predicted by "structural" factors such as income levels, area, and population (equation 3.3). A third measure is Leamer's measure of openness, which equates openness with the share of trade not predicted by differences in factor endowments. Negative correlations of price dispersion with these measures would suggest that in general outward oriented economies are more liberal.

The rank correlations listed in Table 3.5 reveal the relationship to be more complex. While the three measures of openness correspond to low levels of price dispersion for high and low income countries, the relationship is rather weak. With the exception of the Leamer measure, the relationship is reversed in the case of middle income countries; economies with more relative price dispersion show higher trade shares than liberal economies. The difference between the Leamer index and the other trade shares is to be expected, given that the Leamer index is more highly correlated with the raw trade share than with the "adjusted" trade share.

[9] The rankings in table 3.4 for Botswana, Morocco, and Tunisia are based on estimation over the unrestricted sample. Again, the countries' rankings are preserved if grouped with their African peers in the low income category; Botswana shows low equipment prices, while Tunisia and Morocco show medium equipment prices.

3.5.2 Distortions in the Price Level and Relative Price Dispersion

Comparisons with other measures of outward orientation confirm these results. As mentioned above, increases in import restrictions can raise the price of import substituting goods and of nontraded goods, biasing production against exports (see Appendix). These price increases will be reflected in the price level, converted into dollars at the nominal exchange rate. Comparisons of the price level, adjusted for "structural" differences in nontraded goods prices, can be used to construct indices of outward orientation, with a lower price level indicating a more outward economy[10].

Comparisons of price dispersion with price-based openness measures also suggest that for middle income countries, economies with more relative price dispersion have *lower* price levels. Two price-based measures of orientation were used: David Dollar's (1991) measure based on a sample of 95 developing countries over the period 1976-1985, and a measure drawn from a broader sample including developed economies from 1965-1985. Both measures, listed in Table 3.5, confirm the earlier result that interventionist middle income countries are also relatively more outward oriented. Again, low and high income countries show the opposite result; high intervention implies relative inward orientation.

Table 3.6 plots relative price dispersion against the ten year average of price overvaluation[11]. No clear pattern emerges. The table does help to clear up some anomalies; Both Sri Lanka and Peru have very low price levels, for example, causing them to be listed as outward oriented despite what is generally believed. The trade liberalization index shows them, however, to be highly interventionist, revealing them to have the highest measures of price dispersion among the middle income countries.

3.5.3 World Bank Measure of Outward Orientation

If outward orientation is not correlated for middle income countries with trade intervention as measured by relative price dispersion, then what is to be made of taxonomies of trade regime which combine these aspects into a single indicator? The 1987 World Development Report (pp. 82-83) argues for the removal of all trade barriers based on links between growth and their own measure of trade policy which have been questioned by other studies (Helleiner, 1990, Singer, 1988). This measure combines orientation with the degree of intervention categorizing countries by "trade orientation". Categories range from "strongly outward oriented", characterized by very low trade controls, to "strongly inward oriented", in which the incentive structure favors production for the domestic market.

Table 3.7 reveals no systematic relationship between what the Report calls outward orientation

[10] Such measures are subject to move with fluctuations in the nominal exchange rate caused by macroeconomic policies. Some attempt is made to dispel the measure of nominal exchange rate changes by averaging the measure over a period of several years (see Dollar, 1990)

[11] The average of the previous ten years is highly correlated with the value for 1980. Some countries had 1980 prices significantly higher or lower than their ten year averages (see Table 3.6).

and relative price dispersion; inward oriented countries show *lower* median dispersion than outward oriented countries. Korea, one of the only countries to earn the Bank's label "strongly outward oriented", has a higher level of dispersion than Argentina and the Dominican Republic, both "strongly inward oriented" countries. Perhaps unusually high price levels reflecting overvalued exchange rates in these two countries qualify them as inward oriented despite their relative lack of intervention; but Colombia, El Salvador and Pakistan, which are also classified as inward oriented, all have lower price dispersion than Korea and moderate price levels. Overall, "inward oriented" countries also have lower median price levels than "outward oriented" countries. Based on the WDR's orientation index alone, it seems that liberalization is not necessary to achieve outward orientation.

3.6 Comparisons of Relative Price Dispersion with Other Intervention Measures

Since it is now clear that outward orientation is not systematically correlated with intervention as measured by relative price dispersion, it is worth evaluating other measures of trade regime which might approximate trade intervention more closely.

3.6.1 Administrative Measures and Relative Price Dispersion

If average tariff measures and NTB coverage ratios characterized the effects of intervention, we might expect to see them correlated with relative price dispersion in the traded sector. They're not[12]. The rank correlation between NTB coverage ratios and price dispersion is low (13% for middle income countries and 4% for low income countries; see Table 3.5), but at least it is positive. The same is not true for tariffs; high average tariffs are seen in countries having relatively low levels of price dispersion. This suggests that average tariff levels are a poor indicator of the effects of intervention. As Helleiner points out "moving towards neutrality (by reducing tariff)...is not evidently "liberal" if it is accompanied by increasing overall dispersion of incentives." (p.884)

3.6.2 Revealed Quantity Measures and Relative Price Dispersion

Leamer (1990) measures the absolute value of cross-country deviations in trade patterns from those predicted by factor endowments in a Hecksher-Ohlin model. Trade policy intervention is expected to result in large deviations. In the absence of price controls, large distortions in trade patterns will be accompanied by deviations in relative prices from world relative prices. The price dispersion measure was compared with three of Leamer's measures of intervention: deviations relative to GDP,

[12] Although these measures are collected by UNCTAD for the year 1985, some consistency in trade policy regime over time is expected for a majority of countries.

deviations relative to predicted trade, and the percentage of trade unexplained by differences in factor endowments (the r-squared measure).

None of the Leamer measures appear to be correlated with relative price dispersion (see Table 3.5). The second measure in particular is highly negatively correlated with measures of price dispersion within all income groups. The first measure, deviations relative to GDP, is only slightly positively correlated for low income countries. The r-squared measure is slightly positively correlated within the high income group, but significantly negatively correlated with intervention for the middle income group. The poor performance of these indices is not surprising; by Leamer's own admission, "the first criticism of the model is that it does not explain the trade of many countries very well."

3.7 Conclusion

The index of relative price dispersion developed here has the advantage that it is objective, that it measures intervention not just in imports but in exports as well, that it is comparable across countries, and is independent of exchange rate fluctuations caused by macroeconomic mismanagement. Unlike average tariffs, NTB measures, and price level measures, the relative price dispersion index measures incentive distortions *within* categories of goods. While the Leamer index looks directly at the effects of trade policy intervention, the theoretical assumptions required to calculate the pattern of trade in the absence of distortion are questionable. Such assumptions are unnecessary when calculating relative price dispersion, since world prices are directly observable.

Comparisons of relative price dispersion with commonly used outward orientation measures reveal that the relationship between "openness" and trade liberalization is more complicated than is often believed. Not only is it hazardous to characterize a inward oriented countries as interventionist and outward oriented countries as liberal, but the characterization is simply wrong for developing countries.

Whether a country intervenes does not tell the whole story about a country's trade policy, and misses an essential aspect of intervention: which goods are favored by subsidies and which are protected by tariffs. Indonesia and Peru, for example, have comparable measures of intervention, but the relative price of equipment is very high in Peru and very low in Indonesia; consumer nondurables appear to flow freely in Latin America, while prices for these goods in Japan and Korea are inexplicably high. Understanding differences in the growth experience of these countries clearly requires a more subtle view of trade policy than "outward" and "inward oriented", as well as a more informed understanding of the nature of intervention.

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Appendix

3.7.1 Equilibrium Trade Policy Model

Common measures of outward orientation include the share of trade in GDP and the price level[13]; if a country has a low price level or a high trade share, it is considered outward oriented. These measures of outward orientation are often used to assess a country's degree of trade policy intervention, with low measures of outward orientation indicating an interventionist regime and high measures indicating a liberal regime.

I will illustrate the relationship between outward orientation and trade intervention more carefully with an Australian general equilibrium model with three goods: imports, exports, and nontraded goods[14]. I will be concerned with intervention which raises the *average level* of the import tariff, export subsidy, or export tax. A high trade share and a low price level are consistent with trade policy intervention in long run equilibrium (i.e. domestic full employment and balanced trade) if intervention takes the form of import tariffs. The relationship breaks down if intervention in the export sector is allowed: with a tax on exports, a low price level is consistent with *high* intervention; if exports are subsidized, high intervention can result in a *low* trade share. If export intervention is allowed, price level measures also fail as measures of outward orientation; export subsidies can lead to a *high* price level while biasing trade toward exports.

Production

All three goods are produced by the domestic economy with fixed capital together with labor which is mobile across sectors but in fixed supply L^* for the economy. Import goods are both produced at home and imported from the world market. Export goods are both consumed domestically and exported abroad. Labor is allocated over the three sectors such that the value of its marginal product is equal in each sector

$$(1+s)\cdot MP_X(L_X) = (1+\epsilon)\cdot MP_M(L_M) = P_N \cdot MP_N(L_N) \tag{3.15}$$

where $MP_i(L_i)$ is the (diminishing) marginal product in sector i as a function of labor L_i (the subscript X denotes exportables, M importables, and N nontraded goods). Since I will not be considering terms of trade effects, the world price of importables is assumed to equal the world price of exportables, which is normalized to equal one. The domestic price of imports differs from the world price by the amount of the import tariff ϵ, and the domestic price of exportables differs from the world price by the amount of the export subsidy s. Production in each sector is determined

[13] Chenery, among others, uses trade share adjusted for structural cross-country differences; Dollar (1990) constructs an index of outward orientation based on the price level, also adjusted for cross-country structural differences.

[14] see Dornbusch (1981) for a complete discussion of the Australian model.

from equation 3.15 given the total labor supply L^*:

$$Q_i(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) \qquad i = (N, X, M) \tag{3.16}$$

such that

$$\begin{array}{ll} Q_{N1}(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) < 0 & Q_{N2}(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) < 0 \\ Q_{X1}(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) < 0 & Q_{X2}(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) > 0 \\ Q_{M1}(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) > 0 & Q_{M2}(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) < 0 \end{array} \tag{3.17}$$

where all goods are denominated in international currency.

Demand

Consumers value nontraded goods, importables, and exportables according to the Cobb-Douglas utility function

$$U = C_N^{\beta} C_X^{\gamma(1-\beta)} C_M^{(1-\gamma)(1-\beta)} \tag{3.18}$$

where C_i is consumption of good i. Consumer maximization gives the following demand functions:

$$\begin{aligned} P_N \cdot D_N &= \beta E \\ (1+s) \cdot D_X &= \gamma(1-\beta)E \\ (1+\epsilon) \cdot D_M &= (1-\gamma)(1-\beta)E \end{aligned} \tag{3.19}$$

where E is expenditure in dollars. From the demand functions given in equation 3.19 consumers choose their purchases such that expenditures remain constant for each good.

Domestic Market Equilibrium

The market for nontraded goods is always assumed to be in equilibrium (full employment is always obtained). The price of nontraded goods is determined by the interaction of supply (equation 3.16) and demand (equation 3.19) in the nontraded sector; the nontraded price is that which equilibrates demand at a given level of expenditure with supply, determined by the incentives to produce in the nontraded sector relative to the traded sectors. The domestic market equilibrium condition is given by

$$D_N = Q_N(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) \tag{3.20}$$

Substituting nontraded demand (equation 3.19) into equation 3.20 gives

$$P_N \cdot Q_N(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) = \beta E \tag{3.21}$$

Equation 3.21 implicitly defines the expenditure and nontraded price combinations for a given level of trade intervention (ϵ and s). The characteristics of this schedule are derived using the implicit function theorem

$$\frac{\delta P_N}{\delta E} = \frac{\beta}{Q_N - (\frac{1+\epsilon}{P_N})Q_{N1} - (\frac{1+s}{P_N})Q_{N2}} \qquad > 0 \tag{3.22}$$

$$\frac{\delta P_N}{\delta(1+\epsilon)} \cdot (\frac{1+\epsilon}{P_N}) = \frac{(\frac{1+\epsilon}{P_N})Q_{N1}}{(\frac{1+\epsilon}{P_N})Q_{N1} + (\frac{1+s}{P_N})Q_{N2} - Q_N} \qquad > 0 \qquad < 1 \tag{3.23}$$

$$\frac{\delta P_N}{\delta(1+s)} \cdot (\frac{1+s}{P_N}) = \frac{(\frac{1+s}{P_N})Q_{N2}}{(\frac{1+s}{P_N})Q_{N2} + (\frac{1+\epsilon}{P_N})Q_{N1} - Q_N} \qquad > 0 \qquad < 1 \tag{3.24}$$

An increase in the import tariff or an increase in export subsidy shifts the schedule upwards but by less than the amount of the change in the policy measure (equations 3.23 and 3.24). An increase in the tariff or subsidy results in excess demand for nontraded goods, as production is diverted towards the traded sector. The nontraded price increases to ration the excess demand, but the necessary price increase is less than the increase in the tariff; since the increase in the nontraded price lowers the quantity of nontraded goods demanded, less of a supply response is required to equilibrate the domestic market.

Trade Balance

Trade is assumed to balance in the long run. Trade balance is achieved when the world value of exports equals the world value of excess demand for imports

$$Q_X(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) - D_X = D_M - Q_M(\frac{1+\epsilon}{P_N}, \frac{1+s}{P_N}) \tag{3.25}$$

Substituting the demand functions from equation 3.19 into equation 3.25 gives

$$Q_X - \frac{\gamma(1-\beta)}{1+s}E = \frac{(1-\gamma)(1-\beta)}{1+\epsilon}E - Q_M \tag{3.26}$$

Equation 3.26 gives the schedule of nontraded price-expenditure combinations which achieve trade balance comparable to equation 3.21 for the domestic market. The properties of this schedule are derived using the implicit function theorem

$$\frac{\delta P_N}{\delta E} = -\frac{\frac{\gamma(1-\beta)}{1+s} + \frac{(1-\gamma)(1-\beta)}{1+\epsilon}}{(\frac{1+\epsilon}{P_N^2})(Q_{X1} + Q_{M1}) + (\frac{1+s}{P_N^2})(Q_{X2} + Q_{M2})} \qquad < 0 \tag{3.27}$$

$$\frac{\delta P_N}{\delta(1+\epsilon)}\cdot(\frac{1+\epsilon}{P_N}) = \frac{(\frac{1+\epsilon}{P_N^2})(Q_{X1}+Q_{M1})}{(\frac{1+\epsilon}{P_N^2})(Q_{X1}+Q_{M1})+(\frac{1+s}{P_N^2})(Q_{X2}+Q_{M2})} \quad > 0 \quad < 1 \tag{3.28}$$

$$\frac{\delta P_N}{\delta(1+s)}\cdot(\frac{1+s}{P_N}) = \frac{(\frac{1+s}{P_N^2})(Q_{X2}+Q_{M2})}{(\frac{1+\epsilon}{P_N^2})(Q_{X1}+Q_{M1})+(\frac{1+s}{P_N^2})(Q_{X2}+Q_{M2})} \quad > 0 \quad < 1 \tag{3.29}$$

By equation 3.27 the trade balance schedule slopes downward; an increase in expenditures reduces the trade balance by raising the demand for imports while lowering the supply of exports. The nontraded price must fall to shift demand away from tradables and supply toward tradables.

An increase in ϵ or s shifts the trade balance schedule up (equations 3.28 and 3.29); a tariff induced increase in the price of importables increases production of importables while decreasing demand, causing a trade surplus. Trade is balanced with an increase in the nontraded price, shifting production toward nontraded goods. The price increase simultaneously shifts demand away from nontraded goods towards imports, so the increase in the nontraded price required for trade balance is less than the increase in the tariff.

Equations 3.21 and 3.26 determine the unique nontraded price and expenditure level consistent with both domestic equilibrium and trade balance, shown in figure 2. An increase in ϵ or s leads to an increase in the price of nontraded goods consistent with long run equilibrium. If the real exchange rate is defined to be the world price of tradables (the expenditure weighted average of the price of importables and exportables) over the domestic price of nontradables, an increase in intervention in the form of an increase in ϵ or s leads to a *sustainable appreciation* of the exchange rate[15].

An increase in the import tariff or export subsidy also increases the equilibrium expenditure; the upward shift in the trade balance curve exceeds the shift in the domestic equilibrium curve. Demonstrating this requires deriving the relationship between price responses of output of the three goods from the following labor demand conditions

$$\frac{dL_X}{d\epsilon} = -(\frac{dL_N}{d\epsilon}+\frac{dL_M}{d\epsilon}) \tag{3.30}$$

$$\frac{dL_X}{ds} = -(\frac{dL_N}{ds}+\frac{dL_M}{ds})$$

Combine equations 3.30 and 3.15 with the condition that the derivative of the supply of good i with respect to policy measure j is given by $Q_{ij} = MP_i \cdot \frac{dL_i}{dp_j}$, to get the following relationships between output responses to changes in policy measures (let s and ϵ be zero initially)

$$Q_{X1} = -(P_N Q_{N1} + Q_{M1}) \tag{3.31}$$

$$Q_{X2} = -(P_N Q_{N2} + Q_{M2})$$

[15]An alternate definition of the real exchange rate is the *domestic* price of tradables over the nontraded price. The two definitions are identical if there are no trade barriers.

Substituting equation 3.31 into the trade balance conditions (equations 3.28 and 3.29) gives

$$\frac{\delta P_N}{\delta(1+\epsilon)} \cdot (\frac{1+\epsilon}{P_N}) = \frac{(\frac{1+\epsilon}{P_N})Q_{N1}}{(\frac{1+\epsilon}{P_N})Q_{N1} + (\frac{1+s}{P_N})Q_{N2}} \tag{3.32}$$

$$\frac{\delta P_N}{\delta(1+s)} \cdot (\frac{1+s}{P_N}) = \frac{(\frac{1+s}{P_N})Q_{N2}}{(\frac{1+s}{P_N})Q_{N2} + (\frac{1+\epsilon}{P_N})Q_{N1}} \tag{3.33}$$

The shift in the trade balance schedule with a shift in trade policy in equations 3.32 and 3.33 are larger than the shift in the domestic equilibrium schedule (equations 3.23 and 3.24). In fact, the change in expenditure with respect to policy measure p_i can be shown to be

$$\frac{dE}{dp_i} = Q_N \frac{dP_N}{dp_i} \tag{3.34}$$

The larger shift implies expenditure must increase in equilibrium in response to an increase in the import tariff or export subsidy.

3.7.2 Trade Policy Intervention and Outward Orientation

The model can be used to predict the impact of various forms of trade policy intervention on two standard measures of outward orientation: the trade as a share of total output, and the price level. A low trade share or a high price level are interpreted as indications of inward orientation.

Share of Trade in GDP

Equation 3.25 gives the trade balance condition for the economy. since exports equal imports in trade balance and output equals expenditures, the share of trade in output will move identically with the ratio of exports (or imports) to expenditures, defined below

$$T = \frac{Q_X - D_X}{E} \tag{3.35}$$

Combining equation 3.35 with demand in equation 3.19 gives

$$T = \frac{Q_X}{E} - \frac{\gamma(1-\beta)}{1+s} \tag{3.36}$$

Trade policy intervention will be correlated with outward orientation if (in the absence of export measures) increasing the import tariff ϵ lowers the trade share. The change in T with a change in the import tariff is found by differentiating equation 3.36 with respect to ϵ

$$\frac{dT}{d\epsilon} = \frac{dQ_X}{d\epsilon}\frac{1}{E} - \frac{dE}{d\epsilon}\frac{Q_X}{E^2} \tag{3.37}$$

Changes in ϵ affect Q_X in two ways: the direct effect of increases in ϵ on output in the export sector, and the indirect effect of changes in ϵ on the equilibrium price of nontraded goods. The net effect is given in equation 3.38

$$\frac{dQ_X}{d\epsilon} = \frac{1}{P_N}((1-\eta_\epsilon)Q_{X1} - \eta_\epsilon \frac{s}{\epsilon} Q_{X2}) \qquad < 0 \tag{3.38}$$

where η_ϵ is derived from equations 3.23 and 3.28

$$\eta_\epsilon = \frac{dP_N}{d\epsilon} \cdot (\frac{\epsilon}{P_N}) \qquad > 0 \quad < 1 \tag{3.39}$$

Since $\frac{dE}{d\epsilon}$ is positive by the argument in section 3.7.1, the derivative $\frac{dT}{d\epsilon}$ is negative, and trade intervention results in a lower trade share and inward orientation.

By changing relative prices between the three goods, import restrictions bias production away from exportables and towards importables; the bias hurts exports, which sell at the same world price, by increasing the price export producers pay for their factor of production. Export production declines while import production increases. With a steady demand for exportables and importables, the result is a decline in trade.

The link between policy intervention and low trade share does not hold when intervention is allowed to take the form of an export subsidy. Differentiating the export share of expenditures with respect to the subsidy s gives

$$\frac{dT}{ds} = \frac{dQ_X}{ds}(\frac{1}{E}) - \frac{dE}{ds}(\frac{Q_X}{E^2}) \tag{3.40}$$

The first term in equation 3.40 expands to

$$\frac{dQ_X}{ds}(\frac{1}{E}) = (\frac{1}{E})((1-\eta_s)\frac{Q_{X2}}{P_N} - \frac{\epsilon}{s}\eta_s \frac{Q_{X1}}{P_N}) \qquad > 0 \tag{3.41}$$

where η_s, comparable to η_ϵ given in equation 3.39, is greater than zero and less than one.

Since $\frac{dE}{ds} = \frac{P_N}{s}\eta_s Q_N$ from equation 3.34, the second term in equation 3.40 can be expressed

$$\frac{dE}{ds}(\frac{Q_X}{E^2}) = \frac{1}{E}(\frac{\beta\eta_s}{s}Q_X) \tag{3.42}$$

Restating the first and second terms, equation 3.40 simplifies to

$$\frac{dT}{ds} = (\frac{Q_X}{sE})(\frac{dQ_X}{ds} \cdot \frac{s}{Q_X} - \beta\eta_s) \tag{3.43}$$

Equation 3.43 shows that the trade share can *increase* with trade intervention in the export sector, provided the net elasticity of the export supply in response to the subsidy exceeds $\beta\eta_s$, a number between zero and one.

Price Level

Price level is often used as a measure of outward orientation, where a high price level indicates an inward oriented economy (Dollar, 1990). The model clarifies the link between trade policy intervention and outward orientation in an economy in long run equilibrium. The price level increases with intervention and outward orientation if intervention takes place in the import sector. If intervention in exports are allowed, the price level fails both as a measure of intervention and as a measure of outward orientation; the price level can decline, for example, in response to an export tax which biases trade against exports.

A price index for the economy is derived from the utility function in equation 3.18 to be

$$P = P_N^{\beta}(1+s)^{\gamma(1-\beta)}(1+\epsilon)^{(1-\gamma)(1-\beta)} \tag{3.44}$$

The change in the price level with a change in the import tariff is

$$\frac{dP}{d(1+\epsilon)} \cdot (\frac{P_N}{1+\epsilon}) = \beta\eta_\epsilon + (1-\gamma)(1-\beta) \qquad > 0 \tag{3.45}$$

Equation 3.45 indicates that trade policy intervention in the form of import tariffs causes the price level to increase in long run equilibrium. The tariff increases import prices both directly and indirectly by increasing nontraded goods prices, the indirect effect in response to the supply shortage in the nontraded goods sector caused by increased production of importables. With import tariffs alone, a high price level indicates intervention and inward orientation.

The link between intervention and a high price level is broken if intervention takes the form of an export tax; a decline in the export subsidy will lead to a decrease in the nontraded goods price as well as a decrease in the price of exports. This low price level is sustainable in long run equilibrium with balanced trade and domestic equilibrium. The change in the price level with a change in the export tax is

$$\frac{dP}{d(1+s)} \cdot (\frac{P_N}{1+s}) = \beta\eta_s + \gamma(1-\beta) \qquad > 0 \tag{3.46}$$

A positive derivative indicates an increase in the export tax (a decrease in s) will cause a decline in the price level which is consistent with long run equilibrium.

Not only does the fall in the price level fail to capture intervention, but the fall coexists with a decline in the incentives to export relative to import substitute; the import price is stationary relative to a fall in the export price which exceeds the fall in the price of nontraded goods (η_s is less then one). Both the import price The price level in this case fails to reliably measure either trade policy intervention or outward orientation.

In the absence of export subsides or taxes, the model justifies the use of trade share and price level as measures of both outward orientation (the incentive to produce for export relative to producing import substitutes) as well as measures of trade policy intervention. Intervention taking the form of import restrictions will bias production against exports, reduce trade as a share of income, and increase the price level.

The model's predictions of the impact of import restrictions differ if intervention causes export prices to deviate from world prices. An export subsidy can raise the share of trade to GDP, even in long run equilibrium; the subsidy could be large enough to offset the impact of a tariff on the trade share, causing a country to be considered outward oriented while maintaining a high level of intervention. An export tax can be used to offset the impact of an import tariff on the price level, both by decreasing the price of exportables directly, and by lowering the nontraded goods price by increasing the excess supply of goods in the nontraded sector. If price level were used to measure trade policy, a country with an export tax having a low price level would be wrongly considered liberal and outward oriented.

Table 3.1: Traded Goods Categories and World Expenditure Shares

Consumer Goods: Good	Share	Capital Goods: Good	Share
Food	0.30	Transportation	0.04
Tobacco & Beverage	0.07	Machines	0.08
Clothing	0.10	Agr. Machines	0.01
Fuel	0.03	Elec. Equipment	0.04
Household	0.06		
Appliance	0.01		
Medical	0.02		
Auto	0.04		
Auto Parts	0.05		
Recreate - Durable	0.03		
Recreate - Nondur	0.02		
Government	0.09		
Other	0.01		

Table 3.2: Explaining Differences in Relative Prices Across Countries

$$\rho_{ij} = A_i + \beta_1 rent\_\hat{p}_j + \beta_2 service\_\hat{p}_j + \beta_3 \log urban_j + \beta_4 \log density_j + \beta_5 ex\_rate_j + \eta_{ij}$$

ρ_{ij} is the log price of traded good i in country j relative to the expenditure weighted sum of all traded prices in country j, minus the same relative price of good i in the United States.

Good	Coefficient on the Independent Variable					r-squared
	$service\_\hat{p}_j$	$rent\_\hat{p}_j$	$\log density_j$	$\log urban_j$	ex_rate_j	
Food	0.31	-0.20	0.006	0.037	0.34	0.41
	(2.1)	(1.1)	(0.4)	(0.6)	(2.0)	
Tobacco & Beverage	-0.075	0.112	0.008	-0.182	0.16	0.17
	(0.2)	(0.3)	(0.3)	(1.5)	(0.4)	
Clothing	0.72	-0.28	-0.08	-0.04	-0.07	0.43
	(3.0)	(0.9)	(3.0)	(0.3)	(0.2)	
Fuel	0.70	-0.50	0.106	0.047	0.007	0.16
	(1.0)	(0.6)	(1.4)	(0.2)	(0.0)	
Household	0.56	-0.14	0.006	-0.200	0.52	0.16
	(1.8)	(0.4)	(0.2)	(1.5)	(1.4)	
Appliance	-0.31	0.54	0.077	-0.218	-0.29	0.24
	(0.8)	(1.2)	(1.9)	(1.3)	(0.7)	
Autos	-1.04	2.08	0.034	-0.003	-0.20	0.32
	(2.1)	(3.2)	(0.7)	(0.0)	(0.4)	
Auto Parts	-0.644	0.934	0.049	0.153	-0.408	0.16
	(2.0)	(2.3)	(1.4)	(1.1)	(1.1)	
Recreate-Durable	-0.50	0.030	-0.074	0.147	-0.190	0.19
	(1.4)	(0.1)	(1.9)	(0.9)	(1.4)	
Recreate-Nondur	0.441	-0.224	-0.078	-0.087	0.62	0.14
	(1.2)	(0.5)	(1.9)	(0.5)	(1.4)	
Other	-0.517	1.08	-0.021	0.087	0.071	0.19
	(1.7)	(2.8)	(0.7)	(0.7)	(0.2)	
Government	0.271	-0.047	-0.012	0.066	-0.018	0.31
	(1.5)	(0.2)	(0.6)	(0.9)	(0.1)	
Transportation	-0.598	-0.528	-0.054	0.086	-0.85	0.40
	(1.6)	(1.2)	(1.4)	(0.6)	(2.0)	
Machines	-0.137	-0.927	-0.014	0.095	-0.216	0.48
	(0.6)	(3.3)	(0.6)	(1.0)	(0.8)	
Agricult. Mach.	-0.215	-0.350	-0.162	-0.152	-1.00	0.40
	(0.6)	(0.6)	(3.5)	(0.8)	(2.0)	
Elec. Equipment	-0.953	0.192	0.023	0.286	-0.905	0.28
	(2.7)	(0.4)	(0.6)	(1.9)	(1.8)	

t-statistics in parentheses

Coefficients from estimation on the *restricted* sample

Table 3.3: Relative Price Dispersion Within Income Categories

$$V_j = \sum_i \alpha_{ij} \hat{\eta}_{ij}^2$$

Low		Medium Low		Medium High		High	
	Middle Income Countries						
Panama	0.037	Korea	0.050	Guatemala	0.061	Sri Lanka	0.102
Argentina	0.036	Greece	0.046	Peru	0.060	Bolivia	0.086
Paraguay	0.033	Colombia	0.042	Chile	0.056	Portugal	0.083
Dominican Rep.	0.032	El Salvador	0.042	Brazil	0.055	Indonesia	0.080
Costa Rica	0.030	Ireland	0.039	Ecuador	0.053	Honduras	0.075
Pakistan	0.025	Venezuela	0.037	Philippines	0.052	Uruguay	0.061
		Morocco*	0.016	Tunisia*	0.070	Botswana*	0.125
	Upper Income Countries						
Belgium	0.016	Norway	0.022	Finland	0.044	Japan	0.140
France	0.013	Luxembourg	0.020	Canada	0.036	Israel	0.112
Italy	0.012	Germany	0.019	United Kingdom	0.032	Spain	0.055
Austria	0.005	Netherlands	0.017	Denmark	0.027		
	Lower Income Countries*						
Mali	0.025	Senegal	0.032	Cameroon	0.054	Nigeria	0.095
Kenya	0.021	Zimbabwe	0.029	Ethiopia	0.050	Zambia	0.079
Madagascar	0.018	Ivory Coast	0.029	Malawi	0.038	India	0.067
						Tanzania	0.064

Intensities of price dispersion are defined *within* each income category. Numbers represent the variance of relative price dispersion from predicted.
Based on index estimated over unrestricted sample.

Table 3.4: Relative Equipment Prices and Relative Price Dispersion Within Income Categories

Values are deviations from predicted equipment price

Relative Equipment Price	Relative Price Dispersion: Low		Medium		High	
	Middle Income Countries					
Low	Pakistan	-0.006	Greece	-0.021	Bolivia	-0.007
	Ireland	-0.009	Korea	-0.053	Honduras	-0.019
	Botswana*	-0.118			Portugal	-0.022
					Indonesia	-0.025
Medium	Costa Rica	0.007	Brazil	0.010	Uruguay	-0.005
	Panama	-0.002	El Salvador	0.001		
	Paraguay	-0.003	Philippines	-0.004		
	Venezuela	-0.004	Tunisia*	-0.001		
			Morocco*	0.005		
High	Argentina	0.025	Colombia	0.032	Sri Lanka	0.053
	Dominican Rep.	0.023	Chile	0.030	Peru	0.022
			Ecuador	0.016	Guatemala	0.020
	Upper Income Countries					
Low			Norway	-0.024	Finland	-0.024
			Denmark	-0.030	Israel	-0.035
					Japan	-0.048
Medium	Italy	0.009	Luxembourg	0.014	United Kingdom	0.008
	Austria	0.008			Canada	-0.021
High	France	0.021	Netherlands	0.028	Spain	0.015
	Belgium	0.017	Germany	0.014		
	Lower Income Countries*					
Low	Zimbabwe	-0.022			Tanzania	-0.029
					Nigeria	-0.033
					Zambia	-0.060
Medium	Kenya	-0.009	Cameroon	0.008		
			Ivory Coast	0.007		
			Ethiopia	-0.000		
			Malawi	-0.005		
High	Mali	0.040	Senegal	0.012	India	0.011
	Madagascar	0.032				

equipment price distortions defined *within* income categories

* Based on estimation over the unrestricted sample

Table 3.5: Rank Correlations between Relative Price Dispersion and Common Measures of Trade Regime

		Income Category		
Measure		Middle	High	Low
Openness Measures*	Trade Share	18	-7	-20
	Adjusted Trade Share	37	-28	-9
	Leamer Openness	-24	-14	-
Intervention Measures	Average Tariff	-43	-	-3
	NTB Coverage	13	-	4
	Dollar (1990) Measure	-17	56	39
	Price Level	-24	-10	13
	Leamer (GDP)	-1	6	-
	Leamer (Trade Share)	-60	-33	-
	Leamer (R-squared)	-40	12	-

* A negative relationship indicates high price dispersion is associated with low trade share

Table 3.6: Price Level (Adjusted Ten Year Average) and Relative Price Dispersion Within Income Categories
see equation 3.4 and Dollar (1990) for a description of adjustment

Middle Income Countries

	Relative Price Dispersion		
Price Level	Low	Medium	High
Low	Pakistan	Philippians Ecuador Chile Colombia	Uruguay^{21} Peru^{-17} Sri Lanka^{-19}
Medium	Costa Rica Paraguay Argentina^{49}	Brazil^{-14} El Salvador	Indonesia Guatemala Bolivia
High	Ireland^{12} Venezuela Dominican Rep.$^{-10}$ Panama	Greece Korea	Honduras^{-11} Portugal

Upper Income Countries

Low			United Kingdom^{17} Israel Canada^{-18} Spain
Medium	Austria France Italy	Norway Luxembourg	
High	Belgium	Denmark Germany Netherlands	Japan Finland

Lower Income Countries

Low	Mali^{22} Madagascar	Malawi Ethiopia^{-26}	India
Medium	Kenya Zimbabwe	Zambia Senegal	Tanzania
High	Ivory Coast	Cameroon	Nigeria^{18}

The percent deviation of 1980 price level from the ten year average is given in the superscript

Table 3.7: World Bank (1987) Measure of Trade Orientation and Relative Price Dispersion Within Income Categories

	Relative Price Dispersion		
World Bank Measure	Low	Medium	High
Outward Oriented		Korea*	
Moderately Outward Oriented		Brazil Chile△ Uruguay	Israel
Moderately Inward Oriented	Colombia△ Costa Rica* El Salvador Pakistan	Guatemala Philippians	Honduras* Indonesia Sri Lanka△
Inward Oriented	Argentina*△ Dominican*△	Peru△	Bolivia

* indicates high average price level

△ indicates high relative equipment prices

Table 3.8: Relative Price Dispersion Estimates for the Restricted Sample

$$V_j = \sum_i \alpha_{ij} \hat{\eta}_{ij}^2$$

Rank	Country	Dispersion
1	Austria	0.00495
2	Italy	0.0118
3	France	0.01340
4	Belgium	0.01640
5	Netherlands	0.01684
6	Germany	0.01893
7	Luxembourg	0.01971
8	Norway	0.02178
9	Pakistan	0.02507
10	Denmark	0.0271
11	Costa Rica	0.0296
12	United Kingdom	0.0319
13	Dominican Republic	0.0323
14	Paraguay	0.03247
15	Argentina	0.03582
16	Canada	0.03584
17	Panama	0.03724
18	Venezuela	0.03735
19	Ireland	0.03857
20	El Salvador	0.04157
21	Colombia	0.04182
22	Finland	0.04390
23	Greece	0.0460
24	Korea	0.04961
25	Philippines	0.0521
26	Ecuador	0.05301
27	Brazil	0.05458
28	Spain	0.05538
29	Chile	0.05552
30	Peru	0.06002
31	Guatemala	0.06058
32	Uruguay	0.06078
33	Honduras	0.07488
34	Indonesia	0.07968
35	Portugal	0.08282
36	Bolivia	0.08637
37	Sri Lanka	0.1021
38	Israel	0.1118
39	Japan	0.1368

Table 3.9: Relative Price Dispersion Estimates for the Unrestricted Sample

$$V_j = \sum_i \alpha_{ij} \hat{\eta}_{ij}^2$$

Rank	Country	Dispersion	Rank	Country	Dispersion
1	Austria	0.00587	39	Philippines	0.06380
2	Belgium	0.01027	40	Portugal	0.06544
3	Italy	0.01035	41	Tanzania	0.06579
4	France	0.01073	42	Chile	0.06652
5	Netherlands	0.01530	43	India	0.06701
6	Morocco	0.01637	44	Tunisia	0.07040
7	Germany	0.01667	45	Peru	0.07475
8	Luxembourg	0.01686	46	Zambia	0.07854
9	Madagascar	0.01843	47	Guatemala	0.08147
10	Kenya	0.02111	48	Indonesia	0.08371
11	Norway	0.02163	49	Nigeria	0.09466
12	Pakistan	0.02200	50	Israel	0.09659
13	Mali	0.02504	51	Venezuela	0.1050
14	Ivory Coast	0.02863	52	Japan	0.11737
15	Canada	0.02871	53	Bolivia	0.12348
16	Zimbabwe	0.02882	54	Botswana	0.12463
17	United Kingdom	0.03006	55	Sri Lanka	0.17082
18	Senegal	0.03169			
19	Dominican Rep	0.03210			
20	Denmark	0.03287			
21	Uruguay	0.03465			
22	Panama	0.03631			
23	Costa Rica	0.03746			
24	Malawi	0.03784			
25	Finland	0.03891			
26	El Salvador	0.04023			
27	Paraguay	0.04184			
28	Argentina	0.04244			
29	Spain	0.04320			
30	Ireland	0.04324			
31	Greece	0.04757			
32	Ethiopia	0.05030			
33	Ecuador	0.05194			
34	Brazil	0.05389			
35	Cameroon	0.05406			
36	Colombia	0.06131			
37	Korea	0.06195			
38	Honduras	0.06266			

Table 3.10: Equipment Price Distortion Estimates

Rank	Country	Distortion	Rank	Country	Distortion
1	Botswana	-0.11770	40	Luxembourg	0.01400
2	Zambia	-0.06031	41	Germany	0.01435
3	Korea	-0.05260	42	Spain	0.01503
4	Japan	-0.04826	43	Ecuador	0.01621
5	Israel	-0.03521	44	Belgium	0.01723
6	Nigeria	-0.03335	45	Guatemala	0.01972
7	Denmark	-0.0296	46	France	0.02109
8	Tanzania	-0.02890	47	Peru	0.02234
9	Indonesia	-0.02511	48	Dominican Rep	0.02275
10	Finland	-0.02382	49	Argentina	0.02492
11	Norway	-0.02382	50	Netherlands	0.02754
12	Portugal	-0.02227	51	Chile	0.02951
13	Zimbabwe	-0.02178	52	Colombia	0.0320
14	Canada	-0.02144	53	Madagascar	0.03203
15	Greece	-0.02139	54	Mali	0.04006
16	Honduras	-0.01867	55	Sri Lanka	00.05301
17	Ireland	-0.00937			
18	Kenya	-0.00888			
19	Bolivia	-0.0069			
20	Pakistan	-0.0057			
21	Malawi	-0.00529			
22	Uruguay	-0.00525			
23	Philippines	-0.00440			
24	Venezuela	-0.00368			
25	Paraguay	-0.00321			
26	Panama	-0.00219			
27	Tunisia	-0.00102			
28	Ethiopia	-0.00074			
29	El Salvador	0.00185			
30	Morocco	0.00499			
31	Ivory Coast	0.00650			
32	Costa Rica	0.00715			
33	United Kingdom	0.00752			
34	Cameroon	0.00763			
35	Austria	0.00832			
36	Italy	0.00904			
37	Brazil	0.01019			
38	India	0.01064			
39	Senegal	0.01171			