Essays on International Trade and Plant Behavior

by
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ABSTRACT

CHARLES B. BRAYMEN: Essays on International Trade and Plant Behavior
(Under the direction of Patrick J. Conway)

This work investigates the influences of international trade on plant-level behavior. While the traditional trade literature has focused on inter-industry reallocations driven by increased international economic relationships, the more recent availability of plant-level data has provided an opportunity to investigate the intra-industry reallocations that occur due to this foreign exposure. I examine the impact of international trade using plant-level data from the Chilean manufacturing sector during the years 1979-1996.

I develop a theoretical methodology to examine the joint role of trade liberalization and macroeconomic shocks on manufacturing plant behavior. An econometrically calibrated simulation of plant behavior is embedded into a computable general equilibrium model to reconsider the impact of trade liberalization on the Chilean manufacturing sector. I find that, once the other macroeconomic influences are addressed, the impact of the trade liberalization on manufacturing plants was relatively minor. However, I also find that real exchange rate effects and the surplus of labor played a role in the sector's growth.

I also examine the influence of international trade on plant-level behavior by creating quantified measure of output from each plant's materials usage, which is then used to estimate a production function in capital and labor. This allows a productivity term to be created that measures a plant's ability to create physical output from capital and labor. This productivity measure is used to provide evidence that foreign competition, in the form of both import penetration and pricing pressure, promotes short-term efficiency gains at the plant level.

The relationship between exports, capital investment, and economic growth is also investigated. Empirical results indicate that plant-level export status positively influences a plant's investment behavior. The evidence concurs with previous findings that exporting behavior is

closely linked to past establishment-level export status. These results support the notion that entrants to the export market face a substantial obstacle. However once this initial hurdle is overcome, manufacturing plants not only maintain their export orientation, but also expand their capital stocks and output at greater rates than their non-exporting counterparts

To my grandparents.

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Chapter 1

Introduction

The influence of international trade on plant-level behavior has been a prominent topic in the recent trade literature. While the traditional trade literature has focused on inter-industry reallocations driven by increased international economic relationships, the more recent availability of plant-level data has provided an opportunity to investigate the intra-industry reallocations that occur due to this foreign exposure. This work is composed of three self-contained essays that investigate the manner in which international trade impacts the behavior of plants within the Chilean manufacturing sector during the years 1979-1996. While methodological approach of each essay differs, the general theme of trade-induced influences on plant behavior remains consistent throughout the work.

In the first essay, I develop a theoretical methodology to examine the joint role of trade liberalization and macroeconomic shocks on manufacturing plant behavior. An econometrically calibrated simulation of plant behavior is embedded into a computable general equilibrium model to reconsider the impact of trade liberalization on the Chilean manufacturing sector. The methodology developed permits an examination of the industrial evolution of the manufacturing sector while accounting for both the heterogeneous nature of the plants in the industry and the economy-wide, inter-sector reallocation of resources that is predicted by traditional trade theory. I find that, once the other macroeconomic influences are addressed, the impact of the trade liberalization on manufacturing plants was relatively minor; a one percent decline in aggregate revenue productivity (Melitz 2000) is attributed to the trade liberalization. To provide a further explanation of the manufacturing sector's growth, I conduct two additional simulations that address real exchange rate effects and excess labor supply. The results obtained from these alternative scenarios imply that the growth of the industry was driven by the depreciation of the real exchange rate in the mid-1980s and a surplus of labor stemming from the earlier recession.

The second essay investigates manufacturing productivity in the post-trade liberalization years of Chile, a period marked by a dramatic depreciation of the peso, a severe recession, and fluctuating, double-digit rates of inflation. In such an economic environment, it is likely that plant-specific price changes influence the estimation of plant-level productivity. An estimation method is developed that addresses the impact of plant-level price changes on the measurement of time- and plant-specific productivity. A measure of physical output is predicted from the plant's materials usage, while also accounting for the market structure in which the plant produces. This quantified measure of output is then used to estimate a production function in capital and labor, which allows a productivity term to be created that measures a plant's ability to create physical output. Regressions using this productivity measure provide evidence that foreign competition, in the form of both import penetration and pricing pressure, promotes short-term efficiency gains at the plant level.

The final essay examines the relationship between exports, capital investment, and economic growth. The results support the notion that entrants to the export market face a substantial obstacle. Further evidence concurs with previous findings that exporting behavior is closely linked to past establishment-level export status. These results support the notion that exporters face a substantial obstacle to begin exporting. However once this initial hurdle is overcome, manufacturing plants not only maintain their export orientation, but also expand their capital stocks and output at greater rates than their non-exporting counterparts. A series of policy simulations is conducted that examine exogenous export shocks. The results suggest that larger gains in the growth of capital and output occur when these shocks induce entrants into the export market.

Chapter 2

Trade Liberalization and Plant Behavior: An Analysis of Chile 1986-1996

2.1 Introduction

When trade liberalization is viewed in a general equilibrium context, long-run welfare gains occur through a more efficient allocation of economy-wide resources. This reallocation alters the environment in which manufacturing plants operate. Recent micro-level empirical studies address the effect of trade liberalization by examining the evolution of plant-level productivity in recently liberalized economies. However, shifts in trade policy are often a political response to turbulent macroeconomic conditions, which may also impact the behavior of plants. Thus, changes in plant behavior driven by other macroeconomic influences may be incorrectly attributed to the trade liberalization. In this paper I develop a theoretical methodology to examine the joint role of trade liberalization and macroeconomic shocks on plant behavior. I apply this methodology to reconsider the impact of trade liberalization on manufacturing plants in Chile. I find that the gradual reduction on the tariff had little impact on the evolution of the industry. To provide a further explanation of the manufacturing sector's growth, I conduct additional simulations that address the real exchange rate movements and excess labor supply. The results obtained from these alternative scenarios imply that the growth of the industry was driven by the depreciation of the real exchange rate in the mid-1980s and surplus of labor stemming from the earlier recession.

When the Socialist regime of Chile was overthrown by Augusto Pinochet in 1973, a process of deregulation and privatization began. The economy had been hurt by hyperinflation, which had reached 487.5 percent in 1972 and 605.9 percent in 1973. Further, extremely protectionist trade barriers existed; the average nominal tariff rate was over 105 percent. In 1975, nontariff trade barriers were abolished. By 1979, the tariff rate was lowered to a flat rate of ten percent. The trade liberalization came to a halt when the economy entered a deep recession 1982. During this recession the government imposed a series of increases of the across-the-board tariff rate, which reached 35 percent in 1984. Following the recession Chile began a period of economic expansion that continued through the mid-1990s. The tariff rate was gradually lowered to 11 percent during this recovery. Figure C.1 shows real GDP and inflation for Chile during the 1979 to 1996 time period. Plant behavior in the period following the recession is the primary topic of this paper.

Micro-data based studies of plant behavior typically take the approach of analyzing plant-level data during the period following a shift in trade policy. Most of this research supports the results of Melitz (2003), who examines the impact of trade liberalization on a distribution of heterogeneous plants. Melitz models the notion of a trade-induced reallocation of output. Plants of higher efficiency levels, who enter the export market despite a cost of entry, gain from the liberalization. However, less efficient plants lose both market share and profits, which creates a pressure that forces the plants of the lowest efficiency levels from the market. An examination of manufacturing productivity in Chile during this time period might lead to the conclusion that a reduction in tariffs created an increasingly competitive environment that produced productivity gains. Alternatively, the earlier recession may have induced a Schumpeterian cleansing of the least productive manufacturing plants. Liu and Tybout (1996) examine the manufacturing sector in Chile during the years 1979-1986 and find, on average, exiting plants are less productive than continuing plants. Likewise, Pavcnik's (2002) analysis using the same data provides evidence that plants with higher productivity levels gain market share over the period. Both of these studies analyze a time period following Chile's initial trade liberalization, and, therefore, support Melitz's notion of a trade induced reallocation. However, since this was also a period marked by a deep recession and a series of temporary tariff increases, it is likely that the 16 percent decline in GDP from 1981 to 1983 also played a role in plant exit and output reallocation during and after the recession. This paper examines productivity during the time period following the recession in a manner that addresses the impact of the macroeconomic environment.

Trade policy has also been examined using computable general equilibrium (CGE) models. Some are multi-country models that analyze multilateral trade policies, while other one-country models examine the impact of economy-wide or sector specific shifts in trade policy.[1] In the case of Chile, Harrison, Rutherford and Tarr (2002) examine potential regional trade agreements for Chile in a 11-region CGE model.[2] They find that Chile benefits from welfare gains from such agreements despite the fact that at least one trading partner experiences a welfare loss in all potential agreements. However, the impact of trade liberalization on heterogeneous individuals and firms is not specifically addressed, and, thus, no insight into the behavior of microeconomic agents achieved.

A related body of literature seeks to address macroeconomic effects on heterogeneous micro-agents by linking macro-oriented CGE outcomes to simulations based upon household data. By linking household data with CGE outcomes, these studies address the impact of economy-wide events such as trade liberalizations or exchange rate shocks on a distribution of households. Bourguignon, Branson, and de Melo (1989) develop a framework to analyze the impact of macroeconomic stabilization policies on the distribution of household income and wealth. Endogenously determined macroeconomic variables such as final goods and factor prices are passed to the microsimulation, where the equilibrium levels of income and wealth are determined. While the Bourguignon, Branson, and de Melo framework is calibrated on ad hoc parameters, further studies such as Ferreira, et al. (2003) and Robilliard, Bourguignon, and Robinson (2003) take similar approaches in their analyses of macroeconomic stabilization policies using parameters calibrated on macroeconomic and household data.

The macro-micro literature is not limited to examinations of macroeconomic stabilization

[1]See de Melo (1988) for a survey of the CGE literature. Francois and Reinert (1997) provide an accessible introduction to CGE modeling.

[2]Other CGE models of Chile include O'Ryan et al. (2003) and Rutherford and Tarr. (2003)

policies. King and Handa (2003) analyze the influence of a balance of payments liberalization on poverty in Jamaica. Similar approaches have been used to analyze the impact of trade liberalization on household income. Annabi, et al. (2005) analyze the effects of a potential trade liberalization by Senegal on the distribution of households. They find that despite long run gains by all households, the gains from trade liberalization are concentrated among urban and skilled workers. Likewise, Vos and de Jong (2003) show that despite the mild macroeconomic welfare gains from trade liberalization in Ecuador, the poverty reducing effect of trade liberalization is limited due to the increasing differentials between skilled and unskilled workers.

The household-based macro-micro literature illustrates an important concept: the impact of macro-based policies on a distribution of micro-agents can have consequences that are not necessarily apparent in analyses using higher levels of aggregation. Through the use of similar methodology applied to plant-level data, this paper develops a framework that will allow the influence of economy-wide events on plant-level outcomes to be examined. At the micro level, parameters of plant-level behavior are estimated from a manufacturing census. I then embed this plant-level behavior in a dynamic-sequential computable general equilibrium (DS-CGE) model that provides estimates of factor and goods prices and output levels. This structure is then used to examine alternative policy options in a manner that addresses both plant-level behavioral characteristics and economy-wide reallocation effects. More specifically, I simulate plant behavior under the premise that Chile maintained its 1986 tariff level throughout the entire time period. This experiment allows me to contrast plant behavior under the two trade policy options.

Section 2 of this paper presents the parameter estimation and simulation techniques that will be used in the analysis. This is followed in Section 3 by a description of the micro, sector, and macroeconomic data. Section 4 presents the results of both the parameter estimations and the simulations.

2.2 Methodology

The goal of the micro module is to simulate plant behavior. This simulation seeks to embody several types of behavior, including exit, factor use, and output. Several variations of trade-related dynamic macroeconomic models with heterogeneous firms have recently entered the literature. Betts and Kehoe (2001) develop a model with firms that possess heterogeneous costs of trade. Ghironi and Melitz (2004) develop a model with heterogeneous productivity and endogenous entry into the export market. Although both of these models relax the standard assumption of homogeneous firms, the analysis does not permit firm-level characteristics to drive plant-specific behavior. The simulation developed in this paper addresses heterogeneity with a different approach. Plant-specific characteristics are taken from a manufacturing census and these plants begin the simulation with these actual values of capital, labor, and productivity. Plant-level behavior is then simulated using the behavioral characteristics estimated from the data.

At the beginning of a time period a plant's productivity is updated using a randomly drawn productivity shock, which is estimated from the distribution of shocks in the data. The plant then updates its levels of skilled and unskilled labor, which is dependent upon changes in the plant's level of capital and the industry environment, which includes factor prices and industry growth. After choosing its levels of labor, the plant produces its output. At the end of the period, plants decide whether or not to continue production, which is a decision based upon each plant's own characteristics as well as the economic environment of the industry. The surviving plants invest in capital which becomes active in the next period. The following subsection describes the methods used to estimate and simulate plant behavior under the baseline and counterfactual policy scenarios.

2.2.1 The Production Function Estimation

The estimation of the production function follows Melitz (2000), which develops an econometric method to estimate production functions in industries with differentiated goods. It is assumed that plants produce symmetrically differentiated products within their own industry groups. A common elasticity of substitution, σ, between any two differentiated products exists. Demand is driven by a representative consumer with utility U at time t:

$$U_t\left(\left(\sum_{i=1}^{N_t}(\Lambda_{it}Q_{it})^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)},Z\right), \tag{2.1}$$

where $U(\cdot)$ is assumed to be differentiable and quasi-concave and Z represents a numeraire good. The representative consumer's valuation of plant i's product quality is Λ_{it}. A total of N_t plants exist in the domestic industry at time t. Each plant is assumed to produce one variety of the good.[3] Plant i's time t revenue is denoted by

$$R_{it} = P_{it}Q_{it}, \tag{2.2}$$

where P_{it} is the price charged by plant i for its physical units Q_{it}. A price index of goods, $\tilde{P}_t$, measures the aggregate changes in the price for a given industry. The total revenue for all plants in the industry at time t is $\tilde{R}_t = \sum_{i=1}^{N_t} R_{it}$.

From the representative consumer's maximization of (2.1), a plant-level price is derived as

$$P_{it} = \Lambda_{it}^{\left(\frac{\sigma-1}{\sigma}\right)}\tilde{P}_t^{\left(\frac{1+\sigma}{\sigma}\right)}\left(\frac{\tilde{R}_t}{N_t}\right)^{\frac{1}{\sigma}}\left(\frac{1}{Q_{it}}\right)^{\frac{1}{\sigma}}. \tag{2.3}$$

The above equation indicates the price the plant receives is a decreasing function of the plant's output, but also that the market structure and the consumer's perception of the plant's quality affect the price that the plant receives. This plant specific price will be combined with the plant's production function to create a revenue production function (Melitz 2000).

I assume that plants possess Cobb-Douglas technology in the production of their physical

[3] Melitz (2000) examines the case of multiple varieties per plant. However, the assumption of a constant number of varieties per plant is required.

output. Accordingly, plant i's time t production function is expressed as[4]

$$q_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \varphi_{it} + \varepsilon_{it}, \tag{2.4}$$

where q_{it}, l_{it}, and k_{it}, represent, respectively, value-added output, labor, and capital, all of which are in logs. Productivity is represented by φ_{it}. The final term, ε_{it}, is an unexpected productivity shock or measurement error.

In most manufacturing censuses, including the one examined in this paper, the measure of output is usually reported by plants as revenue, r_{it}, instead of physical output. Likewise, a plant specific price, p_{it}, is unknown. Revenue is typically deflated by the industry's price level to obtain a proxy measure of the plant's real output. If the goods produced in the industry are homogeneous, then this proxy measure is equivalent to the plant's physical output, and, therefore,

$$r_{it} - \tilde{p}_t = q_{it}, \tag{2.5}$$

where r_{it} is log revenue and $\tilde{p}_t$ indicates the log of the industry's price level at time t.[5] However, the plant-specific price likely varies within a given industry. Likewise, intertemporal changes in prices presumably vary between these plants. Viewing the previous production function, (2.4), in terms of log revenue, r_{it}, demonstrates the need to address plant level prices:

$$r_{it} - \tilde{p}_t = q_{it} + (p_{it} - \tilde{p}_t) \tag{2.6}$$

$$= \beta_l l_{it} + \beta_k k_{it} + \varphi_{it} + (p_{it} - \tilde{p}_t) + \varepsilon_{it}. \tag{2.7}$$

In the above equation, if a plant's price level changes at a rate greater than the industry's average, then using revenue deflated by the industry price index will overstate the plant's productivity growth. The following estimation method reinterprets productivity in a manner

[4]The estimations distinguish between skilled and unskilled labor. This distinction is excluded here for expositional ease.

[5]Alternatively, in a differentiated goods industry if the price received by all plants changes by an equal percentage, then deflated revenue would equate to a measure of the plant's physical output.

that combines a plant's physical productivity with the plant-specific changes in price.

The plant's production function can be rewritten by combining (2.6) and (2.3) to yield

$$r_{it} - \tilde{p}_t = \frac{\sigma - 1}{\sigma}(\beta_l l_{it} + \beta_k k_{it}) + \frac{1}{\sigma}[(\tilde{r}_t - \tilde{p}_t - n_t)] + \frac{\sigma - 1}{\sigma}(\varphi_{it} + \lambda_{it}) + \varepsilon_{it}. \qquad (2.8)$$

Although an estimation problem exists in separating the plant's physical productivity from its quality measure, these variables can be combined into Melitz's (2000) revenue productivity, $\omega_{it} = \varphi_{it} + \lambda_{it}$ (henceforth, productivity).

Several additional issues arise when estimating (2.8). First, productivity, ω_{it}, is not observed, but the plant has some knowledge of this productivity level as it chooses inputs and decides to continue production. As notes Pavcnik (2002), this information asymmetry leads to both a survival bias and selection bias in the estimation. More productive plants are more profitable and less inclined to exit the market. If a plant's profits are positively correlated with its capital stock, then a plant with a higher capital stock will be more likely to continue to production than would a plant with a similar productivity level, but a lower capital stock. The failure to account for the bias induced by plants exiting the market will lead to a downward bias on the coefficient on capital.

While the other variables in (2.8) are observed, productivity ω_{it} is unknown. I proxy for ω_{it} using the plant's time t investment in a manner similar to Olley and Pakes (1996), which assumes that investment is a monotonically increasing function of productivity, $i(\omega_{it}, k_{it})$. This nonparametric investment function can be inverted and substituted into (2.8) to yield

$$r_{it} - \tilde{p}_t = \frac{\sigma - 1}{\sigma}(\beta_l l_{it} + \beta_k k_{it}) + \frac{1}{\sigma}[(\tilde{r}_t - \tilde{p}_t - n_t)] + \frac{\sigma - 1}{\sigma}\omega_{it}(i_{it}, k_{it}) + \varepsilon_{it}. \qquad (2.9)$$

The nonparametric specification of productivity $\omega_{it}(i_{it}, k_{it})$ in (2.9) cannot be separated from the influence of capital on $r_{it} - \tilde{p}_t$. Thus, these variables must be combined as ϕ_{it} and estimated using a polynomial expansion in capital and investment as[6]

$$r_{it} - \tilde{p}_t = \frac{\sigma - 1}{\sigma}\beta_l l_{it} + \frac{1}{\sigma}[(\tilde{r}_t - \tilde{p}_t - n_t)] + \frac{\sigma - 1}{\sigma}\phi_{it}(i_{it}, k_{it}) + \varepsilon_{it}, \tag{2.10}$$

which identifies β_l, σ, and ϕ_{it}. However, an additional step is required to separate the influence of capital from productivity. Subtracting the influence of labor and mean revenue from deflated revenue yields

$$r^l_{it} = r_{it} - \tilde{p}_t - \frac{\hat{\sigma} - 1}{\hat{\sigma}}\hat{\beta}_l l_{it} - \frac{1}{\hat{\sigma}}[(\tilde{r}_t - \tilde{p}_t - n_t)]. \tag{2.11}$$

A final estimation is used to identify the coefficient on capital. To correct for survival bias, the $t-1$ expectation of productivity conditional on survival instead of the unconditional expectation is employed in a manner similar to Pavcnik (2002) and Olley and Pakes (1996). The coefficient on capital obtained by a nonlinear least squares estimation of

$$r^l_{it} = \frac{\hat{\sigma} - 1}{\hat{\sigma}}\hat{\beta}_k k_{it} + \frac{\hat{\sigma} - 1}{\hat{\sigma}}\sum_{j=0}^{3-m}\sum_{m=0}^{3}\beta_{jm}\hat{P}^j_{it-1}\hat{h}^m_{it-1} + \varepsilon_{it}, \tag{2.12}$$

where $\hat{h}_{it-1} = \hat{\phi}_{it-1} - \beta_k k_{it-1}$ and $\hat{P}_{it}$ is the time t probability of survival estimated as a probit on a series expansion of k_{it} and i_{it} interacted with time dummy variables and $\hat{\phi}_{it}$ is the estimated influence of the series expansion of capital and investment in (2.10).[7]

This section has described the estimation method used to obtain consistent estimates of the production function parameters. However, the production process is just one of many decisions made by each plant. The next section describes the estimation of parameters used to simulate other behaviors of each plant, such as exit, investment, and the use of labor.

[6]Since investment also varies with the economic environment, time dummies, similar to those employed by Pavcnik (2002) and Olley and Pakes (1996), are included in the polynomial expansion. Although the macro environment will be altered in the counterfactual simulation, the use of such dummies remains appropriate in the estimation process given the objective of obtaining consistent estimations on capital and labor.

[7]Investment in time $t-1$ is determined before the plant's time t productivity is known and, therefore, the use of the lagged series expansion is used to approximate the plant's expectation of time t productivity conditional upon its survival and $t-1$ productivity level, i.e. $E_{it}[\omega_{it+1}|\omega_{it}, \chi_{it} = 1]$. Thus, the series expansion in (2.12) represents a nonlinear approximation of this function by interacting survival probability into time t, $\hat{P}_{it-1}$ with the plant's time $t-1$ productivity level.

2.2.2 Additional Micro Estimations

Liu (1993) and Liu and Tybout(1996) find that exiting plants typically possess lower levels of productivity than continuing plants. The exit decision is not based solely on industry parameters such as goods and factor prices, but also on individual plant characteristics. To incorporate heterogeneous plant characteristics into the creation of a plant-level exit probability that will be used in the simulation. Denoting plant exit as

$$\chi_{it} = \begin{cases} 1 & \text{if the plant exits} \\ 0 & \text{otherwise} \end{cases},$$

a logit model defined by

$$\chi_{it}* = \gamma_0 + \gamma_\omega \omega_{it} + \gamma_k k_{it} + \gamma_w w_t + \gamma_u u_t^k + \varepsilon_{it}, \tag{2.13}$$

where ω_{it} represents the plant-level productivity calculated from the production function and

$$\chi_{it} = \begin{cases} 1 & \text{if } \chi_{it}* > 0 \\ 0 & \text{otherwise} \end{cases}.$$

The exit decision also takes into account the price of labor and capital relative to the price of output, w_t and u_t^k. The estimation of the above equation provides an econometric basis for the exit decision of each plant in the simulation, which is based on both the plant's current productivity and capital levels as well as factor prices.[8]

It is also necessary to update the levels of capital and labor for each plant. While the estimation of labor is typically estimated through first order conditions, such an approach does not fare well when predicting the plant-level labor due to the heterogeneous nature of the plants in the sample. Instead, labor is updated using estimates of log linear approximations

[8] Entry into the sample during the time period is limited by data constraints, which prevents entry from being included in the simulation. The next section provides descriptive statistics including exit and entry.

of a differenced first order condition[9]:

$$\Delta l_{it} = \varsigma_0 + \varsigma_k \Delta k_{it} + \varsigma_\omega \Delta \omega_{it} + \varsigma_w \Delta w_t + \varsigma_u \Delta u_t^k + \varsigma_g \Delta g_t^{mfg} + \varepsilon_{it}, \tag{2.14}$$

where g_t^{mfg} is growth in the industry's value-added output over the previous time period. While such a variable is simultaneously determined with the plant's labor decision and output during time t, the inclusion of growth in the updating equation here allows both intra-period labor decisions as well near-term expectations to be included in the simulation. [10]

Similar to the labor updating condition described above, each plant invests in capital. However, unlike labor, which becomes active immediately, the plant's investment becomes active in the next period according to $K_{t+1} = (1-\delta)K_t + I_t$ where δ indicates the time-invariant depreciation rate of capital and I_t is the plant's investment at time t. Parameters used in the simulation of plant investment are estimated from the following tobit regression

$$\bar{i^*} = \psi_0 + \psi_\omega \omega_{it} + \psi_u u_t^k + \psi_e e_t^r + \psi_\tau \tau_t + \varepsilon_t, \tag{2.15}$$

where

$$\bar{i}_{it} = \begin{cases} \bar{i^*} & \text{if } \bar{i^*} > 0 \\ 0 & \text{otherwise} \end{cases},$$

and $\bar{i}$ is real investment relative to the plant's total real capital, $\frac{I_{it}}{K_{it}}$, and u_t^k is the user cost of capital. Although they typically do not directly enter into a plant's first order conditions, the real exchange rate, e_t^r, and the tariff rate, τ_t, are included above to address foreign pressures. These additional variables are included as indirect influences that affect the plant's return on investment in capital. [11] More specifically, these variables may alter the current and future expectations of the price that a plant will receive for its output, thereby, increasing the return

[9] The change in skilled labor and unskilled labor are estimated separately.

[10] Given the differentiated market structure of the industry, some measure of output in the sector is needed in the the above equation.

[11] An alternative approach would be to address foreign pressures in an explicit manner similar to Conway (2007), which includes a foreign price in the the joint estimation of the revenue production and first order conditions.

on capital. The estimation of the investment provides the final set of micro parameters needed for the simulation. The simulation is described in the next subsection.

2.2.3 Microsimulation

The above regressions provide estimates of parameters that will be used in the simulation. The simulation first creates a sample of plants based on the data in 1986. The characteristics for each plant during this year represent the starting values for the simulation. These characteristics include the plant's capital, productivity, and labor. Let $\wp_{it}(k_{it}, \omega_{it}, l_{it})$ denote plant i's time t characteristics.

The first step in simulating plant behavior is to predict each plant's initial output level. This is accomplished using the plant's characteristics, $\wp_{it}(\cdot)$, along with the estimates of the production function parameters. Note from (2.9) that the plant's deflated revenue is dependent upon the mean deflated revenue of all plants in the industry. Thus, the mean of the industry's plant revenue, which includes each individual plant's revenue, must be calculated before an individual plant's revenue can be predicted. To enhance the linkages between the CGE and microsimulation, the mean revenue is calculated using the growth in manufacturing value-added from the CGE.

Following the simulation of the production process, plant exit is simulated. While Liu and Tybout (1996) show that exiting plants are, on average, less productive than plants that continue production, they also find that influence of a positive economic environment may allow less productive plants to continue production rather than be forced to exit. However, they note that over the long run, the relationship between productivity and exit is more substantial.

The simulation incorporates the stochastic nature of exit alongside the influence of the economic environment. The probability that a plant will exit in time t, P^x_{it}, is calculated from plant's own characteristics, such as productivity, as well as the industry's current environment, which is the set of the industry variables and estimated coefficients from the right-hand side of (2.13). For each plant a random draw from a uniform distribution, $x \sim U(0,1)$, is taken. The plant exits the industry if $x < P^x_{it}$. Exiting plants are removed from the sample of plants proceeding to the next year. This method of simulating plant exit embodies the stochastic properties of plant exit, while eliminating the short-run truncation of the distribution of productivity that would occur with a deterministic approach. [12]

After plant exit is simulated, the remaining plants decide upon their level of investment. Investment relative to each plant's level of capital is predicted according to (2.15). This, along with the plant's current level of capital, allows the plant's level of investment to be calculated. Each plant's $t+1$ level of capital can then be calculated according to the evolution of capital.

While the previous components of plant behavior are determined by the plant's own characteristics as well as the industry environment, the evolution of plant-level productivity also has random properties. However, the estimation process creates a time-specific measure of productivity at the plant level, which allows the evolution of productivity in the simulation to be calibrated from the data. An examination of the changes in plant-level productivity shows a correlation exists between productivity and the level of capital. Plants with higher levels of capital experienced lower levels of revenue productivity growth. The evolution of productivity is modeled as

$$\Delta\omega_{it+1} = \theta_0 + \theta_k k_{it} + \varepsilon_{it}, \tag{2.16}$$

where $\varepsilon_{it} \sim N(0, \sigma_\omega^2)$. The creation of $\Delta\omega_{it+1}$ from the panel data allows θ_0, θ_k, and σ_ω to be estimated. Each plant's time t productivity is then updated using a random draw and these parameters to create time $t+1$ productivity, ω_{t+1}.[13]

At the beginning of the next time period the number of employees is updated. This update occurs using the new period's measures of capital, as well as the industry variables. These measures, along with the parameters estimated in (2.13) are used to create the plant's new

[12]Missing observations combined with the technique used to create exit leads to a bias in the estimation of exit. Since many plants have missing observations without exiting, the estimation is biased towards over-predicting exit since these non-exit observations do not enter the sample. This bias is not addressed in the estimation of the parameters for exit. However, the simulation addresses this bias in the prediction of exit. The draw of the random variable is truncated to represent the proportion of plants with missing observations.

[13]Extreme values of the random draw have the potential to lead to unreasonable results. Therefore, the random draw is taken from a normal distribution that is truncated to limit draws to one standard deviation from zero. Likewise, an additional bound was applied to limit successive draws of large random values, which would lead to an unreasonable rate of productivity growth over time. A plant's revenue productivity growth was limited to 120 percent during the ten year period.

level of employment.

The simulation procedure described above allows the updating of simulated plants to continue through the time period examined. However, it should be noted that the simulation uses numerous draws on random variables, and, thus, a Monte Carlo approach is taken to ensure robust results.

This section has described the techniques used to calibrate and simulate plant-level behavior. However, the impact of trade policy on the industry parameters is not addressed. The next section describes the CGE model, which will be used to create estimates of these industry variables. These variables will then be linked to the microsimulation to examine the impact of trade policies on plant-level behavior. The linkages between the microsimulation and CGE model are shown in Figure C.4.

2.2.4 The CGE Framework

This section describes the creation of the dynamic CGE model that is employed to create estimates of industry and macroeconomic variables that are linked to the microsimulation. Dynamic CGE models are typically classified into one of two categories. Dynamic models based on optimal growth theory assume perfect foresight of future events. Given the volatile political and economic climate of Chile in the 1970's and 1980's, this assumption of perfect foresight is not appropriate. Instead, a sequential dynamic CGE model, similar to that of Annabi et al. (2005), is developed. The static portion of the model is based upon Lofgren, Harris, and Robinson's "Standard CGE Model in GAMS" (2002), (henceforth, IFPRI).[14] The model links a series of static CGE models together with equations that update each sector's capital stock over the time. Exogenous variables, such as labor supply and the real interest rate, are also updated in the model. Similar to microsimulation, sector-level capital accumulation is considered endogenous. This, along with the changes in wages calculated by the CGE, allows resource reallocation to be linked to the microsimulation. This section provides an overview of the CGE components.

[14]The GAMS code and documentation is found on the International Food Policy Research Institute's website: www.ifpri.com. I thank the authors and IFPRI for making the code publicly available.

The CGE model consists of a static module with updating equations to address the dynamics involved. On the production side of the static model, a representative plant in each sector generates value added by combining labor and capital with CES technology. The output of the plant is a Leontief function of value added and intermediate goods. Data regarding the composition of labor into skilled and unskilled was unavailable at the macro level. Therefore, labor consists of only one category in the CGE.[15]

One representative household exists. Each household is assumed to earn an equal rate of return on its capital. Each household earns income from labor and capital as well as dividends and government transfers. Households pay a direct income tax to the government. Household savings is considered a fixed proportion of total disposable income. Household consumption is derived from the CES preferences defined in the appendix.

Foreign goods enter the economy as imperfect substitutes for domestic goods. The standard Armington (1969) assumption is utilized, which implies a constant elasticity of substitution between exports and domestic goods. Likewise, producers distribute their products between the domestic and foreign markets according to a constant elasticity of transformation (CET) function, which defines the physical trade-off between the production of exports and goods for domestic consumption.

The government collects tax revenue from several sources. The government receives a direct tax from households and imports. Government expenditure is comprised of two categories.[16] The first is the consumption of goods and services. The second is government expenditure is transfer payments. Government transfers are adjusted to maintain the savings-investment balance. The static general equilibrium in each period is defined such that all markets are in equilibrium and the CPI is numeraire.

Capital is accumulated in each industry in a manner similar to the perpetual inventory

[15] Although the microsimulation incorporates both skilled and unskilled labor, the microsimulation is calibrated on changes in the aggregated wage rate. This facilitates the linking of the CGE wage outcome to the microsimulation.

[16] Notably absent is payment of wages by the government. This is due to the nature of the data in the social accounting matrix (SAM) used to calibrate the CGE model. Government payments to “Other Services” includes payment the payment of such wages. The SAM is described in the next section.

method used at the plant level as

$$K_{j,t+1} = (1 - \delta)K_{j,t} + I_{j,t}, \tag{2.17}$$

where the j subscript denotes capital and investment for the sector. The evolution of capital described above does not determine the distribution of capital across sectors. The method used to address the distribution of new investment is similar to that proposed by Bourguignon et al. (1989), which assumes that the relative rate of capital accumulation, $\frac{I_{j,t}}{K_{j,t}}$, is an increasing function of the ratio of the return to capital, $R_{j,t}$, to its user cost, $U_{j,t}$:

$$\frac{I_{j,t}}{K_{jt}} = \gamma_j \left(\frac{R_{jt}}{U_{jt}} \right)^2, \tag{2.18}$$

where

$$U_t = P_t^k (r_t + \delta) \tag{2.19}$$

defines the user cost of capital as the depreciation rate, δ, plus the exogenous real interest rate, R_t adjusted for the endogenously determined time t price of investment goods, P_t^k. Since all variables in (2.18), including investment and depreciation, are known for 1986, γ_j can be calculated for each sector.

The DS-CGE model used in this paper is not without weaknesses. Monetary and financial influences are not modeled, but rather are included as exogenously determined variables. The CGE results should be viewed with this caveat in mind. While such a deficiency would be detrimental to the analysis of monetary phenomena such as currency crises, the primary impact of a trade liberalization lies in the changes in factor and goods prices that occur as a result of the resource reallocation throughout the economy.

2.3 Data

2.3.1 Micro Data

The data used to estimate and calibrate the microsimulation are drawn from a manufacturing census collected by the Chilean National Institute of Statistics. The census provides detailed information regarding Chilean manufacturing plants with ten or more employees for the years 1979-1996. These data are an extended version of the data used by Lui and Tybout (1996) and Pavcnik (2002).[17]

Plant exit is not specifically recorded in the census. Exit information is assumed from a plant's lack of presence in future years. An exit is recorded only if the plant leaves the sample and does not return in later years. A plant with a missing observation, but observations in future years, is not treated as an exiting plant. The manufacturing census does not include any information on the presence of plants beyond 1996. Therefore, exit in 1996 is unknown.

The construction of the capital value deserves special attention. Capital stock was only reported in 1980, 1981, and 1992. The capital variable utilized in this paper was created using a perpetual inventory method described by Liu (1993), which involves projecting capital forward or backward for the appropriate years by accounting for depreciation and investment. Similar to Pavcnik (2002), the capital stock is created such that investment becomes active capital in the year after the investment takes place. Some plants reported capital stock in one of the years, and others reported capital stock in more than one of the above years. The capital variable used in this paper is based upon the reported base year 1992. If the 1992 level was not reported, then the capital measures constructed from the base year 1981 are used. Similarly, if 1981 was not present then the capital stock was created using 1980 as the base year.

Table C.1 shows the number of plants, as well as entry and exit. A comparison of three samples is present. The first sample is all plants present in the data. The second group shows all plants with a capital stock measure, which represents the estimation sample that

[17] Liu (1993), Levinsohn and Petrin (2003) also examine the shorter panel. Kandilov (2004) uses the manufacturing census for 1979-1996.

is employed in the analysis.[18] A comparison of entry in columns 3 and 6 show that while entry exists after 1992, that the appropriate data is not available. Since these plants were not present in 1992, which is when capital was recorded, the level of capital for these plants is unknown. The final three columns shows all plants without missing data that were present in 1986. The simulation begins in 1986 with these plants, and their respective levels of capital, labor, and productivity.

2.3.2 Macro and Sector Data

The DS-CGE model is calibrated on a 1986 social accounting matrix (SAM) for Chile. A SAM is a data framework that represents the flows of all economic transactions between the sectors of an economy in a given year. The SAM used in this paper was developed from a SAM developed by Morales (1992). Unlike many SAMs, the SAM includes detailed information on transactions in the capital account. Many of these transactions are unnecessary for the DS-CGE developed in this paper. Thus, this SAM was aggregated in a manner similar to Montero (2005), which creates an aggregated SAM that is appropriate for the IFPRI model using a 1996 SAM produced by the Central Bank of Chile. The aggregated SAM used to calibrate the CGE model is displayed in Figures C.5-C.5.

Capital is assumed to be immobile across each industry during each year. However, over time capital is reallocated across sectors through the investment distribution process described in the preceding section. Information beyond that contained in the aggregated SAM is required to calibrate the investment parameters. To create the price of investment, the composition of investment for each sector, as well as the price of these commodities, is needed. While it could be assumed that the proportion of commodities composing investment is identical across sectors, a better approach is to create a sector-specific composition for investment. The Central Bank's SAM contains information regarding the composition of each sector's investment. Using this information I create a price of investment unique to each sector, which is based on the weighted average of the prices of the commodities purchased by

[18] If a plant was not present in 1980, 1981 or 1992, then no base level of capital was known. These plants were necessarily excluded from the sample for estimation and simulation purposes.

each sector as investment. In similar fashion, the Central Bank's SAM contains information regarding the consumption of fixed capital. This information is used to obtain a sector-specific depreciation rate for capital by dividing each sector's value of the consumption of capital by its capital stock.

The DS-CGE model developed in this paper does not include financial assets. This prevents addressing the additional influences of monetary and financial shocks, but also does not require monetary policy responses to be included in the model. While Ferreira et al. (2003) develop a financial sector in their micro-macro examination of the welfare effects of the depreciation of the Brazilian real, the use of such an approach is limited in the micro-macro literature, which instead focuses on the effects of real changes in the economy. Accordingly, the real interest rate is assumed to be exogenous. While the real exchange rate can be calculated from the CGE based on the price and composition of imports and exports, it does not include financial and monetary influences on the real exchange rate. Thus, the monetary component of the real exchange rate is treated as exogenous when linking the exchange rate outcomes to the microsimulation. The real exchange rate linked to the microsimulation is created by multiplying the ratio of import and export prices by the nominal exchange rate. The nominal lending rate and the nominal exchange rate are taken from the International Monetary Fund's International Financial Statistics CD-ROM (2004). The real interest rate is calculated as the nominal lending rate net of the inflation rate.[19].

Certain parameters required by the CGE model can not be derived from the SAM. In particular, the elasticities of substitution and transformation used in the study are taken from Coeymans and Larrain (1994) and Coeymans and Mundlak (1991).

2.4 Results

2.4.1 Aggregate Productivity

The estimation of the production function parameters allows measures of revenue productivity to be constructed. The productivity analysis presented in this subsection follows Olley

[19]The inflation rate is calculated from the consumer price index

and Pakes (1996) and Lui and Tybout (1996), but uses estimates of revenue productivity from the previously described estimation process.[20]

The plant-level revenue productivity measures are created by subtracting the expected level of deflated revenue, less the revenue productivity term, from the deflated revenue measure of the plant. This creates the productivity measure for plant i at time t as:[21]

$$\omega_{it} = \frac{\hat{\sigma}}{\hat{\sigma}-1}(r_{it} - \tilde{p}_t) - (\hat{\beta}_l l_{it} + \hat{\beta}_k k_{it}) - (\hat{\sigma}-1)[(\tilde{r}_t - \tilde{p}_t - n_t)]$$

This plant- and time-specific productivity measure allows aggregate levels of each to be constructed on an annual basis. The aggregate productivity measure, $\mathcal{W}_t$, is constructed as a weighted average of each plant's time t productivity using the plant's share of the industry's deflated revenue, s^r_{it}, as the weighting scheme:

$$\mathcal{W}_t = \sum_{i=1}^{N_t} s^r_{it}\omega_{it} = \bar{\omega_t} + \sum_{i=1}^{N_t}(s^r_{it} - \bar{s}^r_t)(\omega_{it} - \bar{\omega}_t)$$

where the bars represent the mean of all plants at time t. Similar to Pavcnik (2002), aggregate productivity is decomposed in the second portion of the above equation into unweighted average productivity and the covariance between industry share and plant productivity. The aggregate productivity measure allows the overall productivity of the industry to be examined, while the creation of this covariance term allows intraindustry changes in output relative to productivity to be examined. If the covariance term is increasing over time, then output, as measured by deflated revenue, is shifting towards more productive plants.

Table C.3 and Figures C.7 and C.8 show the aggregate productivity measures calculated

[20] Pavcnik (2002) uses a similar method, but subtracts a base plant's productivity from the measure described in this section. Similar methods of productivity analysis have also been utilized by Caves, Christiansen, and Tretheway (19881), Klette (1996), and Aw, Chen, and Roberts (2001).

[21] Olley and Pakes (1996) note that the use of this measure instead of

$$\omega_{it} = \hat{\phi}_{it} - \hat{\beta}_k k_{it},$$

which is defined in (2.12), is advantageous because this productivity measure can be created for all observations in the sample, instead of only those observations where investment is greater than zero. For a further discussion, see footnote 33 in Olley and Pakes (1996).

from three different estimation methods.[22] The first set shows aggregate productivity measures calculated from estimates of the production function coefficients shown in column 4 of Table C.3, which is a fixed effects estimation with year and 3-digit industry effects. Aggregate productivity grows by 30 percent over the time period. However, the covariance terms are negative, which indicates that output is shifting away from the most productive plants in the industry.

The second set of aggregate productivity measures are based upon the estimates in column 9 of Table C.3. These estimates were obtained using the Olley-Pakes estimation method, but under the assumption of homogeneous goods.[23] Again, the aggregate productivity increases from 1986 to 1996. Likewise, the covariance term is increasingly negative. The final set of aggregate productivity measures is based on productivity estimates calculated using coefficients from the previously described estimation method that addresses differentiated products. Using this methodology, aggregate productivity falls by six percent during the period. However, mean productivity increases during the time period, a phenomenon that is likely driven by plant-level productivity growth alongside the exit of the least productive plants. The large negative covariance term indicates that output is shifting away from the least productive producers over the time period. Alternatively, producers with a large share of the industry's deflated revenue may have experienced declines in revenue productivity. These results show that an inconsistency exists between the aggregate revenue productivity measure and more traditional measures. This inconsistency is driven by differences in production function parameter estimates that exist when differentiated products are addressed.

As noted earlier, it was necessary to address the influence of a plant's capital stock when

[22] A large difference exists between the coefficients obtained using more traditional estimations and those using the method employed in this paper. See Melitz (2000) and Klette and Griliches (1996) for an extended discussion on returns to scale.

[23] The homogenous goods production function is estimated as

$$r_{it} - \tilde{p}_t = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \varphi_{it} + \varepsilon_{it},$$

where productivity φ_{it} is plant-specific in the case of the fixed-effects estimation and time- and plant-specific using the OP method. The differentiated products estimation utilizes

$$r_{it} - \tilde{p}_t = \frac{\sigma - 1}{\sigma}\beta_l l_{it} + \frac{1}{\sigma}[(\tilde{r}_t - \tilde{p}_t - n_t)] + \frac{\sigma - 1}{\sigma}\phi_{it}(i_{it}, k_{it}) + \varepsilon_{it},$$

which is derived in Section 2.1.

simulating the evolution of productivity. Figures C.9 and C.10 show kernel density estimates of the change in revenue productivity over time and by capital stock, respectively. Figure C.9 shows that the distribution of the change in productivity is consistent with the previous results indicating an increase in mean productivity over time. However, Table C.10 shows that plants of the higher levels of capital experience a lower rate of productivity growth. This is consistent with the increasingly negative covariance term that occurs regardless of the estimation method employed.

The revenue productivity term is estimated as a joint term that includes both plant-level physical productivity, φ_{it}, and plant-level quality, λ_{it}, which indicative of a plant's pricing ability versus its peers. As previously noted, these terms cannot be separated in the estimation process because plant-level prices are unknown. Therefore, it is impossible to determine whether or not the decline in revenue productivity is due to a decrease in the relative price of a plant's output or a decline in the plant's physical productivity. While a quantity measure of a plant's output is the ideal weighting scheme for aggregate productivity, a physical quantity is unknown. However, one might note the intermediate goods are often more homogeneous in nature than manufacturing output.[24] Thus, using a plant's deflated intermediate materials as a substitute for quantity is a possibility. An aggregate productivity measure using deflated materials as the weighting scheme, $\mathcal{W}_t^m$, is constructed as a weighted average of each plant's time t productivity using the plant's share of the industry's use of deflated materials, s_{it}^m, as the weighting scheme:

$$\mathcal{W}_t^m = \sum_{i=1}^{N_t} s_{it}^m \omega_{it} = \bar{\omega}_t + \sum_{i=1}^{N_t} (s_{it}^m - \bar{s}_t^m)(\omega_{it} - \bar{\omega}_t),$$

which is also decomposed into mean productivity and a covariance..

Table C.4 shows the aggregate productivity measure using materials as the weighting scheme. The materials-based aggregate productivity measure shows a 17 percent decline in aggregate productivity. This is a greater decrease in aggregate productivity than using the deflated revenue weighting scheme. If a plant's λ_{it} is declining over time, the plant's revenue

[24]This assumption is even more appropriate in the case of Chile, where the manufacturing industry, most notably food processing, is centered around the country's natural resources.

will be negatively affected. In such a situation, the plant's share of deflated revenue will also be declining, even if the plant's share of physical output is constant. This will reduce the impact of the plant's revenue productivity on the aggregate measure. This, in turn, will lead to a higher aggregate revenue productivity measure than if a quantitative measure of output is used as the weighting scheme.

While a plant's share of the industry's materials use is an imperfect proxy for a quantified measure of output, the resulting calculation of materials-weighted aggregated productivity yields an interesting result. The greater decrease in the materials-weighted aggregate productivity measure as compared to the deflated revenue-weighted measure supports the notion that the decline in aggregate revenue productivity is, in part, based on the loss of pricing power by larger plants. If such a decline in pricing power occurred, it is possible that increased foreign competition, due to the liberalization of import tariffs, played a role. Alternatively, such a decline may be caused by increased competition at home. The results of the microsimulation, described at the end of this section, support the latter.

2.4.2 Simulation Results

Following the creation of CGE results and estimation of the micro parameters, I simulate plant-level behavior. I first present a comparison of the simulation of the base scenario with the actual data. If the results of the counterfactual scenario are to provide valid insights, the baseline simulation itself must accurately model plant behavior.

The baseline and counterfactual simulations begin with the sample of plants present in the data during 1986. Each plant's output for the year is simulated given the plant's actual 1986 levels of labor, capital, and productivity. Following the simulation of output, each plant makes its exit and investment decisions. The plant then continues into the next year. Herein lies the problem in providing a valid comparison of the simulation with the actual data: plants with missing data. If a plant is present in 1986, but its next observation is not until 1990, then a comparison of the simulation with all observations in the data is not indicative of the simulation's ability to model plant behavior. Therefore, a modified sample of the simulated plants was created to compare with the actual data. Simulated plant-years entered the simulated sample statistics only if the plant-year was present in the data. This allows a comparison of statistics with matching samples. While this approach seeks to provide a comparison of the simulation with the data, it is not without its own faults. A plant that exits in the data, but remains in the simulation is excluded from the comparison. Likewise, a plant that exits the market earlier in the simulation than the data, causes a deviation between these two samples. Despite these caveats, the approach of matching simulated observations with those in the data provides the best opportunity to evaluate the accuracy of the simulation.

Table C.8 presents the results of the simulation created from the matched sample. The simulation results present are the mean of the values generated by 1000 repetitions of the simulation. The standard deviation of the value over these repetitions is listed in parentheses. The simulation overestimates the remaining plants in the sample by 2.5 percent. However, the trend in exit from the simulation resembles that in the data. If plant exit were solely dependent upon plant parameters to the exclusion of the industry variables, such a similarity would not exist. This result supports the concept that macroeconomic and industry influence must also be addressed when examining the role trade liberalization plays on plant exit. The final two columns provide an estimate of the mean deflated revenue of the plants in the industry. The simulated value of deflated revenue again follows the general trend of the actual sample. However, deflated revenue is underestimated throughout the sample, only reaching a close proximity to the matched observations in 1986.

Table C.9 shows the simulated values of mean factor use during the period. While the simulated levels of capital follow the trend of capital in the matched sample, the resulting simulated capital level is higher than that in the data. The impact of the missing observations on the mean values of the data can be seen by examining the capital stock. The mean value of capital stock falls by 12.2 percent from 1995 to 1996. Given the nine percent depreciation rate assumed when creating the capital stock, such a decline would be impossible if the sample remained the same.[25] Columns 3-6 in Table C.8 show the simulated and actual mean levels of employment. The simulated level of skilled labor fall under the actual level, while

[25] Such a decline would also occur if a group of large plants exited the sample. However, an examination of plants exiting in 1995 shows that this represents only a mild influence on the mean value.

the simulated value of unskilled labor is higher than the actual level. The total number of workers in the simulation and the actual data is almost identical.[26]

The previous simulation results represent the mean values of plant characteristics. However, accurate means do not necessarily imply the simulation accurately reflects the distribution of productivity across plants. Given the use of the randomly drawn productivity, it is unlikely that the simulation will repeatedly simulate the actual behavior of each plant. However, the baseline simulation results do need to reflect accurately the evolution of the distribution of revenue productivity across plants with different capital stocks if the impact of the trade liberalization on aggregate productivity is to be examined. The simulation Table C.10 shows estimates of aggregate revenue productivity over time. The simulation estimates follow the same trend as the matched sample. However, the simulation tends to underestimate, in absolute terms, the covariance, which leads to an an overestimate of aggregate revenue productivity. Given the random nature of the simulation and the missing observations, which are plant specific, the deviation of the simulation from the actual data is not surprising. However, despite such deviations, the simulation does embody the trends in the examined variables, namely, capital, labor, revenue, and productivity.

Tables C.6 and C.7 show the values of industry and macroeconomic variables that are linked to the the microsimulation according to the schematic show in Figure C.4. The effect of the higher tariff rate on the manufacturing sector can be seen in the last three columns of Table C.7. The increased tariff leads to an increase in domestic sales, in quantities, of one percent. This increase is driven, in part, by a drop in imports of 2.5 percent. While exports also fall with the higher tariff, exports compose a much smaller portion of total production as compared to imports. Table C.6 shows the increased tariff rate also leads to a higher price of manufactured goods, but that this increase is less than one percent. Table C.6 also shows that the real wage falls by 1.4 percent and the price of investment goods increases by .4 percent.

Tables C.11-C.13 show the results of the counterfactual simulation, which is based on the

[26]These results are driven by the use of a single wage rate in updating each plant's labor.While simulations using a separate wage for unskilled and skilled workers yields more accurate results, the SAM does not distinguish between skilled and unskilled labor. Therefore, the current approach is used, which allows the change in the wage calculated by the counterfactual CGE experiment to be linked to the microsimulation.

assumption that the 1986 tariff rate of 20 percent was maintained through the entire time period. Tables C.11-C.13 also show the results for the baseline simulation, which uses the actual gradual decline in tariff rates. The results shown in these tables are calculated using all plants in the sample. The CGE model is linked to the microsimulation, which allows the microsimulation to embody the different sector and macroeconomic pressures that occur under the higher tariff rate. Since the tariff rate is equal across simulations during the first two years, all results of the baseline and counterfactual simulations should be similar during the first two years. However, given the nature of the random draws used in the creation of productivity and exit, these results are not identical.[27]

Plant exit is shown in columns 3 and 4 of Table C.11, which shows exit is higher in the baseline simulation for all years. In 1988 and 1991, which are years when the tariff rate was decreased, plant exit is noticeably higher in the baseline simulation. The difference between simulations decreases in years after the rate cut, although exit in the counterfactual experiment remains lower. Despite this increase in exit, the total impact of the tariff cut on the number of plants in the industry is minimal. The number of plants remaining in 1996 is only increased by an average of 3.45 if the tariff rate stays the 1986 level.

The last two columns of Table C.11 shows the mean deflated revenue of plants in the industry. Values for factors and productivity are identical across simulations during 1986, and, therefore, deflated revenue is also constant across simulations.[28] Through most years in the sample, deflated revenue is slightly higher in the counterfactual experiment, which coincides with the outcome of the CGE model.

Table C.12 shows factor use under each of the simulations. Given the decrease in the real wage and increase in the price of investment that occurs under the counterfactual experiment, a plant-level Heckscher-Ohlin type shift from labor to capital might be expected. However, the use of all factors, both labor and capital, is higher in the counterfactual. While the reduction in the real wage and the increase in the user cost of capital play a role in the addition of labor,

[27]The results for the first two years are identical if the simulations are started with the same seed for the random number generator. However, such a technique seems contrary to the concept of a random draw.

[28]Likewise, revenue is constant across repetitions of the same simulation.

an additional influence affects investment in capital. As described in the previous subsection, the effect of a real exchange rate appreciation on investment in the microsimulation was negative; plant-level investment was negatively affected by the real appreciation of the peso.

Table C.13 shows aggregate productivity measures created from the simulated plants. Mean productivity under the baseline, tariff-cutting simulation increases only slightly over the counterfactual. This small increase can be attributed to a Melitz (2003) type of effect. Plant exit is increased, albeit mildly, with the reduction of tariffs. Since plants with lower productivity levels are more likely to exit, the higher level is expected. However, while mean productivity increases, the difference in mean productivity between the scenarios is small. Other influences beyond the reductions in tariffs played a much larger role in affecting the distribution of productivity in the industry.

The 1996 measure of aggregate productivity under the counterfactual is one percent higher than in the baseline simulation. Larger plants experience a loss in revenue productivity over the time period, which led to a fall in the aggregate measure. However, comparing the baseline and counterfactual simulations shows a relatively minor portion of the change in aggregate productivity can be attributed to the tariff reductions. If, as the evidence provided by the earlier comparison of productivity measures suggests, the fall in revenue productivity was driven by increased competition driving the price of output down for the larger plants, this fall in pricing ability can be primarily attributed to domestic, not foreign, competition.

The previous results indicate that the gradual decline in the tariff rate had very little impact on investment behavior and the evolution of productivity. However, these results do not provide an explanation for the growth of the the industry. Although the price of capital increased under higher tariffs, the mean capital stock of plants increased over the time period. As noted earlier, the effect of the depreciation of the real exchange rate in the mid-1980s on investment exceeded the negative impact of the increasing price of capital. This led to an initial expansion of capital preceding the mild appreciation of the exchange rate in the 1990s.

I address the role of macroeconomic influences through two additional simulations based upon alternative assumptions. In the first simulation I hold the real exchange rate constant.[29] The second simulation seeks to address the surplus labor market. While economy-wide employment grew by 36 percent during the time period examined, the population grew by only 18 percent.[30] The surplus labor in the market allowed the manufacturing sector to expand its output without additional wage pressures. The second counterfactual limits the growth of the labor market to the rate of population growth.

Table C.14 shows the results of the CGE model under each of the scenarios. The columns labeled (1) show the results based on the assumption of a fixed exchange rate. The columns labeled (2) show the results based on the assumptions of a fixed exchange rate and the restriction of the labor supply. Table C.14 shows the assumption of a fixed exchange rate leads to minor increase in the real wage of 1.85 percent by 1996. However, additional assumption of a restricted labor supply leads to a strong increase of the wage; the 1996 real wage under this assumption is over 35 percent greater than under the baseline scenario. This increase in the real wage leads to a fall in manufacturing output of over 13 percent relative to the baseline scenario.

This impact of the real exchange rate on investment behavior leads to the final simulations of plant behavior presented in the paper. Tables C.15 and C.16 present the results of a simulation based on the assumption that the Chilean real effective exchange rate (REER) is held constant at its 1986 level. As can be noted in the previously described Table C.12, the mean capital stock increases by 40 percent under the true REER. However, under the assumption of a constant REER, the mean capital stock of plants in the industry increases by only 21 percent during the time period. This supports the notion that the growth in the true capital stock can be partially attributed to the depreciation of the real exchange rate that occurred in the late 1980s.

It should also be noted that output and labor usage decline very little under the assumption of the constant REER as compared with the simulation based on the true REER. The fall

[29]This assumption implies that foreign savings becomes variable in the CGE. Under the prior assumption of a flexible exchange rate, foreign savings was fixed.

[30]Sources: World Bank *World Development Indicators* (2006) and International Monetary Fund *International Financial Statistics* (2004).

in the covariance of the productivity measure displayed in Table C.16 is less than under the true REER. Thus, while the mean capital stock declines, output is allocated more efficiently throughout the manufacturing sector. While this simulation does not directly account for the growth of the industry over the time period examined, it does provide additional evidence that supports the inclination that the relatively stable macroeconomic environment was a catalyst for the sector's growth.

The simulations results based on the assumption of the restricted labor supply and fixed exchange rate are shown in Tables C.17 and C.18. The results indicate a dramatic change in the evolution of the industry that takes place under these alternative scenarios. The mean 1996 level of deflated output falls by 10 percent relative to the baseline scenario. Likewise, the mean level of capital is 12 percent lower than the baseline scenario. While the number of skilled workers falls slightly as compared to the baseline scenario, the change in the number of unskilled workers is much more pronounced. Under the baseline scenario, the mean number of unskilled workers per plant increased by 20 percent. Under these alternative assumptions, the increase in the real wage limits the hiring of unskilled workers. In this scenario the number of unskilled workers increases by less than one percent.

This section began by a comparing of productivity measures derived from alternative estimation methods. The results, regardless of the estimation method employed, indicate an increase in mean productivity. However, aggregate productivity differed substantially across estimation methods. The decrease in aggregate revenue productivity suggests that larger plants experienced a decline in their pricing power during the time period. While such a decrease might be attributed to the trade liberalization, the linking of the CGE model to the microsimulation enables a more robust analysis. The results of the simulation, which jointly address macroeconomic influences as well as plant-level characteristics, shows that the liberalization resulted in an additional one percent decline in aggregate revenue productivity. Additional simulations show that other macroeconomic influences played a much larger role in the growth of the industry. These results support the notion that the relatively loose labor market and the mild exchange rate depreciation on the late 1980s created an environment suitable for the sector's expansion.

2.5 Concluding Remarks

I have examined the evolution of manufacturing plant productivity while addressing the influence of macroeconomic factors. This approach allows me to make a comparison of the plant behavior under an alternative trade policies. The results indicate that the trade liberalization in Chile had a minor impact on plant behavior.

The aggregate productivity measure in this paper varies from measures used in past research. The aggregate measure of revenue productivity yields a substantially different results than aggregate measures calculated from more traditional estimates of productivity. The evidence presented in this paper suggests that these differences are driven by changes in plant-level prices. The literature has just begun to address these unknown plant-level price changes that are typically embodied in manufacturing censuses. Trade liberalizations do not affect the pricing ability of all plants equally. Improved methodologies to address plant-level price changes will further enhance research on the effects of trade liberalizations on heterogeneous plants.

This paper shows that the evolutionary behavior of a plant is based upon its own unique characteristics such as productivity and capital stock. However, the industrial environment in which a plant exists also plays a role in the plant's decision making process. The methodology developed in this paper jointly addresses both of these influences. The methodology embodies the benefits of past research by including both the heterogeneous characteristics of plants examined in micro-level studies, as well as the resource reallocation effects inherent in trade-oriented CGE models.

I have applied the methodology to examine the trade liberalization in Chile. While previous research such as Pavcnik (2002) and Melitz (2003) find that trade liberalization leads to productivity improvements, I find that the trade liberalization led to a very minor impact on the manufacturing sector during the time period examined. I also find that macroeconomic influences, such as real exchange rate movements and surplus labor, play a large role in determining plant behavior. Likewise, this recession created a surplus of labor that allowed the expansion of the manufacturing sector to take place, which would have otherwise been constrained by increasing wages. The previous recession likely played a role in eliminating the least productive plants from the market. The elimination of these plants from the market in the years preceding the liberalization created an industry composed of plants more resistent to the increased foreign competition. If the liberalization followed a period of prosperity, its impact may have been much larger.

The relationship between macroeconomic shocks and firm and plant behavior is largely unexplored in the literature. The methodology developed in this paper provides a framework suitable for such investigations. The impact of trade liberalizations on plant behavior is one of many macroeconomic phenomenon that can be analyzed. Many of the policy options and shocks explored in the household-based macro-micro literature would be relevant topics to examine using the methodology developed.

The linkages of between the CGE and microsimulation are based upon sector (1-digit) changes in price and output, as well as economy-wide changes in the price of labor and capital. This permits an examination of the role the resource reshuffling plays on plant behavior. While this paper was limited by data constraints from further disaggregation of the manufacturing sector, such a disaggregation would provide further insights into the impact of trade liberalizations by addressing the different changes in the price of intermediate goods used by exporting and import-competing industries.

This paper has concentrated on the micro outcomes of an economy-wide policy. The top-down linkages feed macro-oriented outcomes into the microsimulation. Such unidirectional linkages allow the macro outcomes to affect the behavior of the microeconomic agents. The updating process of the DS-CGE model occurs without regard for results of the microsimulation. An opportunity exists to develop bidirectional linkages between the microsimulation and the DS-CGE. As the industry evolves at the micro-level, industry parameters such as productivity, capital stock, and input coefficients also vary at the aggregated sector level used by the DS-CGE. The development of such bidirectional linkages would further increase the robustness of the analysis.

Chapter 3

Productivity and Foreign Competition: Chile 1979-1996

3.1 Introduction

The liberalization of trade by developing countries creates a pressure on domestic plants by exposing these plants to foreign competition. This increased competition creates demands on domestic plants to increase productivity in order to compete with foreign firms at home and abroad. This paper examines the impact of foreign competitive pressures on Chilean manufacturing plants during 1979 to 1996. During this time period Chile experienced a severe recession followed by a period of rapid growth, a dramatic currency devaluation, and high inflation.

The period examined in this paper immediately follows the drastic reduction of tariffs by Chile that began with the overthrow of the Socialist regime of Chile by Augusto Pinochet in 1973. After gaining power, Pinochet began a process of deregulation and privatization. The economy had been hurt by hyperinflation, which had reached 487.5 percent in 1972 and 605.9 percent in 1973. By 1979, the average tariff rate was lowered to a flat rate of ten percent. Export subsidies and credits were also abolished. In 1982 Chile entered into a deep recession. Figure D.1 shows the 1982 decline in GDP of over 18 percent, which is followed by an expansion leading into the 1990s. Chile was also plagued by high rates of inflation. Figure D.2 shows that the consumer price index increased by almost 2000 percent over the

the time period. Figure D.3 shows the real effective exchange rate of the Chilean peso from 1979 to 1996. The value of the peso declined through the mid-1980s to less than have of its 1979 value. This depreciation was followed by a mild appreciation beginning in 1988 into the 1990s.[1]

Most previous examinations of productivity have not explicitly addressed the issue of variation in the markups of plants. In manufacturing censuses, such as that used in this paper, measures of plant-level output in terms of physical quantity are typically unknown. Therefore, production function coefficients, and their corresponding productivity measures, are usually estimated using plant-level revenue deflated by an industry price index as the measure of plant-level output. Productivity measures created by using deflated revenue can be influenced by plant-level variation in price. The production function estimation method utilized in this paper addresses the variation in plant-level markups in the estimation of productivity. A measure of physical output is predicted from the plant's materials usage in a manner that addresses the market structure in which the plant produces. This quantified measure of output is then used to estimate a production function in capital and labor, which allows a productivity term to be created that measures a plant's ability to create physical output absent from plant-specific price changes. Given the extremely volatile conditions in Chile during this period, addressing the issue of plant-level price changes is important. Although plant-specific price changes may play an important role in economic growth, and are clearly important to the plant itself, not controlling for these influences in the creation of productivity measures can distort the analysis of productivity and foreign competition.

The latter portion of the paper analyzes plant-level productivity via several methods. First, an aggregate measure of productivity is calculated, which shows a fall in manufacturing productivity during the 1982-1983 recession. Such a decline was likely caused by a decline in the intensity of factor utilization during this period of decreased demand. The decomposition of this productivity measure shows that the more productive plants experienced gains in industry output share during this recession. Next, plant-level productivity is analyzed in

[1] Brock (2000) provides an extended discussion on changes in Chilean tariffs. Roberts and Tybout (1996) includes a background of the political and economic events in Chile during the time period examined.

a series of regressions on indicators of the intensity of foreign competition. These regression results show an immediate productivity response to foreign competition. While these regressions are not intended to provide evidence of the impact of foreign competition on the longer term evolutionary trends of productivity, they do show a more immediate plant-level response to foreign competition. Import-competing industries respond to foreign pricing pressure and import penetration with increases in short-term productivity. However, the findings for the exporting industry contrast those of the import-competing industries. Productivity increases correspond with increases in foreign prices. These results suggest that foreign pressures influence productivity in import-competing industries, while exporters respond to opportunities abroad through productivity improvements. Likewise, the relationship of exports and productivity is examined. The results show that productivity and the export-output ratio of each industry have a positive correlation.

Section 2 develops the model that will be used to estimate production function parameters. These estimates are presented in Section 3. This section also includes the aggregate productivity analysis and the plant-level productivity regressions. The final section is the conclusion.

3.2 The Model

This section describes the theoretical model and the estimation strategy that will be implemented. The first subsection describes the estimation issues that will be addressed by the estimation method developed. The next subsection describes the model that will be estimated. The third subsection explains the timing of the plant's exit and investment decisions. The estimation procedure is described in the final subsection. The estimation of the production function combines components of the models brought forth by Olley and Pakes (1996), Ackerberg and Caves (2004) and Melitz (2000). The estimated values of these production function parameters will then be used in the next section to create time-specific productivity measures at the plant level.

3.2.1 Estimation Issues

In a heterogeneous industry, plant i's time t Cobb-Douglas production function can be written as

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it} + \omega_{it} + \varepsilon_{it}, \tag{3.1}$$

where y_{it}, l_{it}, m_{it}, and k_{it} represent, respectively, gross output, labor, materials, and capital, all of which are in logs. Productivity is represented by ω_{it}. The final term, ε_{it}, is an unexpected productivity shock or measurement error.

Several issues arise when estimating (3.1). First, productivity, ω_{it}, is not observed, but the plant has some knowledge of this productivity level as it chooses inputs and decides to continue production. As Pavcnik (2002) notes, this information asymmetry leads to both a survival bias and selection bias in the estimation. More productive plants are more profitable and less inclined to exit the market. If a plant's profits are positively correlated with its capital stock, then a plant with a higher capital stock will be more likely to continue to produce than would a plant with a similar productivity level, but a lower capital stock. The failure to account for the bias induced by plants exiting the market will lead to a downward bias on the coefficient on capital. To correct for this survival bias, the $t-1$ expectation of productivity conditional on survival instead of the unconditional expectation will be employed in a manner similar to Olley and Pakes (1996). However, another issue in estimation remains.

The measure of output, y_{it}, is usually reported by plants as a revenue instead of physical output. Revenue is typically deflated by the industry's price level to obtain a proxy measure of the plant's real output. If the goods produced in the industry are homogenous, then this proxy measure is equivalent to the plant's real output. Alternatively, in a differentiated-goods industry if the price received by all plants changes by an equal percentage, then deflated revenue would equate to a measure of the plant's physical output. However, the plant-specific price likely varies within a given industry. Likewise, intertemporal changes in prices presumably vary between these plants. Viewing the previous production function, (3.1), in terms of log revenue, r_{it}, demonstrates the need to address plant level prices:

$$r_{it} - \tilde{p}_t = p_{it} + q_{it} - \tilde{p}_t \tag{3.2}$$

$$= \beta_0 + \beta_l l_{it} + \beta_m m_{it} + \beta_k k_{it} + \omega_{it} + \varepsilon_{it}. \tag{3.3}$$

In the above equation, if a plant's price level changes at a rate greater than the industry's average $\tilde{p}_t$, then using revenue deflated by the industry price index will overstate the plant's productivity growth. Thus, an issue arises in separating the physical productivity and plant-specific price deviations. The estimation method that follows addresses this issue.

3.2.2 The Revenue Production Function

Similar to Ackerberg and Caves (2004), the production function is assumed to be Cobb-Douglas in capital and labor and Leontief in materials, which can be denoted as:[2] [3]

$$Q_{it} = \min\left\{M_{it}^{\beta_m}, K_{it}^{\beta_k} L_{it}^{\beta_l} e^{\omega_{it}}\right\}, \tag{3.4}$$

where ω_{it} is a time varying productivity measure and L_{it}, M_{it}, and K_{it}, denote, respectively, labor, materials, and capital used by plant i at time t. If a measure of physical output were available, (3.4) could be estimated. However, in most plant-level manufacturing censuses, including the one examined in this paper, physical output is not reported; plants report revenue rather than physical output. If a homogeneous product were produced by all plants in a given industry, physical output could be obtained by deflating each plant's reported level of revenue by the industry price level. If products are differentiated within an industry, a plant-level price must be used to deflate revenue into an accurate measure of physical output. Therefore, a measure of plant-level demand needs to be combined with (3.4), which can then be used to derive a measure of plant-level physical output.

[2] Ackerberg and Caves (2004) assumes a production function where materials are a constant proportion of output. The above specification varies slightly from such a specification.

[3] The estimation results presented later in the paper divide labor into skilled and unskilled categories. This is displayed here as one variable for simplicity in presentation.

Following Melitz (2000), it is assumed that plants produce symmetrically differentiated products within their own industry groups. A common elasticity of substitution, σ, between any two differentiated products exists. It is assumed that demand is driven by a representative consumer with utility U at time t:

$$U_t\left(\left(\sum_{i=1}^{N_t}(\Lambda_i Q_{it})^{(\sigma-1)/\sigma}\right)^{\sigma/(\sigma-1)}, Z\right), \tag{3.5}$$

where $U(\cdot)$ is assumed to be differentiable and quasi-concave and Z represents a numeraire good. The representative consumer's valuation of plant i's product quality is Λ_i, which is assumed to be constant across the time period examined. A total of N_t plants exist in the domestic industry at time t. Each plant is assumed to produce one variety of the good.[4] Plant i's time t revenue is denoted by

$$R_{it} = P_{it}Q_{it}, \tag{3.6}$$

where P_{it} is the price charged by plant i for its physical units Q_{it}. A price index of goods, $\tilde{P}_t$, measures the aggregate changes in the price for a given industry. The total revenue for all plants in the industry at time t is denoted by $\tilde{R}_t = \sum_{i=1}^{N_t} R_{it}$.

From the representative consumer's maximization of (3.5), a plant-level price is derived as

$$P_{it} = \Lambda_i^{\left(\frac{\sigma-1}{\sigma}\right)}\tilde{P}_t^{\left(\frac{1+\sigma}{\sigma}\right)}\left(\frac{\tilde{R}_t}{N_t}\right)^{\sigma}\left(\frac{1}{Q_{it}}\right)^{\frac{1}{\sigma}}. \tag{3.7}$$

The above equation indicates the price the plant receives is a decreasing function of the plant's output, but also that the consumer's perception of the plant's quality and market structure affect the price that the plant receives. By combining the production function, (3.4), and plant-level demand function, (3.7), in a manner similar to Melitz (2000), the plant's revenue production function is created, which can be defined as

[4]Melitz (2000) examines the case of multiple varieties per plant. However, the assumption of a constant average number of varieties per plant is required for the estimation procedure described by Melitz.

$$
\begin{aligned}
R_{it} &= Q_{it}P_{it} && (3.8)\\
&= \min\left\{\left(M_{it}^{\beta_m}\right)^{\left(\frac{\sigma-1}{\sigma}\right)}\Lambda_i^{\left(\frac{\sigma-1}{\sigma}\right)}\tilde{P}_t^{\left(\frac{1+\sigma}{\sigma}\right)}\left(\frac{\tilde{R}_t}{N_t}\right)^{\sigma},\right.\\
&\qquad\left.\left(K_{it}^{\beta_k}L_{it}^{\beta_l}e^{\omega_{it}}\right)^{\left(\frac{\sigma-1}{\sigma}\right)}\Lambda_i^{\left(\frac{\sigma-1}{\sigma}\right)}\tilde{P}_t^{\left(\frac{1+\sigma}{\sigma}\right)}\left(\frac{\tilde{R}_t}{N_t}\right)^{\sigma}\right\}. && (3.9)
\end{aligned}
$$

Given the above revenue function, plant i's time t profit maximization yields the following condition:

$$M_{it}^{\beta_m} = K_{it}^{\beta_k}L_{it}^{\beta_l}e^{\omega_{it}}. \tag{3.10}$$

This condition, when used in conjunction with the estimation strategy of Olley and Pakes (1996), can be used to identify the productivity component in the revenue production function.

3.2.3 The Plant's Exit and Investment Decisions

The timing assumptions described are similar to those of Olley and Pakes (1996), but these assumptions are implemented into a differentiated goods model similar to Melitz (2000). This subsection describes the plant's exit and investment decisions for the model that will be estimated, which are similar to those of Olley and Pakes.

The first decision the plant must make is whether or not to produce. The plant receives a liquidation value of Φ_{it} if it exits the market. If this liquidation value exceeds the plant's expected profits, the plant will choose to exit the market. Given some function $g_t(\omega_{it}, \lambda_i, k_{it})$, the plant continues to produce if this function exceeds some threshold value, $\underline{g}_{it}$. This can be expressed as

$$
\chi_{it} = \begin{cases} 1 & \text{if } g_{it} \geq \underline{g}_{it}(k_{it}) \\ 0 & \text{otherwise.} \end{cases}
$$

More intuitively, a plant will exit if its expected profits, as determined by its levels of λ_i and ω_{it} given its level of capital k_{it}, falls below some threshold level. After deciding to stay in the market, the plant chooses whether or not to invest in new capital. The current period's investment becomes active as capital in the next period. Capital evolves as

$$K_{it} = (1 - \delta)K_{it-1} + I_{it-1}, \tag{3.11}$$

where I_{it} denotes investment and δ denotes a time-invariant depreciation rate. Similar to Olley and Pakes (1996), the plant's investment is dependent on its current productivity, markup ability, and capital:

$$i_{it} = i_{it}(\omega_{it}, \lambda_i, k_{it}). \tag{3.12}$$

Olley and Pakes (1996) shows that the investment demand function can be written as $i_{it}(\omega_{it}, \lambda_i, k_{it})$, which is strictly increasing in ω_{it} for all $i_{it} > 0$. Given this monotonicity condition, the plant's investment demand function, $i_{it}(\omega_{it}, \lambda_i, k_{it})$, can be inverted as[5]

$$\omega_{it} = \omega_{it}(i_{it}, \lambda_i, k_{it}) = i_{it}^{-1}(\omega_{it}, \lambda_i, k_{it}), \tag{3.13}$$

which allows investment to serve as a proxy variable for productivity in the estimation method that follows.

3.2.4 Estimation

The estimation of the production function parameters begins with the materials portion of the revenue production function, (3.8), which is denoted in logs as

$$r_{it} - \tilde{p}_t = \left(\frac{\sigma - 1}{\sigma}\right)\beta_m m_{it} + \frac{1}{\sigma}(\tilde{r}_t - n_t - \tilde{p}_t) + \left(\frac{\sigma - 1}{\sigma}\right)\lambda_i + \varepsilon_{it}, \tag{3.14}$$

where lowercase indicates the logs of the previously defined variables. The above equation identifies σ and β_m. Likewise, the plant-specific markup measure, λ_i, is estimated as a normally distributed plant-specific random effect. This measure indicates the amount of revenue that is unexplained by a plant's materials usage and the current time period's market structure, which is attributed to the representative consumer's perception of the plant's product

[5] Olley and Pakes (1996) also includes the plant's age an influence in investment. The above equation substitutes a plant's markup ability for age.

quality. If the industry is perfectly competitive, then $r_{it} - \tilde{p}_t = \beta_m m_{it}$ would hold. The difference between this condition and (3.14) is attributed to the industry parameters, $\sigma, \tilde{r}_t, n_t$, and $\tilde{r}_t$, as well as the plant-specific markup measure, λ_i. Simply, plants with relatively higher markups over materials are assumed to have higher levels of quality than their lower markup counterparts.

The first stage of the estimation identifies the elasticity of substitution, σ, and creates an estimate of plant-level markups, $\hat{\lambda}_i$. The estimate of the coefficient on materials, $\hat{\beta}_m$, is used to predict a quantified measure of output for the plant:

$$\check{q}_{it} = \hat{\beta}_m m_{it} \tag{3.15}$$

$$= \beta_k k_{it} + \beta_l l_{it} + \omega_{it}(i_{it}, \hat{\lambda}_{it}, k_{it}) \tag{3.16}$$

$$= \beta_l l_{it} + \phi_{it}(i_{it}, \hat{\lambda}_{it}, k_{it}), \tag{3.17}$$

where (3.15) comes from the results of the first stage of the estimation and (3.16) contains the remaining unidentified variables in (3.4). Productivity in (3.16) is proxied by investment in a manner similar to Olley and Pakes (1996). The nonparametric specification of productivity $\omega_{it}(i_{it}, \hat{\lambda}_i, k_{it})$ in (3.16) cannot be separated from the influence of capital on $\check{q}_{it}$. Thus, similar to Olley and Pakes this term, ϕ_{it}, is estimated using a polynomial expansion in capital, investment, and markup ability, which is interacted with time variables.

The first two estimation stages identify all parameters except the coefficient on capital, β_k and productivity, ω_{it}. A final stage is needed to separate the influence of each on $\check{q}_{it}$. This can be accomplished in a manner similar to that used by Olley and Pakes (1996).

The final stage of the estimation uses the timing assumption regarding capital. Since capital is decided for a given time period before investment is known, the unexpected innovation in productivity, ξ_{it} is orthogonal to capital, k_{it}. The final estimating equation becomes

$$\check{q}_{it} - \hat{\beta}_l l_{it} = \beta_k k_{it} + \sum_{j_1=0}^{3-j_2} \sum_{j_2=0}^{3} \beta_{j_1 j_2} \hat{h}_{it-1}^{j_2} \hat{P}_{it-1}^{j_1} + \varepsilon_{it}, \tag{3.18}$$

where $\hat{h}_{it-1} = \hat{\phi}_{it-1} - \beta_k k_{it-1}$ and $\hat{P}_{it-1}$ denotes the plant's survival probability, which is estimated as a probit on a fourth order series expansion of capital and investment interacting with plant-specific quality and time variables.[6]

3.3 Empirical Results

The plant-level data utilized by this paper come from a manufacturing census collected by the Chilean National Institute of Statistics for the years 1979 to 1996. These data contain information from all Chilean manufacturing plants with 10 or more employees. Four industries are used in the current analysis. The food industry (ISIC 311) is the largest of the four in both output and the number of plants. Non-ferrous metals (ISIC 372) is the second largest industry by output size, but the smallest in terms of plants. These two industries export a large portion of their output while the other two industries, Textiles (ISIC 321) and Metal Products (ISIC 381), are import-competing. Table D.1 shows number of plants in each industry across time. Each industry's import-output ratio, export-output ratio, and import share of domestic consumption are shown in Table D.2. The appendix details the creation of the variables used in the estimation of the parameters described above. The data used are an extended version of the same panel used by Liu (1993), Tybout (1996), Roberts and Tybout (1996), Levinsohn and Petrin (2003), and Pavcnik (2002).

3.3.1 Production Function Parameters

The estimation of production function parameters specified in the previous section is presented in Table D.3. The first two columns, β_m and σ, are obtained in the estimation of the materials side of the revenue production function, (3.14). The remaining columns provide a comparison of the series estimation described in the previous section and a fixed effects regression on the quantified measure of output. The coefficient on capital in the fixed effects regressions are noticeably smaller than those in series estimates in three of the four industries. This is likely a phenomenon similar to that described by Blundell and Bond (1997); the effect

[6] Since investment in time $t-1$ is determined before the plant's time t productivity is known, the use of the lagged series expansion is used to approximate the plant's expectation of time t productivity conditional upon its survival and $t-1$ productivity level, i.e. $E_{it}[\omega_{it+1}|\omega_{it}, \chi_{it} = 1]$.

of capital in a fixed-effects regression is partially embedded in the plant's fixed effect.

The estimate of the production function parameters uses a random effects estimation in the first stage. While plant-level effects are typically estimated using fixed-effects, the effect is typically a productivity term. The effect in the case of the first stage of the estimation process is based not on productivity, but instead a plant's ability to mark up its output over materials. Mundlak (1978) argues that if omitted variables are present, as would be the case with markups, then a random effects estimation is appropriate. The use of a random effects model assumes that the effect is uncorrelated with materials. Hausman (1978) tests for each of the industries confirm that it is appropriate to estimate markup ability as a random effect.

The use of materials as a proxy for physical output is utilized with assumption that the coefficient on materials does not change over time. If the amount of materials required to produce one unit of physical output changes over time, then a bias from this structural change would result when predicted the quantified measure of output. A likelihood ratio test is conducted to verify structural change over time. The following equation is estimated

$$r_{it} - \tilde{p}_t = \left(\frac{\sigma - 1}{\sigma}\right) \delta_j \beta_{mj} m_{it} + \frac{1}{\sigma}(\tilde{r}_t - n_t - \tilde{p}_t) + \left(\frac{\sigma - 1}{\sigma}\right) \lambda_i, \tag{3.19}$$

where δ_j represents a 0/1 dummy for each time periods: 1979-1981, 1982-1983, 1984-1988, and 1989-1996.[7] The initial estimation of the materials equation imposes a restriction such that β_{mj} is equal across all time periods. If no change in the coefficient occurred across time, then the null hypothesis could not be rejected. However, null hypothesis is rejected when likelihood ratio tests are conducted for each of the industries.

While the results of the likelihood ratio test suggest that some structural change may occur, the estimation of a production function using more traditional approaches also assumes that no structural change of these coefficients occurs over time. Thus, the true cost of applying the approach utilized in this paper instead of alternative methods is the use of the assumption that materials are not substitutable for labor or capital. However, the use of this assumption allows the total factor productivity of capital and labor in converting materials to be examined

[7] The use of year specific dummies with such an approach is unidentified because of the inclusion of the year-specific mean revenue term, $(\tilde{r}_t - n_t - \tilde{p}_t)$ in the estimation.

measure absent of plant-level price changes over time. In a manufacturing sector that is largely focused on the conversion of raw materials into manufactured goods, such as Chile, this measure allows the productivity in such a conversion process to be examined.

3.3.2 Aggregate Measures of Productivity and Markups

The estimation of the production function parameters allows measures of productivity and markup ability to be constructed. The productivity analysis presented in this subsection follows Olley and Pakes (1996) and is similar to Pavcnik (2002).[8] However, the productivity measure is based upon a plant's quantified measure of output instead of deflated revenue. The analysis of markup ability is conducted in a manner similar to the productivity analysis.

The plant-level productivity measures are created by subtracting the expected level of output from the quantified output measure of the plant. This creates the productivity measure for plant i at time t as:

$$\omega_{it} = \check{q}_{it} - \hat{\beta}_s l^s_{it} - \hat{\beta}_u l^u_{it} - \hat{\beta}_k k_{it}. \tag{3.20}$$

Olley and Pakes (1996) note that the use of (3.20), instead of the measure

$$\omega_{it} = \phi_{it} - \hat{\beta}_{it},$$

which is defined in (3.17), is advantageous because this productivity measure can be created for all observations in the sample, instead of only those observations where investment is greater than zero.[9] Additionally, this measure allows the creation of productivity measures for the year 1996, which was excluded from the production function parameter estimation due to lack of plant exit information.

The plant- and time-specific productivity measure allows aggregate levels of each to be constructed on an annual basis. The aggregate productivity measure, $\mathcal{W}_t$, is constructed as a weighted average of each plant's time t productivity using the plant's share of the industry's

[8]Pavcnik also subtracts a base plant's productivity from the RHS of (3.20). As Pavcnik notes, similar methods of productivity analysis have also been utilized by Caves, Christiansen, and Tretheway (19881), Klette (1996), and Aw, Chen, and Roberts (2001).

[9]See footnote 33 in Olley and Pakes for a comparison of these two different productivity measures.

output, s_{it}^{q}, as the weighting scheme:

$$\mathcal{W}_t = \sum_{i=1}^{n_t} s_{it}^{q}\omega_{it} = \bar{\omega_t} + \sum_{i=1}^{n_t}(s_{it}^{q} - \bar{s}_t^{q})(\omega_{it} - \bar{\omega}_t) \tag{3.21}$$

where the bars represent the mean of all plants at time t. Similar to Pavcnik (2002) and Olley and Pakes (1996), aggregate productivity is decomposed in the second portion of (3.21) into unweighted average productivity and the covariance between industry share and plant productivity. The creation of this covariance term allows intraindustry changes in output relative to productivity to be examined. If the covariance term is increasing, then output is shifting towards more productive plants.

Tables D.4-D.7 present the results of the aggregate productivity measure as well as its decomposition. In this table, results are standardized with the 1979 value equal to zero. Aggregate productivity declines in all industries over the entire time period examined. However, the direction of changes in aggregate productivity varied within the 1979 to 1996 time period. Most notably, aggregate productivity increased in all four industries over the 1979 to 1981 time period. Similarly, all industries experience a drop in productivity in 1982. This decline in productivity corresponds with a continued fall in GDP, which, in conjunction with rigidities of plant choice in labor and capital, likely led to the underutilization of resources. Likewise, as shown in Table D.8, all of the industries experienced an increase in their capital to output and labor to output ratios during the recession. This evidence further supports the notion that excess capacity stemming from input rigidities led to the drop in productivity during the recession. Following the recession, productivity maintained levels exceeding its 1979 value until the mid-1980s. However, despite the output growth in the industry in the mid-1980s and 1990s, the productivity measure in each industry experiences a decline.

Prior work has examined the evolution of productivity using the 1979-1986 subsample of the data. Pavcnik (2002) uses the estimation approach of Olley and Pakes (1996), henceforth OP, to analyze the evolution of productivity. Investment is used as a proxy for productivity in a manner similar to that in this paper. However, plant-level markups are not addressed. Levinsohn and Petrin (2003), henceforth LP, develop a methodology that instead utilizes a plant's materials usage as a proxy for productivity. An aggregate productivity measure is created by applying each of these methods to the data used in this paper. These measures are displayed in Tables D.4-D.7. A comparison of productivity across estimation methods shows that each yields substantially different results. The LP estimation methodology shows an increase in productivity over the time period that is greater than either of the other two methods for all of the three-digit industries examined. Estimates from the OP methodology are substantially lower than the LP estimates, but show mild increases in productivity over the time period. The productivity measure calculated using the methodology created in this paper is even lower than the OP method for all industries except ISIC 372. This difference stems from the ability to address intraplant changes in price across time. The results suggest that these markups affect the aggregate productivity measure in all of the industries except 372.

The aggregate productivity measure examined above does not address the issue of resource reallocation within an industry. More notably, the unweighted-mean productivity measure increases substantially in all of the industries. However, these productivity gains are overshadowed by the reallocation of output share away from the more productive producers in the late 1980s. The decomposition of the aggregate productivity can be used to examine this reallocation. The previously described covariance measure is displayed in Tables D.4-D.7. In all four industries, the covariance measure begins a downward shift in the mid-1980s. This supports the notion that the recession had a disciplinarian effect on the market. Plants with higher productivity levels were rewarded with greater market share. However, this effect was short-lived. The period of growth following the recession allowed plants with lower productivity levels to regain the market share lost in the early 1980s.

By directly addressing plant-level markups in the estimation method, the aggregate productivity measure created in this paper contrasts with those measures created by previous estimation methods. The estimation method in this paper eliminates the effects of plant-level price changes on productivity by creating a plant-level measure of physical output. The use of the output measure in the estimation of productivity eliminates the changes in plant-level prices that may otherwise influence an aggregate productivity measure. If output is reallocated towards plants with higher markups, but such an reallocation is not addressed in the estimation process, then the perceived gains will influence the aggregate productivity measure.

In order to create the aggregate markup ability of plants in an industry, a measure similar to that used to examine productivity, $\mathcal{M}_t$, is created by taking the weighted average of plant-level markup ability using the share of industry quantified output as the weighting scheme. The markup measure, λ_i, is held constant across time. Therefore, this measure cannot be used to examine changes in markups. However, each plant's share of the industry's output does change over time. Thus, the changes in the distribution of output among plants of varying markups can be examined.This measure is also decomposed into an unweighted average and covariance as

$$\mathcal{M}_t = \sum_{i=1}^{n_t} s_{it}^q \lambda_{it} = \bar{\lambda}_t + \sum_{i=1}^{n_t} (s_{it}^q - \bar{s}_t^q)(\lambda_{it} - \bar{\lambda}_t). \tag{3.22}$$

Similar to aggregate productivity, if the covariance is increasing, then larger levels of output are being produced by plants with higher markups. The aggregate markup measure is shown in Table D.9. The aggregate measure provides evidence that markups dropped in three of the industries during the time period leading into the recession. This is indicative of the pressure placed upon plants leading into the recession. However, the aggregate measure is generally increasing for all of the industries except ISIC 381.

The liberalization of trade barriers should also impact the ability of plants to mark up their products. Using data from five developing economies, including Chile during the same years examined in this paper, Roberts and Tybout (1996) find that price-cost margins are negatively correlated with trade exposure. Foreign competition reduces the ability of plants to mark up their final product over their costs.

The results in this paper support this notion brought forth by Roberts and Tybout (1996), but also show that exports play a role in determining the allocation of output. Table D.9 shows that the sign of the covariance measure depends on an industry's trade orientation. The covariance remains negative in most years for import-competing industries, indicating that market share was reallocated towards the lower-markup producers. The export-oriented industries have a positive covariance in most years, which indicates that plants with higher markups gained market share. If the exporters in an industry have higher markups relative to their non-exporting peers, and exports relative to output for domestic consumption increases, then these exporters would gain in market share. The positive covariance measure during the recession in conjunction with the increase in each of these industries export share (shown in Table D.2) provides evidence to support such a notion.

The reallocation of output across plants of differing markups also has an impact on measures of industry output. The impact of the recession on revenue can be seen in Figure D.4. This figure compares each industry's quantified measure of output with deflated revenue over the 1979-1996 period. The time t quantified measure of industry output, $\check{\mathcal{Q}}_t$, is constructed as:

$$\check{\mathcal{Q}}_t = \sum_{i=1}^{N_t} \check{Q}_{it} = \sum_{i=1}^{N_t} M_{it}^{\beta_m},$$

where $\check{Q}_{it}$ represents the non-log quantified output of firm i at time t. The values are standardized so that each represents a percentage change from 1979. These graphs show that the deflated revenue measure tends to understate the magnitude the recession. The growth of the quantified measure is greater in all industries except Food Processing. The difference in the quantified measure of output and deflated revenue stems from the varying markups in the industries. The aggregate markup measure falls during 1982 in all industries except ISIC 372, which experiences a large increase in 1983. As noted earlier, the estimation method assumes that λ_i is fixed over time. The changes in the aggregate markup stem from the reallocation of output within the industries. If output is reallocated to plants with higher markups during the recession, then the deflated-revenue measure of output would result in higher levels than the quantified measure. While a recession might lead to shift towards lower markup goods, an alternative explanation also exists. As domestic demand declines, exports compose a large portion of industry output. If high markup goods are exports, then the output-weighted measure would increase.

While the use of materials provides a proxy for the quantity of output under the assumption that raw materials are more homogeneous in nature than manufactured output, such a technique is not immune from its own problems. The large increase in the quantified measure (parts b-d of Figure D.4) is driven by a drop in the raw materials price index during 1996. The use of this price index to deflate materials is likely responsible for the overstatement of the quantified measure of output in 1996.

The examination of the aggregate measures of productivity and markups provides evidence that supports several conclusions. The recession combined with input rigidities led to a fall in productivity. Despite this decline in productivity, the recession did lead to a reallocation of output share towards the more productive producers. The expansionary period following the recession reduced pressures on firms leading to an eventual decline in productivity. The markup measure shows a drop in markups of three of the industries during the recession, but these industries show a general trend of increasing markups throughout the sample period. More notable, however, is that the sign on the covariance indicating intraindustry reallocation of output corresponds with an industry's trade orientation. A shift towards plants with higher markups occurs in the export-oriented industries, whereas output in the import competing industries moves to the lower markup producers. These results support previous findings that trade exposure leads to a reduction in markups.

This subsection has provided an analysis of productivity and markups during the 1979-1996 period. The estimation method used in this paper results in aggregate productivity measures that are substantially different than previous methods. However, these differences may be partially attributed towards the reallocation of output to plants with a greater ability to markup their output. Although the trade-orientation of an industry provides some explanation of the evolution of markups within an industry, the impact of the recession plays a primary role in determining the evolution of the industries. The next subsection discusses the influences of international pressures on productivity in the industries examined.

3.3.3 Influences on Plant-Level Productivity

The creation of a time- and plant-specific productivity measure from the quantified level of output allows the impact of competitive foreign pressures on plant productivity to be examined. This subsection provides results from regressing the productivity measure developed in the last section on proxies of foreign competitive pressure, namely, foreign price indices and the share of imports in domestic consumption.

In an import-competing industry, a decrease in the foreign price level should intensify the need for domestic plants to increase their productivity. This hypothesis is evaluated with several approaches using separate regressions for each of the four industries. First, the following equation is estimated:

$$\omega_{it} = \gamma_{pd} p_t^d + \gamma_{pf} p_t^f + \psi_i + \varepsilon_{it}, \tag{3.23}$$

where p_t^d and p_t^f denote the foreign and domestic price indices at time t and ψ_i is a plant fixed effect. If foreign competition has an effect on productivity through pricing pressure, then the coefficient on the foreign price index should be negative.

An alternative measure of foreign competition is the share of the domestic consumption market produced by domestic producers. If this share is falling, foreign competition has been successful in penetrating the domestic market. This foreign competition should put pressure on domestic plants to increase their productivity. This concept is evaluated with the following regression:

$$\omega_{it} = \gamma_d m_t^o + \psi_i + \varepsilon_{it}, \tag{3.24}$$

where m_t^o indicates the import to output ratio of the industry at time t. If productivity increases due to foreign competition then the coefficient on m_t^o should be positive.

Bernard and Jensen (2004) show that exporting plants are more productive than their non-exporting domestic counterparts. The Chilean data do not include a plant-level measure of exports for all years in the sample.[10] Therefore, the comparison of productivity between exporting and non-exporting plants cannot be made at the plant level. However, assuming an increase in productivity allows plants to compete overseas, such an expansion in exports would likely increase the ratio of exports to industry output. Accordingly, an increase in productivity should correspond with an increase in the export to output ratio. This relationship is explored

[10]The data includes plant-specific levels of exports for the years 1990-1996. The plant-level export decision is specifically addressed in the third essay.

using the following:

$$\omega_{it} = \gamma_{xo} x_t^o + \psi_i + \varepsilon_{it} \tag{3.25}$$

where x_t^o is the time t export to output ratio for the industry.

The results of the fixed effects regression are displayed in Table D.10. These regressions are conducted at the three-digit industry level. The negative coefficient on the foreign price indicates that the two import-competing industries, 321 and 381, respond to foreign price pressure by increasing their productivity. However, the coefficient on the foreign price is positive for exporting industries, 311 and 372. Plants in these industries respond to an increase in the foreign price with an increase in productivity. In both cases, the influence of the foreign price is likely linked to excess capacity. Plants in the import-competing industries shed underutilized resources when faced with additional foreign competition, which would lead to an increase in the estimated productivity measure of the plant. Likewise, exporters may expand their output when additional overseas opportunities arise, thereby eliminating excess capacity and increasing the estimated productivity measure. However, the coefficient is not significantly different from zero for ISIC 372. Given that this industry, non-ferrous metals, is based largely on Chile's large portion of world copper resources, it is expected that deviations in the foreign price of this industry's output will drive productivity. However, the direction of causality in this industry may well be reversed. Productivity shocks in this industry likely play a role in determining the foreign prices. This effect is similar to that experienced by all plants when an increase in domestic price occurs. If a price increase occurs, it is likely that plants seek to take advantage of this increase by immediately increasing output. Due to rigidities in the plant's factor usage, this increase occurs through a more efficient use of capital and labor, resulting in higher productivity. Such an increase in output would result in an increase in the export to output ratio, x_t^o. The positive coefficients on x_t^o in all industries coincide with this scenario. However, the causal relationship is likely reversed from that of the price effect; an increase in productivity allows plants in the industry to increase their exports relative to their total output.

The coefficient on m_t^o also suggests that foreign competition increases the pressure on domestic plants to increase their productivity. This coefficient is positive for the two import competing industries. This indicates that the increased competition from abroad forces firms towards efficiency. The coefficient on m_t^o is positive in the two exporting industries, which is an unexpected result. While the coefficient is insignificant for the non-ferrous metals industry, the coefficient is significant for the food processing industry. This result likely stems from the long-run trend away from imports and the expansion of the industry, which was led by the larger, but less productive plants.

This subsection has presented the results that seek to relate the influence of foreign pressures on domestic productivity. The results presented show that trade orientation plays a large role in determining the response of an industry to changes in foreign prices. Most notably, import competing plants respond to external competitive pressures through increases in productivity gains. Furthermore, the exports allow plants to utilize excess capacity resulting in increases in productivity.

3.4 Concluding Remarks

This paper provides further insights into the impact of foreign competition on the productivity of domestic plants. The model used to estimate production function parameters removes the influence of plant-specific price changes by creating a quantified measure of output from each plant's materials usage. The manner in which the production function parameters are estimated allows the creation of a time- and plant-specific productivity term that is absent of plant-level price changes. By creating such a measure, the influence of foreign competition on productivity can be analyzed. The results of this analysis show that foreign competition does have a significant impact on plant-level productivity changes.

The estimation method used in this paper controls for the highly volatile economic climate of Chile in the early 1980's. However, several issues should be noted. First, the functional form of the production function implies that labor and capital are not substitutes for materials. Furthermore, excess capacity is not explicitly modeled. The inclusion of such a component may yield additional relevant results.[11]

The results presented in this paper provide evidence that the 1982-1983 recession was a large influence on the manufacturing sector. While input rigidities led to a drop in productivity during the recession, more productive plants with higher markups gained market share during the recession. This phenomenon is likely driven by a fall in domestic demand increasing the overall share of exports in industry output. However, the recession was followed by a period of growth that allowed larger, less productive plants with higher markups to gain market share. The resulting productivity measure shows a downward trend, a result that contrasts the evolution of productivity measures created by the Olley and Pakes (1996) and Levinsohn and Petrin (2003) estimation methods. This paper also provides evidence that plants in export producing industries respond to increases in foreign prices with increases in productivity. These productivity gains are achieved by eliminating excess capacity. Likewise, import competing industries experience efficiency gains when pressures from abroad intensify.

It should also be noted that the analysis of the effects on foreign competition on productivity is driven by capacity utilization. The presented evidence suggests that foreign competitive pressures do impact the productivity of domestic plants. However, this impact is a short-term pressure on each plant's efficient use of capital and labor. The analysis does not address the impact of foreign competition on a more evolutionary process of productivity change. Therefore, the impact of foreign competition should be considered as a pressure on a plants's near-term efficiency rather than longer-term technical growth.

While elements of structural change may exit, the estimation method addresses the issue of plant-specific price changes in a manner that allows the impact of foreign competition on plant-level productivity to be shown. In a turbulent economic such as that examined in this paper, plant-specific price changes need to be addressed. The estimation method and corresponding productivity measure are applicable in any industrial environment where foreign pressures may lead to plant-specific price changes, which may otherwise drive productivity measures. The heterogeneity in price changes of the materials used by different plants is likely minimal

[11] For example, a component similar to Petropoulos's (2000) use of energy as a proxy for capital utilization might be added to the in the model presented in this paper. In particular, see Chapter 2.

as compared to the price changes in the output of those plants. Therefore, the use of materials to predict a physical quantity of output accomplishes the objective of creating a productivity measure that is void of plant-level price changes.

Chapter 4

Export-led Growth: Examining the Microevidence in Chile

4.1 Introduction

The export-led growth hypothesis states that an increase in exports is an injection into an economy that provides both a Keynesian oriented stimulus and induces efficiency gains. Export-promotion policies are seen as way to induce this injection with the overall objective of supporting economy-wide growth. Additional growth may also be stimulated by technology transfer, learning-by-doing, and economies of scale. Previous studies vary in the methodologies applied to analyze the macro-level relationship between exports and growth. However, the micro mechanisms through which this relationship occurs are not directly examined. This paper extends previous analyses by examining the relationship between exports, capital investment, and economic growth using plant-level data from the Chilean manufacturing sector from 1990 to 1996. The examination of exporting behavior confirms previous findings that export behavior is closely linked to past establishment-level export status. The analysis presented here goes beyond previous treatments to indicate that the plant-level export status positively influences an establishment's investment behavior. These results support the notion that exporters face a substantial obstacle to begin exporting, but that once this initial hurdle is overcome, manufacturing plants not only maintain their export orientation but also expand their capital stocks and output at greater rates than similar non-exporting counterparts. A series of simulations is conducted that examine the effects of exogenous export shocks on investment and growth in value added. The results suggest that larger gains in the growth of capital and value added occur when these shocks affect potential entrants into the export market as compared with shocks that increase current exporters.

Previous examinations of export-led growth fall into two categories. The first group of studies, such as Michaely (1977) and Balassa (1978), examined the relationship between the growth in national output and exports. Balassa notes that export-oriented policies operate through channels to induce growth[1]

> " export-oriented policies, which provide similar incentives to sales in domestic and foreign markets, lead to a resource allocation according to comparative advantage, allow for greater capacity utilization, permit the exploitation of economies of scale, generate technological improvements in response to competition abroad, and, in labor-surplus countries, contribute to increased employment."

Using data from a cross section of countries, both Balassa and Michaely find that at the macro level export growth rate and domestic output growth are correlated. The work of Balassa and Michaely is expanded upon by others such as Jaffee (1985) and Otani and Villaneuva (1990), where more complex cross-sectional analyses are conducted to counter the criticism that the prior cross-sectional studies may give misleading results because they fail to address cross-country differences in economic structure and institutions.

These cross-sectional studies are followed by more recent analyses that implement time-series examinations of specific countries. Giles and Williams (2000) note that a large majority of the time-series based studies use some form of Granger causality in the examination of the relationship between exports and output growth.[2] One of the first studies to implement this approach was Jung and Marshall (1985), which conducts country-by-country Granger causality tests on 37 countries. The results from only four of these countries supported the export-led growth hypothesis. This methodology was expanded in studies, such as Jin (1995)

[1]see p.181

[2]Giles and Williams (2000) provide and extensive survey of more than 150 export-led growth papers

and Jin and Yu (1995) by incorporating additional variables, such as the real exchange rate, in the examination of the export-growth relationship. The numerous studies that incorporate this type of methodology find mixed results for the export-led growth hypothesis.

While these previous studies seek to examine the econometric relationship between exports and growth, they do not provide direct support for the theoretical reasons behind such a relationship. Several theories support the notion that export-led growth may exist. The first is the simple Keynesian notion that exports increase demand for a country's output, thereby stimulating output throughout the economy. Alternatively, the reallocation of resources may occur as resources move away from less productive uses and towards the production of exports. Likewise, as export opportunities increase, the reward for innovation increases, thereby, promoting productivity and technological advancement. Further, foreign exposure may lead to technological gains stemming from technology transfer and learning-by-doing.[3] The increase in output with the expansion to the foreign market may also necessitate the growth in capital stock, thereby increase the productive capacity of the economy.

The analysis presented in this paper examines these hypotheses at the micro level with a rigorous modeling of establishment level behavior. A learning-to-export component is embedded into a theoretical model of plant investment. This component assumes that the per-unit of cost of exporting decreases as a plant's exports increase. As a plant's level of exports increase, the plant further expands its capital stock, which allows it to take advantage of the lower cost of exporting. The model is used to examine empirically the manufacturing sector of the Chilean economy. While the plant-level approach concentrates on the manufacturing sector and not the economy as whole, it allows the impact of exporting opportunities on establishment-level behavior to be examined. The next section provides a brief historical background of the Chilean economy during the time period examined. The theoretical model of exports and investment is brought forth in Section 3. This relationship is examined empirically in Section 4 using an approach similar to the recent literature regarding the plant-level export decision. The impact of export-induced investment on output growth is the examined

[3]See Saggi (2002) for a review of trade and technology transfer. Aw, Chung, and Roberts (2000) find no evidence of learning-by-exporting in Korea, but find evidence to support this notion in some Taiwanese industries.

through the use simulations of plant behavior in Section 5.

4.2 Historical Background and Descriptive Statistics

Chile began the 1990s with a period of growth that continued its post-recession expansion in the 1980s. Figure E.1 shows the economy-wide 63 percent increase in real exports over the 1990-1996 time period. This increase in exports coincided with a 53 percent increase in real domestic product over the same time period.

Herzer, Nowak-Lehmann, and Siliverstovs (2004) test the export-led growth hypothesis for Chile by analyzing time-series data for 1960-2001. While their study examines a longer time period than this paper, several key findings remain relevant. First, they find a positive long-run Granger causality of exports and capital stock on non-export GDP exists. While the time-series techniques fail to address specific micro behaviors in the Chilean manufacturing sector, a relationship between exports, investment, and output exists at the macro level. However, they also find that non-manufactured exports negatively affect long-run GDP growth. Herzer, Nowak-Lehmann, and Siliverstovs treat capital as an endogenous variable in their empirical examination of the relationship between exports and GDP growth. Their results indicate that growth in exports in the manufacturing sector necessitates growth in the sector's capital stock, whereas the relationship is much more limited when raw materials are exported. When exports serve to eliminate excess capacity or exhaust existing natural resources, the influence of exports on growth is minimal or adverse. This finding brings about an important point: if exports are to impact long-run GDP positively, the growth in exports must lead to an increase in the productive capacity. Table E.1 shows industry-level data based upon Nicita and Olarreaga (2001). The first two columns of values show the 1996 level of revenue and exports for each industry examined. The largest industry examined is ISIC 311, Food Manufacturing, followed by ISIC 372, Non-Ferrous Metal Products. The large size of these industries is indicative of the manufacturing sector's reliance on the country's natural resources. Chile's copper reserves account for over 30 percent of the known reserves in the world, which has allowed this industry to develop a strong export orientation. The third column shows that exports in ISIC 372 accounted for approximately 71 percent of the overall revenue in the sector. The final columns of Table E.1 show the growth in deflated revenue and exports over the 1990 to 1996 time period. All industries experienced a gain in total output. Likewise, all but two industries experienced an increase in exports. Figure E.2 shows the growth rates of revenue and exports over the 1990-1996 period. The size of the indicator is weighted by each industry's share of the manufacturing sector's revenue. The slower growth of the non-ferrous metal industry relative to most other sectors of the economy supports a hypothesis similar to that Herzer, Nowak-Lehmann, and Siliverstovs (2004), that those industries reliant upon natural resources provide less opportunity for additional growth.

The data used to examine the relationship between exports, investment, and growth are taken from a manufacturing census collected by the Chilean National Institute of Statistics. The census provides detailed information regarding Chilean manufacturing plants with ten or more employees for the years 1979-1996. This data is an extended version of the data used by Liu and Tybout (1996), Levinsohn and Petrin (2003), and Pavcnik (2002). However, the census only includes plant-level export data for the 1990-1996 subsample. Therefore, the analysis presented in this paper makes use of the observations in the data for these years. A comparison of exports reported by plants with industry statistics indicates that exports reported by plants are lower than exports reported at the industry level. The presence of intermediaries that purchase domestic output with the intent to export provides an explanation for this difference. While the final destination of all goods sold by each plant would provide an ideal measure, the use of the plant-level measure more directly permits the influence of plant-level exports on the investment decision to be examined. Furthermore, the use of domestic intermediaries eliminates the plant-level costs associated with establishing an overseas market.

Table E.2 shows descriptive statistics created from the census for each of the industries examined in this paper. The values displayed include the 1996 mean levels of output, capital, and labor, for exporters and non-exporters. A comparison of each column shows that exporters are larger in each industry except for ISIC 372, Non-Ferrous Basic Metals. The large size of plants in this industry, regardless of export orientation, is driven by scale economies within the industry and Chile's large portion of the world's copper reserves. Measures of productivity for each of these industries will be presented in a later section.

4.3 Theoretical Framework

This section establishes a theoretical justification for the relationship between investment and exports that is empirically explored later in the paper. The model developed in this section is similar to that employed by Bernard and Jensen (2004) and Roberts and Tybout (1997), but is distinct for several reasons. While the models in these previous papers include a sunk entry cost into the export market, the theoretical model in this paper assumes that the plant faces a cost of exporting that is decreasing with its previous established level of exports, thereby introducing a learning-to-export component into the model. This component differs from previous learning-by-exporting notions by assuming that exports do not lead to productivity gains in the production of all of a plant's output, but instead reduces only the cost of exports. I assume that the plant produces domestically and has the option of selling in the domestic market, exporting its output, or both. The plant's variable profits at time t are defined by[4]

$$\Pi_t = R_t^d(Q_t^d) + R_t^f(X_t), \tag{4.1}$$

where $R_t^j(\cdot)$ denotes revenue less variable production costs from market j, domestic and foreign, and Q_t^d and X_t, denote the quantity sold to the respective market. The plant's total output is the sum of domestic sales and exports, $Q_t = Q_t^d + X_t$. I assume that a plant's revenue is increasing with the quantity sold, but that some element of imperfect competition exists in both markets such that marginal revenue is declining, $R_t^{j'}(\cdot) > 0$ and $R_t^{j''}(\cdot) < 0$. For expositional purposes, it is assumed that plant utilizes only one input, capital, in the

[4]Firms maximize profits; plants in a multi-establishment plant do not. The data used in this study are based upon plant-level observations. However, over 90% of the plants in the data used in this paper are single-plant establishments. I use the term "plants" above to provide consistency throughout the paper.

production of its time t output.[5] The plant's production function is defined as:

$$Q_t = f(K_t),$$

where K_t is the plant's level of capital and Inada conditions hold such that $f'(K_t) > 0$ and $f''(K_t) < 0$. Capital is assumed to evolve using the perpetual inventory method where investment, I_t, becomes active immediately, $K_t = K_{t-1}(1-\delta) + I_t$, and δ is the depreciation rate. The plant faces two costs that affect its dynamic decision-making process. The first is the cost of installing new capital. The plant pays C_I for each unit of investment, I_t.[6] The plant also faces a second per-unit cost associated with exporting. This cost is assumed to be decreasing with prior exports according to $C_t^{x'}(X_{t-1}) < 0$ and $C_t^{x''}(X_{t-1}) = 0$. Furthermore, this cost of exporting is separable from the cost of producing output, which is assumed to be the same regardless of the destination of the output. Accordingly the total cost of exporting X_t given X_{t-1} is $C_t^x(X_{t-1})X_t$. The framework established allows the cost of exporting to be reduced as the volume of exports increases, thereby creating a framework with a learning-to-exporting component. A minimum cost of exporting any quantity, s, is assumed to obey $C_t^x(X_{t-1})X_t = \max\{s, C_t^x(X_{t-1})X_t\}$, which is shown in Figure E.3.

Dixit (1989) and Krugman (1989) develop models of sunk costs for exporting. A plant that initially develops a market for its product abroad will be able to benefit from this expanded market in the future. Bernard and Jensen (2004) and Roberts and Tybout (1997) confirm this notion and find that a plant's export decision in a given time period is closely related to past exporting experience. The sunk cost of export differs slightly from the exporting cost with learning-by-exporting properties applied to the theoretical model in this paper. However, both theories support the notion of that past influences play a role in determining current exports. The above assumptions create an intertemporal maximization problem for the plant. The plant enters each period with its prior levels of capital and exports as state variables. The plant's choice of exports and investment in the current period affect its future behavior.

[5]The inclusion of variable inputs (and costs) does not substantially change the model or theoretical results.

[6]The use of a constant cost of investment simplifies the model without substantially changing the results that are obtained by assuming as increasing marginal cost of investment.

Accordingly, the plant's problem is expressed as the value function:

$$V_t(K_{t-1}, X_{t-1}) = \max_{I_t, X_t}\{\Pi_t(K_t, X_t) - C_I I_t - C_t^x(X_{t-1})X_t + E_t[V_{t+1}(\cdot)|K_t, X_t]\} \tag{4.2}$$

$$st.$$

$$K_t = K_{t-1}(1-\delta) + I_t$$

$$\Delta X_t = X_t - X_{t-1}$$

$$Q_t = f(K_t) = Q_t^d + X_t$$

$$I_t \geq 0,$$

where the second-order sufficient conditions are assumed to hold. Accordingly, a plant that is not currently exporting will continue to produce solely for the domestic market if the cost of expanding into the export market exceeds the present and future gains of establishing the export flow, which can be written using the plant's optimal levels of output, investment, and capital Q_t^*, I_t^*, and K_t^* as:

$$\begin{aligned} &\Pi_t(Q_t^*, X_t = 0) - C_I I_t^* + \beta E_t[V_{t+1}(\cdot)|K_t^*(X_t = 0), X_t = 0] \\ &\qquad > \Pi_t(Q_t^*, X_t > 0) - C_I I_t^* - s + \beta E_t[V_{t+1}(\cdot)|K_t^*(X_t > 0), X_t > 0], \end{aligned} \tag{4.3}$$

The above condition represents an export condition similar to that of Bernard and Jensen (2004), but assumes that exports represent a continuous state variable defined by the level of exports instead of discrete state variable based upon export status.[7] The first order conditions of the plant's maximization problem w.r.t. I_t is

$$C_I = \Pi_t^K + (1-\delta)E_t V_{t+1}^K \tag{4.4}$$

[7] See Bernard and Jensen (2004) equation 9. The inclusion of investment in the above equation also creates an additional state variable that is addressed below.

and w.r.t. X_t is

$$C_t^x - E_t C_{t+1}^{x'} = \Pi_t{}^X, \tag{4.5}$$

where $\Pi_t^K = R_D^{'} f'$ and $\Pi_t^X = R_F^{'} - R_D^{'}$. The above first order conditions highlight several components of the plant's maximization problem. First, (4.4) shows that the plant's optimal investment is chosen such that the cost of one unit of investment, C_I,is equal to the gain in the current period's profit plus the gain in future periods attributed to the increase in capital. Similarly, a plant's optimal level of exports equates the cost of export expansion less the expected discounted cost of the next period's expansion with the gain in profits achieved through this export expansion, Π_t^X.

The impact of the plant's previous level of exports, X_{t-1}, on current investment and exports can be analyzed using (4.4) and (4.5). First, denote the second derivatives of the per-period profit functions as:

$$\Pi_t^{KK} = R_D^{''} f^{'} + R_D^{'} f^{''} < 0,$$

$$\Pi_t^{XX} = R_F^{''} + R_D^{''} < 0,$$

and

$$\Pi_t^{XK} = -R_D{}^{''} f^{'} > 0.$$

The comparative statics are derived in Appendix A as:

$$\frac{dX_t^*}{dX_{t-1}} = \frac{C_t^{x'} [\Pi_t^{KK} + \beta V_{t+1}^{KK}]}{|H|} > 0 \tag{4.6}$$

and

$$\frac{dI_t^*}{dX_{t-1}} = \frac{-C_t^{x'} \Pi_t^{XK}}{|H|} > 0, \tag{4.7}$$

where $|H|$ indicates the determinant of the Hessian, which is necessarily positive at the maximum of $V_t(K_{t-1}, X_{t-1})$. The above conditions, bring forth several implications. First, (4.4) shows that the past level of exports is not explicitly included in the plant's first order condition for investment. However, a higher level of exports in the past allows the additional expansion of exports to occur in future periods. This expansion of exports simultaneously increases the marginal benefit of investment.[8]

The comparative statics described above are driven by the assumption that the per-unit export cost decreases with the plant's prior level of exports. However, if the plant's level of exports increase to a certain point such that the lower bound of the export cost, s, is reached then the export cost is no longer decreasing and $C_t^{x'} = 0$. Under such a premise, an exogenous increase in exports will not affect future levels of exports and investment. Therefore, export expansion and capital stock growth would only occur in response to changes in the influences on the plant's revenue function such as foreign or domestic prices.

This section has developed a theoretical basis for exploring the relationship between export status and investment. The model developed differs from past work by embodying the evolution of capital and an adjustment cost based upon the expansion of a plant's exports. If the benefit of entering the export market, both in the current period as well as future periods, does not exceed the expansion cost, then the plant will not begin to export or expand its level of exports. The inclusion of this export expansion cost alongside the evolution of capital shows that plant with higher levels of past exports will, therefore, choose higher levels of investment in the current period. Higher levels of past exports reduce the current period's cost of exporting, thereby, increasing the return on investment. The next section will discuss the empirical methodology used to explore the relationship between investment and exports.

[8] The above comparative statics show that an increase in a plant's prior level of exports affects its current exports. However, other factors may also determine a plant's export status. For example, a plant may experience an increase in exogenously determined productivity, ω, that increases, ceteris paribus, the marginal return of investment and exporting such that $\Pi_t^{K\omega} > 0$ and $\Pi_t^{X\omega} > 0$. Accordingly, the following comparative static can be obtained using similar methods to those shown in the appendix as:

$$\frac{dX_t^*}{d\omega} = \frac{-[\Pi_t^{KK} + E_t\beta V_{t+1}^{KK}]\Pi_t^{K\omega} + \Pi_t^{XK}[\Pi_t^{X\omega} + E_t\beta V_{t+1}^{K\omega}]}{|H|} > 0,$$

which shows that a shift in a plant's productivity increase its level of exports. This result is similar to that of Melitz (2003), who finds that export producing plants have higher productivity levels than their non-exporting counterparts. Similarly, an increase in productivity may induce a non-exporting plant into the export market if the gain in productivity reverses the sign of the inequality in (4.2).

4.4 An Empirical Examination of Exports and Investment

This section develops the methodology used to examine the relationship between investment and exports. The section begins by describing the estimation of a production function. This estimation process allows for estimates of plant- and time- specific productivity. These estimates of productivity are then utilized in the analysis of plant-level investment and export behavior.

4.4.1 Productivity

It is assumed that plant i's time t value-added, y_{it}, is determined by Cobb-Douglas technology defined in logarithms as:

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \omega_{it} + \varepsilon_{it}, \tag{4.8}$$

where l_{it} and k_{it}, denote the plant i's time t levels of labor and capital, respectively.[9] The plant's productivity, ω_{it}, is a plant- and time-specific productivity measure. The error term, ε_{it}, is considered a measurement error. It is assumed the capital, k_{it}, is a state variable that is updated through investment over time, but is not variable within time period t. Labor and materials are assumed to be freely variable within the time period.

A plant's value-added is defined as deflated gross revenues minus the deflated cost of materials and services. The use of a value-added production function, instead of revenue deflated by the an industry-level price index, is used in the analysis for several reasons. First, the next section involves the use of simulations that require the dynamic update of inputs across years. The use of materials in the estimation of a deflated revenue production function would require the update of plant-level materials usage. However, the updating of plant-level materials based on an estimated first-order condition in the simulation of heterogeneous plants produces unreasonable results. The use of value-added extends beyond technical constraints. A large section of the Chilean manufacturing sector is involved in the conversion

[9] I do not distinguish between skilled and unskilled labor for expositional simplicity. Labor is divided into skilled and unskilled variables in the results presented later in the paper.

of the country's natural resources into manufactured products. Accordingly, growth in the manufacturing sector's value-added is the more likely welfare-enhancing target than growth in deflated revenue, which may occur solely through the increased depletion of the country's natural resources. However, despite these differences, value-added and revenues remain highly correlated in the data.[10]

The estimation of the production function follows Levinsohn and Petrin (2003) which is motivated by the estimation strategy of Olley and Pakes (1996) to use intermediate inputs as a proxy in the identification of ω_{it}. Levinsohn and Petrin (henceforth LP) note that the use of materials, m_{it}, will be increasing in productivity for a given k_{it}.[11] Thus, the demand for materials, $m_{it} = m_{it}(\omega_{it}, k_{it})$, is a monotonic function in ω_{it}. Given this monotonicity, the materials demand equation can be inverted to obtain $\omega_{it} = \omega_{it}(m_{it}, k_{it})$. The production function (4.8) can now be rewritten as:

$$y_{it} = \beta_l l_{it} + \beta_k k_{it} + \phi_{it}(m_{it}, k_{it}) + \varepsilon_{it}, \tag{4.9}$$

where

$$\phi_{it}(m_{it}, k_{it}) = \beta_k k_{it} + \omega_{it}(m_{it}, k_{it}). \tag{4.10}$$

I assume that each plant's capital stock evolves according to

$$K_{it} = K_{it-1}(1 - \delta) + I_{it}, \tag{4.11}$$

where δ is a time- and plant-invariant depreciation rate and I_{it} is plant i's investment in time period t. A final identification restriction is required in the estimation process. Following LP I assume that productivity follows a first-order Markov process:

$$\omega_{it} = E[\omega_{it}|\omega_{it-1}] + \xi_{it}, \tag{4.12}$$

[10]The correlation coefficient is .90 in the industries examined.

[11]See the appendix of LP for teh full derivation.

where ξ_{it} is an unanticipated productivity shock that is uncorrelated with k_{it}. Given the nature of the evolution of capital in (4.12), investment becomes active as capital immediately. Thus, if investment in time t is made with knowledge of $\omega_i t$, then ξ_{it} would influence the investment decision. I avert this issue by following LP's timing, which assumes that the time t investment decision is made with only knowledge of ω_{it-1}.

The equation used for the first stage of estimation is created by substituting in a third-order polynomial approximation in k_{it} and m_{it}:

$$y_{it} = \beta_l l_{it} + \sum_{j_1=0}^{3} \sum_{j_2=0}^{3-j_1} \gamma_{j_1 j_2} k_{it}^{j_1} m_{it}^{j_2} + \varepsilon_{it}. \tag{4.13}$$

This first stage identifies the coefficient on labor, $\hat{\beta}_l$, but does not identify the coefficients on capital and labor. To identify these remaining coefficients some additional steps are required.

The second stage of estimation is based upon the Generalized Method of Moments (GMM) estimator. The moment condition stems from the timing assumption that assumes that capital does not respond to unexpected innovations in productivity:

$$E(\xi_{it} + \varepsilon_{it} | k_{it}) = E(\xi_{it} | k_{it}) = 0. \tag{4.14}$$

The second moment condition identifies β_m under the premise that materials use in the previous time period is uncorrelated with the innovation to productivity in the current period:

$$E(\xi_{it} + \varepsilon_{it} | m_{it-1}) = E(\xi_{it} | m_{it-1}) = 0. \tag{4.15}$$

To implement the estimation process, $\hat{\phi}_{it}$ is computed as the predicted level of output excluding the influence of labor:

$$\hat{\phi}_{it} = y_{it} - \hat{\beta}_l l_{it} - \sum_{j_1=0}^{3} \sum_{j_2=0}^{3-j_1} \gamma_{j_1 j_2} k_{it}^{j_1} m_{it}^{j_2}. \tag{4.16}$$

Using this computed value of $\hat{\phi}_{it}$, an estimate of $\hat{\omega}_{it}$ for potential values of β_k^* can be created as

$$\hat{\omega}_{it} = \hat{\phi}_{it} - \beta_k^* \tag{4.17}$$

Likewise, an estimated prediction of the expectation of productivity can be created as

$$E[\omega_{it}|\omega_{it-1}] = \alpha_0 + \alpha_1\omega_{it-1} + \alpha_2\omega_{it-1}^2 + \alpha_3\omega_{it-1}^3 + \varepsilon_{it}. \tag{4.18}$$

Utilizing the constructed values above alongside $\hat{\beta}_l$ and the potential value for β_k^*, the residual of the production function, which enters the moment conditions, is calculated as

$$\hat{\xi}_{it} + \hat{\varepsilon}_{it} = y_{it} - \hat{\beta}_l l_{it} - \beta_k^* k_{it} - (E[\omega_{it}\hat{|}\omega_{it-1}]), \tag{4.19}$$

which is inserted into a GMM criterion function to obtain estimates on the coefficients on capital and labor. The GMM criterion function yielding these estimates is

$$min_{(\beta_m^*,\beta_k^*)} \sum_{j \in Z_t} \left\{ \sum_t (\hat{\xi}_{it} + \hat{\varepsilon}_{it}) Z_{jt}^2 \right\}, \tag{4.20}$$

where $Z_t \equiv (m_{t-1}, k_t)$. The estimation of the production function allows the predicted level of productivity to be created. This plant- and time-specific productivity level, $\hat{\omega}_{it}$, is created as

$$\hat{\omega}_{it} = y_{it} - \hat{\beta}_l l_{it} - \hat{\beta}_k k_{it}. \tag{4.21}$$

The previous estimation of the production function allows the plant- and time-specific measure of productivity to be utilized in investment and export decision making processes of each plant. The estimates of the above coefficients and a comparison of productivity between exporters and non-exporters are presented in the next section. Further, the productivity measure stemming from this estimation allows a plant- and time-specific measure of productivity to be created, which can be employed in the examination of plant-level investment and exports. However, additional estimations are required to address the influence of a plant's export intensity on its investment in capital.

4.4.2 The Export Decision

The investigation of the impact on investment must also examine the influences on exports. Accordingly, I assume that a plant's exports can be estimated as a Tobit by:

$$x_{it}^{*} = a_0 + a_1\omega_{it} + a_2k_{it} + a_3e_t + a_4gdp_t^w + a_5su_{it} + a_6x_{it-1} + \mu_j + \varepsilon_{it} \qquad (4.22)$$

where

$$x_{it} \begin{cases} x_{it}^{*} & if \;\; x_{it}^{*} > 0 \\ 0 & otherwise \end{cases}$$

and e_t and gdp_t^w denote the real exchange rate and real world gross domestic product, respectively. A depreciation in the real exchange, indicated by a falling e_t, would increase the relative competitiveness of a plant's output in foreign markets, thus, a negative coefficient is expected. Likewise, gdp_t^w, enters to address the influence of world demand. The exchange rate, e_t, and world GDP, gdp_t^w, both enter into the theoretical model through R_F. A depreciation in the exchange rate or an increase in world GDP would increase the marginal revenue of exports relative to domestic output, $R_F^{'} - R_D^{'}$, thereby increasing the marginal profits of exporting, Π_t^X. This increase would results in an expansion of exports under the first-order condition for exports in (4.4), which equates the marginal gain of current exports with the current cost of exporting minus expected future cost reductions. Aw, Chung, and Roberts (2000) note that exporting plants typical employ workers with higher skill levels. The ratio of skilled versus unskilled employees, su_{it}, is included in the estimation of (4.22) to address this influence of human capital on the export decision. While such a measure of human capital is not included in the theoretical model, it is included above as an additional influence on investment.

The previous section shows in (4.8) that higher productivity levels should positively influence a plant's exports. The measure of productivity used in the estimations results presented in the next section is created as log difference from the three-digit mean level of productivity. The use of this measure allows the influence of productivity on exports to be examined while still accounting for differences in production function specifications across industries.

A three-digit industry fixed effect, μ_j, is also included in the estimation to address additional industry differences.

4.4.3 Investment

Melitz (2003) develops a theory that predicts a) which plants will export and b) that exporting plants will increase their share of the industry's overall production. Melitz finds that only the plants of higher productivity levels are able to compete as exporters. Further, Melitz notes that the plants with the highest productivity levels expand their market share. A comparison of productivity levels between plants of differing export statuses can be used to test the first prediction. Likewise, the market share of exporters can be contrasted with that of non-exporters. However, neither of the empirical tests provides an explanation of the mechanism through which this growth might take place. The remainder of this section develops the estimation strategy that will be used to explore the relationship between investment and exports. More specifically, the methodology seeks to address the role that exporting status plays on a plant's investment decision. Plant i's time t investment is assumed to be determined by an investment demand function, which is estimated as:

$$i_{it} = c_0 + c_1 k_{it-1} + c_2 \omega_{it-1} + c_3 x_{it} + \varepsilon_{it}, \tag{4.23}$$

where i_{it} represents the plant's investment and x_{it} is the plant's exports. The choice of regressors in (4.23) warrants additional discussion. The variables can be directly related to the plant's first order condition for investment defined in (4.4). A plant chooses its level of investment to obtain its optimal level of capital given its level of capital in the previous period. The prior level of capital enters the first order condition for investment (4.4) through Π^K, which is a function of the plant's time t capital, $K_t = K_{t-1}(1-\delta) + I_t$. Using a similar Markov process for productivity to that described above, Ericson and Pakes (1995) show that investment is increasing with productivity. The LP estimation method assumes that the current period's productivity is unknown during the investment process. However, LP also note that productivity follows the Markov process defined in (4.12) and a plant is aware of its past levels of productivity, when forming its expectation of productivity in the next period. Accordingly, lagged productivity, ω_{it-1}, enters (4.23), which is expected to have a positive coefficient as predicted by the comparative static in (4.7). The use of lagged productivity makes use of the timing assumption utilized in the estimation of the production function, which supposes that the investment decision is made before the current period's productivity is known.[12]

The final term included in (4.23) is the plant's level of exports.[13] The theory in the last section predicts that both investment and exports increase as the plant gains experience in exporting. The reduced export cost creates an incentive for the plant to expand to meet its overseas demand. Under such a premise, investment should be increasing with exports. Such an expansion of the plant's capital stock and output would support the notion that export-led growth hypothesis occurs at the establishment level.

As noted earlier, many plants in the sample do not invest every year, which results in a censoring of investment that must be included in the estimation process. Thus, the estimation of the investment equation takes the form of the typical Tobit:

$$i_{it}^* = c_0 + c_1 k_{it-1} + c_2 \omega_{it-1} + c_3 x_{it} + \varepsilon_{it}, \tag{4.24}$$

where

$$i_{it} \begin{cases} i_{it}^* & if \;\; i_{it}^* > 0 \\ 0 & otherwise. \end{cases}$$

The estimation of (4.24) as a Tobit addresses the issue of the censored data, but fails to account for the simultaneity of exports and investment. If investment and exports are simultaneously determined as in the theoretical model presented in the last section, then the failure to address this issue would result in an upward-biased estimate of c_3. Such a bias would overemphasize the influence exports on investment. Therefore, the instrumental variable

[12]The use of productivity instead of lagged productivity yields similar results. Lagged productivity is used in the results presented in this paper to provide consistency in the LP timing assumptions.

[13]A measure of the cost of capital goods, such as the real interest rate should also be included in the first order condition for investment. However, the coefficient on the real interest rate is positive and insignificant.

Tobit similar to Newey (1987) is used in the estimation process, which applies Amemiya's (1978) generalized least squares (AGLS). The reduced-form parameter estimates are obtained from the export equation. The estimation begins by treating x_{it} as linear function of the instruments, e_t and gdp_t^w, and the other exogenous regressors in (4.24):

$$x_{it} = a_0 + a_1\omega_{it-1} + a_2k_{it-1} + a_3e_t + a_4gdp_t^w + a_5x_{it-1} + \varepsilon_{it}. \tag{4.25}$$

Next, the coefficients on the exogenous variables of the investment equation are then estimated as a Tobit using the predicted value of exports, $\hat{x}_it$, obtained from a least squares estimate of (4.25):[14]

$$i_{it}^* = c_0 + c_1k_{it-1} + c_2\omega_{it-1} + c_3x_{it} + \varepsilon_{it}, \tag{4.26}$$

where

$$i_{it} = \begin{cases} i_{it}^* & if\ \ i_{it}^* > 0 \\ 0 & otherwise. \end{cases}$$

The resulting estimation not only seeks to address the simultaneity issue, but it also closely follows the plant's decision process. A plant's expectation of exports in the current period would be determined by foreign demand, relative prices, and the plant's prior levels of capital and exports. It is this expectation of exports that influences the plant's investment decision, which is a decision that occurs before the exports are produced.

This section has described the estimation strategy that will be employed to examine the relationship between exports and investment, while also addressing the simultaneity issue between exports and investment. The next subsection presents the results of the previously described estimations. The influences on plant-level exports are also examined.

4.5 Empirical Results

This section uses the methodology discussed to the previous section to provide an analysis of investment and export behavior of plants during the period 1990-1996. The section begins

[14]Newey (1987) equation (5.6) provides the AGLS estimator.

with a comparison of productivity measures across exporters and non-exporters. Additional influences on the plant-level export decision are then examined. The remainder of the section concentrates on the plant-level relationship between export status and investment.

4.5.1 Productivity Estimates

Table E.3 shows the estimates of the production function parameters for each three-digit industry. With the exception of the coefficient on unskilled labor in ISIC 361 (Glass Products), the coefficients on all inputs are positive.[15] However, the degree of significance varies, particularly on the coefficient on capital across industries. The estimated production function parameters are used to calculate a time- and plant-specific productivity measure. Tables E.4-E.6 show the annual mean productivity growth measure for exporters and non-exporters, columns 1 and 2, respectively, for each industry. Column 3 of Table E.3 shows the ratio of mean productivity levels of exporters and non-exporters. A value greater than unity in Column 3 indicates that the productivity levels of exporters is higher, on average, than their non-exporting peers, which is an outcome that occurs in all but one of the 18 industries.[16]

If the dynamic effects of exporting, such as learning-by-exporting and technology transfer, were to take place they should be reflected in the change in productivity over time. If the productivity of exporters is increasing faster than non-exporters then the ratio of mean productivity levels, displayed in the Column 3 of Tables E.4-E.6 should be increasing over time. Column 3 shows that exporters report mean gains in productivity that are higher than the gains in non-exporters in less than half of the 18 industries. Furthermore, in those industries where a gain occurs, the gain in productivity of exporters over non-exporters is minimal and inconsistent across years.[17] These descriptive statistics provide little support of

[15]The two-stage estimation process necessitates the use of bootstrapped standard errors. The standard errors shown in Table E.3 are boostrapped with 50 repetitions.

[16]Several industries experience a reversal during a one year period. However, these reversals do not appear to be persistent, but rather a temporary shock.

[17]The discussion above is intended to provide a descriptive analysis of productivity. A more robust empirical analysis of technology transfer and learning-by-doing can be found in Clerides, Lach, and Tybout (1998).

the learning-by-exporting hypothesis, which is a finding that confirms the results of Clerides, Lach, and Tybout (1998).

4.5.2 The Export Decision

Several different theories have evolved concerning the relationship between exports and productivity. First, productivity may play a role in the export decision process, thereby affecting both the export status and volume of a manufacturing plant. If the fixed costs of exporting extend beyond the costs of domestic production, then only the most productive plants will export. Alternatively, competition may be more intense in foreign markets resulting in lower prices, thereby restricting the possibility of profitably exporting to plants of higher productivity levels. Second, exports may lead a gain in productivity that is achieved by technology transfer and learning-by-doing. Further, larger markets may also increase the incentive for plants to achieve efficiency gains.

By assuming a fixed cost associated with exporting, Melitz (2003) shows that only plants of higher productivity levels are able to enter the export market. However, the empirical evidence supporting productivity's influence on the export decision is limited. For example, Bernard and Jensen (2004) examine the export decision of U.S. manufacturing plants during the 1984 to 1992 time period. They include a measure of plant-level productivity when examining a plant's decision to export. They find this productivity measure significantly influences the export decision. However, once a plant's other attributes, such as capital stock, are addressed in the estimation process by either fixed effects or first differences, then this relationship becomes insignificant.

Columns 1 and 2 of Table E.7 show the results from (4.23). Column 1 excludes the industry fixed-effects term, μ_j, whereas column 2 includes this term in the estimation. The coefficient on productivity is insignificant in both cases. The coefficients on real exchange rate and world GDP, the two variables included to address the influence of world demand on exports, are different from zero above the one percent confidence level. The negative coefficient on the real exchange rate indicates that the real depreciation of the Chilean peso leads to an increase in exports. Similarly, the positive coefficient of real world GDP on exports suggests that the level of a plant's exports is directly related to this measure of foreign demand.

Similar to Bernard and Jenson (2004), the coefficient in the Tobit on the previous year's exports is positive and different than zero above the one percent confidence level. This supports the notion that the size of overseas business likely plays a large role in the export decision. The coefficient on su_{it} is also positive. Exports tend to be produced by workers with higher skill levels. This result supports the concept that a degree of human capital is required in order to export. Brooks (2006) finds that the exports of Colombian plants are limited due to the quality of the products. If skilled labor is required to produce products of higher quality, then such a relationship may also exist in the case of Chile. Finally, the coefficient on capital is positive as expected. While this positive coefficient might indicate that a plant must achieve a certain size in order to export, the result could also be driven by the fact that more machines are required to produce more exports. The results of a similar least squares estimation using the subsample limited to exporters are displayed in Table E.8. These results are included to verify the robustness of the results of the previously described Tobit. If the results of the Tobit were driven by the export decision, i.e. the censoring of the data, then the influence of a given variable on the level of exports might be incorrectly interpreted. However, these results produce similar results to the Tobit used in the full sample.

To analyze the discrete export decision, a probit is estimated using similar variables similar to (4.23). Formally, the model is estimated as:

$$x^*_{it} = a_0 + a_1\omega_{it} + a_2k_{it} + a_3e_t + a_4gdp^w_t + a_5su_{it} + a_6x_{it-1} + \mu_j + \varepsilon_{it}, \tag{4.27}$$

where

$$x_{it} \begin{cases} x^*_{it} & if \;\; x^*_{it} > 0 \\ 0 & otherwise. \end{cases}$$

The results of (4.27) are presented in columns 3 and 4 of Table E.8. While the formulation of (4.23) represents the determinants of the level of exports, the results (4.27) more directly answer the export decision, i.e."to export or not export." The sign and significance of the coefficients remains the same as in the previous equation. However, the coefficient on capital yields a more direct result regarding the export decision and capital. The export decision is, in part, determined by a plant's size. This result is supported by two theoretical explanations. First, scale economies may allow larger plants to be competitive overseas. Second, larger plants may find it relatively easier to enter foreign markets. Larger plants may be able to absorb the initial sunk cost of exporting that is prohibitive of smaller plants, which is a notion further supported by the positive coefficient on past exports.

The final columns of Table E.8 display results based upon the export share of output, $s_{it} = x_{it}y_{it}$. The model can be expressed as a two-limit Tobit model as:

$$s_{it}^* = a_0 + a_1\omega_{it} + a_2k_{it} + a_3e_t + a_4gdp_t^w + a_5 + su_{it} + a_6x_{it-1} + {}_j + \varepsilon_{it}, \tag{4.28}$$

$$s_{it}\begin{cases} 0 & if \;\; s_{it}^* < 0 \\ s_{it}^* & if \;\; 0 < s_{it}^* < 1 \\ 1 & otherwise. \end{cases}$$

The upper limit enters to address the concept that exports should not exceed output.[18] The results for (4.28) are similar to the other estimations based upon export. Most notable of the results are the coefficients on past export share and capital. The positive coefficient on lagged export share indicates that plants generally increase their export share over time. This result coincides with the more aggregated data that indicates an opening of the economy during the time period. The positive coefficient on capital indicates that plants with higher levels of capital export a larger share of their output.

This section has provided a discussion of the influences on plant-level exports. The results based upon the Chilean manufacturing sector indicate similar influences concerning plant-level export decision making as compared with previous studies in other countries. The results provide evidence supporting the concept of a sunk cost necessary to enter the export market. Further, macroeconomic influences such as world GDP and the real exchange rate directly affect both the export decision and volume of exports. The next section will apply these influences on exports as instruments to address the impact of plant-level export status on

[18] An exception to this boundary exists. A plant's sales of its current inventory may lead its reported exports to exceed its output in a given period. However, this exception was limited to one observation in that data.

investment.

The results show that a plant's current exporting decision is influenced by its past export orientation. If a plant overcomes the initial hurdle into the export market, the plant has the potential to expand its output to meet overseas demand. If such a relationship exists, then the investment patterns of exporting plants should differ from their non-exporting counterparts. Table E.9 shows the results of the estimations detailed in the previous section concerning the estimation methodology. Column 1 shows the estimation of a Tobit estimation of investment on log exports and the other variables in (4.26) without the use of instrumental variables. Column 2 and 3 show the results of the instrumental variables Tobit that treats exports, in log levels, as an endogenous variable. Column 3 also includes the square of capital.[19] As in the estimations concerning exports, the productivity term represents the percentage deviation in productivity over a plant's three-digit industry mean. The coefficient on productivity is positive, which is a result that matches the theoretical relationship developed and Ericson and Pakes (1995) and Pakes and Maguire (1994), which shows that plant-level investment is increasing with productivity. The coefficient on productivity is positive and significant indicating that plants with higher levels of productivity invest at greater rates than their lower productivity, but otherwise similar, counterparts. The coefficient on lagged capital is positive. This indicates that larger plants invest more, which can be attributed to the replacement of larger amounts of equipment.

The final coefficient is the coefficient on exports. This term is positive and different from zero at the five percent confidence level. While the examination of the influences on exports neglected the simultaneity issue of exports and investment, the results in Column 2 are obtained from the previously described instrumental variables Tobit estimation method.[20] This methodology is employed to address the endogeneity issue that results by introducing exports as an influence on investment. The use of such a methodology is not superfluous. As theory would predict, the coefficient on exports is greater in the non-instrumental variables

[19]It was necessary to include this additional term to accurately model the evolution of capital in the policy simulations modeled later in the paper.

[20]The primary focus of this paper is the impact of exports on investment and output. Therefore, the simpler estimation methods were applied in the analysis of the export decision.

approach of Column 1. Smith and Blundell (1986) develop a test to verify exogeneity conditions in the Tobit model. The null hypothesis of exogeneity using Smith and Blundell's test is rejected. This result supports the hypothesis that a plant's level of exports affects its investment decision. However, such a result could be driven by magnitude of several plants, and not necessarily the export status of the plants in the sample. More specifically, it does not indicate that exporting plants have greater investment rates than their non-exporting counterparts.

Column 3 of Table E.9 shows the result of the Tobit replacing exports level with export status, while Column 4 displays the results of the instrumental variables Tobit treating export status as an endogenous variable. The first stage of the estimation regresses the binary export status on the instruments and exogenous variables. This predicted value is then used as export status in the second stage. The first stage, thus, amounts to a linear probability model, which has the potential to estimate the probability of exporting outside of the 0-1 range.[21] Despite this caveat, the approach allows the endogeneity of the export decision to be addressed in the estimation process. The results shown in Columns 3 and 4 indicate similar relationships exist as compared with the first two columns, but the coefficient on export status is positive and significant at the higher one percent confidence level.

The results presented in this section support the hypothesis that the exporting status, orientation, and volume, of manufacturing plants influence the plant's investment decision. The analysis of the export decision finds that an element of hysteresis exists in the export market that coincides with the export expansion costs included in the theoretical model. The results indicate that plants encounter an initial hurdle in entering the export market. However, once a plant becomes an exporter, the investment of exporters occurs at higher levels than their otherwise similar non-exporting counterparts.

[21]In their examination of the export decision Bernard and Jensen (2004) conduct robustness tests across various estimation methods in the examination of the export decision. They find similar relationships exist across estimation methods.

4.6 Simulation Analysis: The impact of exports on value-added

The previous section provides evidence that supports the relationship of exports and investment at the plant level. However, the influence of exports on the growth of industry output has not yet been examined. This section seeks to develop the linkage between exports and the growth in industry output. If exports provide an increased incentive for a plant to invest in capital, and, in turn, capital produces value-added output, then an exogenous increase in exports should lead to higher level of future plant-level output.[22] Therefore, export shocks, such as those driven by shifts in trade policy and exchange rate movements, lead to an increase in the output capacity of an industry. If, ceteris paribus, plant-level output increases, then industry output as a whole should increase. However, the increased level of exports may also affect the exit and entry plants within the industry. Thus, these dynamic effects must also be included in the analysis of industry growth.

The industry output, $\tilde{Y}_t$, is the sum of the output in the industry at time t:

$$\tilde{Y}_t = \sum_i Y_{it},$$

and likewise the growth of the industry can be denoted as

$$\frac{\tilde{Y}_t - \tilde{Y}_{t-1}}{\tilde{Y}_t} = \frac{\sum_i \tilde{Y}_{it} - \sum_i Y_{it-1}}{\sum_i Y_{it}}. \tag{4.29}$$

However, if plants exit or enter the industry, then the set of plants is changing across time. These entry and exit effects must also be addressed when analyzing the effects of an exogenous increase in exports on the evolution of industry output. Accordingly, the growth of industry value-added is decomposed as

$$\frac{\tilde{Y}_t - \tilde{Y}_{t-1}}{\tilde{Y}_t} = \frac{\tilde{Y}_{Ct} - \tilde{Y}_{Ct-1}}{\tilde{Y}_t}\frac{\tilde{Y}_{Ct}}{\tilde{Y}_{t-1}} + \frac{\tilde{Y}_{Nt}}{\tilde{Y}_{t-1}} - \frac{\tilde{Y}_{Xt-1}}{\tilde{Y}_{t-1}}, \tag{4.30}$$

[22] As noted in the previous section, the measure of output used in the analysis is value-added created as deflated revenue less deflated materials and services. Output and value-added are used interchangeably in the remainder of the paper with the understanding that output is value-added in nature.

where $\tilde{Y}_{Ct} = \sum_{i \in C} Y_{it}$ represents the sum of output from plants continuing from the last period, $\tilde{Y}_{Xt-1} = \sum_{i \in X} Y_{it-1}$ is the sum of output of plants that exited at the end of the previous period, and $\tilde{Y}_{Nt} = \sum_{i \in N} Y_{it}$ is the output from plants that entered the market in time period t. The above decomposition of growth demonstrates the three influences on industry growth. The first term on the right hand side represents contribution of continuing plants towards the industry's growth. The second term is the impact of entering plants on the industry's growth rate. The last term reduces the growth rate to account for plants that exited the industry. Table E.10 shows the decomposition of growth of all plants in the industry during the 1990 to 1996 period. This table shows that the growth occurs through both the increase in the output of existing plants as well as additional entrants, which more than offsets the loss of industry revenue occurs due to exit.

The results in the previous section suggest that the exporting behavior of a plant positively influences a plant's investment behavior. If an exogenous shift in exports occurs, then an increased rate of investment should lead to increased capital stocks, thereby allowing increased production by already active plants. Further, exports may also provide a growth opportunity for plants that might otherwise exit the market. Finally, exports may also induce the entry of plants that would not otherwise enter the market. The simulation analysis that follows allows the evolution of the manufacturing sector to be examined under the premise of an exogenous increase in exports. More specifically, the growth effects of a series of exogenous shocks are examined through the use of counterfactual simulations. This methodology allows the impact of each of these decomposed components of growth to be addressed.

A typical open-economy macroeconomic model might show the economy-wide increase in output that occurs due to an autonomous increase in exports. The simulations presented in this section contrast these concepts by looking at the role exports play at the plant level. A simulation is first conducted to verify the robustness of the results. A series of simulations is then used to examine the impact of exogenous export shocks on the growth of capital and investment in the industry. While the last section provides evidence that a relationship between exports and investment exists, this section more closely links the relationship between exports and industry output by simulating the manufacturing sector's evolution. Figure E.4

shows the plant-level timeline that occurs during each period. Each plant-level decision identified in the timeline is based upon parameters estimated from the data. The simulation methodology is described in detail in the appendix.

Tables E.11-E.3 present the results of the robustness simulation. The values displayed represent the mean value of each variable for 1000 repetitions. A problem is encountered in the comparison of the baseline simulation with the actual data. The baseline simulation begins with plants that are present in the data in 1990. If a plant is present in 1990, then its behavior is simulated through 1996 unless it exits prior to 1996. This baseline simulation creates these synthetic values regardless of whether or not a plant is missing an observation in the data. For example, a plant might fail to submit its information in a 1993, but exist in the data during all other years. In such a situation, the plant has a missing observation in the data, but the simulation has created synthetic values for the plant in 1993. Accordingly, when the sample is restricted to only those plants present in 1990, the number of synthetic observations created by the simulation outnumbers those in the data due to missing observations.

The robustness verification compares the characteristics of plants in the sample with the simulated values for the same plants. The robustness simulation uses plants that are present in 1990, simulating their behavior through 1996. Entry is not included in the simulation for two reasons. The capital stock of entrants after 1992 is unknown.[23] This makes a comparison of the simulation results with the data impossible. Further, entering plants can be implemented using the entry draw, the methodology does not allow the prediction of an entering plant's characteristics, i.e. capital stock, exports, etc. Therefore, this method creates a greater deviation from the data than occurs if entry is excluded.[24]

Tables E.11-E.14 compare the mean number of plants in each year of the simulation with the data. The observations column indicates the number of observations that are present in the data for each year. Observations of entrants and plants otherwise not present in 1990 are excluded in the columns calculated from the data. To address the missing observations

[23]Simulations using a random draw on only those entrants from the year 1990-1992 yield results that are inconsistent with the data since the properties of the entrants varies across years.

[24]Entry is included in the comparison of policies presented later in this section. Additional discussion of entering plants can be found in the appendix.

in calculating the number of plants that exist, the initial number of plants less plant exit is calculated, this number is displayed in the column labeled "actual". A comparison of the simulation with the data shows that the simulation accurately predicts the final number of plants, as well as the timing of the exit across years. Plant exit is minimal in the earlier years, but increases in the mid-1990s. As noted earlier, exit is unknown in the year 1996, thus, this column excludes a value for 1996. However, the tables do include simulated exit for this year.

Table E.12 displays a comparison of the mean factor levels in the simulation and the data. The general trend of each of the three inputs, skilled labor, unskilled labor follows the movement in the actual data. The labor columns indicate the mean number of workers per plant and the capital column is standardized so that mean level of real capital in 1990 is 100. The mean level of skilled labor in the simulation trails the actual mean level by failing to incorporate the relatively large increases in skilled labor usage in 1993 and 1994. Despite this difference, the simulation does predict the general trend of skilled labor usage and likewise accurately predicts the overall growth in the levels of unskilled labor and capital within the manufacturing sector.

Table E.13 shows the simulated and actual levels of industry and mean real output. Each of these values is standardized so that the 1990 value is equal to 100. Both measures of simulated output follow the general trend of industry output, but fail to incorporate the large growth of output that occurs in 1993, the year following the liberalization of the capital account. While the impact of such a liberalization may indirectly influence the simulation through exchange rate and real interest effects, additional influences are more difficult to model without the use of time dummy variables. However, the use of such dummy variables would incorporate additional influences beyond the capital account liberalization, and, therefore, are excluded from the simulation.

Table E.14 displays the number of exporters, standardized real industry exports, and the standardized mean level of exports by exporters. As noted in the previous section, the methodology specifically models the plant-level exit and entry into the export market as well as the production of exporters. Although the simulation results in a higher number of exporters in the final year, it does model the overall trend of active exporters. The number of exporters initially increases, but then declines in the later years, a result that matches the trend in the data. Likewise, the simulation shows the overall growth of exports in the industry throughout the time period. The actual level of real exports at the industry and plant level varies to a much greater extent than the general trend of the simulation. The simulation fails to predict the drop in exports in the final year, which results in a higher predicted value of exports at both the industry and plant-level. However, the levels of simulated exports remains below the 1995 levels found in the data.

The results presented show that the simulation of heterogeneous plants results in levels of input usage, output, and exports consistent with the evolutionary trends found in the data. The use of such an econometrically calibrated simulation makes use of the mean influence of each of the variables included in the decision process of the plants, thereby resulting in a smoother evolution of the industry as compared to the data. However, this approach allows plant behavior to be modeled in a manner that addresses the heterogeneous nature of the plants in the sample and eliminates temporary shocks that do not play a role in the long-run evolution of the industry.

The simulations are used to examine five types of exogenous shocks in exports. Tables E.15-Table E.22 show the results of each of these simulations. This simulation is identical to the previously described robustness simulation, but also simulates entry into the industry. Plant entry is also included in the simulation. As previously described, capital is only reported in 1992, therefore the capital stocks of plants that enter after 1992 are unknown. The percentage of plants entering in each year is calculated from the overall sample. The number of entrants for each year in the simulation is then calculated as this percentage of plants in the current year of the simulation. This number of entrants is randomly drawn from the year specific pool of entrants found in the data.[25] This approach allows the characteristics of entrants, such as input level, productivity, and exports, to be differentiated from the existing

[25] An alternative approach would be to conduct a Poisson regression that estimated the number of entrants in a given year. However, foreign influences, such as the real exchange rate and world GDP are not significant in such a regression, which is limited to seven observations of each year in the sample. This result supports the notion that the possibility of exporting is not driving entry behavior, which indicates that export-induced entry is not driving the growth of the industry. Therefore, the entry effect on the growth of industry output, $\frac{\tilde{Y}_{Nt}}{\tilde{Y}_{t-1}}$, is not influenced by exporting potential. Accordingly, the simpler approach in modeling entry, described above, is used in simulations.

plants in the sample. The method used to simulate entry is not without some drawbacks. First, use of a fixed percentage of entrants each year has several caveats. A decline in plants exiting from the industry in previous years increases the number of plants remaining in the sample. This results in an increased number of plants entering the industry in future years. If economic conditions occur that lessen exit and induce entry, then the modeling of entry may accurately reflect the industry's evolution. However, the approach does not address entry that is induced by the exit of plants, which may create opportunities for these potential entrants. Furthermore, the use of the random draw from the year-specific pool of entrants found in the data, provides an influence that limits the variability of plant-level variables across simulations conducted under the premise of different policies.

Simulation 1 uses the estimated parameters and plant-level characteristics found in the data. Simulations 2 and 3 model the evolution of the industry if the probability of entry into the export market is increased. The use of a random draw alongside the plant- and time-specific entry probability allows the probability of each plant to be changed to reflect an increased probability of entry into the market. The calculated entry probabilities are doubled and quadrupled, respectively, in Simulations 2 and 3. These simulations seek to model shocks that address the initial entry decision, but do not affect the plant's decisions beyond this initial decision. Simulation 4, which combines the shocks of Simulations 2 and 3, is likely the most realistic approach to modeling export assistance. The entry probability is doubled and entrants to the export market experience a 20 percent increase in their initial level of exports. This simulation seeks to model a scenario where an exogenous shock allows a plant overcome the initial hurdle and establish an overseas market. The final simulation, Simulation 5, assumes that all exporters receive a form of assistance that allows a 20 percent increase of exports. Current exporters experience the increase in 1990. Plants that enter the export market in later years also receive a 20 percent increase in their initial level of exports.

Each of the scenarios seeks to evaluate the evolutionary impact of an exogenous shock to plant-level exports. The simulation methodology allows the impact on the capital stock, labor usage, and output of plants in the industry to be examined through the use of counterfactual experiments. Table E.15 shows the number of plants that exist in the manufacturing sector under each of the above described simulations. The implementation of such shocks does not directly affect the number of plants in each simulation. The initial number of plants for each simulation is identical and entry is a fixed proportion, the exit of plants from the market, shown in Table E.16, drives the number of plants in the simulation. This result supports Melitz's (2003) finding that exporters are not the least productive plants in the market, but rather the most efficient and, therefore, profitable, producers. Accordingly, the shocks to exports do not provide aid to the ailing producers in an industry, but rather direct resources towards plants that would not exit the market regardless of their export orientation. The lack of response in the number of plants to the exogenous export shocks indicates that any export-induced growth must occur through the growth of existing plants, which enters the decomposition of industry growth as $\frac{\tilde{Y}_{Ct}-\tilde{Y}_{Ct-1}}{\tilde{Y}_t}$.

Table E.17 shows the evolution of real capital within the manufacturing sector for each of the scenarios examined. The values are standardized so that 1990 is equal to 100. The baseline scenario (Simulation 1) shows an increase in the mean capital stock of the industry of 81 percent over the entire period. The export shocks raise the mean level of capital in all situations. The shocks that affect entrants (Simulations 2, 3, and 4) show an increase in the final level of capital that is 2.64 to 4.41 percent greater than the increase of the baseline scenario. The scenarios where recent entrants or existing exporters are affected, but the entry decision is not altered (Simulations 5) results in a smaller increase in the growth of the capital stock. These results support the notion that once the hurdle into the export market is overcome (equation 4.3), new exporters seek to expand their capital base to fulfill overseas demand. However, once an exporter has developed its overseas markets, additional increases in exports that occur through assistance programs do not result in increased investment.

Tables E.17 and E.18 show labor usage under each scenario. The growth in labor, either skilled or unskilled, does not increase by over one worker in any of the simulations. Thus, despite the additional growth in capital, these shocks do not have a large impact on employment by the industry. However, this result should not directly eliminate the more general equilibrium oriented growth effects that are not embodied in the simulation. For example, the expansion of the manufacturing sector may lead to growth of other industries. In the case of Chile, the manufacturing industry is largely involved in the conversion of agriculture and raw materials. The expansion of the manufacturing sector may lead to an increased demand for the output of these other sectors, thereby stimulating employment in these other more labor intensive sectors. However, the simulation methodology does not address these general equilibrium effects, and accordingly, little evidence is found that supports the notion that the increase in exports leads to increases in employment.

Table E.13 shows the mean level of output of plants during each simulation year. A comparison across simulations finds similar results to the evolution of capital. Those shocks that induce entry in the export market lead to an increase in output of between 2.8 and 4.0 percent. However, the increase of the export level of entering or exiting exporters yields an increase of less than one percent. It should be noted that the level of output in the simulation is input-driven and capacity issues are not addressed. A plant's level of exports indirectly affects its investment in capital, thereby, expanding its total output. If additional exports reduce a plant's excess capacity, additional gains may occur that are not driven by this increase in capital stock.

These results contrast with Conway's (2007) findings of the impact of import competition on the U.S. textile industry. Conway shows that although productivity growth limits a plant's size, the number of plants in the industry decreases with foreign competition. The simulations presented in this paper show a different type of response when the trade incentive is reversed. The export-induced increase in industry output occurs through the growth of existing plants and not an increased number of plants in the industry, which would occur through decreased exit or increased entry.

Tables E.20-E.22 show the number of exporters, mean plant exports, and total industry exports for each of the scenarios examined. The number of exporters increases regardless of the type of positive shock to exports that is applied to the model. However, the increase in exporters is dramatic in the case of entry assistance, whereas as the number of exporters rises by a much smaller degree in the case of an increase the level of exports by existing exporters. However, it should be noted that these results underestimate the impact on exporters because such shocks would indirectly influence the entry of plants into the export market.

The additional impact of this induced entry into the export market is not modeled in the simulation.

Table E.21 shows the mean level of exports by exporters in the sample for each policy scenario. The value for each repetition is created as the mean value of exporters in a given year. Non-exporting plants are not included in the calculation. Accordingly, it is not surprising that the entry-oriented shocks result in lower mean levels of exports, since entrants into the export market begin with lower levels of exports on average than continuing exporters. These additional entrants in the three entry-oriented simulations (Simulations 2, 3, and 4) drive down the mean level of exports. However, despite this decline in the mean level of exports, the total level of industry exports expands in these three simulations. The increased number of exporters leads to gains in the growth of overall sector exports between 15.8 and 35 percent. However, the exogenous shock that targets the level of exports produce much milder gains. Also, despite a 20 percent increase in initial exports in Simulation 5, the resulting 1996 level of overall exports only exceeds the baseline simulation by 19.4 percent. Thus, while this type of exogenous shock might have a short-run impact, its longer term influence on the industry is minimal.

Tables E.23-E.27 shows the decomposition of growth for each of the simulations in a manner similar to that used to create Table E.10. While the contribution of entrants and exiting plants towards the growth rates in are similar to annual rates found in the data, the timing of the growth rates by existing plants differs from the data. A comparison of Table E.10 with Tables E.23-E.27 shows that the simulations overestimate the growth of existing plants during 1993 and 1994 and underestimate the growths rates in 1995 and 1996. These deviations result from the inability of the simulations to correctly model the year-to-year behavior of entrants following their initial year in the market. However, the growth of these existing exporters over the entire 1990 to 1996 remains consistent with the data. While plant exit follows the general trend found in the data, the reduction in industry revenue attributed to exit is overestimated in the latter years of the simulation. This deviation can again be attributed to the introduction of entrants into the sample. While plant exit for those plants that existed in the sample in 1990 can be modeled in a manner more consistent with the data, the prediction of exit by entrants into the market following 1990 is less robust. An extended discussion of the entrant behavior id found in the appendix.

The results presented are based upon a partial equilibrium model of the manufacturing sector's evolution. Output growth in the simulation is driven by the export-induced investment in capital. However, this methodology does not address general equilibrium effects that may occur alongside such an expansion. Much of the sector is involved in the conversion of raw materials into manufactured products.[26] Accordingly, an increased demand for raw materials resulting from increased manufactured exports would result in downstream growth of these industries. Furthermore, an increase export-led investment will also lead to a Keynesian injection supporting the machinery and construction industries. Therefore, the partial equilibrium results in this paper likely understate the growth effects of the export shocks examined.

The results of the counterfactual simulations support several findings. These shocks to exports serve to increase the capital stock and output of the industry. However, the type of shock plays a substantial role in determining the magnitude of the outcome. The growth of capital, exports, and output is much greater when a shock affects entrants into the export market rather than the increase of exports by existing exporters.

4.7 Conclusion

There is an extensive body of literature that examines the export-led growth hypothesis at the macro level. This paper deviates from past work by addressing the issue using establishment-level data. Although previous micro-level studies have examined the influences of sunk costs on exporting plants, these studies do not address the issue of capital formulation. This paper extends the work by imposing an exporting cost that exhibits the properties of learning-to-export. This allows an examination of the role that a plant's export status plays in the plant's investment process.

The current literature on examining foreign influences of plant-level investment remains

[26] The relatively large number of food processing plants (311) and sheer volume of the copper oriented non-ferrous metals industry (372) are prime examples.

limited. The results presented in this paper provide evidence that foreign factors influence the export decisions of manufacturing plants. In turn, the outcome of this export decision directly impacts the investment process of the plants. More specifically, the potential to expand beyond limitations of local markets induces the expansion of a capital stock. The results confirm previous findings that an element of hysteresis exists in the export decision. Plants must overcome an initial sunk cost to enter into the export market. However, once a plant enters the export market, its rate of investment is higher than similar plants.

While the results in this paper have examined the relationship between investment and exports at the micro-level, additional insights into the more macro-oriented mechanisms are also gained. For example, the very basic Keynesian injection that occurs with an increase in exports is not necessarily limited to the role played by exports. There is a direct link between exports and investment that occurs as plants extend their capital stock to produce these exports. Thus, the initial Keynesian stimulus is based not only in exports, but also the corresponding rise in investment that occurs concurrently. While such a result is intuitive, it is also possible that growth in exports could occur at the expense of production for the domestic market or depletion of raw materials. As previous macro studies, such as Herzer, Nowak-Lehmann, and Siliverstovs (2004), have shown, this form of export growth would not conducive to the long-run formulation of a country's capital stock or GDP. The micro-data based partial equilibrium results of this paper show that increase in manufactured exports coincides with an expansion of the capital stock, a condition that supports the hypothesis of export-led growth. The simulation analysis presented in this paper shows that growth in capital induced from export shocks leads to accelerated growth of output.

Appendix A

Appendix for Essay Two

A.1 Data and Descriptive Statistics

The plant-level data utilized by this paper is a manufacturing census collected by the Chilean National Institute of Statistics for the years 1979 to 1996. For each census year, each plant reported nominal values. These values are expressed in constant 1980 Chilean pesos by deflating each with three-digit level price indices. The data used is an extended panel similar to that used by Liu (1993), Tybout (1996), Roberts and Tybout (1996), Levinsohn and Petrin (**?**), and Pavcnik (2002).

The estimation of the production function estimates requires knowledge of the plant's survival into the next period. The manufacturing census does not include any information on the presence of plants beyond 1996. Exit information is derived from a plant's presence in future years. [1]

The analysis in this paper is conducted on four three-digit industries in the manufacturing census. These industries include ISIC 311 (Food Processing), ISIC 321 (Textiles), ISIC 372 (Non-Ferrous Metals), and 381 (Metal Products). Table D.1 shows that Food Processing is the largest of these industries in terms of the number of plants.

The prevalence of plant exit can been seen in the exit column of Table D.1. Each of the three industries experienced a large exodus of plants exiting 1979, which is likely in response the tariffs reductions that occurred in the late 1970's. Likewise, the number of plants rise

[1] Since, this information could be not determined for 1996, observations from 1996 are not used in the estimation of production function parameters. Estimation including observations from 1996 under the assumption that all plants survive produces unrealistic results (i.e. negative coefficients on capital, etc.).

with the appreciation of the peso in the 1990s.[2]

The construction of the capital value deserves special attention. Capital stock was only reported in 1980, 1981, 1992. The capital variable utilized in this paper was created using a perpetual inventory method described by Liu (1993), which involves projecting capital forward or backward for the appropriate years by accounting for depreciation and investment. Similar to Pavcnik (2002), the capital stock is created such that investment becomes active capital in the year after the investment takes place. Some plants reported capital stock in only 1980, 1981, or 1992, and others reported capital stock in more than one year. The capital variable used in this paper is based upon the reported base year 1981. If the 1981 level was not reported, then the capital measures constructed from the base year 1980 are used. Likewise, if a capital measure for a plant is not available in 1980 or 1981, then the 1992 measure is used. The creation of the capital stock levels using the perpetual inventory method resulted in negative capital levels for several observations, which uses a separate depreciation rate for the three categories of capital, buildings, vehicles, and machinery. These negative levels occur due to the assumption of an industry-wide depreciation rate that is inappropriate for the given plant. These observations were dropped from the sample.

The estimation method described earlier requires that investment be greater than zero in order for the monotonicity condition to hold. Thus, the estimation only uses those observations where investment is greater than zero. Albeit with a different production function, Pavcnik (2002), using the same dataset, provides a comparison between series parameter estimates using only observations where investment is greater than zero and estimates that use the complete sample. Her coefficient estimates using these two different samples are similar.

The data for the world industry level price indices come from the NBER-CES Manufacturing Industry Database (constructed by Bartlesman, Becker, and Gray).[3] This database (BBG) provides U.S. price indices at the four-digit usSIC industry classifications. Two is-

[2]The changes in the number of plants per year does not exactly correspond with the appropriate exit and entry levels. The number of plants reported is the number of plants with observations in a given year. If a plant is not observed in a given year after having previously been observed, but later returns to the sample, this plant is not considered as "exiting".

[3]The NBER-CES Manufacturing Industry Database is available on the NBER website at http://www.nber.org/nberces/nbprod96.htm.

sues arise in corresponding the BBG data with the plant data. First, the plant data uses ISIC industry classifications instead of usSIC codes. The BBG data was converted into ISIC classifications using the information provided on OECD and United Nations industry concordances.[4] Second, the BBG data is provided at the four-digit level, while the production function estimations occurred at the three-digit level. Therefore, the BBG price indices were aggregated from the four-digit to the three-digit level using the total value of the four-digit industry's shipment as the weighting scheme. The price index is adjusted by the market exchange rate taken from the International Monetary Fund's International Financial Statistics CD-ROM (IMF IFS). Figure 5 shows these indices for each of the industries over the time period. While these U.S. price indices are not perfect substitutes for the price indices of Chile's trading partners, their use seems reasonable considering that a large portion of trade occurs with the United States. For example, approximately two-thirds of Chilean food exports end up in the United States.

The export-output ratio and import-output ratio are calculated from the data contained in the World Bank's Trade and Production Database and the United Nation's COMTRADE database. The Trade and Production data is provided at the 3-digit ISIC level for the years 1981-1996. However, export and import information was needed for the years 1979 and 1980. This data was constructed from the COMTRADE database and converted from 2-digit SITC data to 3-digit ISIC using a weighting scheme similar to that used for the price indices. However, identity checks revealed that such measures of exports and imports were imprecise. Therefore, a percentage gain in exports was calculated using COMTRADE data and applied to the World Bank data's 1981 levels in an order to extend these series into earlier years.

Gross domestic product, manufacturing production, the consumer price index, and the real effective exchange rate (shown in Figures D.1-D.3) are taken from the International Monetary Fund's International Financial Statistics CD-ROM. Standardization of these variables is done by the author.

[4]The concordances are available at http://unstats.un.org/unsd/cr/registry/regot.asp?Lg=1 and http://www.macalester.edu/research/economics/page/haveman/Trade.Resources/tradeconcordances.html

Appendix B

Appendix for Essay Three

B.1 Derivation of the Comparative Statics in the Theoretical Model

The first order conditions of the plant's value function (4.2) are defined in the text as

$$C_I = \Pi_t^K + (1-\delta)E_t V_{t+1}^K \tag{B.1}$$

and w.r.t. X_t is

$$C_t^x - E_t C_{t+1}^{x'} = \Pi_t{}^X, \tag{B.2}$$

The effect of an exogenous change in the state variable X_{t-1} on the optimal choice of X_t and I_t can be obtained by differentiating (B.6) and (B.7) w.r.t. X_{t-1}, which is expressed in matrix as

$$\begin{bmatrix} \Pi_t^{KK} + E_t\beta V_{t+1}^{KK} & \Pi_t^{XK} \\ \Pi_t^{XK} & \Pi_t^{XX} \end{bmatrix} \begin{bmatrix} \frac{dI_t}{dX_{t-1}} \\ fracdX_t dX_{t-1} \end{bmatrix} = \begin{bmatrix} 0 \\ C_t^{x'} \end{bmatrix},$$

where

$$\Pi_t^{KK} = R_D^{''} f^{'} + R_D^{'} f^{''} < 0,$$

$$\Pi_t^{XX} = R_D^{''} + R_F^{''} < 0,$$

and

$$\Pi_t^{XX} = -R_D^{''} f^{'} > 0.$$

By applying Cramer's Rule, the following comparative statics are obtained:

$$\frac{dI_t^*}{dX_{t-1}} = \frac{\begin{vmatrix} 0 & \Pi_t^{XK} \\ C_t^{x'} & \Pi_t^{XX} \end{vmatrix}}{|H|} = \frac{-C_t^{x'}\Pi_t^{XK}}{|H|} > 0$$

and

$$\frac{dX_t^*}{dX_{t-1}} = \frac{\begin{vmatrix} \Pi_t^{KK} + E_t\beta V_{t+1}^{KK} & 0 \\ \Pi_t^{XK} & C_t^{x'} \end{vmatrix}}{|H|} = \frac{C_t^{x'}[Pi_t^{KK} + E_t\beta V_{t+1}^{KK}]}{|H|} > 0.$$

where $|H|$ indicates the determinant of the Hessian of the matrix, which is necessarily positive at the maximum of $V_t(K_{t-1}, X_{t-1})$.[1]

B.2 Simulation Methodology

A plant enters each time period with its prior levels of capital, labor, productivity, and exports. During the period the plant makes choices regarding its input use, export status and level, and survival into the next period. These decisions reflect not only the plant's own characteristics, but also the macroeconomic environment in the given year, which indirectly affects investment by altering the export potential of a plant.

Investment is deemed the plant's first decision. The parameters used to simulate the investment process follow from Table E.9, Column 2. The plant's investment decision is followed by an update of the plant's productivity. Each plant enters the simulation with the level of productivity estimated from the data in 1990. This productivity variable is then updated in future periods using the mean change in productivity experienced by plants during the time period. Accordingly, the evolution of productivity becomes:

$$\Delta\omega_{it} = \Delta\omega + \varepsilon_i t \tag{B.3}$$

[1]Note that the transversality condition implies that V_{t+1}^{KK} approaches zero from the negative side as $\lim_{t\to\infty}(1-\delta)^t l_{t-1} = 0$.

where $\Delta\omega$ is the plant- and time-invariant change in productivity that is estimated from the data as .041, which indicates that the mean annual productivity change of plants is increasing by just over four percent.[2] The error term in (B.3) is also included in the simulation through the use of a random draw from a normal distribution with the standard deviation calibrated by the data.

The update of the plant's productivity is followed by an update of the plant's levels of skilled and unskilled workers. While labor does not directly enter the plant's value function in (4.2), it is assumed to be determined within each period. Parameters used to update these levels of labor are estimated using a linear approximation of the plant's time-differenced first order condition for labor, which assumes that the plant's capital decision has already occurred:

$$\Delta l_{it}^{j} = \lambda_0 + \lambda_1 \Delta k_{it} + \lambda_2 \Delta w_t^s + \lambda_3 \Delta w_t^u + \lambda_4 \Delta x_{it} + \lambda_5 \Delta \omega_{it} \tag{B.4}$$

where w_t^j represents the real wage paid to labor relative to the price of the plant's output and $j \in (s, u)$. The results of (B.4) are presented in Table E.28. The positive coefficients on the change in capital indicate that employment of both skilled and unskilled workers increases as a plant increases its capital stock. The estimated coefficients also indicate that an increase in the wage paid to a type of labor has a negative influence on the quantity of labor employed. Further, a degree of substitution also exists between labor types. An increase in the skilled wage results in an increase in unskilled labor. Similarly, an increase in the unskilled wage results in an increase in the use of skilled labor. Two final terms also enter (B.4). The coefficient on exports displayed in Table E.28 indicated that an increase in exports leads to an increase in the usage of both types of labor. The final term in (B.4) is productivity, which theory would predict to be positive. An increase in productivity would allow the plant to expand its output in a cost effective manner. However, Table E.28 shows that this term is both negative and significant, which suggests that the productivity gains were driven by the introduction of labor reducing technologies.

[2]The estimations and respective simulated values for investment and exports are based upon a plant's productivity differenced from its three-digit industry mean. These means are recalculated for each year in the simulation.

The above equations address the updating of inputs and productivity, which allows output to be predicted for the given time using the production function described in (4.10):

$$\hat{y}_{it} = \hat{\beta}_l l_{it} + \hat{\beta}_k k_{it} + \hat{\omega}_{it},$$

where productivity, capital, and labor are the updated values for each time period.

The plant also must make an export decision, which varies according to a plant's previous export status. Existing exporters must decide whether or not to continue exporting (the export status decision) in the current period. If the plant chooses to export, it then must decide its level of exports. Likewise, non-exporters can choose to enter the export market. If the plant does enter the export market, it must decide upon its level of output.

The probability that an existing exporter exits the export market is estimating using the probit equation defined as

$$x_{it}^{exit*} = a_0 + a_1 k_{it} + a_2 e_t + a_3 x_{it-1} + \omega_{it}, \tag{B.5}$$

where

$$x_{it}^{exit} = \begin{cases} 1 \quad if \;\; x_{it}^{exit*} > 0 \\ 0 \quad\; otherwise. \end{cases}$$

While other determinants of the export decisions, such as productivity, industry, and world GDP, are included in previous estimations of export behavior, they do not result in significant coefficients when included in the above equation. The estimates of the above parameters, shown in Table E.29, allow the probability that plant i exits to be calculated as $p(x_{it}^{exit})$. However, the actual decision process is more random in nature. While a plant may have a high probability of exiting the export market in any given time period, it does not necessarily exit the export market. To incorporate this random nature, a random variable is created $u{\sim}U(0,1)$ for each plant. The plant exits the export market if $u < p(x_{it}^{exit})$. This methodology embodies the random of nature of exit from the export market while also incorporating characteristics that influence the likelihood that a plant exits in any given year. Plants that stay in the market as exporters next choose their level of exports. Using only the continuing exporters in the data, the following equation, similar to (4.23), is estimated via OLS

$$x_{it} = a_0 + a_1 k_{it} + a_2 e_t + a_3 x_{it-1} + \mu_j + \varepsilon_{it}, \tag{B.6}$$

which excludes world GDP, productivity, and the skilled-unskilled labor ratio due to insignificance.[3] The parameters obtained from this estimation are used to create a predicted level of exports for each of the continuing exporters. Simulations conducted using the predicted measure in (B.6) tend to underestimate the level of industry exports over the time period, which is likely driven by an element of survival bias that stems from the exit of plants who experience negative shocks in exporting. To address this issue, an error term in (B.6) is drawn from the distribution estimated from the data. This error term added to the predicted level of output for the continuing exporter, which can be calculated using the parameter estimates from (B.6) alongside observation specific variables.

The above estimations address the export behavior of existing exporters, but they do not consider the export decision process of potential entrants into the market. Accordingly, two additional equations are estimated to simulate entry into the export market and an entrant's level of exports. Entry into the export market is estimated as

$$x_{it}^{entry*} = a_0 + a_1 k_{it} + a_2 e_t + a_3 \omega_{it} + \mu_j + \varepsilon_{it}, \tag{B.7}$$

where

$$x_{it}^{entry} = \begin{cases} 1 \quad if \;\; x_{it}^{entry*} > 0 \\ 0 \qquad otherwise. \end{cases}$$

which excludes lagged exports since all entrants report zero exports in the previous period. Likewise, productivity and the three-digit industry significantly influence the probability that a plant enters the export market, which is different from the results obtained from existing

[3]The above equation does not address the endogeneity issue stemming from the current period's capital, which is partially composed of the current period's investment. However, various alternatives, such as using lagged capital and the instrumental variables approach result in similar simulation results. Accordingly, the above estimation process is used for simplicity.

exporters. These results indicate that plants of higher productivity levels are able to overcome the hurdle into the export market. However, once this hurdle has been overcome, the productivity level of a plant becomes relatively less important in determining its export status. The estimation of the above entry probit allows the probability of entry into the export market, $p(x_{it}^{entry})$, to be calculated, which is utilized to simulate entry using a random draw method similar to that described for exit from the export market.

The above method allows entrants into the export market to be created. However, the simulation requires that the level of exports for each of these entrants to be calculated if a plant's entry is simulated. Since the lagged export value of each entrant is zero, other influences must determine a plant's initial level of exports. The following equation is estimated using an OLS regression with industry dummy variables to calculate a plant's initial level of exports:

$$x_{it} = a_0 + a_1 k_{it} + a_2 e_t + a_3 \omega_{it} + \mu_j + \varepsilon_{it}, \tag{B.8}$$

which is estimated using a sample limited to the observations of plants in their initial year of exporting. Once a plant's initial level of exports are determined, a plant is deemed an exporter in future years, and, thus, the plant's level of exports is simulated using the parameters obtained for existing exporters. The results of each of these export estimations are presented in Table E.29.

Two additional components are needed to complete the simulation. While entry to and exit from the export market have been discussed, plant entry and exit from the overall market also need to be included in the simulation. The probability that a plant exits the market, $\chi_{it} = 1$, is created from estimates of the coefficients in the below probit equation

$$\chi_{it}^* = d_0 + d_1 k_{it} + d_2 e_t + d_3 \omega_{it} + d_4 l_{it}^s + \mu_j + \varepsilon_{it}, \tag{B.9}$$

where

$$\chi_{it} = \begin{cases} 1 & if \;\; \chi_{it}^* > 0 \\ 0 & otherwise. \end{cases}$$

While the real exchange rate, e_t, had previously entered the export equations to measure relative price competitiveness of exports, it serves as a dual purpose in the case of exit from the overall market. A real exchange rate appreciation decreases the relative price of foreign producers, thereby increasing import competition in the domestic Chilean market. Likewise, such an appreciation diminishes the ability of Chilean producers to export. Plants with larger capital stocks have already committed resources towards future production, and, therefore should be less likely to exit. Similarly, sunk investment in human capital is addressed by including the level of skilled workers in the above probit equation. The parameters estimated from these equations are used to create the probability that a plant exits. This probability is used alongside a random draw to simulate plant exit using the methodology applied to the export entry and exit components of the simulation. The results of (B.9) are shown in Table E.28.

The data do not specifically include a measure of plant exit. Therefore, such an exit variable must be manufactured from the data. If a plant leaves the sample and does not return in any year, the plant is recorded as exiting during its last reported year. The use of this methodology eliminates prevents the creation of exit for the last year in the sample, 1996. Therefore, the estimation of exit is only conducted on observations before 1996.

Plant entry is also included in the simulation. As previously described, capital is only reported in 1992, therefore the capital stocks of plants that enter after 1992 are unknown. The percentage of plants entering in each year is calculated from the overall sample. The number of entrants for each year in the simulation is then calculated as this percentage of plants in the current year of the simulation. This number of entrants is randomly drawn from the year specific pool of entrants found in the data.[4] This approach allows the characteristics of entrants, such as input level, productivity, and exports, to be differentiated from the existing plants in the sample. While all entrants include recorded levels of value added and labor,

[4] An alternative approach would be to conduct a Poisson regression that estimated the number of entrants in a given year. However, foreign influences, such as the real exchange rate and world GDP are not significant in such a regression, which is limited to seven observations of each year in the sample. This result supports the notion that the possibility of exporting is not driving entry behavior, which indicates that export-induced entry is not driving the growth of the industry. Therefore, the entry effect on the growth of industry output, $\frac{\tilde{Y}_{Nt}}{\tilde{Y}_{t-1}}$, is not influenced by exporting potential. Accordingly, the simpler approach in modeling entry, described above, is used in simulations.

only those plants that exist in 1992 have reported levels of capital stock.[5] The productivity level of entrants is then calculated as the net of real value added and the influence of these inputs. It is necessary to create the capital stock for the remaining plants. The three-digit industry-specific mean level of productivity for entrants is assumed for each plant.[6] This assumption allows the plant's capital stock to be created using the three-digit industry's estimated production function parameters in conjunction with value-added and labor to solve (4.10) for the plant's level of capital.

Table E.30 shows descriptive statistics of the entering plants. The first column shows the number of entrants relative to plants that already exist in an industry. This percentage is used to calculate the number of plants that enter the simulation during each year. The second column shows real valued added of entering plants. This column shows that the average size of plants in terms of value added varies greater across years, which necessitates a random draw of entrants from a year specific pool. The final two columns show, respectively, the mean number of workers for each entering plant. These levels are lower than number of workers employed by existing plants, which lowers the industry's mean number of workers as these entrants are introduced to the market.

Once an entrant has entered the simulation, its behavior must be simulated in future years. The simulation of entrant behavior proceeds in a manner similar to the existing plants. However, the use of the parameters used to simulate the behavior of the existing plants produces unrealistic results when applied to recent entrants. It is likely that a recent entrant's decision making process is different from plants that have existed for a longer period of time. Further, the previously described process used to create capital and productivity values likely leads to some inaccurate values for plant specific values. Accordingly, the behavior of entrants is estimated using the limited sample of entrants. Tables E.31-E.32 show the behavior parameters estimated from the data for entrants. Each equation is similar to the non-entrant equations described earlier, but utilizes a limited number of independent variables. For

[5]This includes plants that enter in 1990 or 1991 and are also present in 1992. In such cases the previously described perpetual inventory method is used to calculate the plant's capital stock.

[6]The industry-wide productivity level is used for entrants to ISIC 311 since no entrant observations have reported levels of capital.

example, productivity is excluded from estimations due to the necessity of creating artificial values for most entrants. Further, the inclusion of capital in estimation restricts the sample to only those pre-1993 entrants that have reported levels of capital.[7] While the use of the separate updating conditions for entrants provides a less robust method for the updating of plants than the previously described method used for existing plants, the approach seeks to makes use of the available data in order to include entry in the simulation methodology.[8]

The results in Table E.31 do not include parameters that allow the exit of plant exit from the market to be included. Plant productivity and capital stock are two primary influences in the exit of the existing plants from the market. Since the majority of the entrants in the simulation have artificially calculated productivity levels and capital, the use of such parameters is inappropriate. Accordingly, it is assumed that each entrant has the same exit probability of .0738, which is the probability that an entrant will exit the market in any given year. This probability is used in conjunction with a random draw in a manner similar to that applied to existing plants. However, this simpler approach has a drawback, as larger entrants exit the market in the simulation as compared with the data, which leads to an overstatement the industry revenue lost to exit in Tables E.23E.27.

The simulation begins by using the 1990 values of capital, labor, productivity, and exports for each of the plants in the sample. Exit in 1990 is then simulated and the exiting plants are removed from the sample and the plants proceed into the next year. Investment for each of these plants is then calculated. Investment is followed by the productivity and labor updates. The entrants are then added to the simulation sample. Next output is created using the updated values of inputs and productivity. Finally, the export decision making process is simulated. The period ends with the exit of plants from the overall market and the plants proceed into the next period.

The use of random draws for export behavior, entry and exit necessitates the use of a Monte Carlo simulation. Therefore, each policy simulation described in the next section is

[7] A much larger sample is used for the probit on the export from the export market, which excludes the capital. However, the positive coefficient on lagged exports provides a result inconsistent with the theory presented in the text.

[8] Policy simulations excluding entry produce similar export-induced growth effects.

repeated 1000 times. The robustness of the simulations is verified by increasing the number of repetitions with similar results. The Monte Carlo approach with numerous random draws occasional results in extreme values of capital and exports. Therefore, the level of capital and exports of plants in the simulation are constrained to maximum levels found in the data. Similarly, a rigidity in labor usage is applied by restricted the reduction of skilled and unskilled workers of any one plant during a given year to 10 percent. Finally, the random draw of error terms in productivity and exports is restricted to the inter-quartile range of the errors found in the data. While an unconstrained simulation would be ideal, the approach used creates results much more consistent with the data. The results of the simulations are described in the next section.

The simulation analysis permits the effects of an exogenous shift in exports on industry output to be examined. The previous section provided empirical evidence supporting the notion that exports have a positive influence on investment in capital. Likewise, parameters estimates from the production function show that output increases with capital. Accordingly, an increase in industry output might be expected when an exogenous shift in exports occurs. However, the dynamic effects of entry and exit also need to be included in the analysis. Further, an increase in exports by all plants may not be long lived. Plants with lower productivity levels may choose to exit the export market in the years after the initial shock. Additionally, such shocks to exports may not be identical. For example, an export-promotion policy may ease entry into the export market, which would not provide support for existing exporters. Alternatively, a shock may affect the export level of existing exporters, but provide little incentive for potential entrants. The simulation methodology developed allows each of these issues to be addressed.

Appendix C

Essay 1 Tables and Figures

C.1 Tables

Table C.1: Comparison of Samples

	full sample			estimation sample			matched sample		
year	obs	exit	entry	obs	exit	entry	obs	exit	entry
1986	4205	236	247	1471	27	17	1471	27	17
1987	4566	246	569	1700	26	43	1092	8	-
1988	4498	232	206	1738	31	13	1064	10	-
1989	4533	229	237	1775	32	18	1047	16	-
1990	4585	171	214	1685	14	30	968	5	-
1991	4765	217	363	1705	21	42	955	13	-
1992	4938	269	351	1683	75	46	908	14	-
1993	5042	282	358	1623	72	-	918	16	-
1994	5082	379	296	1473	76	-	857	21	-
1995	5112	450	380	1354	104	-	809	31	-
1996	5466	-	733	1145	0	-	711	0	-

Table C.2: A Comparison of Production Function Estimates

				Fixed Effects					Olley-Pakes	Melitz
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
skilled labor	0.4523**	0.4502**	0.4312**	0.4295**	0.4142**	0.4118**	0.2743**	0.3265**	0.4723**	0.6297**
	(0.0084)	(0.0083)	(0.0085)	(0.0084)	(0.0085)	(0.0084)	(0.0115)	(0.0126)	(0.0080)	(0.2124)
unskilled labor	0.3634**	0.3624**	0.3947**	0.3970**	0.4432**	0.4466**	0.3625**	0.3265**	0.3042**	0.5579**
	(0.0086)	(0.0053)	(0.0087)	(0.0086)	(0.0089)	(0.0087)	(0.0127)	(0.0106)	(0.0083)	(0.0146)
capital	0.3694**	0.3624**	0.3586**	0.3509**	0.3145**	0.3038**	0.2537**	0.1210**	0.3382*	0.8693**
	(0.0054)	(0.0053)	(0.0055)	(0.0054)	(0.0057)	(0.0057)	(0.0102)	(0.0106)	(0.1473)	(0.0152)
year effects	no	yes	no	yes	no	yes	no	yes		
industry effects (2-digit)	yes	yes	no	no	no	no	no	no		
industry effects (3-digit)	no	no	yes	yes	no	no	no	no		
industry effects (4-digit)	no	no	no	no	yes	yes	no	yes		
plant effects	no	no	no	no	no	no	yes	yes		
N	17352	17352	17352	17352	17352	17352	17352	17352	15592	15592

Note: Standard errors in columns 9 and 10 are bootstrapped with 1000 repetitions. $*$ denotes the coefficient is significantly different from zero at the 95% confidence level. $**$ denotes the coefficient is significantly different from zero at the 99% confidence level.

Table C.3: Productivity by Estimation Method

Estimation Method	Year	Aggregate Productivity	Mean Productivity	Covariance
Fixed Effects	1986	0.00000	0.00000	0.00000
	1987	0.00370	0.01724	-0.01354
	1988	0.10580	0.13316	-0.02736
	1989	0.41375	0.22115	0.19260
	1990	0.22745	0.21747	0.00997
	1991	0.12353	0.19188	-0.06836
	1992	0.12041	0.27755	-0.15714
	1993	0.34759	0.37585	-0.02826
	1994	0.24226	0.39959	-0.15733
	1995	0.21413	0.40216	-0.18804
	1996	0.30209	0.45324	-0.15115
Olley-Pakes	1986	0.00000	0.00000	0.00000
	1987	-0.00878	0.01471	-0.02349
	1988	0.08268	0.13385	-0.05117
	1989	0.40832	0.22493	0.18339
	1990	0.21643	0.22335	-0.00692
	1991	0.11490	0.19923	-0.08434
	1992	0.11393	0.28659	-0.17266
	1993	0.35004	0.38546	-0.03542
	1994	0.23691	0.41130	-0.17439
	1995	0.20263	0.41201	-0.20937
	1996	0.24124	0.44796	-0.20672
Melitz	1986	0.00000	0.00000	0.00000
	1987	0.05439	0.09019	-0.03580
	1988	0.10332	0.16949	-0.06617
	1989	0.50381	0.19433	0.30948
	1990	0.18149	0.18484	-0.00335
	1991	0.06230	0.18874	-0.12644
	1992	0.01742	0.30103	-0.28361
	1993	0.22345	0.28692	-0.06347
	1994	-0.00199	0.29624	-0.29823
	1995	-0.10252	0.25243	-0.35495
	1996	-0.06348	0.26829	-0.33177

Note: Productivity measures are standardized such that the 1986 value is equal to zero. Deviations from zero represent the percentage change from 1986.

Table C.4: An Alternative Approach to Aggregate Productivity

Year	Weight: Deflated Revenue			Weight: Deflated Materials		
	Aggregate Productivity	Mean Productivity	Covariance	Aggregate Productivity	Mean Productivity	Covariance
1986	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
1987	0.05439	0.09019	-0.03580	0.50025	0.09019	0.41006
1988	0.10332	0.16949	-0.06617	0.47234	0.16949	0.30285
1989	0.50381	0.19433	0.30948	0.57176	0.19433	0.37743
1990	0.18149	0.18484	-0.00335	0.43452	0.18484	0.24968
1991	0.06230	0.18874	-0.12644	0.15643	0.18874	-0.03232
1992	0.01742	0.30103	-0.28361	0.11073	0.30103	-0.19030
1993	0.22345	0.28692	-0.06347	0.27127	0.28692	-0.01565
1994	-0.00199	0.29624	-0.29823	0.21641	0.29624	-0.07983
1995	-0.10252	0.25243	-0.35495	-0.21117	0.25243	-0.46360
1996	-0.06348	0.26829	-0.33177	-0.17688	0.26829	-0.44517

Note: Productivity measures are standardized such that the 1986 value is equal to zero. Deviations from zero represent the percentage change from 1986.

Table C.5: Micro Parameter Estimates

	$r_t - \tilde{p}_t$	$\chi_t = 1$	$\frac{I_t}{K_t}$	Δl_t^u	Δl_t^s
intercept		-13.6570**	0.0675**	-0.0516**	0.0023
		(4.0431)	(0.0675)	(0.0067)	(0.0078)
k_t	0.8693**	-.1638**	-0.0080**		
	(0.152)	(.0451)	(0.0007)		
l_t^s	0.6297**				
	(0.2124)				
l_t^u	0.5579**				
	(0.0146)				
σ	2.1959**				
	(0.7471)				
ω_t		-0.2502**	0.0116**		
		(0.0461)	(0.0009)		
w_t		1.1562**			
		(0.3861)			
u^k		-4.6907**	-0.1170**		
		(1.3695)	(0.0127)		
e_t^r			-0.0652**		
			(0.0146)		
τ_t					
g_t^{mfg}				0.8440**	0.2658**
				(0.0983)	(0.1151)
Δu_t^k				0.1120**	0.0379**
				(0.0294)	(0.0344)
Δk_t				0.0491**	0.0659
				(0.0327)	(0.0383)
Δw_t				-0.2730**	-0.1779**
				(0.0105)	(0.0123)
N	15592	11107	18670	13016	13016

Note: Standard errors for the production function are bootstrapped with 1000 repetitions. with 1000 repetitions. $*$ denotes the coefficient is significantly different from zero at the 95% confidence level. $**$ denotes the coefficient is significantly different from zero at the 99% confidence level.

Table C.6: CGE Results: Changes in Linked Variables

	Price of Manufactured Goods		Real Wage		Price of Investment Goods		Real Exchange Rate	
	baseline	counterfactual	baseline	counterfactual	baseline	counterfactual	baseline	counterfactual
1986	1.0000	0.000%	1.0000	0.000%	1.0000	0.000%	0.0000	0.000%
1987	1.2101	0.000%	0.9290	0.000%	1.1791	0.000%	0.0000	0.000%
1988	1.3664	0.372%	1.0121	-0.752%	1.4199	0.267%	0.2268	-1.624%
1989	1.5469	0.367%	1.1788	-0.757%	1.6081	0.263%	0.2227	-1.633%
1990	1.9311	0.366%	1.2606	-0.758%	2.0526	0.262%	0.2218	-1.635%
1991	2.3660	0.666%	1.3463	-1.378%	2.4898	0.483%	0.4095	-2.979%
1992	2.6676	0.652%	1.4406	-1.392%	2.7872	0.471%	0.3994	-3.000%
1993	2.9145	0.641%	1.6388	-1.406%	3.1662	0.461%	0.3909	-3.018%
1994	3.1554	0.641%	1.8685	-1.406%	3.4670	0.461%	0.3908	-3.018%
1995	3.4295	0.639%	1.9486	-1.408%	3.6262	0.459%	0.3893	-3.021%
1996	3.6606	0.625%	2.1069	-1.427%	2.8854	0.447%	0.3791	-3.041%

Note: values in the baseline columns are standardized so the 1986 value is equal to one. Values in this column represent the actual data. Values in the the counterfactual columns represent the percent change in values in the counterfactual simulation from the baseline simulation.

Table C.7: CGE Results: Manufacturing Domestic Sales, Exports, and Imports

Year	Commodity	Baseline Domestic Sales	Baseline Imports	Baseline Exports	Counterfactual Domestic Sales	Counterfactual Imports	Counterfactual Exports
1986	C-MFG	1313.754	619.918	61.681	0.0000%	0.0000%	0.0000%
1987	C-MFG	1332.909	626.731	62.770	0.0000%	0.0000%	0.0000%
1988	C-MFG	1365.540	650.401	66.459	0.6166%	-1.4299%	-1.9987%
1989	C-MFG	1389.946	658.933	67.918	0.6118%	-1.4271%	-2.0097%
1990	C-MFG	1395.172	660.746	68.233	0.6108%	-1.4266%	-2.0120%
1991	C-MFG	1400.197	672.738	70.140	1.1162%	-2.5704%	-3.6634%
1992	C-MFG	1433.953	684.425	72.238	1.1054%	-2.5647%	-3.6872%
1993	C-MFG	1463.588	694.534	74.098	1.0967%	-2.5604%	-3.7063%
1994	C-MFG	1463.944	694.655	74.121	1.0966%	-2.5604%	-3.7065%
1995	C-MFG	1469.067	696.388	74.444	1.0952%	-2.5597%	-3.7097%
1996	C-MFG	1505.443	708.582	76.753	1.0855%	-2.5553%	-3.7305%

Note: Counterfactual values represent percentage change from baseline quantities.

Table C.8: Matched Sample: Number of Plants, Exit and Deflated Revenue

Year	Number of Plants Actual	Number of Plants Simulation	Exit Actual	Exit Simulation	Deflated Revenue Actual	Deflated Revenue Simulation
1986	1466	1466.00	27	19.4010	638.9123	638.9123
				(4.4846)		0.0000
1987	1439	1446.60	8	8.0080	750.6137	669.8140
				(2.3068)		(18.0987)
1988	1431	1438.59	10	14.4750	907.9825	735.9176
				(3.0229)		(27.4546)
1989	1421	1424.12	16	4.3520	1101.8698	959.4762
				(1.6198)		(57.9219)
1990	1405	1419.76	5	0.4710	1151.9102	1100.1150
				(0.4660)		(72.9917)
1991	1400	1419.29	13	7.4460	1129.8569	1016.1246
				(1.9252)		(67.3767)
1992	1387	1411.85	14	12.0330	1202.7915	1142.1930
				(2.4097)		(76.9834)
1993	1373	1399.81	15	12.7180	1473.1041	1326.7754
				(2.4914)		(96.7464)
1994	1358	1387.10	21	21.8700	1518.4874	1265.3384
				(3.3480)		(65.0716)
1995	1337	1365.23	31	26.0990	1590.7161	1474.0254
				(3.4228)		(106.7881)
1996	1306	1339.13	-	45.8900	1595.6250	1586.1100
				(4.3520)		(121.5615)

Note: Numbers in parentheses indicate standard deviations of the mean values of 1000 repetitions. The number of plants is created by subtracting exiting plants from the 1986 value. It is not indicative of the number of plants with observations in a given year. Exiting plants reported for the simulation are from the full (non-matched) sample.

Table C.9: Matched Sample: Capital and Labor

Year	Capital		Skilled Labor		Unskilled Labor	
	Actual	Simulation	Actual	Simulation	Actual	Simulation
1986	501.6150	501.6150	27.8104	27.8104	73.8076	73.8076
		0.0000		0.0000		0.0000
1987	459.2300	499.4116	34.6553	32.9747	86.8061	87.3611
		(6.6825)		(0.1973)		(0.3787)
1988	441.7342	481.3908	36.8040	34.5874	93.4420	89.6957
		(6.0790)		(0.2526)		(0.4504)
1989	463.7248	562.6423	40.1171	36.7665	99.9088	93.5491
		(17.2776)		(0.5496)		(0.5715)
1990	572.5693	693.3411	44.3430	41.4453	107.3461	101.1527
		(17.7639)		(0.6641)		(0.6695)
1991	610.9566	653.4860	44.4397	42.1641	109.8384	101.9115
		(15.9364)		(0.6595)		(0.6164)
1992	641.5872	720.3026	46.3695	45.9697	112.9381	110.2913
		(15.9336)		(0.7555)		(0.7035)
1993	659.5576	776.5643	46.2917	45.9343	114.6239	108.3226
		(15.3681)		(0.8515)		(0.8314)
1994	714.2089	797.0267	49.9836	46.9201	119.0035	107.8217
		(12.0353)		(0.5246)		(0.9046)
1995	823.3941	824.1183	49.9083	47.9831	115.8798	106.1370
		(17.1274)		(0.9720)		(1.0277)
1996	733.4314	800.0254	57.5607	51.2536	101.4873	108.1958
		(17.8030)		(1.0249)		(1.1832)

Note: Numbers in parentheses indicate standard deviations of the mean values of 1000 repetitions.

Table C.10: Matched Sample: Productivity

Year	Aggregate Productivity		Mean Productivity		Covariance	
	actual	simulation	actual	simulation	actual	simulation
1986	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1987	-0.0991	-0.3077	0.2179	0.1432	-0.3170	-0.4509
1988	-0.0718	-0.3390	0.2682	0.1296	-0.3400	-0.4686
1989	0.3446	0.1308	0.3136	0.1182	0.0310	0.0126
1990	-0.0454	0.0646	0.2819	0.1702	-0.3273	-0.1055
1991	-0.1278	-0.1004	0.3354	0.1765	-0.4632	-0.2769
1992	-0.2060	-0.1058	0.4312	0.1780	-0.6372	-0.2838
1993	0.0828	-0.0009	0.3550	0.2021	-0.2722	-0.2029
1994	-0.1256	-0.3716	0.3423	0.2110	-0.4679	-0.5826
1995	-0.2597	-0.0897	0.2611	0.2474	-0.5207	-0.3371
1996	-0.2206	-0.1203	0.3038	0.2469	-0.5245	-0.3672

Note: Mean and Aggregate Productivity are standardized such that the 1986 value is equal to zero. Deviations from zero represent the percentage change from 1986.

Table C.11: Simulation Comparison: Number of Plants, Exit and Deflated Revenue

Year	Number of Plants		Exit		Deflated Revenue	
	baseline	counterfactual	baseline	counterfactual	baseline	counterfactual
1986	1466	1466	19.401	19.319	638.912	638.912
	(0.000)	(0.000)	(4.286)	(4.317)	(0.000)	(0.000)
1987	1446.599	1446.681	8.008	7.979	653.727	653.877
	(4.286)	(4.317)	(2.845)	(2.777)	(21.221)	(22.016)
1988	1438.591	1438.702	14.475	14.069	723.357	727.527
	(5.113)	(5.029)	(3.631)	(3.656)	(33.359)	(33.708)
1989	1424.116	1424.633	4.352	4.219	814.824	821.329
	(6.090)	(6.020)	(2.157)	(2.051)	(43.071)	(44.386)
1990	1419.764	1420.414	0.471	0.450	846.661	854.840
	(6.359)	(6.363)	(0.661)	(0.646)	(47.876)	(48.549)
1991	1419.293	1419.964	7.446	6.878	840.878	853.991
	(6.388)	(6.380)	(2.738)	(2.563)	(47.128)	(49.753)
1992	1411.847	1413.086	12.033	11.725	913.422	927.730
	(6.840)	(6.822)	(3.410)	(3.359)	(53.046)	(54.110)
1993	1399.814	1401.361	12.718	12.327	1031.717	1048.248
	(7.512)	(7.618)	(3.532)	(3.412)	(60.536)	(61.829)
1994	1387.096	1389.034	21.870	21.000	1064.351	1082.105
	(8.125)	(8.244)	(4.676)	(4.408)	(61.860)	(64.112)
1995	1365.226	1368.034	26.099	25.457	1132.652	1151.391
	(9.070)	(9.192)	(5.056)	(4.984)	(64.800)	(68.052)
1996	1339.127	1342.577	45.890	44.595	1196.381	1215.543
	(10.391)	(10.263)	(6.795)	(6.555)	(68.062)	(71.971)

Note: Numbers in parentheses indicate standard deviations of the mean values of 1000 repetitions.

Table C.12: Simulation Comparison: Capital and Labor

year	Capital		Skilled Labor		Unskilled Labor	
	baseline	counterfactual	baseline	counterfactual	baseline	counterfactual
1986	501.615	501.615	27.8104	27.8104	73.8076	73.8076
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
1987	516.516	516.200	29.8158	29.8103	79.1559	79.1634
	(11.914)	(12.258)	(0.2586)	(0.2659)	(0.3186)	(0.3326)
1988	506.968	507.145	30.8648	30.9838	81.1537	81.7963
	(12.142)	(12.050)	(0.3243)	(0.3220)	(0.3660)	(0.3883)
1989	528.684	529.060	32.0200	32.1316	84.3323	84.9701
	(13.308)	(13.107)	(0.4087)	(0.4065)	(0.4569)	(0.4757)
1990	542.057	543.211	33.5716	33.6991	86.7420	87.3963
	(12.551)	(12.491)	(0.4559)	(0.4500)	(0.4814)	(0.4994)
1991	549.535	551.150	34.8351	35.0722	87.8515	89.0715
	(11.335)	(11.313)	(0.4800)	(0.4700)	(0.4929)	(0.5094)
1992	571.287	573.986	36.6865	36.9474	94.4556	95.7463
	(10.940)	(10.965)	(0.5291)	(0.5217)	(0.5484)	(0.5775)
1993	597.517	600.948	37.1817	37.4393	92.0250	93.2691
	(10.565)	(10.894)	(0.5559)	(0.5549)	(0.5893)	(0.6051)
1994	624.929	629.512	37.5571	37.8299	89.0215	90.2149
	(10.189)	(10.860)	(0.5751)	(0.5794)	(0.6187)	(0.6337)
1995	660.038	664.938	38.7041	38.9359	89.5228	90.6939
	(10.254)	(11.127)	(0.5919)	(0.6099)	(0.7095)	(0.7242)
1996	699.191	705.057	39.4251	39.6666	87.7679	88.9041
	(10.5495)	(11.3270)	(0.5919)	(0.6086)	(0.7973)	(0.7923)

Note: Numbers in parentheses indicate standard deviations of the mean values of 1000 repetitions.

Table C.13: Simulation Comparison: Productivity

Year	Aggregate Productivity		Mean Productivity		Covariance	
	baseline	counterfactual	baseline	counterfactual	baseline	counterfactual
1986	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
1987	0.003271	0.005371	0.016201	0.016375	-0.012930	-0.011004
1988	0.019438	0.016885	0.026561	0.026249	-0.007124	-0.009364
1989	0.011138	0.015762	0.040402	0.039574	-0.029264	-0.023813
1990	-0.002464	0.005510	0.044877	0.045193	-0.047341	-0.039683
1991	-0.022614	-0.012988	0.044078	0.044406	-0.066691	-0.057394
1992	-0.037359	-0.024975	0.052124	0.051097	-0.089483	-0.076072
1993	-0.048679	-0.039633	0.062500	0.061519	-0.111179	-0.101152
1994	-0.064497	-0.053631	0.072167	0.071525	-0.136665	-0.125156
1995	-0.078147	-0.067940	0.088158	0.087240	-0.166305	-0.155180
1996	-0.087547	-0.078339	0.106047	0.103275	-0.193594	-0.181614

Note: Mean and Aggregate Productivity are standardized such that the 1986 value is equal to zero. Deviations from zero represent the percentage change from 1986.

Table C.14: CGE Results: Alternative Scenarios with Fixed REER

	Price of Manufactured Goods		Real Wage		Price of Investment Goods		Manufacturing Output	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
1986	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
1987	-0.0096%	-0.3567%	3.1389%	8.4114%	0.1509%	-0.1845%	-0.0406%	-2.6317%
1988	0.3392%	-0.7139%	2.3975%	13.1779%	0.7343%	-1.0665%	0.3750%	-4.0125%
1989	0.3187%	-1.1291%	2.4151%	16.6271%	0.9127%	-1.5604%	0.3046%	-6.8317%
1990	0.3150%	-1.2151%	2.4195%	17.3781%	0.9512%	-1.6632%	0.2891%	-8.4294%
1991	0.6070%	-1.1154%	1.7909%	18.3917%	1.2632%	-1.8972%	0.6673%	-8.7638%
1992	0.5729%	-1.6532%	1.8118%	23.3952%	1.4980%	-2.5250%	0.5556%	-9.5276%
1993	0.5424%	-2.1009%	1.8259%	27.9462%	1.7001%	-3.0449%	0.4550%	-11.5952%
1994	0.5425%	-2.1057%	1.8307%	28.0034%	1.7024%	-3.0510%	0.4538%	-13.3292%
1995	0.5377%	-2.1804%	1.8341%	28.8086%	1.7378%	-3.1380%	0.4361%	-13.3496%
1996	0.5024%	-2.6934%	1.8530%	34.6383%	1.9808%	-3.7332%	0.3101%	-13.6419%

Note: Values represent change from the baseline scenario.

Table C.15: Simulation: Fixed REER

Year	Number of Plants	Mean Deflated Revenue	Capital	Skilled Labor	Unskilled Labor
1986	1466.000	638.912	501.650	27.810	73.808
1987	1447.735	639.023	517.261	29.011	76.688
1988	1438.170	702.613	473.590	30.162	78.789
1989	1420.815	801.260	488.374	31.630	83.225
1990	1416.790	833.407	496.541	32.950	87.554
1991	1416.320	833.920	498.622	34.117	90.849
1992	1407.415	901.863	515.020	35.900	97.347
1993	1392.525	1022.262	537.177	36.775	95.102
1994	1379.345	1063.620	560.548	37.590	92.105
1995	1359.815	1117.765	590.344	38.543	89.328
1996	1336.190	1173.370	625.668	39.405	85.258

Table C.16: Simulation: Fixed REER

Year	Aggregate Productivity	Mean Productivity	Covariance
1986	0.00000	0.00000	0.00000
1987	0.00362	0.01436	-0.01074
1988	0.02205	0.02639	-0.00435
1989	0.02692	0.04351	-0.01659
1990	0.01408	0.04864	-0.03455
1991	0.00884	0.04837	-0.03953
1992	-0.01235	0.05768	-0.07003
1993	-0.03326	0.07095	-0.10420
1994	-0.03494	0.08220	-0.11715
1995	-0.04270	0.09621	-0.13891
1996	-0.04562	0.11207	-0.15769

Table C.17: Simulation: Fixed REER, Alternative Labor Supply

Year	Number of Plants	Mean Deflated Revenue	Capital	Skilled Labor	Unskilled Labor
1986	1466.00	638.91	501.65	27.81	73.81
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
1987	1448.62	634.28	515.66	28.88	75.60
	(4.26)	(22.00)	(12.35)	(0.26)	(0.30)
1988	1440.07	692.69	471.28	29.90	76.44
	(5.16)	(30.57)	(12.35)	(0.34)	(0.36)
1989	1429.19	774.58	484.05	31.09	78.59
	(5.88)	(37.81)	(12.75)	(0.41)	(0.43)
1990	1420.03	806.88	499.42	32.32	81.48
	(6.64)	(44.94)	(12.60)	(0.46)	(0.49)
1991	1411.10	818.11	515.97	33.73	85.25
	(6.97)	(45.22)	(11.81)	(0.50)	(0.55)
1992	1403.11	882.47	533.44	35.36	89.79
	(7.61)	(52.06)	(11.26)	(0.53)	(0.62)
1993	1396.11	987.16	552.41	35.99	85.92
	(7.81)	(58.95)	(10.63)	(0.55)	(0.61)
1994	1390.01	1017.75	572.67	36.71	82.81
	(8.02)	(61.42)	(10.10)	(0.57)	(0.60)
1995	1384.71	1052.65	593.79	37.45	79.57
	(8.40)	(62.89)	(9.74)	(0.56)	(0.59)
1996	1380.27	1082.21	615.47	37.90	74.27
	(8.65)	(66.41)	(9.60)	(0.56)	(0.55)

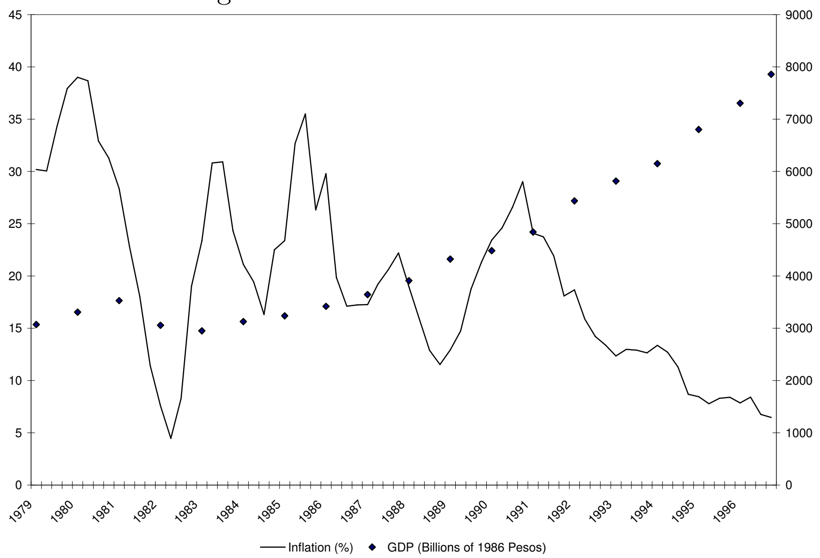
Note: Numbers in parentheses indicate standard deviations of the mean values of 1000 repetitions.

Table C.18: Simulation: Fixed REER, Alternative Labor Supply

Year	Aggregate Productivity	Mean Productivity	Covariance
1986	0.0000	0.0000	0.0000
1987	-0.0017	0.0155	-0.0172
1988	0.0226	0.0264	-0.0038
1989	0.0145	0.0393	-0.0248
1990	0.0093	0.0479	-0.0387
1991	-0.0112	0.0576	-0.0687
1992	-0.0153	0.0653	-0.0806
1993	-0.0307	0.0712	-0.1019
1994	-0.0466	0.0754	-0.1220
1995	-0.0595	0.0785	-0.1379
1996	-0.0646	0.0807	-0.1453

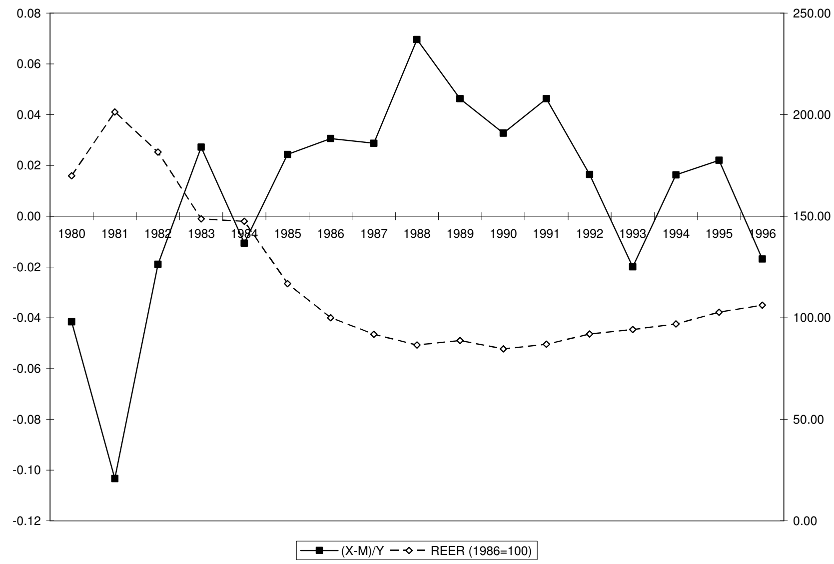
C.2 Figures

Figure C.1: Real GDP and Inflation



Source: IMF International Financial Statistics (2004)

Figure C.2: Real Effective Exchange Rate and Relative Net Exports



Source: IMF International Financial Statistics (2004)

Figure C.3: Tariff Rate

Source: World Bank

Figure C.4: Simulation Schematic

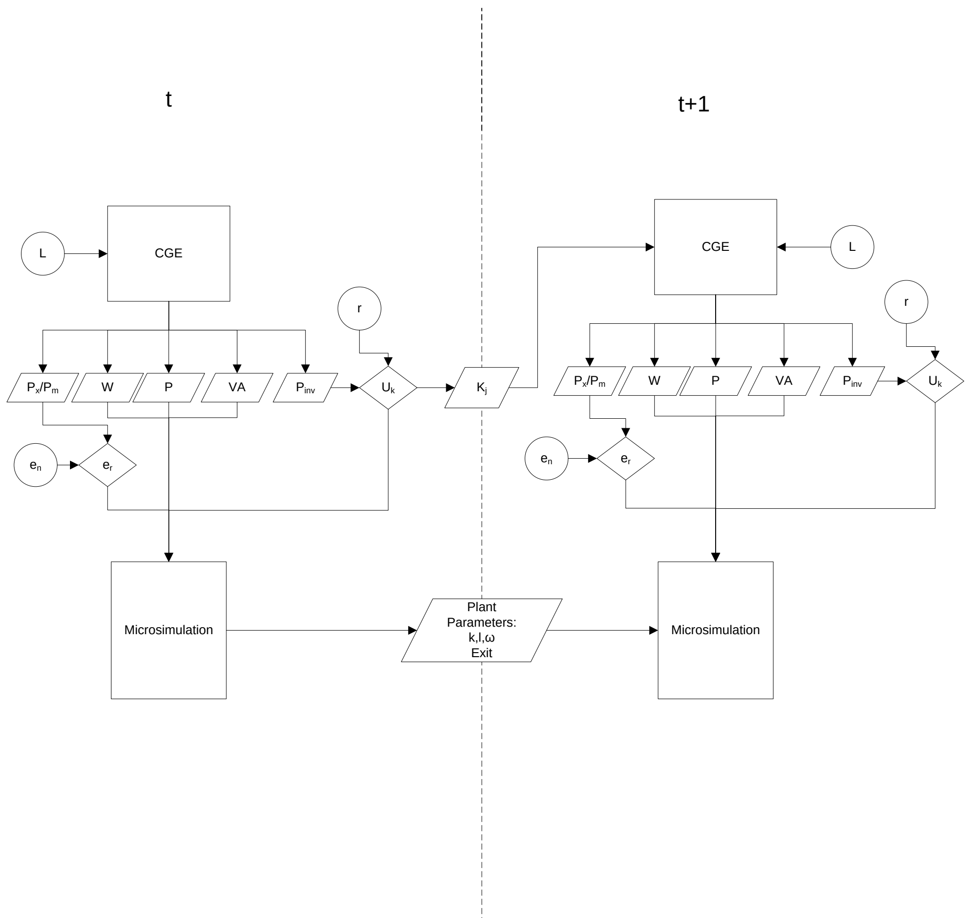


Figure C.5: Social Accounting Matrix: Chile 1986 Part 1

	A-AG	A-WOOD	A-FISH	A-MIN	A-PET	A-MFG	A-ELEC	A-CONS	A-COM	A-TRAN	A-OSE	C-AG	C-WOOD	C-FISH	C-MIN	C-PET	C-MFG	C-ELEC	C-CONS
A-AG												417.67					9.79		
A-WOOD													177.26				2.77		
A-FISH														190.28			3.49		
A-MIN															571.68		2.55		
A-PET													0.38			246.07	3.92		
A-MFG													5.01	0.23	3.34	0.28	1330.83		0.21
A-ELEC																0.35	0.22	172.43	
A-CONS																			390.18
A-COM												1.48	0.44				17.89		
A-TRAN													0.21				1.52	0.49	
A-OSE												0.88	0.38	0.21			2.46		
C-AG	56.09	0.48	0.41			203.12		0.51	0.63		5.49								
C-WOOD	2.33	26.12	1.82	0.71	0.39	41.62	0.35	17.02	9.68	0.85	6.18								
C-FISH	3.21		60.79			3.78					1.33								
C-MIN	7.42	1.32	1.55	70.08	0.25	37.49	9.48	8.25			0.96								
C-PET	18.48	4.27	9.56	20.98	134.02	17.24	5.97	10.37	3.76	63.27	13.57								
C-MFG	56.51	18.12	22.71	86.57	16.07	457.06	4.47	109.16	27.21	41.64	148.31								
C-ELEC	2.16	4.19	2.07	28.54	1.24	18.31	47.13	0.94	7.97	3.12	18.27								
C-CONS		4.17		3.87	0.26	5.87	4.89	0.37	1.86	1.25	52.57								
C-COM	26.48	9.01	11.53	18.49	3.18	74.20	2.00	44.44	24.96	27.61	44.66								
C-TRAN	13.64	17.65	4.50	28.65	6.70	35.80	1.99	5.39	79.65	80.14	25.01								
C-OSE	4.03	8.75	6.80	23.35	12.77	68.62	5.11	14.92	298.41	34.62	112.72								
C-O											4.25								
WAGES	64.16	18.42	24.04	92.44	10.53	167.86	22.31	74.28	93.53	78.29	514.42								
CAPITAL	162.04	68.80	48.51	202.27	64.18	240.31	68.68	78.76	112.36	133.40	534.84								
HH																			
ENTR																			
GOV																			
INSTAX																			
ACTTAX	2.20	0.35	1.04	0.96	0.24	0.64	0.66	15.76	0.76	19.19	31.56								
VATAX	8.71	1.41	0.80	2.08	0.98	3.73	0.93	10.02	19.40	5.10	37.34								
IMPTAX												2.66	2.44	0.21	1.62	21.01	85.68		
DSTK																			
S-I																			
ROW												13.76	13.57	0.39	13.16	97.78	534.24	0.24	0.21
TOTAL	427.46	183.07	196.12	578.98	250.83	1375.64	173.96	390.18	680.18	488.49	1551.48	436.44	199.71	191.32	589.79	365.50	1995.35	173.16	390.60

Figure C.6: Social Accounting Matrix: Chile 1986 Part 2

	C-COM	C-TRAN	C-OSE	C-O	WAGES	CAPITAL	HH	ENTR	GOV	INSTAX	ACTTAX	VATAX	IMPTAX	DSTK	S-I	ROW	TOTAL
A-AG																	427.46
A-WOOD	2.21	0.51	0.32														183.07
A-FISH	1.32	1.02															196.12
A-MIN	0.51	0.38	3.86														578.98
A-PET			0.46														250.83
A-MFG	18.65	0.54	16.56														1375.64
A-ELEC		0.29	0.66														173.96
A-CONS																	390.18
A-COM	642.86	2.18	15.34														680.18
A-TRAN	0.48	484.50	1.28														488.49
A-OSE	12.53	1.80	1533.23														1551.48
C-AG							75.52							0.79	17.52	75.89	436.44
C-WOOD							13.34							1.22	2.77	75.29	199.71
C-FISH							12.21							8.95		101.05	191.32
C-MIN							0.28							1.64		451.09	589.79
C-PET							52.75							-0.91	8.48	3.68	365.50
C-MFG							690.78							47.56	207.50	61.68	1995.35
C-ELEC							39.21										173.16
C-CONS															315.48		390.60
C-COM							319.09							1.01	33.54	66.59	706.79
C-TRAN							135.67								3.32	102.93	541.05
C-OSE							558.53		447.58						0.28	10.45	1606.93
C-O							65.02										69.26
WAGES																	1160.27
CAPITAL																55.96	1770.10
HH					1156.27	752.42			322.88								2231.57
ENTR						824.97			27.33								852.30
GOV						-230.39	92.19	34.60		377.27	73.35	90.50	113.84			25.36	576.72
INSTAX							312.23	65.04									377.27
ACTTAX																	73.35
VATAX																	90.50
IMPTAX			0.22														113.84
DSTK															60.26		60.26
S-I							-135.25	752.66	-225.46							257.21	649.16
ROW	28.24	49.82	35.01	69.26	3.99	423.11			4.39								1287.18
TOTAL	706.79	541.05	1606.93	69.26	1160.27	1770.10	2231.57	852.30	576.72	377.27	73.35	90.50	113.84	60.26	649.16	1287.18	

KEY:

Abbreviation	Description
Activities and Commodities	
AG	Agriculture
WOOD	Forestry
FISH	Fishing
MIN	Mining (excluding petroleum products)
PET	Petroleum
MFG	Manufacturing
ELEC	Electricity Production
CONS	Construction
COM	Commerce
TRAN	Transportation
OSE	Services (including those provided by government)
O	Other
Factors	
WAGES	Wages paid to labor
CAPITAL	Rent Paid to Capital
Institutions	
HH	Households
ENTR	Businesses
GOV	Government
Taxes	
ACTTAX	Tax on activities
VATAX	Value-added tax
IMPTAX	Import Tariffs
Other	
DSTK	Change in Capital Stock
S-I	Savings-Investment
ROW	Rest of the World

Figure C.7: Comparison of Aggregate Productivity by Estimation Method

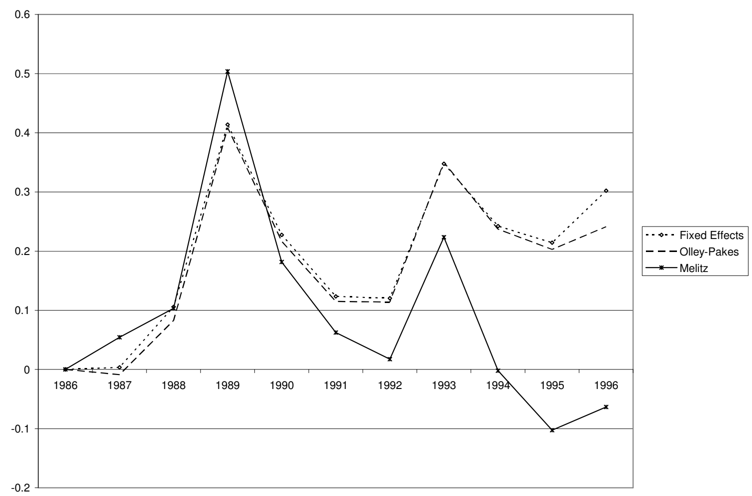


Figure C.8: Comparison of Mean Productivity by Estimation Method

Figure C.9: Plant-level Productivity Changes over Time

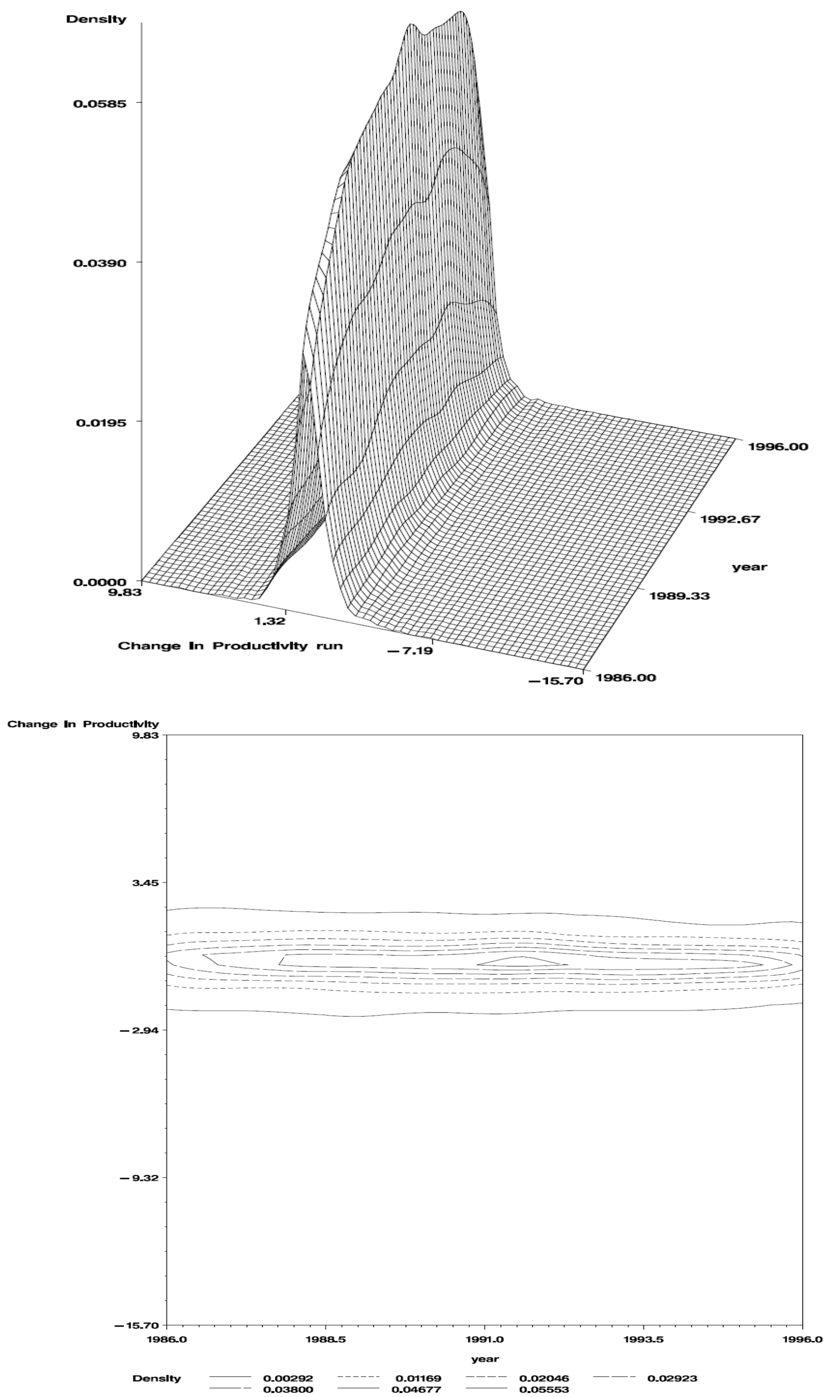
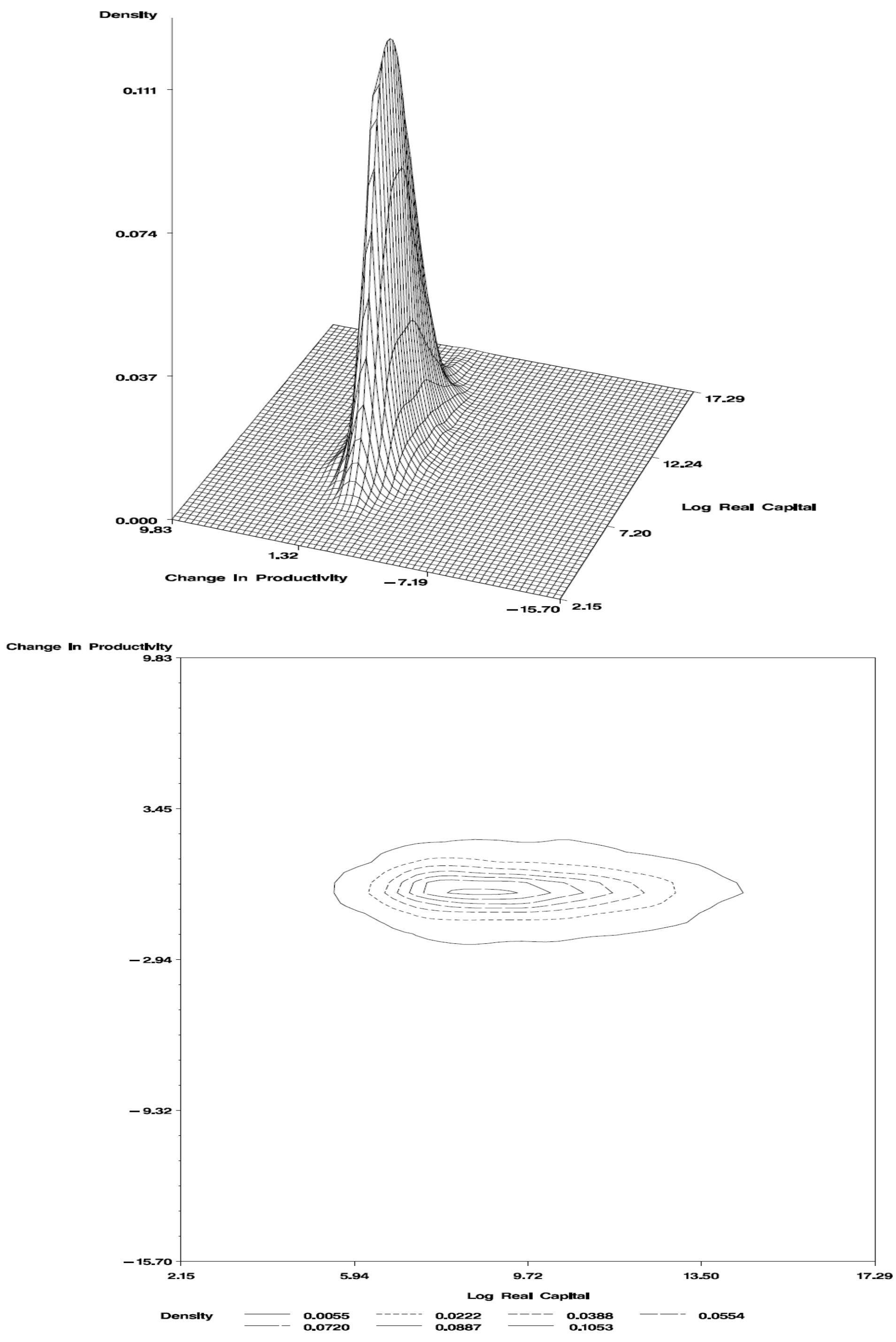


Figure C.10: Plant-level Productivity Changes by Capital Stock



Appendix D

Essay 2 Tables and Figures

D.1 Tables

Table D.1: Industry Size, Exit, and Entry

	ISIC 312				ISIC 321		
	plants	enter	exit		plants	enter	exit
1979	1,537	-	107	1979	503	-	53
1980	1,439	69	102	1980	445	17	51
1981	1,351	33	72	1981	403	14	37
1982	1,319	40	77	1982	350	1	41
1983	1,297	54	86	1983	327	13	26
1984	1,340	93	78	1984	336	26	11
1985	1,338	70	83	1985	337	8	20
1986	1,289	73	95	1986	331	19	11
1987	1,327	133	76	1987	364	45	14
1988	1,332	82	86	1988	356	10	15
1989	1,326	62	63	1989	358	19	13
1990	1,339	63	52	1990	364	14	11
1991	1,349	69	69	1991	377	21	16
1992	1,389	94	71	1992	386	21	32
1993	1,376	50	79	1993	357	9	25
1994	1,356	53	102	1994	360	24	36
1995	1,340	82	114	1995	355	30	38
1996	1,451	203	-	1996	368	42	-

	ISIC 372				ISIC 381		
	plants	enter	exit		plants	enter	exit
1979	34	-	1	1979	459	-	42
1980	31	0	1	1980	447	16	36
1981	28	0	1	1981	413	10	48
1982	27	1	4	1982	365	7	50
1983	21	1	1	1983	322	9	24
1984	24	2	0	1984	358	48	6
1985	25	0	1	1985	351	7	23
1986	21	0	0	1986	347	18	14
1987	31	6	0	1987	356	41	15
1988	38	3	0	1988	348	12	15
1989	40	2	3	1989	360	21	16
1990	37	2	2	1990	351	4	12
1991	35	2	0	1991	374	33	15
1992	34	1	1	1992	405	29	18
1993	41	2	5	1993	420	44	20
1994	32	1	1	1994	444	36	25
1995	46	4	2	1995	470	51	35
1996	53	9	-	1996	515	76	-

Table D.2: Import and Export Shares

Year	ISIC 311 Imports/Output	Exports/Output	Year	ISIC 321 Imports/Output	Exports/Output
1979	0.1194	0.1165	1979	0.3423	0.0028
1980	0.1486	0.1292	1980	0.3167	0.0263
1981	0.1222	0.1333	1981	0.5449	0.0024
1982	0.1413	0.3366	1982	0.4379	0.0056
1983	0.1114	0.2124	1983	0.3813	0.0020
1984	0.0960	0.1787	1984	0.4460	0.0042
1985	0.0586	0.2092	1985	0.3437	0.0080
1986	0.0296	0.2239	1986	0.3460	0.0110
1987	0.0370	0.2296	1987	0.3698	0.0304
1988	0.0432	0.2405	1988	0.3778	0.0424
1989	0.0416	0.2334	1989	0.3993	0.0489
1990	0.0571	0.2654	1990	0.3624	0.0615
1991	0.0639	0.2770	1991	0.4499	0.0692
1992	0.0671	0.2813	1992	0.5113	0.0837
1993	0.0700	0.2515	1993	0.5647	0.1046
1994	0.0741	0.2687	1994	0.5541	0.1251
1995	0.0791	0.2901	1995	0.6232	0.1075
1996	0.0843	0.2695	1996	0.7433	0.1541

Year	ISIC 372 Imports/Output	Exports/Output	Year	ISIC 381 Imports/Output	Exports/Output
1979	0.0288	1.4380	1979	0.1949	0.0688
1980	0.0205	0.8906	1980	0.2331	0.0630
1981	0.0245	0.7114	1981	0.2994	0.0428
1982	0.0125	1.1821	1982	0.4214	0.0598
1983	0.0101	0.7827	1983	0.3536	0.0718
1984	0.0122	0.6539	1984	0.4655	0.0490
1985	0.0111	0.7106	1985	0.3646	0.0493
1986	0.0121	0.7178	1986	0.4133	0.0746
1987	0.0124	0.6446	1987	0.3796	0.0724
1988	0.0116	0.6920	1988	0.2934	0.6392
1989	0.0121	0.6197	1989	0.3649	0.5431
1990	0.0106	0.7214	1990	0.4065	0.0501
1991	0.0119	0.6555	1991	0.2988	0.0549
1992	0.0154	0.6201	1992	0.3019	0.0560
1993	0.0208	0.6581	1993	0.4055	0.0550
1994	0.0182	0.7200	1994	0.5039	0.0735
1995	0.0230	0.8543	1995	0.4317	0.0817
1996	0.0183	0.7128	1996	0.5439	0.1016

Sources: Nicita and Olarreaga (2001) and United Nations COMTRADE

Table D.3: Production Function Parameter Estimates

Industry		β_m	σ	Fixed Effects β_s	β_u	β_k	Series β_s	β_u	β_k
311	Estimate	0.7094	4.3809	0.1544	0.3334	0.0517	0.2113	0.2625	0.1260
	(s.e.)	(0.0107)	(0.3529)	(0.0046)	(0.0062)	(0.0040)	(0.0938)	(0.0519)	(0.0363)
	N	24109		17751			17359		
321	Estimate	0.6360	3.5080	0.1442	0.3143	0.0524	0.2158	0.2373	0.0306
	(s.e.)	(0.0177)	(0.6654)	(0.0096)	(0.0109)	(0.0066)	(0.1155)	(0.0486)	(0.1086)
	N	6601		5000			4953		
372	Estimate	0.9315	4.2706	0.4949	0.3424	0.1687	0.4134	0.4740	0.2271
	(s.e.)	(0.0458)	(2.9414)	(0.0549)	(0.0660)	(0.0362)	(0.1723)	(0.1032)	(0.1753)
	N	592		361			353		
381	Estimate	0.8523	2.4497	0.2350994	0.3659872	0.0470569	0.2588	0.3542	0.1468
	(s.e.)	(0.0203)	(0.2272)	(0.0107)	(0.0111)	(0.0069)	(0.0296)	(0.0264)	(0.0396)
	N	7046		4887			4853		

Note: The standard errors for the series estimation are bootstrapped with 500 repetitions.

Table D.4: Aggregate Productivity: ISIC 311

Year	Aggregate Productivity	Braymen Mean Productivity	Covariance	Aggregate Productivity	OP Mean Productivity	Covariance	Aggregate Productivity	LP Mean Productivity	Covariance
1979	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1980	0.2569	0.0154	0.2415	0.0751	0.0251	0.0500	-0.0528	0.0027	-0.0555
1981	0.5524	0.1754	0.3770	0.0284	-0.0189	0.0472	-0.0912	-0.0801	-0.0111
1982	0.2876	-0.1068	0.3945	0.1196	0.0150	0.1045	0.0337	-0.0634	0.0971
1983	0.4205	0.1572	0.2633	0.0096	-0.1317	0.1413	-0.0341	-0.1927	0.1586
1984	0.3283	0.2062	0.1221	0.0593	-0.0294	0.0886	0.0363	-0.0287	0.0650
1985	0.2805	0.2726	0.0079	0.0377	-0.0484	0.0861	0.0327	-0.0583	0.0909
1986	0.1608	0.3349	-0.1740	-0.0925	-0.1739	0.0814	-0.1046	-0.3188	0.2142
1987	0.0054	0.3116	-0.3061	-0.0583	-0.1527	0.0945	0.0448	-0.2668	0.3117
1988	-0.0905	0.2780	-0.3686	0.0251	-0.0601	0.0852	0.1718	-0.1517	0.3235
1989	-0.1283	0.2817	-0.4100	0.0033	-0.0512	0.0545	0.2112	-0.0515	0.2627
1990	-0.2161	0.2697	-0.4858	-0.0435	-0.0160	-0.0274	0.1858	0.0018	0.1840
1991	-0.2470	0.2848	-0.5318	-0.0725	-0.0261	-0.0464	0.1712	-0.0038	0.1751
1992	-0.2429	0.2532	-0.4961	-0.0822	0.1088	-0.1910	0.2080	0.2176	-0.0096
1993	-0.2770	0.2910	-0.5680	-0.0106	0.3901	-0.4007	0.2330	0.3960	-0.1630
1994	-0.4287	0.2672	-0.6958	0.0141	0.3912	-0.3772	0.2863	0.4641	-0.1778
1995	-0.6313	0.2716	-0.9028	-0.0398	0.4040	-0.4438	0.3443	0.5109	-0.1666
1996	-0.4725	0.9234	-1.3959	0.2526	1.3905	-1.1379	0.6271	0.7077	-0.0806

Note: Productivity measures have been standardized so 1979 is equal to zero. Values in other years represent the percentage change from 1979.

Table D.5: Aggregate Productivity: ISIC 321

		Braymen			OP			LP	
Year	Aggregate Productivity	Mean Productivity	Covariance	Aggregate Productivity	Mean Productivity	Covariance	Aggregate Productivity	Mean Productivity	Covariance
1979	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1980	0.2695	0.0177	0.2517	0.1516	0.1585	-0.0069	0.0146	-0.0091	0.0237
1981	0.5622	0.1918	0.3703	0.2494	0.1877	0.0617	0.1424	-0.0795	0.2219
1982	0.3230	-0.1797	0.5028	0.1333	-0.1841	0.3174	0.0780	-0.2868	0.3648
1983	0.4947	0.1145	0.3802	-0.0202	-0.4344	0.4141	0.1104	-0.3810	0.4914
1984	0.4949	0.1798	0.3151	0.0120	-0.2227	0.2347	0.0949	-0.1463	0.2412
1985	0.4469	0.1851	0.2618	-0.0543	-0.5004	0.4461	0.0704	-0.2608	0.3312
1986	0.4104	0.2791	0.1314	0.1170	-0.3471	0.4641	0.0694	-0.2377	0.3071
1987	0.2640	0.2989	-0.0349	0.0123	-0.4102	0.4225	-0.0011	-0.2057	0.2046
1988	0.2298	0.2696	-0.0398	0.1365	-0.1108	0.2473	0.0961	-0.1182	0.2143
1989	0.1037	0.2919	-0.1882	0.1968	0.2563	-0.0595	0.2700	-0.0360	0.3060
1990	0.0713	0.2335	-0.1622	0.0790	0.0897	-0.0107	0.2600	-0.0717	0.3317
1991	0.0999	0.3139	-0.2139	0.1912	0.3697	-0.1785	0.2993	-0.0523	0.3517
1992	0.1679	0.3053	-0.1374	0.2272	0.4999	-0.2727	0.2572	0.0562	0.2010
1993	0.0100	0.2725	-0.2626	0.1334	0.4818	-0.3483	0.2419	0.0481	0.1937
1994	-0.0177	0.2316	-0.2493	0.0853	0.4161	-0.3308	0.3012	-0.0182	0.3194
1995	-0.0940	0.3023	-0.3963	0.1828	0.6960	-0.5132	0.4518	0.0541	0.3977
1996	-0.1566	0.7879	-0.9444	0.1748	1.0842	-0.9094	0.3800	0.1079	0.2720

Note: Productivity measures have been standardized so 1979 is equal to zero. Values in other years represent the percentage change from 1979.

Table D.6: Aggregate Productivity: ISIC 372

Year	Aggregate Productivity	Braymen Mean Productivity	Covariance	Aggregate Productivity	OP Mean Productivity	Covariance	Aggregate Productivity	LP Mean Productivity	Covariance
1979	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1980	0.1177	0.2547	-0.1370	0.2328	0.2483	-0.0156	-0.1159	-0.0297	-0.0862
1981	0.0788	0.2123	-0.1335	-0.1310	-0.0288	-0.1021	-0.0471	0.1334	-0.1805
1982	-0.1695	-0.1228	-0.0467	0.1108	0.2764	-0.1656	-0.2066	-0.1725	-0.0341
1983	0.2137	0.1310	0.0827	0.1796	0.4571	-0.2774	-0.1103	-0.2205	0.1102
1984	0.3438	0.4806	-0.1368	0.1958	1.1098	-0.9140	-0.0511	-0.1026	0.0515
1985	0.2464	0.4619	-0.2154	0.3917	0.9938	-0.6021	-0.1380	-0.1770	0.0391
1986	0.5136	0.6913	-0.1777	0.0709	0.5116	-0.4406	-0.1237	-0.2002	0.0765
1987	0.4784	0.6718	-0.1934	-0.0622	0.5327	-0.5949	-0.0624	-0.1344	0.0720
1988	0.2426	0.7532	-0.5107	0.3490	1.3283	-0.9793	0.1554	0.0103	0.1451
1989	0.1977	0.7527	-0.5550	0.7620	1.7625	-1.0005	0.2597	0.1939	0.0658
1990	0.2029	0.6072	-0.4043	0.5787	1.9006	-1.3219	0.0289	0.1210	-0.0921
1991	0.1008	0.7389	-0.6380	0.2042	0.9235	-0.7193	-0.0259	0.0269	-0.0529
1992	0.2551	0.9120	-0.6569	0.2844	1.1579	-0.8735	0.0200	0.1934	-0.1734
1993	0.0436	0.8944	-0.8508	-0.0203	0.4681	-0.4884	0.2098	0.3209	-0.1111
1994	0.6690	0.9574	-0.2884	0.2287	2.3511	-2.1223	0.1783	0.1989	-0.0206
1995	0.6407	0.8385	-0.1978	0.2151	2.2477	-2.0327	0.2132	0.2361	-0.0229
1996	0.4563	1.7323	-1.2760	0.3205	1.9765	-1.6560	0.4595	0.3871	0.0723

Note: Productivity measures have been standardized so 1979 is equal to zero. Values in other years represent the percentage change from 1979.

Table D.7: Aggregate Productivity: ISIC 381

Year	Aggregate Productivity	Braymen Mean Productivity	Covariance	Aggregate Productivity	OP Mean Productivity	Covariance	Aggregate Productivity	LP Mean Productivity	Covariance
1979	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1980	0.2041	0.0634	0.1407	0.0543	0.0203	0.0340	-0.1159	-0.0297	-0.0862
1981	0.4672	0.2583	0.2089	0.1778	0.0437	0.1341	-0.0471	0.1334	-0.1805
1982	0.0602	-0.2151	0.2753	-0.0177	-0.0479	0.0302	-0.2066	-0.1725	-0.0341
1983	0.2797	0.0625	0.2172	0.0911	-0.0437	0.1347	-0.1103	-0.2205	0.1102
1984	0.2289	0.1807	0.0482	0.0351	-0.0289	0.0640	-0.0511	-0.1026	0.0515
1985	0.2497	0.2271	0.0227	-0.0410	-0.0564	0.0154	-0.1380	-0.1770	0.0391
1986	0.2307	0.2834	-0.0527	-0.0416	-0.0369	-0.0046	-0.1237	-0.2002	0.0765
1987	0.1807	0.2821	-0.1014	-0.0719	-0.0567	-0.0151	-0.0624	-0.1344	0.0720
1988	0.0922	0.3058	-0.2136	0.0094	-0.0182	0.0276	0.1554	0.0103	0.1451
1989	0.2230	0.3907	-0.1677	0.2956	0.0270	0.2687	0.2597	0.1939	0.0658
1990	0.2554	0.3336	-0.0782	0.1071	0.0091	0.0980	0.0289	0.1210	-0.0921
1991	0.1766	0.3130	-0.1364	-0.1016	-0.0206	-0.0810	-0.0259	0.0269	-0.0529
1992	0.1291	0.3268	-0.1977	0.0057	0.0216	-0.0159	0.0200	0.1934	-0.1734
1993	-0.0379	0.3353	-0.3733	0.0408	0.0496	-0.0088	0.2098	0.3209	-0.1111
1994	-0.2036	0.2238	-0.4274	-0.1377	0.0241	-0.1618	0.1783	0.1989	-0.0206
1995	-0.2270	0.2729	-0.4999	-0.0594	0.0419	-0.1012	0.2132	0.2361	-0.0229
1996	-0.1131	0.8482	-0.9613	0.1152	0.1237	-0.0084	0.4595	0.3871	0.0723

Note: Productivity measures have been standardized so 1979 is equal to zero. Values in other years represent the percentage change from 1979.

Table D.8: Input to Quantity Ratios

	ISIC 311				ISIC 321		
Year	$K/\check{Q}$	$L^s/\check{Q}$	$L^u/\check{Q}$	Year	$K/\check{Q}$	$L^s/\check{Q}$	$L^u/\check{Q}$
1979	0.8756	0.0422	0.1637	1979	1.6254	0.3024	0.5103
1980	0.6681	0.0406	0.1562	1980	1.5249	0.1412	0.4844
1981	0.5089	0.0337	0.1305	1981	1.3494	0.1214	0.4214
1982	0.7303	0.0451	0.1711	1982	1.9533	0.1687	0.5214
1983	0.6034	0.0360	0.1371	1983	1.4940	0.1271	0.4048
1984	0.4975	0.0339	0.1398	1984	1.1051	0.1134	0.4074
1985	0.4531	0.0327	0.1354	1985	1.0486	0.1143	0.4307
1986	0.4118	0.0319	0.1358	1986	0.9352	0.1099	0.4244
1987	0.4128	0.0343	0.1398	1987	0.9398	0.1076	0.4045
1988	0.4115	0.0378	0.1473	1988	1.0179	0.1137	0.4425
1989	0.4302	0.0381	0.1437	1989	0.9193	0.1165	0.4437
1990	0.4533	0.0399	0.1528	1990	1.0740	0.1257	0.4690
1991	0.4193	0.0377	0.1485	1991	1.0039	0.1146	0.4359
1992	0.4435	0.0380	0.1535	1992	1.1610	0.1171	0.4387
1993	0.4414	0.0378	0.1525	1993	1.2144	0.1250	0.4543
1994	0.4550	0.0390	0.1591	1994	1.3580	0.1351	0.4738
1995	0.4587	0.0392	0.1668	1995	1.4240	0.1307	0.4466
1996	0.2449	0.0311	0.0905	1996	0.9798	0.1061	0.2610

	ISIC 372				ISIC 381		
Year	$K/\check{Q}$	$L^s/\check{Q}$	$L^u/\check{Q}$	Year	$K/\check{Q}$	$L^s/\check{Q}$	$L^u/\check{Q}$
1979	0.8639	0.0149	0.0314	1979	0.8873	0.1019	0.3077
1980	0.6600	0.0114	0.0245	1980	0.7339	0.0964	0.3007
1981	0.5932	0.0116	0.0224	1981	0.5736	0.0772	0.2500
1982	0.7351	0.0160	0.0343	1982	1.1010	0.1286	0.3586
1983	0.5367	0.0142	0.0253	1983	0.8215	0.0948	0.2619
1984	0.3961	0.0089	0.0197	1984	0.6831	0.0843	0.2559
1985	0.3993	0.0090	0.0173	1985	0.6333	0.0785	0.2560
1986	0.3220	0.0074	0.0118	1986	0.5291	0.0770	0.2564
1987	0.2457	0.0092	0.0127	1987	0.5217	0.0858	0.2617
1988	0.1665	0.0092	0.0143	1988	0.5004	0.0882	0.2630
1989	0.1817	0.0085	0.0165	1989	0.5007	0.0780	0.2646
1990	0.2007	0.0093	0.0160	1990	0.5342	0.0785	0.2736
1991	0.1818	0.0101	0.0145	1991	0.6449	0.0862	0.2759
1992	0.1444	0.0061	0.0092	1992	0.5197	0.0781	0.2612
1993	0.1204	0.0059	0.0128	1993	0.5758	0.0754	0.2624
1994	0.1241	0.0052	0.0112	1994	0.7141	0.0813	0.2827
1995	0.1317	0.0067	0.0157	1995	0.7982	0.0744	0.2632
1996	0.0893	0.0044	0.0067	1996	0.5039	0.0607	0.1383

Table D.9: Aggregate Markup Measure

	ISIC 311				ISIC 321		
Year	Aggregate Markup	Mean Markup	Covariance	Year	Aggregate Markup	Mean Markup	Covariance
1979	0.00000	0.00000	0.00000	1979	0.00000	0.00000	0.00000
1980	-0.01999	-0.02336	0.00337	1980	-0.02515	-0.01679	-0.00837
1981	-0.03140	-0.03846	0.00707	1981	-0.05261	-0.04387	-0.00873
1982	-0.02358	-0.02873	0.00515	1982	0.01661	0.01850	-0.00189
1983	-0.00690	-0.01473	0.00783	1983	0.00859	0.00353	0.00507
1984	0.00550	-0.00627	0.01177	1984	0.01284	0.00729	0.00555
1985	0.00247	-0.00679	0.00926	1985	0.00446	0.00278	0.00168
1986	0.01708	0.00499	0.01209	1986	0.04780	0.05724	-0.00943
1987	0.02016	0.00528	0.01488	1987	-0.00397	0.00106	-0.00504
1988	0.04457	0.02250	0.02207	1988	0.01399	0.02797	-0.01398
1989	0.09962	0.07560	0.02403	1989	0.05273	0.06307	-0.01034
1990	0.09295	0.07461	0.01834	1990	0.07638	0.09454	-0.01816
1991	0.11878	0.09883	0.01995	1991	0.04950	0.06647	-0.01698
1992	0.14514	0.12152	0.02362	1992	0.01971	0.03227	-0.01256
1993	0.16403	0.14524	0.01879	1993	0.05875	0.08431	-0.02555
1994	0.17013	0.15073	0.01941	1994	0.08900	0.11375	-0.02475
1995	0.19225	0.17119	0.02106	1995	0.09846	0.12962	-0.03116
1996	0.09873	0.08931	0.00942	1996	0.02723	0.07730	-0.05007

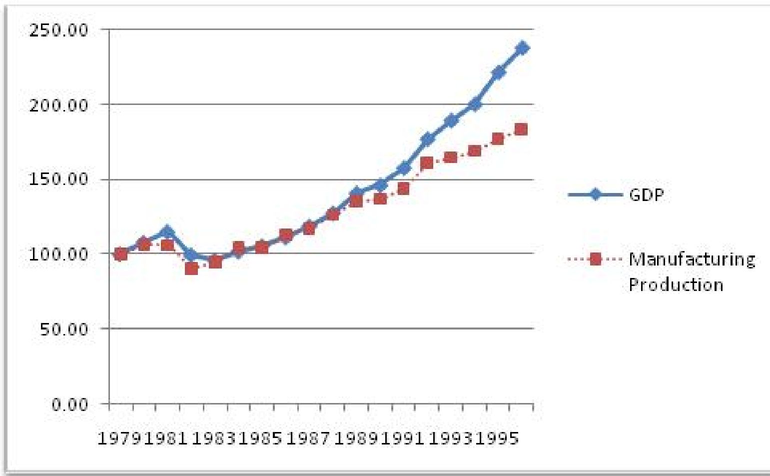
	ISIC 372				ISIC 381		
Year	Aggregate Markup	Mean Markup	Covariance	Year	Aggregate Markup	Mean Markup	Covariance
1979	0.00000	0.00000	0.00000	1979	0.00000	0.00000	0.00000
1980	-0.19560	-0.24556	0.04997	1980	0.02131	0.03117	-0.00987
1981	-0.03478	-0.06307	0.02830	1981	0.03586	0.04744	-0.01157
1982	-0.08396	-0.19757	0.11361	1982	0.11469	0.12276	-0.00807
1983	0.12070	0.08018	0.04053	1983	0.14868	0.15150	-0.00282
1984	-0.06163	-0.14239	0.08076	1984	0.11935	0.11597	0.00339
1985	-0.05995	-0.13074	0.07080	1985	0.10310	0.09737	0.00574
1986	-0.04077	-0.09565	0.05488	1986	0.09088	0.09720	-0.00632
1987	-0.01087	-0.08152	0.07065	1987	0.08403	0.09112	-0.00709
1988	0.09078	0.04833	0.04245	1988	0.08567	0.10295	-0.01728
1989	0.04649	0.01659	0.02990	1989	0.09017	0.10888	-0.01872
1990	0.10098	0.07532	0.02566	1990	0.08901	0.10156	-0.01255
1991	0.08614	0.06244	0.02369	1991	0.07378	0.08758	-0.01380
1992	0.10405	0.08148	0.02257	1992	0.04907	0.06667	-0.01759
1993	0.00147	-0.00977	0.01125	1993	0.05867	0.08050	-0.02183
1994	0.16815	0.15876	0.00938	1994	0.08113	0.10322	-0.02209
1995	0.17130	0.17564	-0.00434	1995	0.03147	0.06159	-0.03011
1996	0.06918	0.05964	0.00955	1996	-0.07713	-0.04430	-0.03283

Table D.10: Plant-level Productivity and Foreign Influences

Industry		domestic price	foreign price	import share	export share	N
311	Estimate	0.0717	0.0426			17751
	(s.e.)	(0.0179)	(0.0169)			
	Estimate			-2.5819		17751
	(s.e.)			(0.0659)		
	Estimate				0.2590	17751
	(s.e.)				(0.0402)	
321	Estimate	0.1251	-0.0129			5000
	(s.e.)	(0.0299)	(0.0282)			
	Estimate			0.6804		5000
	(s.e.)			(0.0407)		
	Estimate				1.9288	5000
	(s.e.)				(0.1014)	
372	Estimate	0.2211	0.1862			361
	(s.e.)	(0.2020)	(0.1891)			
	Estimate			-4.4901		361
	(s.e.)			(6.4068)		
	Estimate				-1.2011	361
	(s.e.)				(0.1532)	
381	Estimate	0.2192	-0.0810			4887
	(s.e.)	(0.0359)	(0.0331)			
	Estimate			0.6119		4887
	(s.e.)			(0.0578)		
	Estimate				0.2448	4887
	(s.e.)				(0.0309)	

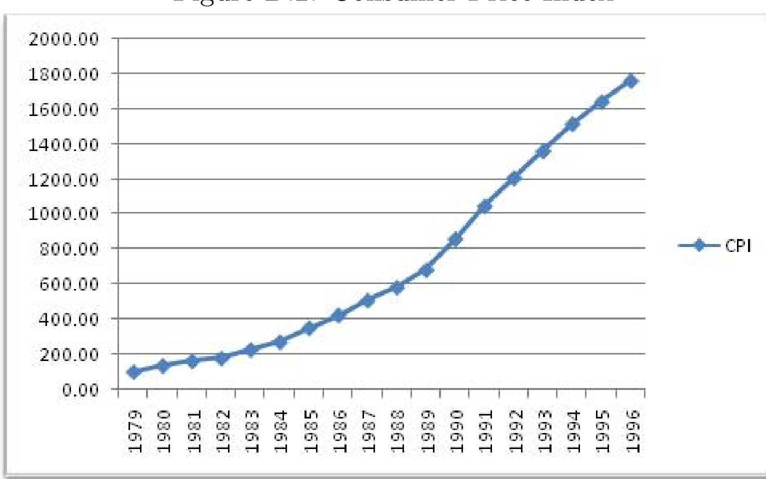
D.2 Figures

Figure D.1: Real GDP and Manufacturing Production



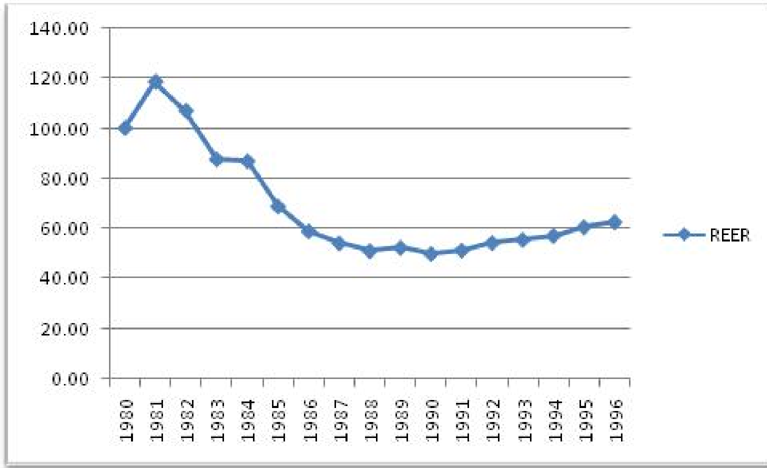
Source: IMF International Financial Statistics (2004)

Figure D.2: Consumer Price Index



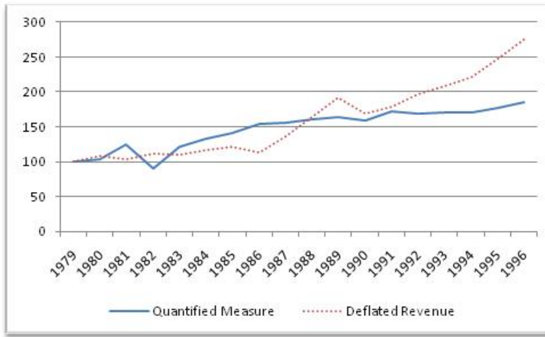
Source: IMF International Financial Statistics (2004)

Figure D.3: Real Effective Exchange Rate

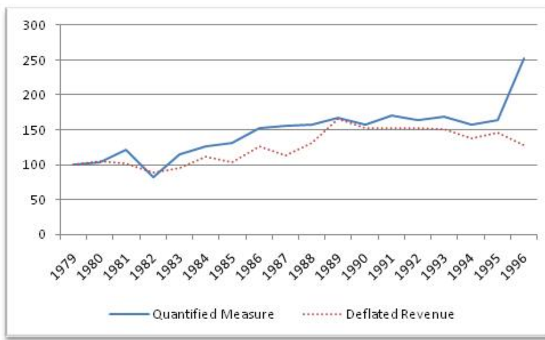


Source: IMF International Financial Statistics (2004)

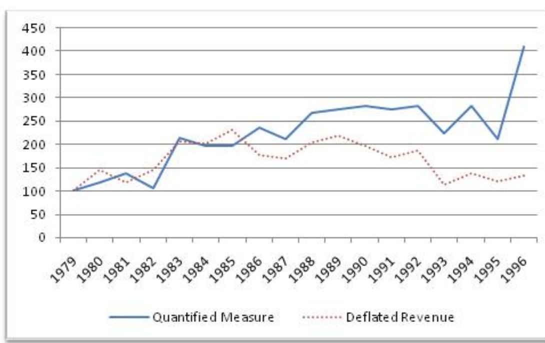
Figure D.4: Quantified Measure versus Deflated Revenue



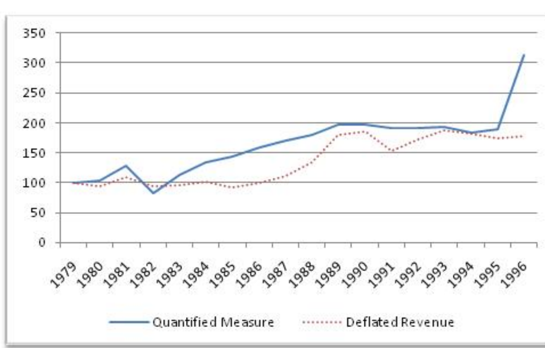
(a) ISIC 311



(b) ISIC 321



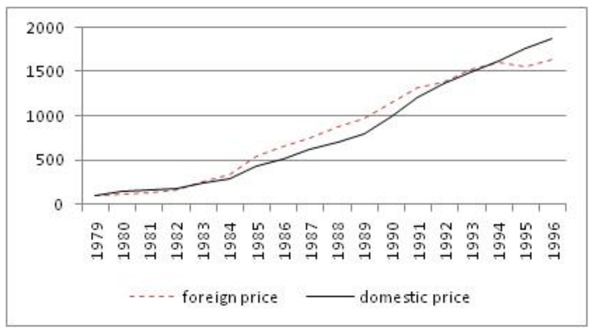
(c) ISIC 372



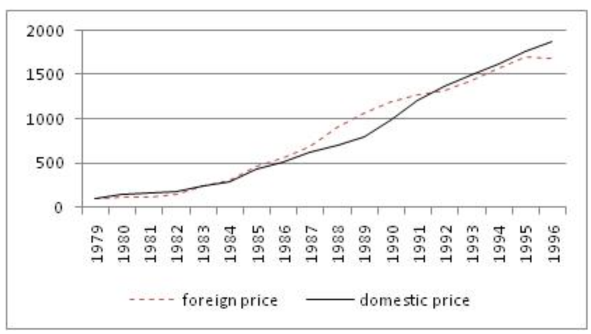
(d) ISIC 381

Figure D.5: Foreign and Domestic Prices

(a) ISIC 311



(b) ISIC 321



(c) ISIC 372

(d) ISIC 381

Note: Calculations and data are described in the text.

Appendix E

Essay 3 Tables and Figures

E.1 Tables

Table E.1: Output, Exports, and Revenue Growth by Industry

Year	ISIC	Product	Revenue (Y)	Exports (X)	X/Y	%Δ Revenue	%Δ Exports
1996	311	Food manufacturing	9242030	2490540	0.2695	97.203	133.31
1996	321	Manufacture of textiles	842493	129805	0.1541	6.796	207.86
1996	322	Manufacture of wearing apparel	737900	46207	0.0626	89.102	38.82
1996	324	Manufacture of footwear	450946	23278	0.0516	54.484	-27.45
1996	331	Manufacture of wood and cork products	1433710	613190	0.4277	83.422	90.36
1996	332	Manufacture of furniture and fixtures	279836	34978	0.1250	128.849	135.25
1996	342	Printing, publishing and allied industries	795126	118880	0.1495	73.432	451.22
1996	351	Manufacture of industrial chemicals	1074350	473310	0.4406	101.538	77.22
1996	355	Manufacture of rubber products	363214	66098	0.1820	115.695	148.24
1996	356	Manufacture of plastic products	1014200	51418	0.0507	110.391	428.72
1996	361	Manufacture of pottery, china and earthenware	77692.4	13445	0.1731	301.513	-14.05
1996	362	Manufacture of glass and glass products	224102	9553	0.0426	137.616	236.28
1996	369	Manufacture of non-metallic mineral products	1136560	11265	0.0099	138.53	120.68
1996	371	Iron and steel basic industries	1012880	90197	0.0891	38.263	26.60
1996	372	Non-ferrous metal basic industries	6384040	4550540	0.7128	11.314	26.51
1996	381	Manufacture of fabricated metal products	1475770	149929	0.1016	48.341	264.35
1996	383	Manufacture of electrical machinery apparatus	355425	76814	0.2161	27.553	462.15
1996	384	Manufacture of transport equipment	1193660	179979	0.1508	140.975	178.57

Source: World Bank Trade and Productivity Database. All values are in thousands of 1996 U.S. Dollars. The values indicating growth in revenue and exports are calculated as the percentage change in deflated values from 1990.

Table E.2: Comparison of Non-Exporters and Exporters

Non-Exporters				
Industry	Output	Capital	Skilled Labor	Unskilled Labor
311	2,608.44	62,136.86	31.14	37.24
321	497.52	12,605.17	15.03	43.40
322	414.29	5,325.14	14.79	42.51
324	429.69	10,787.72	15.07	50.50
331	512.44	14,432.40	10.62	44.57
332	354.64	8,670.42	11.88	36.12
342	815.16	32,131.39	29.94	34.57
351	551.20	42,118.71	19.44	23.89
354	2,074.10	55,656.59	21.33	23.83
355	566.12	14,934.00	12.75	37.40
361	264.06	14,162.49	9.50	56.50
362	845.60	9,902.39	14.57	70.43
369	1,672.54	94,694.16	26.57	45.43
371	3,131.98	132,773.70	42.25	93.38
372	44,406.53	1,384,522.00	178.56	154.44
381	660.55	18,235.63	17.35	44.48
383	1,532.31	31,494.15	27.60	57.13
384	536.80	22,574.04	20.06	38.45

Exporters				
Industry	Output	Capital	Skilled Labor	Unskilled Labor
311	10,911.57	267,364.40	91.38	100.50
321	2,156.81	89,846.18	55.58	151.77
322	4,514.07	98,013.19	164.15	197.15
324	3,494.05	50,438.20	37.85	281.85
331	3,084.21	156,649.10	32.65	189.35
332	4,268.75	136,512.40	64.17	258.50
342	8,065.63	378,080.50	232.92	118.25
351	4,506.44	161,003.00	48.69	60.46
354	9,716.12	151,339.60	52.67	66.67
355	10,103.64	302,750.40	123.33	195.83
361	2,410.47	112,052.50	75.25	247.75
362	4,634.39	276,604.60	77.56	125.89
369	6,323.45	217,588.00	52.91	120.64
371	23,750.08	2,793,958.00	183.50	509.00
372	39,354.08	345,425.70	140.22	162.67
381	3,431.52	142,134.40	68.35	105.42
383	3,345.58	220,144.30	56.08	117.83
384	16,612.01	105,773.90	64.70	160.10

Note: Values indicating growth in revenue and exports are calculated as the percentage change in deflated values from 1990.

Table E.3: Production Function Parameter Estimates

Industry		Skilled Labor	Unskilled Labor	Capital	N
311	Coefficient	0.161	0.393	0.210	5769
	(s.e.)	(0.022)	(0.026)	(0.076)	
321	Coefficient	0.332	0.361	0.136	1630
	(s.e.)	(0.046)	(0.037)	(0.070)	
322	Coefficient	0.324	0.391	0.126	1278
	(s.e.)	(0.045)	(0.052)	(0.092)	
324	Coefficient	0.285	0.329	0.051	572
	(s.e.)	(0.071)	(0.087)	(0.187)	
331	Coefficient	0.258	0.454	0.075	1162
	(s.e.)	(0.034)	(0.051)	(0.082)	
332	Coefficient	0.178	0.531	0.189	486
	(s.e.)	(0.047)	(0.100)	(0.113)	
342	Coefficient	0.370	0.213	0.140	782
	(s.e.)	(0.057)	(0.062)	(0.117)	
351	Coefficient	0.291	0.119	0.045	239
	(s.e.)	(0.167)	(0.174)	(0.416)	
355	Coefficient	0.416	0.248	0.258	230
	(s.e.)	(0.138)	(0.149)	(0.223)	
356	Coefficient	0.232	0.392	0.191	737
	(s.e.)	(0.061)	(0.060)	(0.068)	
361	Coefficient	0.237	-0.029	0.068	76
	(s.e.)	(0.209)	(0.362)	(0.357)	
362	Coefficient	0.344	0.266	0.578	106
	(s.e.)	(0.232)	(0.243)	(0.261)	
369	Coefficient	0.251	0.379	0.304	519
	(s.e.)	(0.138)	(0.113)	(0.106)	
371	Coefficient	0.586	0.175	0.421	132
	(s.e.)	(0.106)	(0.155)	(0.222)	
372	Coefficient	0.239	0.569	0.462	136
	(s.e.)	(0.416)	(0.205)	(0.433)	
381	Coefficient	0.345	0.425	0.222	1637
	(s.e.)	(0.048)	(0.037)	(0.044)	
383	Coefficient	0.592	0.269	0.071	241
	(s.e.)	(0.248)	(0.144)	(0.203)	
384	Coefficient	0.079	0.472	0.505	424
	(s.e.)	(0.108)	(0.053)	(0.172)	

Note: All standard errors are bootstrapped with 50 repetitions.

Table E.4: Productivity Growth of Exporters and Non-Exporters

		(1)	(2)	(3)
Industry	Year	Exporters	Non-Exporters	$\frac{\omega_x}{\omega_n}$
311	1990	0.000	0.000	2.086
311	1991	-0.023	-0.015	2.069
311	1992	0.117	-0.220	2.985
311	1993	0.175	-0.014	2.484
311	1994	0.495	-0.008	3.142
311	1995	0.769	0.039	3.551
311	1996	0.416	0.058	2.792
321	1990	0.000	0.000	1.971
321	1991	-0.057	0.025	1.813
321	1992	-0.058	0.082	1.717
321	1993	-0.090	0.109	1.619
321	1994	-0.154	0.124	1.483
321	1995	-0.085	0.240	1.455
321	1996	-0.046	0.427	1.317
322	1990	0.000	0.000	1.865
322	1991	-0.136	-0.014	1.635
322	1992	-0.090	0.076	1.577
322	1993	0.058	0.041	1.896
322	1994	0.075	0.131	1.772
322	1995	0.213	0.185	1.910
322	1996	0.252	0.364	1.712
324	1990	0.000	0.000	2.551
324	1991	-0.054	-0.099	2.679
324	1992	-0.031	0.060	2.333
324	1993	0.266	0.039	3.109
324	1994	0.251	-0.002	3.197
324	1995	0.359	0.097	3.158
324	1996	0.963	0.326	3.777
331	1990	0.000	0.000	2.585
331	1991	0.003	0.007	2.574
331	1992	-0.257	0.139	1.686
331	1993	-0.244	0.320	1.481
331	1994	-0.053	0.113	2.198
331	1995	0.265	0.101	2.971
331	1996	0.032	0.305	2.046
332	1990	0.000	0.000	1.428
332	1991	-0.080	-0.099	1.458
332	1992	0.225	0.010	1.733
332	1993	0.115	0.178	1.352
332	1994	0.292	0.190	1.550
332	1995	0.099	0.360	1.154
332	1996	0.318	0.248	1.508

Note: all measures of productivity are standardized so that they represent the percentage change in productivity from 1990. from 1990. Column 3 values are calculated from the mean productivity level of each class of producer.

Table E.5: Productivity Growth of Exporters and Non-Exporters Continued

		(1)	(2)	(3)
Industry	Year	Exporters	Non-Exporters	$\frac{\omega_x}{\omega_n}$
342	1990	0.000	0.000	2.670
342	1991	-0.034	-0.085	2.819
342	1992	0.008	0.089	2.470
342	1993	-0.107	0.166	2.044
342	1994	0.075	0.137	2.525
342	1995	0.349	0.198	3.007
342	1996	0.227	0.184	2.767
351	1990	0.000	0.000	1.647
351	1991	-0.101	0.172	1.264
351	1992	-0.226	0.086	1.173
351	1993	-0.371	0.094	0.948
351	1994	-0.038	0.189	1.332
351	1995	-0.186	0.089	1.231
351	1996	-0.110	-0.001	1.469
354	1990	0.000	0.000	7.685
354	1991	-0.001	-0.797	37.812
354	1992	-0.025	-0.615	19.456
354	1993	0.245	-0.691	30.915
354	1994	0.623	1.381	5.236
354	1995	0.797	1.258	6.117
354	1996	0.782	1.165	6.324
355	1990	0.000	0.000	2.059
355	1991	0.259	-0.043	2.707
355	1992	0.113	0.272	1.801
355	1993	0.196	0.217	2.024
355	1994	0.236	0.198	2.125
355	1995	0.233	0.369	1.854
355	1996	2.718	0.430	5.355
361	1990	0.000	0.000	10.052
361	1991	0.100	0.019	10.847
361	1992	0.191	-0.023	12.258
361	1993	0.246	0.231	10.175
361	1994	0.281	0.094	11.770
361	1995	0.221	-0.122	13.983
361	1996	0.355	3.022	3.385
362	1990	0.000	0.000	0.510
362	1991	-0.081	0.052	0.446
362	1992	-0.057	0.153	0.417
362	1993	0.008	0.553	0.331
362	1994	0.192	0.625	0.374
362	1995	0.216	0.184	0.524
362	1996	0.172	-0.055	0.633

Note: all measures of productivity are standardized so that they represent the percentage change in productivity from 1990. from 1990. Column 3 values are calculated from the mean productivity level of each class of producer.

Table E.6: Productivity Growth of Exporters and Non-Exporters Continued

		(1)	(2)	(3)
Industry	Year	Exporters	Non-Exporters	$\frac{\omega_x}{\omega_n}$
369	1990	0.000	0.000	2.207
369	1991	0.198	0.048	2.523
369	1992	0.137	0.127	2.228
369	1993	0.114	0.494	1.645
369	1994	-0.264	0.504	1.081
369	1995	-0.079	0.790	1.136
369	1996	0.102	0.466	1.659
371	1990	0.000	0.000	0.772
371	1991	-0.217	-0.210	0.766
371	1992	-0.103	-0.266	0.943
371	1993	-0.211	-0.232	0.793
371	1994	-0.171	-0.181	0.781
371	1995	-0.163	0.053	0.614
371	1996	-0.258	0.001	0.572
372	1990	0.000	0.000	1.364
372	1991	-0.487	-0.094	0.773
372	1992	-0.242	-0.353	1.598
372	1993	-0.103	0.158	1.057
372	1994	-0.025	0.185	1.123
372	1995	-0.040	0.261	1.038
372	1996	0.341	0.402	1.304
381	1990	0.000	0.000	1.611
381	1991	-0.149	-0.117	1.553
381	1992	-0.056	0.036	1.467
381	1993	0.000	0.201	1.342
381	1994	-0.228	0.150	1.081
381	1995	-0.112	0.187	1.205
381	1996	0.315	0.366	1.550
383	1990	0.000	0.000	1.159
383	1991	-0.145	-0.202	1.242
383	1992	0.169	0.123	1.207
383	1993	0.544	0.567	1.142
383	1994	0.427	0.359	1.217
383	1995	0.387	0.591	1.011
383	1996	0.599	0.558	1.190
384	1990	0.000	0.000	0.591
384	1991	2.397	-0.206	2.527
384	1992	2.102	-0.095	2.025
384	1993	2.475	-0.084	2.242
384	1994	0.958	-0.180	1.412
384	1995	1.388	-0.174	1.709

Note: all measures of productivity are standardized so that they represent the percentage change in productivity from 1990. from 1990. Column 3 values are calculated from the mean productivity level of each class of producer.

Table E.7: Influences on Plant-level Exports

	(1) Tobit Export Level	(2) Tobit Export Level	(3) Probit Export Status	(4) Probit Export Status	(5) Tobit Export Share	(6) Tobit Export Share
Productivity	0.233	0.429	0.092	0.164	0.009	0.017
	(0.377)	(0.545)	(0.019)	(0.025)	(0.002)	(0.003)
REER	-24.182	-23.689	-9.106	-8.909	-0.280	-0.293
	(3.692)	(3.668)	(1.680)	(1.691)	(0.195)	(0.196)
World GDP	26.930	26.380	9.874	9.655	0.351	0.364
	(5.729)	(5.690)	(2.642)	(2.654)	(0.286)	(0.288)
Capital	0.672	.641	0.240	0.246	0.032	0.030
	(0.027)	(0.029)	(0.012)	(0.013)	(0.001)	(0.001)
Skilled/Unskilled	0.021	0.017	0.007	0.009	0.001	0.001
	(0.009)	(.009)	(0.005)	(0.006)	(0.000)	(0.000)
Lag Exports (Level)	1.295	1.247				
	(0.023)	(0.023)				
Lag Exports (Status)			1.791	2.339		
			(0.095)	(0.052)		
Lag Export (Share)					1.058	1.054
					(0.015)	(0.015)
Industry Dummies	No	Yes	No	Yes	No	Yes
N	9384	9384	9384	9384	8091	8091

Table E.8: Influences on Plant-level Exports, Subsample

	(1) Export Level	(2) Export Level
Productivity	0.195	-.025
	(0.060)	(0.026)
REER	-24.575	-26.334
	(2.627)	(2.896)
World GDP	29.524	31.758
	(3.425)	(4.401)
Capital	0.334	0.357
	(0.362)	(0.020)
Skilled/Unskilled	0.005	0.012
	(.007)	(.005)
Lagged Exports (Level)	0.505	0.544
	(.034)	(0.014)
Industry Dummies	No	Yes
N	2047	2047

Table E.9: Investment IV Tobit

	(1) Tobit	(2) IV Tobit	(3) Tobit	(4) IV Tobit
		Investment		Investment
Lag Productivity 0.602	0.597	0.660	0.572	
	(0.073)	(.077)	(0.072)	(0.079)
Lag Capital	1.408	1.424	1.368	1.381
	(0.042)	(0.044)	(0.040)	(0.043)
Export (Status)			1.143	0.973
			(0.169)	(0.223)
Export (Level)	0.132	0.080		
	(.034)	(0.040)		
Industry Dummies	Yes	Yes	Yes	Yes
N	8276	8276	8276	8276

Note: Standard errors are AGLS standard errors calculated in a manner similar to Newey (1987).

Table E.10: Decomposition of Growth

	Existing Plants	Entering Plants	Exiting Plants
1991	-5.63	1.59	-0.40
1992	7.59	4.73	-0.99
1993	3.08	2.20	-1.65
1994	1.37	1.44	-0.80
1995	6.13	3.93	-1.04
1996	5.43	7.12	-1.49

Note: Values represent year to year contribution to growth in percent.

Table E.11: Actual and Simulated Data, Number of Plants and Exiting Plants

	Number of Plants			Exiting Plants	
Year	Observations	Actual	Simulation	Actual	Simulation
1990	1578	1578	1578.00	38	37.16
1991	1501	1540	1540.84	31	45.32
1992	1472	1509	1495.51	104	77.48
1993	1345	1405	1418.03	80	89.36
1994	1263	1325	1328.68	96	107.09
1995	1163	1229	1221.59	111	153.61
1996	995	1118	1067.98	-	163.75

Note: All simulation results represent the mean of 1000 repetitions. "Actual Plants" represents the number of plants in 1990 less exiting plants in earlier years

Table E.12: Actual and Simulated Data, Mean Factor Use

	Skilled Labor		Unskilled Labor		Capital	
Year	Actual	Simulation	Actual	Simulation	Actual	Simulation
1990	23.30	23.30	70.63	70.63	100.00	100.00
1991	24.01	23.47	73.69	70.11	101.17	98.82
1992	24.80	23.74	75.67	71.74	103.68	99.53
1993	27.43	25.03	79.64	70.97	117.34	103.62
1994	30.29	25.88	80.33	74.17	128.10	112.65
1995	31.47	27.19	80.63	73.44	154.97	135.16
1996	36.81	30.93	75.70	70.87	158.96	170.62

Note: All simulation results represent the mean of 1000 repetitions. Labor is defined as the mean number of workers across plants. Capital represents the mean real capital stock of plants and is standardized so that the 1990 is equal to 100.

Table E.13: Actual and Simulated Data, Value Added

	Output Industry		Output Average Firm	
Year	Actual	Simulation	Actual	Simulation
1990	100.00	100.00	100.00	100.00
1991	94.77	101.00	99.63	104.30
1992	102.37	107.19	109.74	114.05
1993	118.03	112.69	138.48	126.47
1994	113.56	120.24	141.88	144.04
1995	123.73	125.09	167.89	163.02
1996	121.26	128.97	192.31	192.35

Note: All simulation results represent the mean of 1000 repetitions. Output is defined as real annual value added of the industry and mean of plants in the sample. values are standardized so that 1990 is equal to 100.

Table E.14: Actual and Simulated Data, Exports

	Exporters		Exports: Industry		Industry: Average Plant	
Year	Actual	Simulation	Actual	Simulation	Actual	Simulation
1990	239	239.00	100.00	100.00	100.00	100.00
1991	296	288.26	92.14	117.87	75.33	102.85
1992	303	306.72	199.03	132.64	160.12	108.79
1993	299	308.66	150.56	146.80	121.12	119.66
1994	294	300.66	179.91	158.46	148.54	132.62
1995	278	279.84	214.72	162.95	185.21	146.61
1996	248	250.50	151.21	164.13	147.11	165.06

Note: All simulation results represent the mean of 1000 repetitions. Exporters are the number of plants that export in a given year. Exports are defined real exports of the industry and mean of plants in the sample. Industry and mean exporters are standardized so that the 1990 is equal to 100.

Table E.15: Comparison of Policies, Number of Plants

Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
1990	1578.00	1578.00	1578.00	1578.00	1578.00
1991	1672.63	1672.33	1672.63	1672.96	1672.90
1992	1741.21	1740.97	1740.76	1741.55	1741.61
1993	1784.62	1783.88	1783.64	1784.25	1784.37
1994	1790.73	1789.63	1789.56	1790.36	1789.50
1995	1780.58	1779.68	1778.96	1780.66	1778.62
1996	1819.30	1817.88	1817.43	1820.77	1817.26

Note: All simulation results represent the mean of 1000 repetitions.

Table E.16: Comparison of Policies, Mean Capital Stock

Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
1990	100.00	100.00	100.00	100.00	100.00
1991	109.62	109.87	109.76	109.75	110.00
1992	115.45	116.00	116.14	115.91	115.81
1993	129.80	131.04	131.30	130.81	130.16
1994	141.46	142.69	143.77	142.69	141.77
1995	154.79	156.39	157.94	156.65	154.70
1996	181.79	184.43	186.20	184.13	181.68

Note: All simulation results represent the mean of 1000 repetitions. Values are standardized such that the 1990 value is equal to 100.

Table E.17: Comparison of Policies, Mean Skilled Labor

Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
1990	23.30	23.30	23.30	23.30	23.30
1991	22.49	22.54	22.58	22.53	22.50
1992	22.52	22.55	22.62	22.55	22.50
1993	23.51	23.56	23.65	23.56	23.49
1994	24.00	24.09	24.20	24.09	24.04
1995	24.97	25.07	25.17	25.09	25.01
1996	28.24	28.41	28.51	28.33	28.29

Note: All simulation results represent the mean of 1000 repetitions.

Table E.18: Comparison of Policies, Mean Unskilled Labor

Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
1990	70.63	70.63	70.63	70.63	70.63
1991	68.09	68.31	68.53	68.28	68.12
1992	69.51	69.71	70.00	69.69	69.44
1993	69.42	69.64	70.04	69.67	69.33
1994	71.19	71.55	71.97	71.57	71.27
1995	71.35	71.73	72.18	71.79	71.44
1996	65.66	66.05	66.38	66.11	65.74

Note: All simulation results represent the mean of 1000 repetitions.

Table E.19: Comparison of Policies, Industry Value Added

Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
1990	100.00	100.00	100.00	100.00	100.00
1991	99.00	99.34	99.79	99.34	99.05
1992	106.85	107.37	108.18	107.52	106.90
1993	113.85	114.61	115.78	114.85	113.87
1994	120.83	121.67	123.47	122.07	120.71
1995	126.51	128.25	129.97	128.40	126.74
1996	122.75	124.95	126.78	124.88	122.95

Note: All simulation results represent the mean of 1000 repetitions. Values are standardized such that the 1990 value is equal to 100.

Table E.20: Comparison of Policies, Number of Exporters

Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
1990	239.00	239.00	239.00	239.00	239.00
1991	303.98	380.81	525.21	379.51	305.47
1992	420.29	523.55	681.82	525.02	423.94
1993	449.62	560.76	717.17	564.85	456.18
1994	518.41	627.96	774.22	634.58	523.20
1995	517.64	620.21	748.33	624.98	524.26
1996	564.60	653.41	761.41	659.66	569.65

Note: All simulation results represent the mean of 1000 repetitions.

Table E.21: Comparison of Policies, Mean Exports

Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
1990	100.00	100.00	100.00	100.00	120.00
1991	100.61	81.22	59.82	82.15	141.10
1992	109.56	84.74	63.71	85.62	148.30
1993	120.76	94.38	73.40	94.83	159.13
1994	131.93	104.24	83.19	104.67	170.15
1995	159.53	128.87	105.30	129.05	204.69
1996	181.14	153.71	128.57	152.85	234.10

Note: All simulation results represent the mean of 1000 repetitions. Values are standardized such that the 1990 value is equal to 100.

Table E.22: Comparison of Policies, Industry Exports

Year	Simulation 1	Simulation 2	Simulation 3	Simulation 4	Simulation 5
1990	100.00	100.00	100.00	100.00	120.00
1991	121.60	122.88	124.80	124.00	141.91
1992	141.75	144.38	148.70	146.29	160.63
1993	162.94	169.05	177.00	171.60	180.96
1994	172.96	182.09	193.82	185.50	187.84
1995	198.07	212.17	227.00	215.52	214.60
1996	215.12	236.72	253.41	238.71	234.53

Note: All simulation results represent the mean of 1000 repetitions. Values are standardized such that the 1990 value is equal to 100.

Table E.23: Decomposition of Growth, Policy Simulation 1

Year	Total	Existing	New	Exiting
1991	-1.348	-2.921	1.918	-0.346
1992	9.308	4.384	5.483	-0.559
1993	10.286	8.991	2.645	-1.350
1994	6.747	6.957	1.657	-1.867
1995	3.807	1.803	4.461	-2.457
1996	-2.287	-4.253	5.539	-3.573

Note: Values represent annual growth in percent decomposed as described in the text

Table E.24: Decomposition of Growth, Policy Simulation 2

Year	Total	Existing	New	Exiting
1991	-0.963	-2.562	1.901	-0.302
1992	9.441	4.632	5.365	-0.555
1993	10.427	9.057	2.651	-1.281
1994	6.782	6.982	1.662	-1.862
1995	4.564	2.377	4.598	-2.411
1996	-1.753	-3.742	5.528	-3.539

Note: Values represent annual growth in percent decomposed as described in the text

Table E.25: Decomposition of Growth, Policy Simulation 3

Year	Total	Existing	New	Exiting
1991	-0.534	-2.083	1.874	-0.325
1992	9.752	4.921	5.365	-0.535
1993	10.710	9.315	2.661	-1.266
1994	7.360	7.497	1.626	-1.764
1995	4.345	2.388	4.404	-2.447
1996	-1.936	-3.679	5.410	-3.667

Note: Values represent annual growth in percent decomposed as described in the text

Table E.26: Decomposition of Growth, Policy Simulation 4

Year	Total	Existing	New	Exiting
1991	-0.985	-2.584	1.928	-0.329
1992	9.639	4.774	5.401	-0.536
1993	10.479	9.169	2.637	-1.327
1994	6.885	7.100	1.652	-1.867
1995	4.433	2.339	4.405	-2.311
1996	-2.269	-4.074	5.517	-3.712

Note: Values represent annual growth in percent decomposed as described in the text

Table E.27: Decomposition of Growth, Policy Simulation 5

Year	Total	Existing	New	Exiting
1991	-1.250	-2.847	1.898	-0.301
1992	9.278	4.354	5.489	-0.565
1993	10.268	8.988	2.612	-1.331
1994	6.605	6.801	1.662	-1.858
1995	4.260	2.095	4.468	-2.303
1996	-2.437	-4.299	5.565	-3.703

Note: Values represent annual growth in percent decomposed as described in the text

Table E.28: Simulation Parameters Estimates, Labor and Exit

	Change in Skilled Labor	Change in Unskilled Labor	Exit
Change in Skilled Wage	-0.405 (0.163)	1.941 (0.151)	
Change in Unskilled Wage	0.589 (0.119)	-1.519 (0.110)	
Change in Capital	0.059 (0.011)	0.080 (0.011)	
Change in Productivity	-0.042 (0.007)	-0.029 (0.006)	
Change in Exports	0.007 (0.004)	0.009 (0.004)	
Capital			-0.051 (0.018)
Skilled Labor			-0.159 (0.031)
Productivity			-0.259 (0.025)
REER			5.105 (0.364)
Industry Dummies	No	No	Yes
N	9821	9821	8962

Table E.29: Simulation Parameters Estimates, Exports

	Export Enter	Export Exit	Exports Entrants	Exports Existing
REER (s.e.)	-1.865 (0.450)	0.992 (0.642)	-3.632 (1.476)	-0.962 (0.445)
Lag Exports (s.e.)		-0.25 (0.023)		0.793 (0.017)
Capital (s.e.)	0.22 (0.019)	-0.099 (0.028)	0.505 (0.064)	0.168 (0.022)
Productivity (s.e.)	0.171 (0.038)		0.227 (0.120)	
Industry Dummies	Yes	No	Yes	Yes
N	6188	1758	320	1508

Table E.30: Entrants

Year	% of Existing Plants	Mean Real Value Added	Mean Skilled Workers	Mean Unskilled Workers
1991	8.60	100.00	8.75	28.87
1992	7.52	323.11	16.10	54.79
1993	8.09	147.36	10.73	44.07
1994	6.81	116.31	9.18	29.14
1995	7.19	318.21	10.94	42.09
1996	13.69	308.24	20.52	26.32

Note: Values in the value-added column are standardized with the 1991 value equal to 100. Values represent the mean number of entrants in a given year.

Table E.31: Entrants

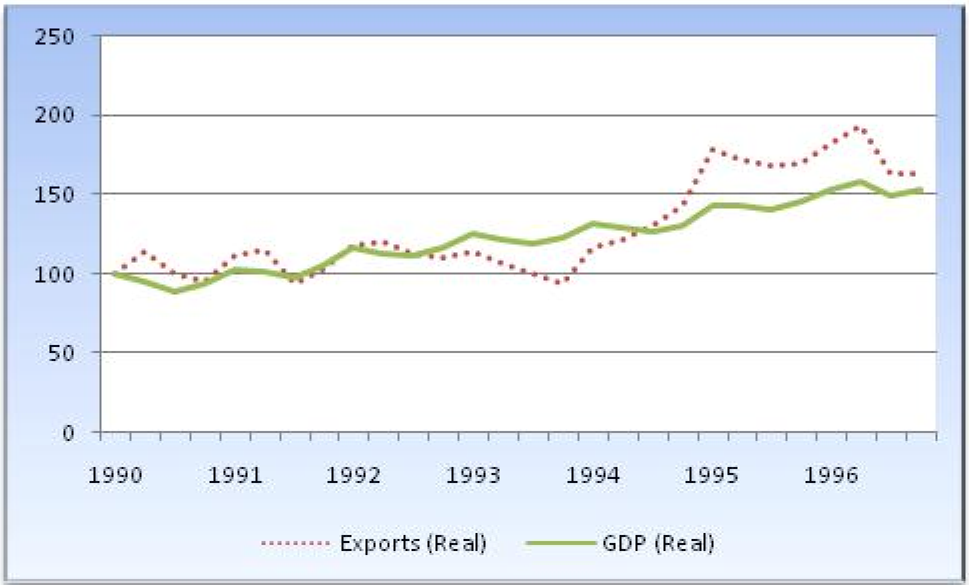
	Change in Unskilled Labor	Change in Skilled Labor	Investment
Change in Capital	0.809	-0.052	
(s.e.)	(0.311)	(0.218)	
Change in Exports	0.067	0.020	
(s.e.)	(0.031)	(0.022)	
Lag Capital			0.705
(s.e.)			(0.084)
Lag Exports			0.119
(s.e.)			(0.079)
N	45	45	137

Table E.32: Entrants

	Export Entry Probit	Export Exit Probit	Existing Exporters Export Level	New Exporters Export Level
Lag Capital	0.164		0.625	0.043
(s.e.)	(0.076)		(0.189)	(0.345)
Lag Exports		0.149	0.296	
(s.e.)		(0.021)	(0.147)	
N	284	2594	35	11

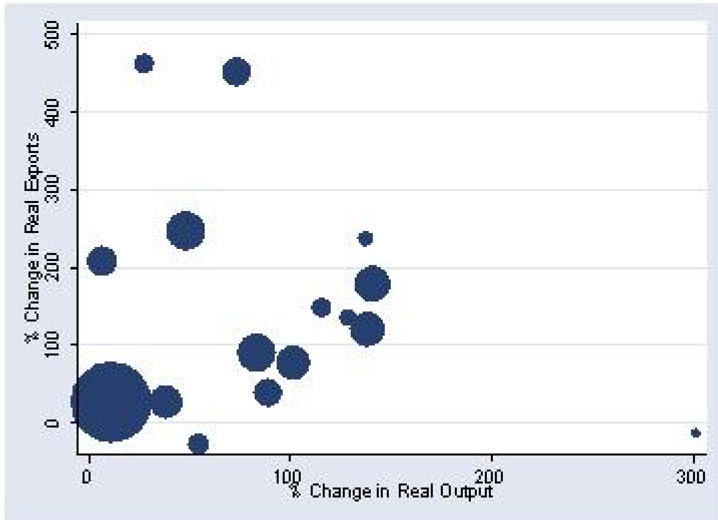
E.2 Figures

Figure E.1: Exports and Growth



Source: IMF International Financial Statistics (2004)

Figure E.2: Industry Growth in Revenue and Exports (1990-1996)



Source: Nicita and Olarreaga (2001)

Figure E.3: Cost of Exports

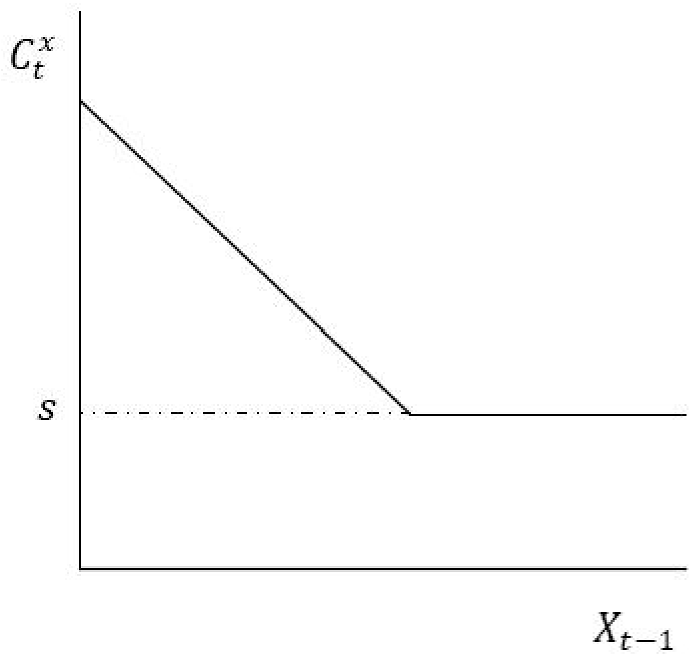
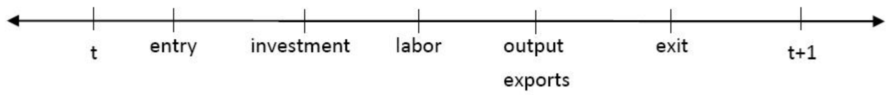


Figure E.4: Simulation Timeline



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