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Title: Trade and Productivity Effects on Firm Behavior: The Case of Korean Manufacturing

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This dissertation's three essays investigate trade and productivity effects on firm behavior based on new heterogeneous-firms trade models in the case of Korea. In the first essay, firms' decision to export in the case of Korean manufacturing industries is examined, where the change in firms' productivity before and after exports are analyzed. In particular, two common hypotheses of export decision - self-selection and learning-by-exporting- are tested using a dynamic model of firm export behavior and a Korean firm-level panel database. Evidence of self-selection is found in only three out of eight industries, but that of learning-by-exporting is limited. Sunk-cost or previous-export-experience effect on the predicted export probability is relatively larger than that of firms' productivity and size.

The second essay investigates the effect of trade cost changes on firms' entry and exit in Korean manufacturing. Empirical support is found for new trade theories' predictions on firm entry and exit, and the number of exporting firms, and changes in market share following trade-cost changes. However, Korean manufacturing appears to differ from some of the outcomes of the heterogeneous-firms theory, especially in the result that large firms are less likely to be a new exporter. Rather, smaller and less

capital-intensive firms tended to enter the export market. In general, the results of this essay show that changing trade costs had important consequences for the structure of manufacturing activity in Korea.

In the final essay, the differences in the scale economies of exporters and non-exporters in Korean manufacturing are investigated. Results from estimating a production function show that exporters face diseconomies of scale in four of five industries. A matching technique confirms the difference in returns to scale between exporters and non-exporters. The evidence that size and hence, scale economies may be less important for trade participation and gains from overseas market, bodes well for small or medium exporters.

In summary, this dissertation has improved the understanding of the relationships among trade, productivity and firm behavior. The key determinant of firms' export behavior in the Korean context appears to be previous experience in overseas markets. Not surprisingly, the Korean government has invested heavily in lowering their firms' cost of accessing foreign markets. In industries where Korea has a comparative advantage, high productivity of firms appears to promote trade participation. However, productivity growth in other industries is low and falling, in some cases. A balanced approach to investments in productivity and export promotion would sustain and improve Korean manufacturing's competitiveness in global markets.

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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to my reader upon request.

Sooil Kim, Author

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Continued)

LIST OF TABLES (Continued)

CHAPTER ONE

INTRODUCTION

New trade theory and recent empirical research with micro data present many challenges to conventional trade models (Bernard and Jensen 1997, 1999; Roberts and Tybout 1997; Melitz 2003; Helpman, Melitz and Yeaple 2004). The latter assumes that firms within an industry are homogeneous and predicts that industries with comparative (dis)advantage expand (contract) as trade costs falls, e.g., unilateral or multilateral trade liberalization or transport costs. Recent empirical studies find that firms are heterogeneous, exporters are different from nonexporters and exporting is relatively rare within any given industry. New trade theories have modeled firm heterogeneity, consistent with observations of the real world, but hypothesize about channels through which industry productivity increases and predict firm behavior, especially the factors determining firm birth and death, and export-market entry and exit (Aw and Hwang 1995; Aitken, Hanson and Harrison 1997; Bernard and Jensen 1997, 1999, 2004a; Roberts and Tybout 1997; Bernard et al. 2003; Melitz, 2003; Helpman, Melitz and Yeaple 2004; Helpman, 2006).

This dissertation, composed of three essays, investigates trade and productivity effects on firm behavior based on new trade models. In the first essay, firms' decision to export in the case of Korean manufacturing industries is examined. In particular, two common hypotheses of export decision - self-selection and learning-by-exporting- are tested. Self-selection suggests that only firms with high productivity can afford trade costs to serve competitive foreign markets. The learning-by-exporting hypothesis suggests that firms learn or improve productivity from exporting, possibly through understanding of the customers' quality demand. For testing the two hypotheses, Roberts and Tybout's (1997) dynamic model of firm export behavior is extended to the Korean case. For 1998-2003, a firm-level panel database is assembled, where productivity is computed using the data envelope analysis (DEA). Since much of trade literature has addressed simultaneous determination of export decision and firm characteristics, tests of possible endogeneity of regressors are conducted to lower the potential bias in estimated coefficients. The latter approach not only addresses regressor's endogeneity, but also permits joint testing of self-selection and learning-by-exporting hypotheses.

The second essay investigates the effect of trade cost changes on firms' entry and exit in Korean manufacturing. To achieve the objective, the work of Bernard, Jensen, and Schott (2006) is extended in several ways in the context of the Korean manufacturing firms between 1991and 2003. More specifically, this essay examines the effect of changes in trade costs on (i) the aggregate industry productivity gain, (ii) the probability of firm exit and firm entry, (iii) the number of exporting firms and export sales, and (iv) the domestic market share of surviving firms and firm-level productivity. The computation of trade costs follows Novy's (2007) approach, which captures not only trade costs, e.g., transportation costs and tariffs, but also non-tariff barriers.

In the final essay, the difference in the returns to scale between exporters and nonexporters within an industry in Korean manufacturing are investigated. Gains from trade depend on the extent of scale economies in an industry (Kemp and Negishi 1969; Eaton and Panagariya 1979; Krugman 1980; Panagariya 1980; Abayasiri-Silva and Mark Horridge 1996; Jason and Liu 2005). For computation of the returns to scale, a stochastic frontier production function is estimated using the log-linear, Cobb-Douglas functional form. To compare the difference in returns to scale between exporters and nonexporters, a matching approach (*t*-test and F test) is employed.

The three essays together improve our understanding of the relationships among trade, productivity and firm behavior. The results have important policy implications, especially by way of insights into how the Korean government can help their firms sustain competitiveness in global markets, while balancing gains and losses from international competition.

CHAPTER TWO

Productivity Before and After Exports: The Case of Korean Manufacturing Firms

2.1. Introduction

International trade has been important for efficiency gains, scale economies and specialization, which significantly contribute to economic growth (Romer 1990; Barro and Sala-i-Martin 2004). Not surprisingly, a country's trade openness commonly measured by its export or import share of GDP is considered to be an indicator of the competitiveness of an economy. In this context, the empirical association between trade and economic growth has led to a flurry of export promotion activities by developed- and developing-country governments (Giles and Williams 2000a, 2000b). Many of these export-promotional activities, e.g., budgetary expenditures, are mostly aimed at mitigating market failures such as informational asymmetries, knowledge spillovers, and credit and exchange rate risks.[1] However, the factors that underlie a firm's decision to export, continue to export or exit a foreign market have not received much attention until recently (Bernard and Jensen 1995). The small number of firm-level export studies indicates the limited understanding of the characteristics of exporting firms as well as limited availability of micro data for such analysis (Bernard and Jensen 1997, 1999; Roberts and Tybout 1997; Melitz 2003; Helpman, Melitz and Yeaple 2004).

The objective of the first essay of this dissertation is to seek an understanding of firms' decision to export in the case of Korean manufacturing industries. Indeed Korea is

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[1] Export subsidies are being phased out via WTO negotiations.

an excellent example of the export-led growth idea, but few studies have explored factors contributing to the increased global participation of Korean firms, and their consequences (Lee, Kim and An 2005). This study focuses on firms in the Korean manufacturing industries, at the ISCI 2-digit level, to identify and compare the determinants of their export behavior.[2] Two common hypotheses of export decision - self-selection and learning-by-exporting - are tested. The self-selection hypothesis suggests that only high-productivity firms self-select into foreign markets, whereas the learning-by-exporting argues that firms learn from exporting, which improves their productivity. The empirical examination of the above two hypothesis will provide important insights into how productivity improvements impact trade participation and economic growth.

To achieve the objective, Roberts and Tybout's (1997) model of firm export behavior is extended to simultaneously examine the self-selection and the learning-by-exporting hypotheses using firm-level data for the period 1998-2003. For this purpose, data on 1335 Korean manufacturing firms are assembled for 6 years from 1998 to 2003. Firm-specific characteristics considered in testing the two hypotheses are total factor productivity (TFP), size (labor or capital) and investments in research and development (R&D). Since much of trade literature has addressed simultaneous determination of export decision and firm characteristics, tests of possible endogeneity of regressors are conducted to eliminate potential bias in estimated coefficients.

The next two sections present a brief review of the recent literature on export decision models and an outline of the basis of our empirical framework description in that

[2] In the early 1960s, the Korean government selected firms in targeted industries, gave them various privileges, and helped them improve productivity through learning-by-doing and importing advanced technologies. Later, the Korean government shifted to a strategy of stimulating economic growth through export promotion, under which policies favored exporting firms according to their (export) performance.

order. Then, data including productivity computation are described followed by the discussion of results. Finally, the summary section concludes and provides policy implications of the study.

2.2. Prior Literature

Since Bernard and Jensen’s (1995) seminal contribution on exporter characteristics, many have studied firms’ decision to produce for foreign markets and export, i.e., the export decision, in manufacturing industries. Recent contributions to the theoretical and empirical literature on factors that underlie a firm’s decision to export, continue to export or exit a foreign market have improved the understanding of firms’ export behavior (Aw and Hwang 1995; Aitken, Hanson and Harrison 1997; Bernard and Jensen 1997, 1999, 2004a; Roberts and Tybout 1997; Bernard et al. 2003; Melitz, 2003; Helpman, Melitz and Yeaple 2004; Helpman, 2006).

Focusing on characteristics of exporting firms, most studies support the link between higher efficiency or productivity and export participation, but two hypotheses are suggested for directionality in this relationship. The first is the self-selection hypothesis, which states that only high-productivity firms will become exporters: Bernard and Jensen (1995, 1999) in the case of the United States; Clerides, Lach and Tybout (1998) for Colombia, Mexico and Morocco; Aw, Chung, and Roberts (2000) in Korea and Taiwan; Alvarez and Lopez (2004) in Chile; and Girma, Greenaway and Kneller (2004) in UK. The reasoning here is that there are extra costs associated with export activities (e.g. quality and supply chain/distribution costs). Only high-productivity firms can afford to incur these additional costs, making them self-select into export markets. That is, pre-determined productivity affects export behavior. The alternative hypothesis, learning-by-exporting, suggests that firms improve their productivity by participating in global markets (Clerides, Lach and Tybout 1998; Aw, Chung and Roberts 2000). Firms learn from buyers/exporting firms, who require specific product and process standards, and supply-chain/distribution cost-sharing to compete in international markets. Productivity gains associated with this learning-by-exporting process helps firms continue to produce for foreign markets.

Empirical studies indicate that high-productivity firms self-select into export markets (Richardson and Rindal 1995; Wagner 2005; Helpman, 2006). Other results include that exporters survive longer and pay higher wages relative to nonexporters in both developed and developing economies. Modeling such firm heterogeneity at the industry level shows resource reallocation in favor of fast-growing exporters, which is an important determinant of the observed correlation between exports and economic growth (Melitz 2003; Bernard and Jensen 2004b). However, the evidence on whether exporting improves productivity, i.e., learning-by exporting, remains mixed.

2.3. Conceptual and Empirical Framework

Roberts and Tybout's (1997) dynamic discrete choice process of export behavior based on sunk (entry and/or exit) costs is the basis of this essay's empirical strategy on self-selection. In their model, firms' export decision depends crucially on profits net of entry/exit costs in foreign markets. At any given time, assuming that the profit-maximizing level of export is always chosen, the difference in profits between exporting and not exporting for a representative firm is a function of factors exogenous and specific to the firm. A firm will export if the difference in profits between exporting and not exporting exceeds the initial sunk entry or export costs. Firms decide to export in every period, so a non-exporting firm at one time can turn into an exporter in the next or following periods. Similarly, an exporting firm at one time can turn into a nonexporter at another time, but it would incur an exit cost. Additionally, if a firm exported in a year $t-j$ ($t \geq 2$), for example, and if it resumes export in year t, it will face reentry costs. With the above suppositions, the maximized payoff of a firm i in period t, V_{it}, is defined as:

$$(1) \quad V_{it}(\Omega_{it}) = \max\ E_t\left(\sum_{j=t}^{\infty} \delta^{j-t} R_{ij} \middle| \Omega_{it}\right)$$

where δ denotes the discount rate, R_{it} is a period t exporting profit, and E_t is a expected value conditioned on the firm-specific information set, Ω_{it}.

Considering export-market participation, a firm exports ($Y_{it} = 1$) if current and expected revenues $\hat{R}_{it}$ are greater than current-period costs c_{it} plus any (sunk) costs of entry, N:

$$(2) \quad Y_{it} = \begin{cases} 1 \ \ if \ \ \hat{R}_{it} > c_{it} + N(1-Y_{it-1}), \\ 0 \qquad otherwise \end{cases}$$

where $\hat{R}_{it} = R^*_{it} + \delta(E_t[V_{it}(\cdot)| R^*_{it} > 0] - E_t[V_{it-1}(\cdot)| R^*_{it} = 0])$, and R^*_{it} is the desired level of export revenues. In equation (2), sunk costs represent the direct costs of entry and exit in the foreign market. To estimate equation (2), one could develop a structural representation by specifying the revenue function. The structural approach can capture the dynamic process through the parameters of the profit function, but requires very restrictive parameterization. Thus, following Roberts and Tybout (1997) and Bernard and

Jensen (2004a), a reduced-form approach is used to identify and quantify factors underlying the probabilistic decision in equation (2). Formally,

$$(3)\quad Y_{it} = \begin{cases} 1 & if \quad \alpha X_{it} + \eta Q_{it} - N(1 - Y_{it-1}) + \varepsilon_{it} > 0 \,, \\ 0 & \quad\quad\quad otherwise \end{cases}$$

Firm characteristics are represented in the vector X_{it}, while entry or sunk costs are represented by one-period lagged, Y_{it-1}, discrete export choice. Often, export decision models represented in equation (3) include other variables exogenous to the firm (Q_{it}): trade shock, industry demand shock, and industry spillovers.

To investigate the impact of sunk costs and firm specific characteristics on a firm's export decision, a probit model is specified for estimating equation (3). The identification of the parameter on the lagged export decision is a key issue in equation (3) since unobserved characteristics may also affect firms' export decision. There are several potential estimation strategies for the binary-choice framework with unobserved heterogeneity: probit with random or fixed effects, conditional logit, and linear probability models with fixed or random effects. A criterion in choosing among the specifications is whether or not unobserved firm characteristics is better modeled as fixed or random effects. In the dynamic specification given a panel database, the fixed-effects probit estimator is shown to yield biased parameter estimates (Roberts and Tybout, 1997; Bernard and Jensen, 2004a; Greene, 2002). The analysis in this essay employs a random-effects probit estimator as in Roberts and Tybout (1997). Similar to the latter's specification, the error ε_{it} is assumed to be the sum of a permanent firm-specific element and a transitory component: $\varepsilon_{it} = \kappa_i + \eta_{it}$. The permanent component is assumed to be uncorrelated across firms, and the transitory component to be uncorrelated across time.

For testing the learning-by-exporting hypothesis, Bernard and Jensen (1999) and Clerides et al. (1998) propose a model of productivity, $Prod$, model as follows:

(4) $\Pr od_{it} = \pi_0 + \pi_1 Y_{it-1} + \pi_2 \Pr od_{it-1} + \pi_3 X_{it-1} + \mu_{it}$,

where X_{it-1} includes firm characteristics and μ_{it} is a random error term. Some studies have sorted the sample into two mutually exclusive groups, e.g., exporters and nonexporters, and examined differences in the two groups' performance (Bernard and Jensen, 1999). We employ the alternative method of adding a dummy for lagged export decision in equation (4) (Clerides et al, 1998).

A major problem with equation (4) is that decision to export is believed to be endogenous: equation (3). To deal with this endogeneity problem, instrumental-variables (IV) estimators have been suggested by some studies (Wagner, 2005; Gopinath, Sheldon, and Echeverria, 2007). In addition, there is a possibility that productivity is also endogenous in the decision to export – equation (3). If both productivity and export decision are simultaneously determined, individual-equation estimation will yield biased parameter estimates. To overcome this problem, this analysis considers the following two-equation model, which incorporates self-selection and learning-by-exporting hypotheses:

(5) $\Pr od_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 \Pr od_{it-1} + \beta_3 Y_{it-1} + \beta_4 X^1_{it-1} + \varepsilon^1_{it}$

$$Y_{it} = \gamma_0 + \gamma_1 \Pr od_{it} + \gamma_2 Y_{it-1} + \gamma_3 X^2_{it-1} + \varepsilon^2_{it}$$

A test of this two-equation model against individual estimation of each of the two hypotheses is also carried out via endogeneity tests appropriate for discrete-choice and continuous-variables models. Assume that the reduced forms from the system in equation (5) can be written as follows:

(6) $Prod_{it} = \prod_1 W + \varepsilon_1$

$$Y_{it} = \prod_2 W + \varepsilon_2$$

where W includes all the exogenous variables in equation (5). In the two-equation model with continuous and discrete endogenous variables, estimation by maximum-likelihood methods is very cumbersome and in some cases even infeasible. Thus, a two-stage estimation procedure is considered, and the asymptotic covariance matrix can be derived by using a procedure proposed by Amemiya for the Nelson-Olsen model (Maddala, 1983).

A concern here is how one might employ statistical criteria to choose between the learning-by-exporting model that permits simultaneity and one that does not. One procedure for doing this is the Hausman specification test, which tests whether or not the regressor of interest is uncorrelated with the error term. Under the null hypothesis that the regressor Y_{it} and the error term ε_{it}^1 are uncorrelated, OLS estimation will yield consistent and efficient estimates of the parameters. In contrast, under the alternative hypothesis that Y_{it} and ε_{it}^1 are correlated, OLS will yield inconsistent estimates.[3]

A similar issue arises with the bivariate probit model testing self-selection, i.e., the correlation between $Prod$ and the probit model's error term. To test the endogeneity of productivity in equation (3), the Vuong test, originally due to Rivers and Vuong (1988), is used. The procedure, described in detail and applied in Wooldridge (2002), is a two-stage conditional maximum likelihood (2SCML) estimator. The Vuong test is based on

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[3] The null hypothesis can be reduced to a test of the simple hypothesis that $\beta_1 = 0$, which can be tested by computing the ratio of the estimated β_1 to its standard error.

the Kullback-Leibler information criteria (KLIC), a measure of the "distance" between the two statistical models. Formally, the KLIC in the Vuong test is defined as,

(7) $KLIC \equiv E_0[\ln h_0(Y|X)] - E_0[\ln f(Y|X;\omega_*)]$,

where h_0 represents the true conditional density of Y given X, E_0 is the expectation under the true model, and ω_* are the pseudo-true values of ω. The best model is the one that minimizes KLIC or maximizes $E_0[\ln f(Y|X;\omega_*)]$, which means that the model is very close to the true specification. The likelihood ratio test proposed by Rivers and Vuong (1988) is given by:

(8) $LR = -2(\ln \hat{L}_R - \ln \hat{L}_U)$

where $\hat{L}_R$ and $\hat{L}_U$ are the log-likelihood values from restricted and unrestricted models (with and without residuals of an IV equation for *Prod* as part of the explanatory variables), respectively. The LR statistic has a chi-squared distribution with degrees of freedom equal to the number of endogenous variables (1, in this essay).

2.4. Data and Productivity Measurement

Korea firm-level panel data are drawn from the Korea Information Service (KIS), the major credit-rating agency in Korea, which was established in 1985 and has compiled the corporate database on the Korean manufacturing sector. Most firms listed on the Korea stock exchange report sales, employment, benefits, investment and related activity, and financial conditions to KIS for credit-rating purposes. Though data are available for 1980s and early 1990s, an initial panel dataset of 1335 firms is considered for the period of 1997-2003. Extending the time period to before 1997 poses two problems. The first is that data reporting was not mandatory prior to 1997 and the number of surviving firms for samples beginning before 1997 is smaller than the initial sample of 1335 firms (e.g. 700 firms for 1996-2003).

The output of the firm is denoted by its total sales in domestic and foreign markets, both of which are deflated using a manufacturing price index. Inputs into production are capital - tangible and intangible, employment (labor), raw or intermediate materials, and R&D expenditures. The inputs and the output reported in values terms are deflated by a price index.

Following Chambers et al. (1996), the data envelopment analysis (DEA) is used to derive firm-specific productivity measures. DEA is a linear programming-based technique for evaluating the relative efficiency of a decision making units and does not require any assumption on the functional form of production technology and error terms. To illustrate, consider a production technology producing M outputs, $z \in R_{+}^{M}$ with N inputs, $x \in R_{+}^{N}$. Letting a closed set $T \subset R_{-}^{N} \times R_{+}^{M}$ denote the production possibility set, $(-x, z) \in T$, the Luenberger's shortage function can be defined by differences in values of the directional distance function as follows:

$$(9) \quad S(x, z, g_x, g_z) = \begin{cases} \min\limits_{\mu} \{ \mu : (-x - \mu g_x, z - \mu g_z) \in T \} & \textit{for some } \mu, \\ +\infty & \textit{otherwise} \end{cases}$$

where $g_x \in R_{+}^{N}$ and $g_z \in R_{+}^{M}$ are directional vectors. Chambers et al. (1996) defines the directional technology distance function as a variation of the Luenberger's shortage function as the following:

$$(10) \quad \vec{D}(x, z : g_x, g_z) = \sup\{ \theta : (x - \theta g_x, z + \theta g_z) \in T \}$$

With the assumption of free disposability of inputs and outputs, the directional distance function in equation (10) can provide an alternative description of the production technology. Consider a set of observations on K firms, (x^k, z^k), $k = 1, \ldots, K$. Assume that the set T is convex and the technology exhibits free disposal. If we impose variable returns to scale on the production technology by restricting the intensity variables to sum to one, i.e., $\sum_{k=1}^{K} \lambda^k = 1,\ \lambda^k \geq 0$, a nonparametric representation of the technology is expressed as:

(11) $$T_{VRS} = \left\{(-x, z) : \sum_{k=1}^{K} \lambda^k x^k \leq x,\ \sum_{k=1}^{K} \lambda^k z^k \geq z,\ \sum_{k=1}^{K} \lambda^k = 1,\ \lambda^k \geq 0,\ k = 1, \ldots, K \right\}$$

The directional distance function of k-th firm for the periods t+1 and t, of $\vec{D}_t(\cdot)$ and $\vec{D}_{t+1}(\cdot)$ respectively, can be represented by the following linear programming problems (Chambers et al., 1996):

(12) $$\vec{D}_{t+1}(x_t^k, z_t^k : g_x^k, g_z^k) = \max_{\theta,\ \lambda} \theta$$

$$\text{s.t.} \quad \sum_{k=1}^{K} \lambda^k x_{t+1}^k \leq x_t^k - \theta g_x^k,\ \sum_{k=1}^{K} \lambda^k z_{t+1}^k \leq z_t^k - \theta g_z^k,\ \sum_{k=1}^{K} \lambda^k = 1,\ \lambda^k \geq 0,\ k = 1, \ldots, K,$$

(13) $$\vec{D}_t(x_{t+1}^k, z_{t+1}^k : g_x^k, g_z^k) = \max_{\theta,\ \lambda} \theta$$

$$\text{s.t.} \quad \sum_{k=1}^{K} \lambda^k x_t^k \leq x_{t+1}^k - \theta g_x^k,\ \sum_{k=1}^{K} \lambda^k z_t^k \leq y_{t+1}^k - \theta g_z^k,\ \sum_{k=1}^{K} \lambda^k = 1,\ \lambda^k \geq 0,\ k = 1, \ldots, K$$

where θ measures how far the input-output vector (x, z) is from the frontier technology, expressed in units of the reference input-output bundle, (g_x, g_z). The average of $\vec{D}_t(\cdot)$ and $\vec{D}_{t+1}(\cdot)$ can be used as the productivity index of the firm in period t+1. Larger values of the average of these two indexes indicate inefficiency, while a zero value indicates that the corresponding firm is efficient given the frontier technology.

2.5. Results and Discussion

This section first reports the results of the endogeneity tests in single-equation models of self-selection and learning-by-exporting. Then, the results of the simultaneous (two-equation) model, jointly testing the above two hypotheses, are discussed.

2.5.1 Endogeneity Tests

First, consider the productivity equation, *Prod* . In every industry, except chemicals (Hausman's chi-squared statistic, 3.99 < 11.07), the Hausman test rejects the null hypothesis that the lagged export decision is independent of the error term. So, the individual-equation specification for *Prod* (equation 4) should account for the endogeneity of LDV, i.e., lagged export decision, via an instrumental-variable estimator. In the individual self-selection model, the Vuong tests also reject the null hypothesis that productivity is exogenous except in the computers and office machinery industry (Vuong statistic 3.8). Both Hausman and Vuong tests imply that individual estimation by OLS and bivariate Probit estimators without taking account of possible simultaneity will yield biased parameters of export behavior. Alternatively, the two-equation model of export decision and productivity is statistically preferred over the individual-equation models for each equation. Nevertheless, tables 2.1.1 through 2.1.8 present the industry-wise parameter estimates of individual as well as joint estimation of export decision and productivity in the case of Korean manufacturing firms.

2.5.2 Two-Equation Model Results

Based on the results of endogeneity tests in the previous subsection, the following two-equation model is considered:

$$(14)\quad \Pr od_{it} = \beta_0 + \beta_1 Y_{it} + \beta_2 \Pr od_{it-1} + \beta_3 Y_{it-1} + \beta_4 R\&D_{it-1}$$

$$Y_{it} = \gamma_0 + \gamma_1 \Pr od_{it} + \gamma_2 Y_{it-1} + \gamma_3 Labor_{it-1} + \gamma_4 TCAP_{it-1} + \gamma_5 INTCAP_{it-1},$$

where $R\&D$ denotes research and development, $Labor$ is the number of employees, $TCAP$ and $INTCAP$ are tangible capital (e.g., buildings and machines) and intangible capital (e.g., industrial property rights, branding, and fishing rights), respectively. Although the estimates of individual equations for $Prod$ and Y_{it} are presented in columns labeled (1) and (2) of tables 2.1.1 through 2.1.8, they are not discussed in the following. Given the results of endogeneity tests, only results of the two-equation (simultaneous) model are explored in depth.

Regression results for the food processing and tobacco industry are reported in table 2.1.1. Recall from the previous section that a larger value of the $Prod$ index indicates greater inefficiency of a firm. Focusing on the productivity equation, column (3) of table 2.1.1, shows that the estimated coefficient on Y_{it-1} is negative, but not statistically significant. That is, exporting in the previous year does not significantly affect firm productivity in the following year. Hence, the learning-by-exporting hypothesis is not supported in the food processing and tobacco industry. Note also that the estimated coefficient on $Prod_{it-1}$ is large indicating slow adjustment of firm productivity over time. The one-period lagged $R\&D$ has a negative and significant effect on productivity, which suggests that such technological investments improve firms' productivity. The probit model results in column (4) of table 2.1.1 do not support the self-selection hypothesis. That is, productivity does not have significant impact on the decision to export. The coefficient on $Prod_{it}$ has the expected negative sign but is not statistically significant. It appears from table 2.1.1 that sunk costs of exporting are a key determinant of Korean food and tobacco firms' export behavior. The coefficient on Y_{it-1} is positive and statistically significant indicating that previous export experience (sunk costs) matters for the current export decision. Other significant effects on export decision arise from size variables. Tangible capital, a proxy for size, positively affects the export decision in the food processing and tobacco industry. In contrast, the coefficient on intangible capital has a negative sign with statistical significance, which may arise from firms' branding specific to Korean markets. In sum, the food processing and tobacco industry provides no evidence of either learning-by-exporting or self-selection.

Table 2.1.2 reports the estimation results for the chemical manufacturing firms. The results in columns (3) and (4) of table 2.1.2 are similar to those of the food processing and tobacco industry with two exceptions. The first is that the one-period lagged $R\&D$ does not have a statistically significant effect on productivity. The other exception is that the coefficient on productivity in column (4) of table 2.1.2 is positive and statistically significant. This means that firms with high productivity are less likely to export, which is a contradiction of the self-selection hypothesis. However, a sharper focus on Korea's chemicals industry provides a partial explanation for this unexpected result. A duty is imposed on crude oil that is used as raw material for most of chemical products. Tariff escalation, i.e., higher tariffs on processed goods, is also observed on petroleum-based products. Compounding the protection scenario are the technological constraints faced by Korean chemical firms. For example, while big chemical manufacturers boast of their huge export, many chemical manufacturers have technical cooperation with foreign firms, which limit the application of certain technologies to only serve the Korean market. Hence, high productivity firms focus on the tariff-supported domestic markets for higher profits, while those that are not bound by foreign technology attempt to participate in global markets, i.e., firms with low productivity are more likely to export.

Table 2.1.3 reports the parameter estimates of export behavior and productivity evolution in the machinery and equipment industry. For the first time, evidence of learning-by-exporting is found in column (3) of table 2.1.3, where the lagged export decision significantly affects firms' productivity. The above effect is in addition to the $R\&D$ effect, which also significantly improves firm productivity. With regard to the probit model, column (4) of table 2.1.3, the machinery and equipment industry presents evidence of self-selection: the coefficient on productivity is negative and statistically significant at the 1% level. As with the previous two industries, sunk costs have a positive and statistically significant effect on the export decision. Firm size effects are mixed in the machinery and equipment industry. Both high employment and intangible capital increase the probability that a firm exports, but the coefficient on tangible capital is negative and statistically significant. In sum, the machinery and equipment industry shows significant evidence of both learning by exporting and self-selection.

The results of estimating the simultaneous model in equation (14) for the computers and office machinery industry are reported in table 2.1.4. As shown in column (3) of that table, only lagged productivity and R&D have a statistically significant and expected effect on current productivity. However, self-selection appears vindicated in column (4) of table 2.1.4, where a negative and significant relationship between productivity and the export decision is found. Sunk-cost effects on the export decision are also significant, but firm-size proxied by intangible capital, has a negative and statistically significant coefficient. It appears that the computers and office machinery industry presents evidence of self-selection, but not of learning-by-exporting. Results in table 2.1.5 for the electronics, TV and communication equipment industry are similar to those of computers and office machinery industry reported in table 2.1.4. Current productivity is mostly explained, in the given specification, by previous period productivity. However, sunk-cost effects and evidence of self-selection are significant in column (4) of table 2.1.5.

Table 2.1.6 reports results of the two equation model for the medical, precision and optical instruments industry. Here, current productivity is affected by previous-period productivity and R&D (column 3). Similar to other manufacturing industries, the coefficient on sunk cost is positive and significant, while size effects on export behavior are mixed (column 4). However, the sign of the productivity coefficient in the probit equation is positive and significant, as in the chemical manufacturing industry. Again, a technological restraint, especially from foreign owners of advanced techniques, is likely driving the result. Firms that use licensed technology in the medical, precision and optical instruments industry appear to have focused on domestic markets. The latter might be the source of the observed correlation between domestic-market orientation and high-productivity firms. The results for the motor vehicles and trailers industry, reported in table 2.1.7, are nearly identical to those in table 2.1.6. In all three industries where a positive and significant coefficient is obtained for productivity in the probit equation, i.e., the opposite of a self-selection effect, both number of exporters and scale of exports are lower relative to industries where Korea has a comparative advantage (machinery and equipment, electronics, TV and communication equipment, computers and office machinery). Appendix tables 2.1 through 2.8 present descriptive statistics on each of the 8 industries investigated in this study. In the case of other transport equipment industry, table 2.1.8, evidence of neither learning-by-exporting nor self-selection is found. However, sunk-cost effects remain statistically significant as in the case of the other 7 industries.

In summary, evidence of learning-by-exporting is found only in the machinery and equipment industry, while self-selection is identified in the case of three major industries, where Korea appears to have a comparative advantage. In some instances, high-productivity firms appear focused on domestic markets, which may arise from trade protection and restraints of imported (licensed) technology. Sunk costs are important in the export decision of firms in each of the eight industries. Firm size, proxied by employment, has a positive and statistically significant association with the decision to export in five of the eight industries.[4]

2.5.3 Marginal/Discrete Effects

The previous section discussed the sign and significance of estimated coefficients of equation (14), but not the relative effects of firm-specific characteristics on the export decision. To infer on the latter, parameter estimates of the probit model are used to derive marginal effects: the change in predicted export probability associated with changes in the exogenous variables. Marginal effects are computed for each of the explanatory variable as in equation (14) for each manufacturing industry.

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[4] However, the effects of tangible and intangible capital are mixed, with a tendency toward negative effects on the export decision. As will be shown in the next section, size effects on the export decision are relatively small compared to the sunk-cost effects.

The predicted probability from a bivariate model is given by

(15) $E(Y|X) = F(\gamma' X)$,

where Y is the choice variable, X is a vector of exogenous variables, γ is a vector of parameters, and F is the cumulative normal distribution. In the *Probit* model, marginal effects for continuous variables are defined as:

(16) $\partial E[Y|X] / \partial X = f(\gamma' X)\gamma$

where f is the corresponding probability density function. The partial derivative with respect to a particular variable X, i.e., marginal effects of X, will depend on the level at which the other exogenous variables are evaluated (Wooldridge, 2002). In this essay, the marginal effects of an continuous independent variable are evaluated by setting all other variables at their respective means, which is the most commonly reported result in the bivariate choice literature (Wooldridge, 2002; Aitken, Hanson and Harrison, 1997). Holding all other exogenous variables at their means, the effect of change in X_i on export decision is presented in two formats: table 2.2 and figures 2.1 through 2.3. In the case of a dummy-type independent variable (for example, sunk cost), the discrete effect of the variable is evaluated by taking the difference in the predicted probability with and without that dummy variable equal to 1. Given the suppositions described above, the discrete effect of a dummy variable, *d*, can be expressed as:

(17) $E(Y|d=1) - E(Y|d=0)$,

Table 2.2 reports the marginal effect of every exogenous variable in each of the eight industries. The general pattern suggests that sunk-costs have the largest effect on the probability of export in all Korean manufacturing industries. For example, column

(1) in table 2, which represents the food processing and tobacco industry, shows the results that a discrete increase in the one-period lag of Y_{it} increases a firm's export probability by 77%. Discrete effects of sunk-costs range from 57% to 79% for the eight industries included in this study. Unlike in tables 2.1.1 through 2.1.8, the marginal effect of self-selection is statistically significant only in one industry (electronics, TV and communication equipment). Marginal effects of size variables are relatively lower than that of the sunk-cost or self-selection observed in table 2.2.

An alternative illustration of marginal effects is shown in figures 2.1-2.3. Figure 2.1 plots the predicted probability of export participation due to a change in productivity for 3 industries, where high productivity is positively associated with the export decision. That is, each of three sub-charts in figure 2.1 illustrates the self-selection effect: that is, the more efficient a firm, the greater is the likelihood that it exports. The predicted probability of export due to sunk costs is illustrated in figure 2.2, where we find an upward trend. This suggests that greater the previous export experience, i.e., invested or sunk costs, the larger is the current predicted export probability in each of the 8 industries. Figure 2.3 shows the predicted probability of export due to a change in firm size, proxied by labor, for the five industries, where a positive and significant coefficient is obtained. As seen in the figure, the predicted probability tends to increase with firm size. Based on table 2.2 and predicted probabilities in figures 2.1 through 2.3, it appears that three variables explain the export decision in the case of Korean manufacturing firms: the one-period lag of Y_{it} (sunk costs), productivity (self-selection), and labor (firm size). Among the three, sunk-cost effects are relatively larger than the other two.

2.6. Summary and Conclusions

This essay examines export behavior of Korean manufacturing firms by testing the self-selection and learning-by-exporting hypotheses. Self-selection suggests that only firms with high productivity can afford trade costs to serve competitive foreign markets. The learning-by-exporting hypothesis suggests that firms learn or improve productivity from exporting, possibly through understanding of the customers' quality demand. The Korean case is indeed interesting since it has often been cited as one of the best examples of the export-led growth idea.

Drawing on a dynamic model of firm behavior, an empirical framework is derived to test the above two hypotheses from the emerging trade literature on firm heterogeneity. The latter, however, views these two hypotheses individually and has not addressed feedbacks or simultaneity of the export and productivity decisions. Building on the prior literature, an empirical model that can jointly test for the two hypotheses is developed, where the validity of the joint specification over individual testing of each of the two hypotheses can be ascertained. The proposed empirical model included two equations: a discrete-choice (probit) model of export behavior, where the dependent variables takes value one when a firm has positive export sales and zero otherwise; and a regression equation for the evolution of firm-level productivity.

Firm-level data from the Korean Information Service are compiled for eight manufacturing industries with time-series information on domestic and export sales, employment, capital stock (tangible and intangible), and R&D expenditure. A data envelope analysis is used to derive firm-level indexes of total factor productivity. Specification tests - Hausman and Vuong, show that the two-equation model of export decision and productivity is statistically preferred over individual equations for each of the two hypotheses.

Estimation results suggest that sunk costs are key determinants of the export decision in all industries, which is consistent with the findings in the case of the United States and few other developing countries. Previous export experience significantly and positively affects the current period decision to export. Evidence of self-selection is found in only three industries (machinery and equipment, computers and office machinery, and electronic components manufacturing), where Korea appears to have a comparative advantage. In some other industries serving mostly domestic markets, high productivity does not encourage export participation. The latter situation may arise if technology used by firms in these industries comes with limitations on market access. Moreover, the Korea Trade Promotion Organization, a public agency, has been supporting exporters during the 1970s and 1980s, while these pre-established foreign market contacts (sunk costs) likely sustained exports in the 1990s. Marginal effects from the discrete- choice model suggest that sunk-cost effects on the predicted export probability are relatively larger than that of firms' productivity and size. Evidence of learning-by-exporting is found only in the machinery and equipment industry, a situation similar to many studies seeking insights on such hypothesis. The investigation of Korean manufacturing suggests that information on foreign markets and lowering cost of accessing overseas markets might be effective instruments for promoting firms' export participation.

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Table 2.1.1. Estimation Results for Food Processing and Tobacco firms

	Individual Estimation		Simultaneous Estimation	
	$Prod_{it}$ (1)	Y_{it} (2)	$Prod_{it}$ (3)	Y_{it} (4)
Intercept	0.0891*** (0.000)	-2.1500*** (0.000)	0.1036*** (0.008)	-2.0890*** (0.000)
Productivity t ($Prod_{it}$)		0.0955 (0.830)		-0.0410 (0.588)
Productivity t-1 ($Prod_{it-1}$)	0.8605*** (0.000)		0.9161*** (0.000)	
Exported Current Year (Y_{it})	0.0181 (0.448)		0.0156 (0.395)	
Exported Last Year (Y_{it-1})	0.0125 (0.592)	2.8990*** (0.000)	-0.0246 (0.657)	2.9034*** (0.000)
R&D t-1	-2.01E-8*** (0.006)		-1.88E-8*** (0.003)	
Labor t-1		-0.00001 (0.877)		-0.00002 (0.177)
Tangible Capital t-1 ($TCAP_{it-1}$)		7.24E-10 (0.350)		6.77E-10*** (0.000)
Intangible Capital t-1 ($INTCAP_{it-1}$)		-1.68E-8 (0.186)		-1.68E-8*** (0.000)
Hausman Test	27.9			
Vuong Test		24.6		
Observations	606	606	606	606
Log Likelihood		-79		-79
R^2	0.88		0.83	
Fixed effects	Yes		Yes	

p-value is in parenthesis.

*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

E-n denotes 10^{-n}.

Table 2.1.2. Estimation Results for Chemicals Manufacturing Firms

	Individual Estimation		Simultaneous Estimation	
	$\Pr od_{it}$ (1)	Y_{it} (2)	$\Pr od_{it}$ (3)	Y_{it} (4)
Intercept	0.1027***	-1.8144***	-0.2173	-1.8228***
	(0.000)	(0.000)	(0.273)	(0.000)
Productivity t ($Prod_{it}$)		0.2589		0.2756***
		(0.337)		(0.004)
Productivity t-1 ($Prod_{it-1}$)	0.8167***		0.8403***	
	(0.000)		(0.000)	
Exported Current Year (Y_{it})	0.0077		-0.1841	
	(0.602)		(0.111)	
Exported Last Year (Y_{it-1})	-0.0181	2.4889***	0.4489	2.4883***
	(0.215)	(0.000)	(0.120)	(0.000)
R&D t-1	-4.20E-9***		-1.38E-9	
	(0.002)		(0.741)	
Labor t-1		-0.00004		-0.00004
		(0.616)		(0.194)
Tangible Capital t-1 ($TCAP_{it-1}$)		5.62E-10		5.69E-10***
		(0.120)		(0.000)
Intangible Capital t-1 ($INTCAP_{it-1}$)		4.07E-9		4.12E-9
		(0.616)		(0.277)
Hausman Test	3.9			
Vuong Test		18.1		
Observations	1176	1176	1176	1176
Log Likelihood		-304		-304
R^2	0.73		0.68	
Fixed effects	Yes		Yes	

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.
E-n denotes 10^{-n}.

Table 2.1.3. Estimation Results for Machinery and Equipment Manufacturing Firms

	Individual Estimation		Simultaneous Estimation	
	$\Pr od_{it}$ (1)	Y_{it} (2)	$\Pr od_{it}$ (3)	Y_{it} (4)
Intercept	0.1262***	-1.4239***	0.2052***	-1.4004***
	(0.000)	(0.000)	(0.000)	(0.000)
Productivity t (Prod_{it})		-0.3143		-0.3524***
		(0.144)		(0.000)
Productivity t-1 (Prod_{it-1})	0.7887***		0.8963***	
	(0.000)		(0.000)	
Exported Current Year (Y_{it})	-0.0027		0.0857***	
	(0.643)		(0.000)	
Exported Last Year (Y_{it-1})	-0.0071	2.1061***	-0.1895***	2.1044***
	(0.225)	(0.000)	(0.000)	(0.000)
R&D t-1	-8.50E-9		-4.25E-8***	
	(0.214)		(0.000)	
Labor t-1		0.0010**		0.0009***
		(0.032)		(0.000)
Tangible Capital t-1 (TCAP_{it-1})		-1.25E-8**		-1.27E-8***
		(0.040)		(0.000)
Intangible Capital t-1 (INTCAP_{it-1})		9.44E-8**		9.47E-8***
		(0.016)		(0.000)
Hausman Test	267.9			
Vuong Test		40.7		
Observations	2964	2964	2964	2964
Log Likelihood		-802		-802
R^2	0.86		0.79	
Fixed effects	Yes		Yes	

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.
E-n denotes 10^{-n} .

Table 2.1.4. Estimation Results for Computers and Office Machinery Manufacturing Firms

	Individual Estimation		Simultaneous Estimation	
	$Prod_{it}$ (1)	Y_{it} (2)	$Prod_{it}$ (3)	Y_{it} (4)
Intercept	0.0667**	-1.1258***	0.0469	-1.0728***
	(0.032)	(0.000)	(0.135)	(0.000)
Productivity t ($Prod_{it}$)		-0.8841		-1.0080***
		(0.255)		(0.007)
Productivity t-1 ($Prod_{it-1}$)	0.6701***		0.8290***	
	(0.000)		(0.000)	
Exported Current Year (Y_{it})	-0.0214		0.0050	
	(0.645)		(0.670)	
Exported Last Year (Y_{it-1})	0.0589	2.0221***	0.0035	2.0202***
	(0.190)	(0.000)	(0.939)	(0.000)
R&D t-1	-2.80E-8**		-2.10E-8**	
	(0.020)		(0.019)	
Labor t-1		0.0004		0.0004
		(0.854)		(0.326)
Tangible Capital t-1 ($TCAP_{it-1}$)		4.13E-10		-5.29E-10
		(0.979)		(0.881)
Intangible Capital t-1 ($INTCAP_{it-1}$)		-9.67E-7		-1.16E-6***
		(0.412)		(0.000)
Hausman Test	17.0			
Vuong Test		3.8		
Observations	90	90	90	90
Log Likelihood		-29		-29
R^2	0.81		0.71	
Fixed effects	Yes		Yes	

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.
E-n denotes 10^{-n} .

Table 2.1.5. Estimation Results for Electronic-Components, TV and Communication-Equipment Manufacturing Firms

	Individual Estimation		Simultaneous Estimation	
	$\Pr od_{it}$ (1)	Y_{it} (2)	$\Pr od_{it}$ (3)	Y_{it} (4)
Intercept	0.0864*** (0.000)	-1.4788*** (0.000)	0.0190 (0.659)	-1.4302*** (0.000)
Productivity t (Prod_{it})		-0.6500*** (0.005)		-0.7418*** (0.000)
Productivity t-1 (Prod_{it-1})	0.8287*** (0.000)		0.8762*** (0.000)	
Exported Current Year (Y_{it})	-0.0159 (0.198)		-0.0274 (0.343)	
Exported Last Year (Y_{it-1})	-0.0362*** (0.002)	2.5002*** (0.000)	0.0280 (0.707)	2.4908*** (0.000)
R&D t-1	6.58E-9** (0.012)		5.45E-9 (0.111)	
Labor t-1		0.0005* (0.066)		0.0005*** (0.000)
Tangible Capital t-1 (TCAP_{it-1})		-2.46E-9* (0.063)		-2.37E-9*** (0.000)
Intangible Capital t-1 (INTCAP_{it-1})		-6.07E-9 (0.683)		-7.21E-9 (0.184)
Hausman Test	79.2			
Vuong Test		17.1		
Observations	1254	1254	1254	1254
Log Likelihood		-315		-316
R^2	0.84		0.78	
Fixed effects	Yes		Yes	

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.
E-n denotes 10^{-n}.

Table 2.1.6. Estimation Results for Medical, Precision and Optical Instruments Manufacturing Firms

	Individual Estimation		Simultaneous Estimation	
	$Prod_{it}$ (1)	Y_{it} (2)	$Prod_{it}$ (3)	Y_{it} (4)
Intercept	0.0947***	-2.0112***	0.0701**	-2.2551***
	(0.000)	(0.000)	(0.020)	(0.000)
Productivity t ($Prod_{it}$)		0.3880		0.9367***
		(0.452)		(0.000)
Productivity t-1 ($Prod_{it-1}$)	0.7551***		0.8475***	
	(0.000)		(0.000)	
Exported Current Year (Y_{it})	-0.0112		0.0048	
	(0.658)		(0.705)	
Exported Last Year (Y_{it-1})	-0.0008	2.5772***	-0.0284	2.5920***
	(0.974)	(0.000)	(0.463)	(0.000)
R&D t-1	-3.82E-9**		-2.65E-9*	
	(0.015)		(0.054)	
Labor t-1		0.0010		0.0014***
		(0.347)		(0.000)
Tangible Capital t-1 ($TCAP_{it-1}$)		8.98E-9		-1.24E-8***
		(0.265)		(0.000)
Intangible Capital t-1 ($INTCAP_{it-1}$)		1.89E-8		2.12E-8***
		(0.190)		(0.000)
Hausman Test	36.7			
Vuong Test		18.5		
Observations	450	450	450	450
Log Likelihood		-86		-85
R^2	0.81		0.73	
Fixed effects	Yes		Yes	

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.
E-n denotes 10^{-n}.

Table 2.1.7. Estimation Results for Motor vehicles and Trailers Manufacturing Firms

	Individual Estimation		Simultaneous Estimation	
	$Prod_{it}$ (1)	Y_{it} (2)	$Prod_{it}$ (3)	Y_{it} (4)
Intercept	0.0777***	-1.9576***	0.0760***	-1.9872***
	(0.000)	(0.000)	(0.000)	(0.000)
Productivity t ($Prod_{it}$)		0.3710		0.4302***
		(0.224)		(0.000)
Productivity t-1 ($Prod_{it-1}$)	0.8622***		0.9016***	
	(0.003)		(0.000)	
Exported Current Year (Y_{it})	0.0023		0.0069	
	(0.850)		(0.534)	
Exported Last Year (Y_{it-1})	-0.0143	2.7032***	-0.0301	2.7032***
	(0.229)	(0.000)	(0.334)	(0.000)
R&D t-1	-1.17E-8***		-1.32E-8***	
	(0.003)		(0.001)	
Labor t-1		0.0009**		0.0009***
		(0.014)		(0.000)
Tangible Capital t-1 ($TCAP_{it-1}$)		-5.84E-9**		-5.92E-9***
		(0.044)		(0.000)
Intangible Capital t-1 ($INTCAP_{it-1}$)		-7.20E-8		-7.10E-8***
		(0.335)		(0.000)
Hausman Test	39.3			
Vuong Test		16.2		
Observations	1200	1200	1200	1200
Log Likelihood		-280		-280
R^2	0.85		0.8	
Fixed effects	Yes		Yes	

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.
E-n denotes 10^{-n} .

Table 2.1.8. Estimation Results for Other Transport Equipment Manufacturing Firms

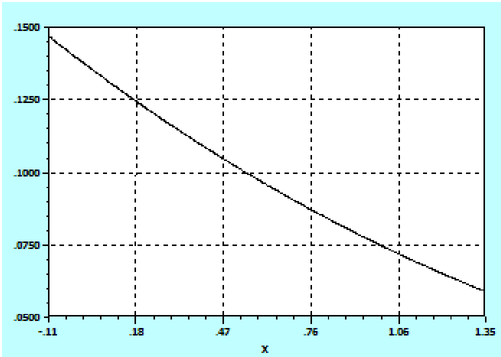
	Individual Estimation		Simultaneous Estimation	
	$Prod_{it}$ (1)	Y_{it} (2)	$Prod_{it}$ (3)	Y_{it} (4)
Intercept	0.0376**	-1.6978***	0.0540**	-1.7383***
	(0.011)	(0.000)	(0.025)	(0.000)
Productivity t ($Prod_{it}$)		-0.0719		0.0715
		(0.905)		(0.573)
Productivity t-1 ($Prod_{it-1}$)	0.7874***		0.8944***	
	(0.000)		(0.000)	
Exported Current Year (Y_{it})	-0.0023		0.0189	
	(0.933)		(0.105)	
Exported Last Year (Y_{it-1})	0.0156	2.2349***	-0.0457	2.2457***
	(0.574)	(0.000)	(0.216)	(0.000)
R&D t-1	4.19E-9		3.43E-9	
	(0.107)		(0.273)	
Labor t-1		0.0025		0.0025***
		(0.247)		(0.000)
Tangible Capital t-1 ($TCAP_{it-1}$)		-1.80E-8		-1.81E-8***
		(0.298)		(0.000)
Intangible Capital t-1 ($INTCAP_{it-1}$)		-9.16E-7		-9.21E-7***
		(0.219)		(0.000)
Hausman Test	28.6			
Vuong Test		12.4		
Observations	270	270	270	270
Log Likelihood		-59		-59
R^2	0.77		0.78	
Fixed effects	Yes		Yes	

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.
E-n denotes 10^{-n}.

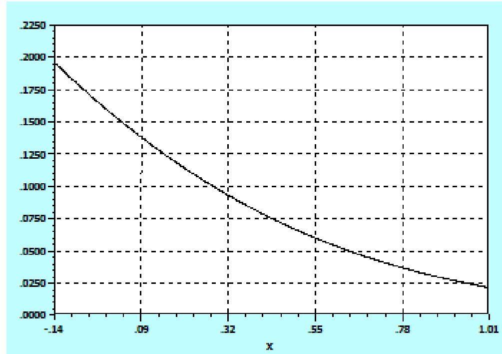
Table 2.2. Marginal / Discrete Effects From Two-Equation Model

	Industry 1 (1)	Industry 2 (2)	Industry 3 (3)	Industry 4 (4)	Industry 5 (5)	Industry 6 (6)	Industry 7 (7)	Industry 8 (8)
Productivity	-0.0030	0.0579	-0.0617	-0.1989	-0.1659***	0.1093	0.0930	0.0067
Exported Last Year	0.7682***	0.7469***	0.6448***	0.5738***	0.7445***	0.7413***	0.7932***	0.5668***
Labor	-2.23E-6	-9.10E-6	0.0002**	0.0008	0.0001*	0.0001	0.0002**	0.0002*
Tangible Capital	5.11E-11	1.19E-10	-2.23E-9**	-1.04E-10	-5.30E-10*	-1.44E-09	-1.28E-9**	-1.71E-9*
Intangible Capital	-1.27E-9	8.68E-10	1.65E-8**	-2.30E-7*	-1.61E-9	2.47E-9	-1.53E-8	-8.69E-8

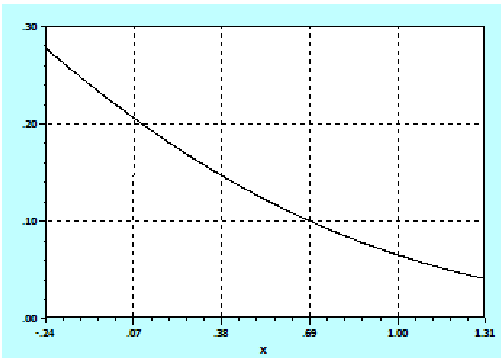
Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic Components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.
E-n denotes 10^{-n}.



(a) Machinery

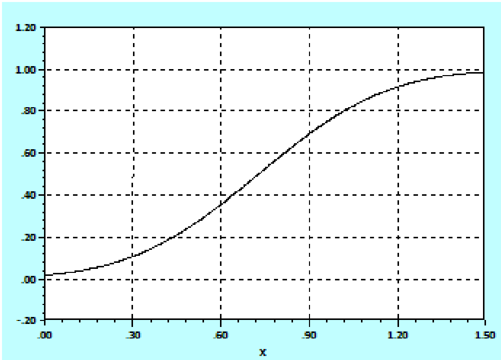


(b) Computers

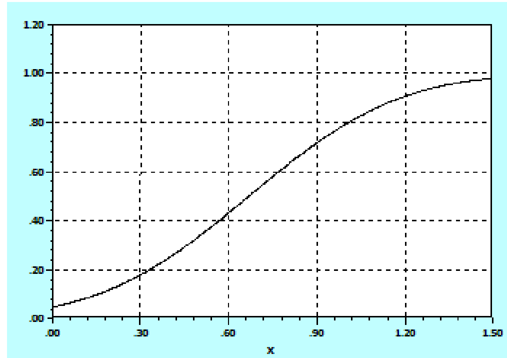


(c) Electronics

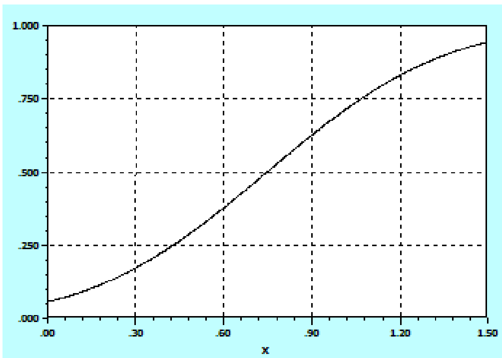
Figure 2.1. Evidence of Self-Selection



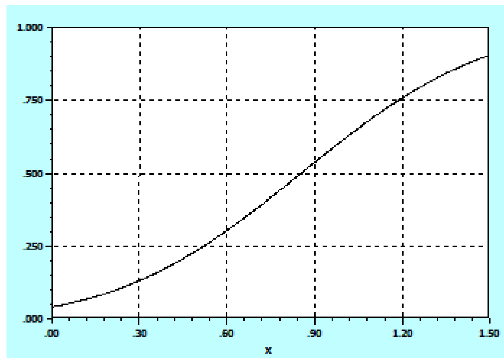
(a) Food Processing



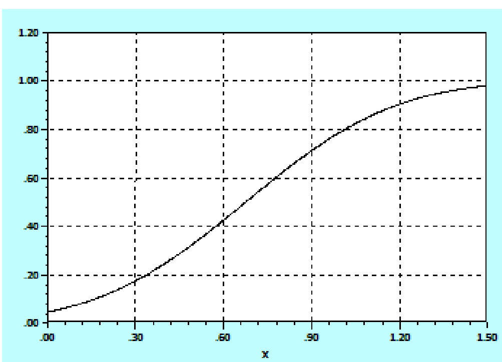
(b) Chemicals



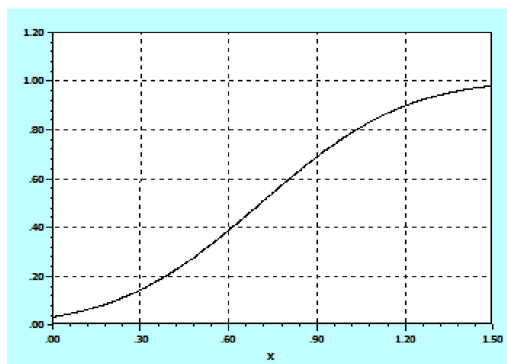
(c) Machinery



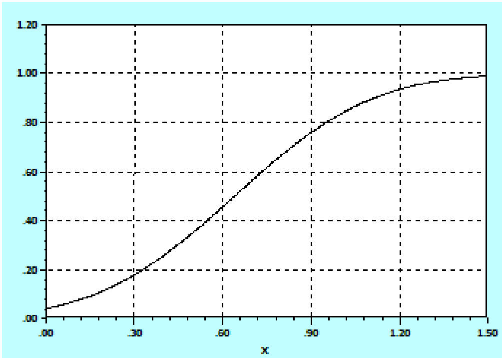
(d) Computers



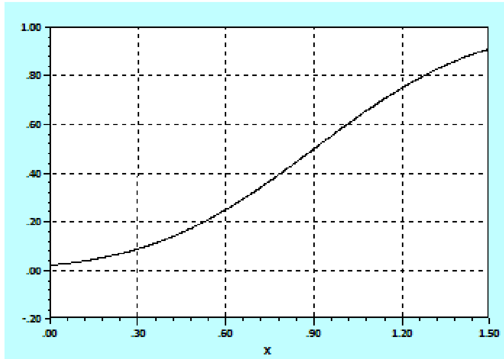
(e) Electronics



(f) Precision Instruments

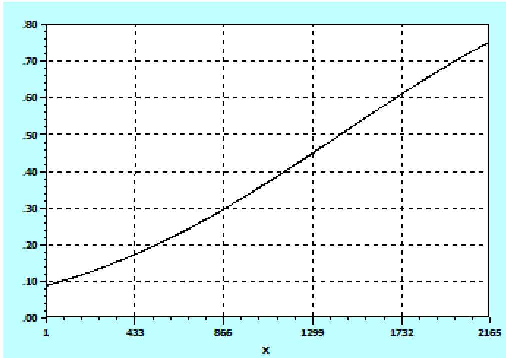


(g) Motor vehicles

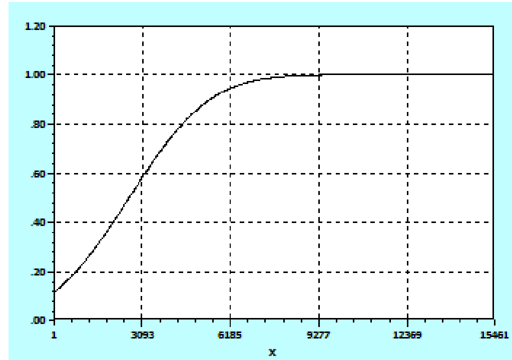


(h) Other Transport Equipment

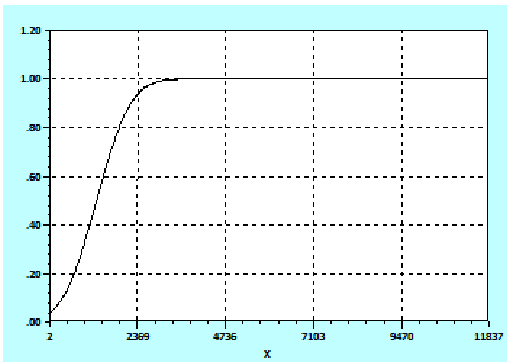
Figure 2.2. Sunk-Cost Effect on the Export Decision



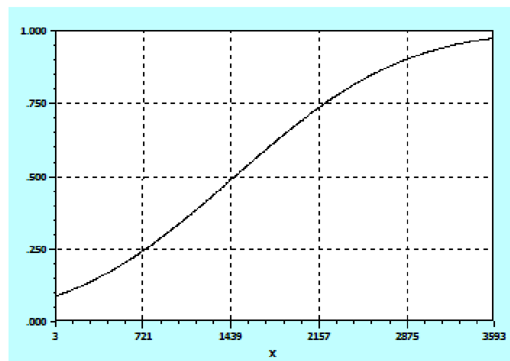
(a) Machinery



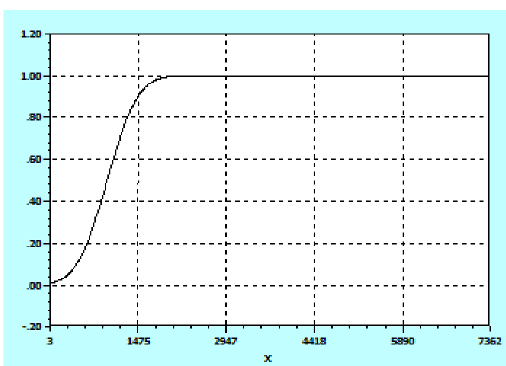
(b) Electronics



(c) Precision Instruments



(d) Motor vehicles



(e) Other Transport Equipment

Figure 2.3. Size Effect on the Export Decision

Appendix 2-1. Descriptive Statistics of Firm-Specific Characteristics of Food Processing and Tobacco firms(101 Firms)

Variable		Mean	S.D	Maximum	Minimum
Productivity	1998	0.29	0.25	0.78	-0.20
	1999	0.32	0.26	0.86	-0.35
	2000	0.37	0.28	0.89	-0.44
	2001	0.39	0.29	0.86	-0.20
	2002	0.45	0.25	0.86	-0.39
	2003	0.48	0.26	0.83	-0.30
Export Dummy	1998	0.19	0.32	1	0
	1999	0.08	0.27	1	0
	2000	0.08	0.27	1	0
	2001	0.08	0.27	1	0
	2002	0.11	0.31	1	0
	2003	0.10	0.30	1	0
Export	1998	358320	1245639	7239310	0
(Million Won)	1999	263736	1274560	8234154	0
	2000	168920	809715	6242266	0
	2001	140453	622934	4620976	0
	2002	226844	868055	6476575	0
	2003	250577	1027524	7572069	0
R&D	1998	272	906	7737	0
(Million Won)	1999	267	658	4450	0
	2000	337	854	5495	0
	2001	342	807	5499	0
	2002	340	674	2815	0
	2003	482	1121	6426	0
Labor	1998	612	1124	5793	11
	1999	633	1105	5549	9
	2000	613	1090	5522	6
	2001	619	1113	5350	16
	2002	601	1090	5490	16
	2003	596	1103	5618	14
Tangible Capital	1998	81124	207645	1407313	117
(Million Won)	1999	83437	199604	1210449	112
	2000	84854	199291	1196653	107
	2001	87552	215646	1482287	102
	2002	84794	209148	1375180	97
	2003	85255	210441	1342615	103
Intangible Capital	1998	2658	17937	136074	0
(Million Won)	1999	3444	18531	130963	0
	2000	3501	20773	171968	0
	2001	3197	19635	182368	0
	2002	2673	17206	169082	0
	2003	2114	13017	129768	0

Appendix 2-2. Descriptive Statistics of Firm-Specific Characteristics of Chemicals Manufacturing Firms (196 Firms)

Variable		Mean	S.D	Maximum	Minimum
Productivity	1998	0.48	0.21	0.82	-0.26
	1999	0.37	0.21	0.80	-0.42
	2000	0.28	0.20	0.76	-0.45
	2001	0.44	0.20	0.75	-0.48
	2002	0.58	0.23	0.86	-0.09
	2003	0.57	0.23	0.87	-0.05
Export Dummy	1998	0.22	0.41	1	0
	1999	0.20	0.40	1	0
	2000	0.20	0.40	1	0
	2001	0.20	0.40	1	0
	2002	0.22	0.41	1	0
	2003	0.22	0.41	1	0
Export	1998	907441	2130753	9386381	0
(Million Won)	1999	701338	1773233	9264890	0
	2000	766560	2042942	9899877	0
	2001	671015	1865095	9887018	0
	2002	644007	1599876	9289062	0
	2003	719657	1814646	9444847	0
R&D	1998	742	2387	20372	0
(Million Won)	1999	922	2715	20369	0
	2000	1088	3059	22259	0
	2001	1344	3753	26985	0
	2002	1470	3707	25873	0
	2003	1690	4377	38098	0
Labor	1998	362	835	9407	5
	1999	352	791	9275	5
	2000	348	709	7983	5
	2001	342	616	6144	7
	2002	336	542	4306	4
	2003	329	493	3314	9
Tangible Capital	1998	76548	224256	1913251	56
(Million Won)	1999	76929	197015	1393887	57
	2000	79129	198850	1405377	57
	2001	83459	204898	1385536	66
	2002	80296	191630	1174257	46
	2003	80256	189016	1167547	50
Intangible Capital	1998	607	4119	54524	0
(Million Won)	1999	1939	9232	90559	0
	2000	1453	6119	69049	0
	2001	1692	6709	65038	0
	2002	1620	6123	57223	0
	2003	1794	6725	62945	0

Appendix 2-3. Descriptive Statistics of Firm-Specific Characteristics of Machinery and Equipment Manufacturing Firms(494 Firms)

Variable		Mean	S.D	Maximum	Minimum
Productivity	1998	0.53	0.17	0.86	-0.14
	1999	0.56	0.19	0.85	-0.28
	2000	0.55	0.20	0.87	-0.26
	2001	0.54	0.20	0.92	-0.32
	2002	0.56	0.20	0.94	-0.21
	2003	0.58	0.20	0.90	-0.18
Export Dummy	1998	0.14	0.35	1	0
	1999	0.14	0.34	1	0
	2000	0.15	0.35	1	0
	2001	0.12	0.32	1	0
	2002	0.17	0.37	1	0
	2003	0.18	0.39	1	0
Export	1998	257599	956236	8175470	0
(Million Won)	1999	230890	921072	8167122	0
	2000	238908	952047	9820946	0
	2001	262736	1100063	9704111	0
	2002	338449	1209425	9295901	0
	2003	398669	1346186	9769005	0
R&D	1998	46	141	1246	0
(Million Won)	1999	75	290	4043	0
	2000	94	350	4593	0
	2001	97	345	5078	0
	2002	112	368	5437	0
	2003	143	535	8836	0
Labor	1998	59	114	1315	3
	1999	61	113	1216	3
	2000	64	114	1170	1
	2001	65	118	1158	2
	2002	63	108	1146	2
	2003	65	108	1133	3
Tangible Capital	1998	3575	11388	152364	9
(Million Won)	1999	4006	11881	138810	15
	2000	4416	11901	128097	10
	2001	4724	12751	125236	6
	2002	4839	12447	117619	2
	2003	4883	11665	115844	4
Intangible Capital	1998	16	94	1500	0
(Million Won)	1999	172	682	8550	0
	2000	241	1031	17079	0
	2001	322	1501	20439	0
	2002	243	743	5759	0
	2003	370	2017	35095	0

Appendix 2-4. Descriptive Statistics of Firm-Specific Characteristics of Computers and Office Machinery Manufacturing Firms (15 Firms)

Variable		Mean	S.D	Maximum	Minimum
Productivity	1998	0.18	0.25	0.50	-0.39
	1999	0.22	0.24	0.52	-0.33
	2000	0.17	0.20	0.50	-0.17
	2001	0.13	0.26	0.53	-0.42
	2002	0.20	0.28	0.59	-0.26
	2003	0.20	0.29	0.57	-0.45
Export Dummy	1998	0.27	0.44	1	0
	1999	0.20	0.40	1	0
	2000	0.20	0.40	1	0
	2001	0.27	0.44	1	0
	2002	0.40	0.49	1	0
	2003	0.33	0.47	1	0
Export	1998	962322	2135599	7405383	0
(Million Won)	1999	1622311	3358510	8130489	0
	2000	471516	1142365	4162823	0
	2001	539039	1012977	3012565	0
	2002	1142351	1606638	5003190	0
	2003	1519561	2480932	7363750	0
R&D	1998	733	1762	6390	0
(Million Won)	1999	502	1521	6175	0
	2000	512	1642	6641	0
	2001	700	1958	7951	0
	2002	859	2293	9375	0
	2003	983	2410	9796	0
Labor	1998	169	265	1085	7
	1999	170	244	997	12
	2000	196	251	994	11
	2001	194	271	1079	8
	2002	198	307	1196	9
	2003	233	345	1194	5
Tangible Capital	1998	17315	35969	121895	13
(Million Won)	1999	17356	34269	122499	16
	2000	18639	34825	129051	21
	2001	18968	35349	133973	10
	2002	19275	35309	136176	16
	2003	18900	36492	142403	8
Intangible Capital	1998	30	80	322	0
(Million Won)	1999	492	1484	5970	0
	2000	853	2265	9056	0
	2001	864	2262	9130	0
	2002	375	595	2201	0
	2003	600	1257	5024	0

Appendix 2-5. Descriptive Statistics of Firm-Specific Characteristics of Electronic components, TV and Communication Equipment Manufacturing Firms (209 Firms)

Variable		Mean	S.D	Maximum	Minimum
Productivity	1998	0.39	0.22	0.84	-0.50
	1999	0.39	0.25	0.86	-0.31
	2000	0.39	0.26	0.91	-0.40
	2001	0.39	0.27	0.84	-0.49
	2002	0.45	0.26	0.86	-0.36
	2003	0.46	0.24	0.83	-0.33
Export Dummy	1998	0.28	0.45	1	0
	1999	0.24	0.43	1	0
	2000	0.20	0.40	1	0
	2001	0.17	0.40	1	0
	2002	0.24	0.43	1	0
	2003	0.24	0.43	1	0
Export	1998	978021	2052196	9842318	0
(Million Won)	1999	811730	1978484	9927505	0
	2000	727131	1848805	9817027	0
	2001	624534	1640545	8719756	0
	2002	679541	1544501	7417742	0
	2003	838775	1993946	9814172	0
R&D	1998	295	684	5009	0
(Million Won)	1999	391	747	5856	0
	2000	544	1167	9982	0
	2001	684	1496	11411	0
	2002	959	2550	29453	0
	2003	1128	3420	40761	0
Labor	1998	241	648	8887	5
	1999	264	565	7467	2
	2000	256	288	1716	6
	2001	235	257	1715	4
	2002	242	266	1583	6
	2003	257	390	4320	6
Tangible Capital	1998	20528	130347	1862300	17
(Million Won)	1999	21811	116713	1649534	19
	2000	23776	94817	1295622	9
	2001	23129	81095	1074512	17
	2002	24483	74817	832742	52
	2003	23664	68124	655828	20
Intangible Capital	1998	215	1437	19958	0
(Million Won)	1999	1052	2665	22092	0
	2000	1395	3404	31406	0
	2001	1767	4155	39926	0
	2002	1842	5004	45982	0
	2003	1931	6217	56711	0

Appendix 2-6. Descriptive Statistics of Firm-Specific Characteristics of Medical, Precision and Optical Instruments Manufacturing Firms (75 Firms)

Variable		Mean	S.D	Maximum	Minimum
Productivity	1998	0.37	0.22	0.71	-0.42
	1999	0.37	0.20	0.70	-0.11
	2000	0.39	0.25	0.74	-0.46
	2001	0.35	0.24	0.75	-0.40
	2002	0.33	0.25	0.74	-0.30
	2003	0.35	0.24	0.74	-0.18
Export Dummy	1998	0.10	0.31	1	0
	1999	0.12	0.32	1	0
	2000	0.09	0.29	1	0
	2001	0.11	0.31	1	0
	2002	0.12	0.32	1	0
	2003	0.15	0.35	1	0
Export	1998	106840	428088	2540904	0
(Million Won)	1999	239250	1204262	9881494	0
	2000	174144	916024	7287436	0
	2001	84583	364893	2589586	0
	2002	264252	1271529	8820834	0
	2003	411259	1711134	9525841	0
R&D	1998	820	6007	52389	0
(Million Won)	1999	953	6095	52198	0
	2000	434	1668	12412	0
	2001	449	1604	10053	0
	2002	721	3538	30347	0
	2003	745	3336	28339	0
Labor	1998	154	715	6222	4
	1999	134	505	4367	3
	2000	136	479	4125	3
	2001	124	425	3669	4
	2002	120	425	3697	4
	2003	122	451	3915	3
Tangible Capital	1998	16904	118621	1035876	6
(Million Won)	1999	13965	83889	729978	10
	2000	14704	80854	697151	7
	2001	14673	74988	639260	16
	2002	13199	69180	596909	12
	2003	12989	66575	574854	9
Intangible Capital	1998	2957	24994	217960	0
(Million Won)	1999	3221	22098	192179	0
	2000	3545	23018	199399	0
	2001	3671	25164	219299	0
	2002	3420	23634	205985	0
	2003	2895	18716	162721	0

Appendix 2-7. Descriptive Statistics of Firm-Specific Characteristics of Motor vehicles and Trailers Manufacturing Firms(200 Firms)

Variable		Mean	S.D	Maximum	Minimum
Productivity	1998	0.28	0.20	0.82	-0.30
	1999	0.28	0.22	0.83	-0.46
	2000	0.40	0.24	0.84	-0.34
	2001	0.45	0.27	0.86	-0.45
	2002	0.41	0.23	0.81	-0.41
	2003	0.43	0.21	0.80	-0.29
Export Dummy	1998	0.22	0.41	1	0
	1999	0.23	0.42	1	0
	2000	0.23	0.42	1	0
	2001	0.24	0.43	1	0
	2002	0.22	0.42	1	0
	2003	0.22	0.42	1	0
Export	1998	804682	1870182	9570449	0
(Million Won)	1999	881321	1930847	8947415	0
	2000	886890	2020626	9093471	0
	2001	963828	2148794	9750594	0
	2002	743570	1760126	8354857	0
	2003	932783	2164563	9499998	0
R&D	1998	205	700	8233	0
(Million Won)	1999	245	677	5008	0
	2000	296	722	5088	0
	2001	414	990	5088	0
	2002	468	1139	9778	0
	2003	588	1483	10859	0
Labor	1998	254	294	2070	6
	1999	260	269	1591	10
	2000	273	270	1595	7
	2001	258	251	1589	8
	2002	265	254	1589	8
	2003	272	254	1598	8
Tangible Capital	1998	19005	37709	298439	106
(Million Won)	1999	20656	39115	313983	75
	2000	22055	37571	284861	292
	2001	21681	34641	258300	208
	2002	21092	31522	249611	228
	2003	22516	31873	277635	294
Intangible Capital	1998	627	6489	90002	0
(Million Won)	1999	428	1054	6917	0
	2000	474	1233	9529	0
	2001	486	1108	9040	0
	2002	427	893	5279	0
	2003	468	1257	12370	0

Appendix 2-8. Descriptive Statistics of Firm-Specific Characteristics of Other Transport Equipment Manufacturing Firms (45 Firms)

Variable		Mean	S.D	Maximum	Minimum
Productivity	1998	0.26	0.21	0.63	-0.22
	1999	0.18	0.28	0.62	-0.51
	2000	0.18	0.28	0.61	-0.48
	2001	0.19	0.25	0.63	-0.51
	2002	0.23	0.23	0.59	-0.37
	2003	0.21	0.24	0.61	-0.42
Export Dummy	1998	0.20	0.40	1	0
	1999	0.16	0.36	1	0
	2000	0.09	0.28	1	0
	2001	0.16	0.36	1	0
	2002	0.11	0.31	1	0
	2003	0.16	0.36	1	0
Export	1998	556228	1718995	9061747	0
(Million Won)	1999	394471	1291446	6236515	0
	2000	196082	770135	4403180	0
	2001	460791	1608525	8967179	0
	2002	386766	1548714	9127050	0
	2003	287116	865821	4520800	0
R&D	1998	58	179	986	0
(Million Won)	1999	584	3413	23176	0
	2000	823	4556	30799	0
	2001	664	4043	27464	0
	2002	853	4256	28077	0
	2003	952	4302	28000	0
Labor	1998	243	589	2878	8
	1999	287	823	4908	7
	2000	294	809	4493	6
	2001	313	870	4562	7
	2002	301	802	3877	7
	2003	290	770	3801	6
Tangible Capital	1998	37235	120052	715976	49
(Million Won)	1999	50288	193865	1260273	49
	2000	52492	190040	1222358	56
	2001	53546	188744	1195105	46
	2002	54808	190353	1198552	43
	2003	55335	190297	1178908	52
Intangible Capital	1998	90	362	1916	0
(Million Won)	1999	200	447	2073	0
	2000	259	666	3730	0
	2001	284	747	4422	0
	2002	338	926	5505	0
	2003	362	1004	6119	0

CHAPTER THREE

Trade Costs and Firm Entry and Exit in Korean Manufacturing

3.1. Introduction

There is much interest in how international trade and globalization affect the structure and performance of firms in a given industry. While traditional trade theories of international trade have much to say about trade liberalization's welfare impacts on industries or consumers, it generally assumes that firms within an industry are homogeneous. In reality, there are significant variations in capital and skill intensity, size, and productivity among firms within an industry. Starting in the 1990s, a new empirical literature has documented patterns of trade and productivity growth at the level of individual firms or plants (Aw, Chung, Roberts, 1998; Tybout, 2003; Bernard and Jensen, 1999). It shows, among other things, that only a handful of the firms in an industry may export, and that the bulk of exports is accounted for by only a small number of exporters.

New theories of trade have attempted to explain these facts, including Bernard et al. (2003) and Melitz (2003). These new-trade models demonstrate that international trade is a catalyst for resource reallocation within industries containing heterogeneous firms. Specifically, trade exposure induces high-productivity firms to enter foreign markets and low-productivity firms to exit domestic markets. In consequence, the industry's productivity distribution shifts to the right, increasing its average productivity.

These theoretical predictions have led empirical studies to sharpen the focus on not only firms' export behavior but also trade-liberalization effects on industry productivity, and firms' entry and exit. For example, Bernard, Jensen, and Schott (2006) examine the response of U.S. manufacturing industries and plants to changes in trade costs using a dataset on industry-level tariff and transportation rates. Their findings are largely consistent with recent heterogeneous-firm models of international trade. For example, they find that as trade costs fall, there is a re-allocation of economic activity towards high-productivity firms.

The objective of the second essay of this dissertation is to extend the work of Bernard, Jensen, and Schott (2006) by examining the role of trade liberalization (measured by changes in international trade costs faced by an economy) on firms' entry and exit in Korean manufacturing. The Korean case is interesting because it has been cited as an excellent example of the export-led growth idea. The panel database from essay 1 shows significant entry and exit of firms in aggregate manufacturing as well as individual industries. On average, for instance, 1500 firms entered and 900 firms exited each year during 1997-2002. Within some of the ISIC 2-digit manufacturing industries, there is significant firm turnover, i.e., firms enter and exit at a high rate.

Firms' entry and exit pattern have been studied mostly in the industrial organization literature, e.g. Tirole (2003), which has examined the reasons underlying these decisions. For instance, a firm might enter because it has high productivity or because it is filling a niche market; that is, responding to newly created consumer or industrial demand for a product. The role of competition, especially from outside an economy through falling trade costs, in deciding firms entry and exit has only received attention in recent times following the seminal contribution of Melitz (2003). Other reasons for entry and exit include firm size, intangibles such as branding/quality, and credit access. In the Korean case, the presence of "chaebol," which is a conglomerate of firms, often with close ties to the government ties, may affect entry and exit.

This study extends the work of Bernard, Jensen, and Schott (2006) in several ways. First, Bernard, Jensen, and Schott (2006) test only part of the theory of trade with heterogeneous firms. In particular, they test the theory's predictions regarding the firms that exit during a given period, but the theory makes predictions regarding the productivity of newly entering firms. In the theory, firms that newly enter start with low productivity, with productivity improvement taking place over time.

Second, the theory of trade with heterogeneous firms has been tested for developing countries (see, e.g., Tybout, 2003). Bernard, Jensen, and Schott (2006) study this for the U.S. This study will be the first one of this type for an Asian country at a mid-level of development. Korea is a particularly interesting case because we can consider the effects of the Asian financial crisis, which may have caused more firm exits (since interest rates are higher). We should be able to separate this effect from that of trade costs, which if falling would have caused more firm exits.

Third, the trade liberalization that they consider consists of changes in ad valorem tariff rates and shipping costs, calculated as the difference between cif and fob prices. The approach of this essay allows for other factors that affect trade costs, such as transport infrastructure investment, law enforcement and related property-rights institutions, informational institutions, regulation, and language. This is important because tariffs are just a small part of total trade costs (McCallum, 1995; Anderson and van Wincoop, 2004).

Fourth, the data series in this essay is longer and more detailed than that used by Bernard, Jensen, and Schott (2006). It is on the firm level and while their's is on the plant level. This presents a better opportunity to see how firms themselves evolve over time.

The remainder of the essay is organized as follows: the next section identifies the hypotheses from new theories of trade on firm entry and exit which will be tested in the context of Korean manufacturing. The following sections describe our dataset, the measurement of trade costs, empirical results and implications.

3.2. Conceptual and Empirical Framework

Bernard, Jensen, and Schott's (2006) approach to the role of international trade costs on firm entry and exit decisions is the basis of this essay's empirical strategy. Recent theoretical studies of trade with heterogeneous firms, e.g. Bernard et al, (2003), Melitz, (2003) examine the effect of changes in trade costs on firms or industries:

- the aggregate industry productivity gain
- the probability of firm exit, the probability of exporting firms
- export sales, the domestic market share of surviving firms and plant-level productivity.

This study examines the above relationships in the context of Korean manufacturing firms.

Hypothesis 1: Industry Productivity Growth

One of the important predictions of heterogeneous-firms models is that high productivity firms self-select into the export market and this selection is driven by the competitive environment. In particular, if trade costs are falling, then domestic firms will face increased foreign competition. This would force low productivity firms from the marketplace, leading to an increase in aggregate industry productivity. Given that trade costs are likely to have fallen in Korea over the period of interest, this is an interesting hypothesis to test.

To examine the relationship between trade costs and industry outcomes, a regression of the change in industry productivity on the decline in industry trade costs is specified as (Bernard, Jensen, and Schott. 2006; Bernard et al. 2007):

(1) $$\Delta TFP_{it} = c_t + \beta \ \Delta Cost_{it-2} + \delta_i + \varepsilon_{it},$$

where ΔTFP denotes the average annual percent change in industry total factor productivity (TFP) between year *t* and year *t+2*, $\Delta Cost_{it-2}$ is the annualized percent change in total trade costs in the preceding two years, and δ_i is an industry fixed-effect dummy variable. In the way that TFP is measured, values closer to zero imply *higher* productivity. Therefore, the expected sign of β is positive. In words, when trade costs decrease, ΔTFP should be negative, because more foreign competition leads to higher productivity.

A cut off of at least three consecutive years of firm data prior to exit or post entry is applied to the sample, and hence, the two-year change in productivity is used in the above equation. While Bernard, Jensen, and Schott (2006) consider year fixed effect, this analysis does not include year dummies: since the same GDP-level trade costs are used for all firms in each year, the trade costs cause a collinearity problem when added in the model. In other words, the lack of industry variation in the GDP-level trade costs makes it a time-specific constant in the model.

Hypothesis 2: Probability of Firm Exit

As mentioned above, new trade theories predict that economic openness driven by falling trade costs cause less productive firms to exit the domestic market. In other words, a decrease in trade costs raises the probability of firm exit. To see the reallocative effects of changing trade costs, logistic regressions are estimated, in which the probability of a firm's exit in industry *i* between year *t* and year *t*+2, $\Pr(D_{f\,t+2}=1)$, is given by:

(2) (base) $\Pr(D_{f\,t+2}=1)=\Phi(\beta\,\Delta Cost_{i\,t-2})$,

(variant) $\Pr(D_{f\,t+2}=1)=\Phi(\beta\,\Delta Cost_{i\,t-2}+\gamma X_{f\,t})$,

where $X_{f\,t}$ denotes a vector of firm characteristics, including size of labor force and the capital-labor ratio. The expected sign of β is negative since as trade costs rise, firm death is less likely, all else the same.

The base specification includes only the regressor of annualized percent change in total trade costs. Industry dummies are not included since we will examine the effects of trade costs by industry. Year dummies are not included due to the collinearity problem as mentioned. The variant adds firm characteristics to the base specification to examine the influence of firm characteristics on firm survival. Bernard, Jensen, and Schott (2006) consider another variant in which the interaction of trade costs and plant productivity, and interaction of trade costs and export status, are added as regressors. Since it is quite likely that productivity and export status are endogenous (as shown in Gopinath, Sheldon, and Echeverria, 2007), this analysis does not include those interaction effects.

Hypothesis 3: Firm Entry

The heterogeneous-firms models examine the resource reallocation in the context of the firms exit, but change on aggregate industry productivity and firms' behavior should be analyzed in the context of both firm entry and exit: firm exit might imply more opportunities for new firms. The industrial organization literature, e.g. Tirole (2003), hints that market characteristics are affected by firms' productivity or economies of scale and the productivity of entrants is lower than that of incumbents. While Bernard, Jensen, and Schott (2006) do not explore the effect of trade costs on the probability of firms' entry, this essay analyses its effect under the hypothesis that falling trade costs decrease the number of new firms. Trade cost falls means that there is more competition in the domestic market, which makes it difficult for new firms to enter the domestic market. To investigate the hypothesis, we estimate the impact of trade costs on the probability that new firms enter the market via a logistic regression. The models are defined as the following:

(3) (base) $\Pr(NF_{f\,t+2}=1)=\Phi(\beta\,\Delta Cost_{i\,t-2})$,

(variant) $\Pr(NF_{f\,t+2}=1)=\Phi(\beta\,\Delta Cost_{i\,t-2}+\gamma X_{f\,t})$

where $\Pr(NE_{f\,t+2}=1)$ is the probability that a firm enters the domestic market newly in industry *i* between year *t* and year *t*+2. The variant specification includes firm characteristics such as size of labor force and the capital-labor ratio. The expected sign of β is positive since increasing trade costs are expected to increase the probability of entry (due to less foreign competition in local markets). As in the previous hypotheses, we do not include year and industry fixed effects in both base and variant specifications.

The base specification include only the regressor of change in trade costs and the variant firm characteristics on firm survival like firms exit hypothesis.

Hypothesis 4: New Exporters

This specification concerns the possibility that changes in trade costs and other firm characteristics help determine the likelihood that a given firm becomes an exporter. The logit model specifications are expressed as follows:

(4) (base) $\Pr(NE_{f\,t+2}=1)=\Phi(\beta\,\Delta Cost_{i\,t-2})$,

(variant) $\Pr(NE_{f\,t+2}=1)=\Phi(\beta\,\Delta Cost_{i\,t-2}+\gamma X_{f\,t})$

where $\Pr(NE_{f\,t+2}=1)$ denotes the probability that non-exporting firms become exporters and the regressors are defined as above. The variant specification includes firm characteristics such as size of labor force and the capital-labor ratio. The expected sign of β is negative since increasing trade costs are expected to decrease the number of exporting firms.

Hypothesis 5: Export Growth

One prediction of the new theories tells us that more productive firms gain the additional export sales from the less productive firms exit. This prediction enables us to set up the hypothesis that a decrease in trade costs raises export sales at existing exporters. To implement a test for the hypothesis, we estimate OLS regression of the log difference in exports, $\ln(Exports_{f,t+2})-\ln(Exports_{f,t})$,on trade costs change and firm characteristics industry by industry: hence industry and year fixed effects are not considered. These regressions are specified as:

(5) (base) $\Delta_{t:t+2}\ln(Exports_f) = \beta\,\Delta Cost_{i\,t-2} + \varepsilon_{f\,i\,t}$,

(variant) $\Delta_{t:t+2}\ln(Exports_f) = \beta\,\Delta Cost_{i\,t-2} + \gamma X_{f\,t} + \varepsilon_{f\,i\,t}$,

where $\Delta_{t:t+2}\ln(Exports_f)$ represents the log difference in exports from *t* and *t*+2. The variant specification includes firm characteristics such as size of labor force and the capital-labor ratio. The expected sign of β is negative since increasing trade costs are expected to decrease export sales by existing exporters.

Hypothesis 6: Domestic Market Share

Following trade liberalization, Melitz (2003) predicts that domestic market share should fall for all surviving plants and plants that exit, which reallocates market shares toward the more productive firms. This paper tests the hypothesis that falling trade costs reduce the domestic market share of surviving firms. To examine effects of changing trade costs on domestic market share, surviving firms' changes in market share, $Share_{f,t+2}$ - $Share_{f,t}$, between tear *t* and year *t*+2 is specified as follows:

(6) (base) $\Delta_{t:t+2}\,Share_f = \beta\,\Delta Cost_{i\,t-2} + \varepsilon_{f\,i\,t}$,

(variant) $\Delta_{t:t+2}\,Share_f = \beta\,\Delta Cost_{i\,t-2} + \gamma X_{f\,t} + \varepsilon_{f\,i\,t}$,

where $\Delta_{t:t+2}\,Share_f$ is surviving firms' changes in market share. The variant specification includes firm characteristics such as size of labor force and the capital-labor ratio. The expected sign of β is positive since increasing trade costs are expected to increase the share of the domestic market held by Korean firms. Industry and year fixed effects are not considered in the analysis, so regressions are estimated industry by industry.

Hypothesis 7: Changes in Firms' Productivity

Recall that Hypothesis 1 concerns the relationship between trade costs and aggregate *industry* productivity. Hypothesis 7 will consider the relationship between trade costs and *firm-level* productivity. In hypothesis 1, the emphasis is on the fact that with falling trade costs, some firms will leave the industry, and overall productivity will be higher as a result. In hypothesis 7, the emphasis is on those firms that stay – falling trade costs could be encouraging existing firms to improve their productivity, perhaps by changing their scale or their product mix. To test this general idea, changes in firm-level productivity over a two year period are regressed on changes in trade costs, and in the variant, upon firm characteristics:

(7) (base) $$\Delta_{t:t+2} TFP_f = \beta \Delta Cost_{i\,t-2} + \delta_i + \delta_t + \varepsilon_{fit} ,$$

(variant) $$\Delta_{t:t+2} TFP_f = \beta \Delta Cost_{i\,t-2} + \gamma X_{f\,t} + \delta_i + \delta_t + \varepsilon_{fit} .$$

Here, $\Delta_{t:t+2} TFP_f$ is the change in firms' productivity from period *t* to period *t*+2. The variant specification includes firm characteristics such as size of labor force and the capital-labor ratio. The expected sign of β is positive since increasing trade costs are expected to decrease firm level productivity.

3.3. Data and Measurement of Trade Costs

Data

Firm level data on Korean manufacturing are obtained from the Korea Information Service (KIS), the major credit-rating agency in Korea. Many previous studies (including Bernard, Jensen, and Schott, 2006) employ plant-level data. It is difficult to determine, in this study's database, how many firms have only one plant, for example, and how much of the activity in an industry takes place in multi-plant firms. Firm-level data may mask the fact that different plants have different performance. However, firm-level data is consistent with the unit of analysis in the theoretical models that we study.

A firms is designated as "in the market" according to whether it was reporting its information to KIS. It is considered to have "entered" in year *t* if the firm did not report in year $t-1$ or any previous year, and if it did report in year *t*, $t+1$, and $t+2$, which means that in particular, there has to be three consecutive years of data after it first reports to KIS. A firm is considered to have "exited" in year *t* if it reported to KIS in years $t-2$, $t-1$, and *t*, but did not report to KIS in year $t+1$ or any following year. Again, there must have been three consecutive years of reporting for a firm to have been considered to be in the market.

Descriptive statistics concerning firm exits, firm entry, new exporters, firm size, and firm capital intensity are reported in tables 3.1 though 3.6. Instead of discussing each table at this point, these tables will be referred to when discussing the results for the seven hypotheses.

Total factor productivity

As in the first essay, total factor productivity (TFP) is calculated using the Data Envelopment Analysis (DEA) approach of Chambers et al. (1996). DEA provides a measure of technical efficiency, which is the ability to obtain maximal output from a given set of inputs. Higher TFP is signified by values that are closer to zero. Interested readers should review chapter 2 for specific details on how these calculations are made. For most of the analysis TFP will be calculated as a change over a period of two years. The frontier changes from year to year, and in a given year, a firm's TFP is measured relative to the frontier. Table 3.7 reports the total factor productivity estimates.

Trade costs

The computation of trade costs follows Novy's (2007) approach, which does not impose any trade cost function that uses distance, borders barriers or other trade cost proxies. His approach draws on Anderson and van Wincoop (2003), who develop a multi-country general equilibrium model of international trade by simplifying the gravity equation and incorporating trade costs to reflect border effects. Anderson and van Wincoop (2003) defined trade costs as all costs incurred in getting a good to a final user other than the marginal cost of producing the good itself: transportation costs (both freight costs and time costs), policy barriers (tariffs and non-tariff barriers), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail). While the typical gravity equation of the simplest form shows the proportional relationship between the bilateral trade and the product of the countries' GDPs, it reflects no border effects, such as transport costs or tariffs. The gravity equation with the assumption of CES utility incorporates border effects using price indexes. However, these indexes may not reflect the true border effects; that is, all kinds of costs involved in trade may not be reflected in price indexes. To solve this problem, Anderson and van Wincoop (2003) suggest a micro-founded gravity equation, which assumes that the trade costs are symmetric, elasticity of substitution is constant and goods are differentiated by country of origin. Their gravity equation can be expressed as follows:

(8) $$x_{ij} = \frac{y_i \, y_j}{y^W} \left(\frac{t_{ij}}{P_i \, P_j} \right)^{1-\sigma} ,$$

where x_{ij} is exports from i to j, y_i is income of country i, y^W is world income, t_{ij} is the gross bilateral trade cost factor(one plus the tariff equivalent), P_i is price indices, and σ (>1) is the elasticity of substitution.

While this may be fine in theory, the model has the problem of the relative trade barrier which affects price indexes P_i. For this reason, Novy (2007) suggests making use of international trade flows to express multilateral resistance terms as a function of observable trade and output data. Novy's basic idea is that bilateral trade costs affect trade flow in both directions and international trade $x_{ii}x_{jj}$ can be used as a size variable that controls for multilateral resistance. Since gross bilateral trade cost factor between i and j are symmetric($t_{ij} = t_{ji}$), bilateral trade costs τ_{ij} can be written as:

(9) $$\tau_{ij} = \left(\frac{x_{ii} \, x_{jj}}{x_{ij} \, x_{ji}} \right)^{\frac{1}{2(\sigma-1)}} - 1 \ ,$$

Here it should be noticed that the trade costs by Novy's (2007) approach capture not only trade costs, for example transportation costs and tariff etc, but also non-tariff barriers, for instance language barrier and currency barriers, etc.

For computation of trade costs, GDP data and trade data of Korea and its major trading partner countries to compute trade costs are obtained from the Bank of Korea. At first data from IMF Direction of Trade Statistics (DOTS) and GDP data from the IMF World Economic Outlook databases are taken to compute industry-level trade costs. The results of the industry-level trade costs did not appear reliable because they are highly non-monotonic over time. It appears this may be explained due to the fact that the data are incomplete and somewhat unbalanced over time. For this reason, bilateral trade costs were also computed for all eight sectors as a whole.

Trade cost estimates with seven major trading partners are reported in Table 3.8 over the period 1993-2003. Outbound and inbound trade costs are assumed to be symmetric, which means that as trade costs fall, there are more opportunities in the export markets as well as greater foreign competition within the domestic market.

Bi-lateral trade cost estimates for the seven countries are plotted over time in Figure 3.1. The tariff-equivalent trade costs with China and Taiwan, for example, declined from 0.70 to 0.49, and 0.79 to 0.61, respectively. The average change in trade cost, weighted by countries' respective trade volumes with Korea, declined 9.4% over the ten years.

3.4. Results and Implications

This section explores the effects of change in trade costs and firm characteristics on industry and firm-level outcomes described in each hypothesis.

3.4.1. Industry Productivity Growth

Hypothesis 1 is that increasing foreign competition due to lower trade costs will increase the aggregate productivity of industries in Korea. Table 3.9 reports the results of regressing the change in industry productivity on the change in trade costs. The first two columns correspond the change in *median* TFP without and with industry fixed effects, respectively. The third and fourth columns correspond to the change in *mean* TFP without and with industry fixed effects, respectively. Looking at Table 3.9, all the coefficients on change in trade costs are positive, which means that a decrease in trade costs leads to an improvement in industry productivity. In the left two columns it is 0.391, while in the right two columns it is 0.447. This is the expected sign for β. While hypothesis tests suggest that the coefficients are not statistically different from zero, the signs are consistent with the predictions of heterogeneous-firm models.

3.4.2. Firm Exit

Hypothesis 2 states that a decrease in trade costs raises the probability of firm exit. Table 3.10 reports the results for firm exit specifications by industry. The first column in the result of each industry focuses only on trade costs, while the second column includes firm characteristics (labor size and the capital-labor ratio). As seen in the table, the coefficient regarding the effect of change in trade costs on firm exit is negative in nearly every industry, for both base and variant specifications. This is the expected sign. The only exceptions were industry 4 (computers and office machinery) and the alternative specification for industry 5 (electronics). The implication is that falling trade costs increase the probability of exit. It is noted, however, that the coefficients show 5% statistical significance only for industry 2 (chemicals). Table 3.1 shows transition in the number of exit firms. Notice that there is a surge in the number of exits since the financial crisis in 1997. Although data reporting was not mandatory prior to mid 1990s and the number of surviving firms in early 1990s is smaller, there is a noticeable change in exit share since 1997 reflecting a more competitive environment in the domestic market.

The variant (alternative) specification includes Log(employment) and Log(K/L) as explanatory variables. For most industries, we find a negative and statistically significant association between firm exit and the Log(employment) variable, which is a proxy for firm size. The implication is that large firms are less likely to exit. The firms that exit tend to be small. This is consistent with the results of Table 3.5, which shows that exiting firms have an average of 100 employees, while continuing firms have an average of 159 employees. The reason of this effect is a subject for further study, but may have to do with access to credit, for example. Large firms with an established reputation, or part of a *Chaebol* conglomerate, may have easier access to credit.

Another coefficient to consider is the one on Log(K/L), which is measure of the capital intensity of a firm. For most industries this coefficient is not statistically significant at conventional levels of significance.

To the extent that these variables do not explain exit, it might be related to 1997 Asian financial crisis. Starting around October 1997, the Korean Won depreciated heavily against most major currencies of the world, and there was a contraction in credit markets (the cost of capital). Table 3.1 shows that after 1997, there was an increase in the proportion of firms that exited in a given year.

3.4.3. New Firms[5]

Hypothesis 3 is that decreases in trade costs are expected to decrease the probability of entry by new firms. Table 3.11 reports the logit regression results for this hypothesis.

[5] This hypothesis is not considered in Bernard, Jensen, and Schott (2006).

The results reveal that in nearly every case, firm entry and trade costs have the predicted positive association: as trade costs fall, firm entry is less likely, since there is more foreign competition. The coefficients are generally statistically different from zero at the 5 percent level. This implies that foreign competition makes it difficult for potential local firms to enter the domestic market. These results are consistent with expectations. As seen in Table 3.2, more firms enter the market over time in each industry. A decrease in trade costs induces more competition in previously unchallenged industries, while facilitating more firm entry into areas where Korea may have a comparative advantage.

Another interesting coefficient to consider is the one on firm size associated with the Log(employment) variable in the variant specifications in Table 3.11. Firm size has a negative and statistically significant relationship with firm entry. In particular, firms that entered tended to be smaller in size than incumbents. This holds regardless of industry, and is in line with expectations. Looking at Table 3.4, which reports descriptive statistics on the size of firms, new firms had 36.62 employees on average, while incumbent firms had 161.90 employees on average. With respect to capital intensity (Table 3.11), we also find a negative and statistically significant relationship between capital intensity and firm entry. In each of the eight industries, new firms tend to use more labor relative to capital than do incumbent firms. Again, these findings are consistent with expectations.

3.4.4. New Exporters[6]

Hypothesis 4 investigates the possibility that the probability of a firm becoming an exporter is determined by changes in trade costs and firm characteristics. Table 3.12 reports the logit regression results for these specifications. The sign on the trade cost

[6] This corresponds to hypothesis 3 in Bernard, Jensen, and Schott (2006).

coefficient is negative for six of the eight industries, which is consistent with expectations. The interpretation is that higher trade costs make it harder for a firm to become an exporter. An unexpected sign occurs only for industry 1 (food processing) and industry 3 (the machinery sector). In general the coefficients cannot be said to be statistically different from zero. Table 3.3 shows an increasing trend in the number of firms that start to export in the aggregate manufacturing industry.

The variant specifications are reported in the right column under each industry. The coefficient on Log(employment), which is a proxy for firm size, is negative in six of the eight industries. This implies that larger firms were less likely to be a new exporter. The two exceptions are industry 3 (machinery) and industry 6 (medical and precision instruments). In general, the coefficient on size is not statistically different than zero. The coefficient on capital intensity is negative in all but one industry (computers and office machinery). In none of the cases is there statistical significance.

Although the lack of statistical significance prevents strong conclusions from being made, it appears that smaller and less capital-intensive firms are the ones most likely to enter the export market. Interestingly, this is different than the result of Bernard, Jensen, and Schott (2006). Looking at U.S. manufacturers, they find that larger and more capital-intensive firms are more likely to become exporters.

This difference in outcomes between Korea and the U.S. may have to do with events in Korea in the 1990s. During this time period there were many new businesses formed with the goal of exporting beyond the small local Korean market. Looking at the data (not reported in the tables), 46% of new exporters in Korea started exporting in the same year that they started their business; 17% started exporting during the second year of their business. Of those firms that started exporting within three years of starting their business, the average number of employees was 69. This is much smaller than the size of the average Korean firm in general (Table 3.6).

3.4.5. Export Growth[7]

Hypothesis 5 is that a fall in trade costs is likely to increase export sales at existing exporters. Table 3.13 reports OLS regression results for the two specifications used to test this hypothesis. In the case of industry 3 (machinery and equipment), the coefficient on change in trade costs is negative, as is expected. For the other seven industries, however, the coefficient is positive, meaning that falling trade costs did not cause exporters to export more. The results for these seven industries are therefore not consistent with the predictions of the heterogeneous-firm models. The reasons for this result are not clear. One possible explanation is that the financial crisis of the late 1990s prevented firms from expanding export operations as trade costs fell.

The coefficients on the firm size and capital intensity variables in the variant specifications tended not to be statistically different from zero. Therefore we can make no strong conclusion about how firm size or capital intensity might play a role in increasing the level of exports.

3.4.6. Domestic Market Share[8]

Hypothesis 6 is that falling trade costs reduce the domestic market share of surviving firms. Regression results are reported in Table 3.14. Except for the food processing and electronic component sectors, the sign of the coefficient on trade costs is positive, which

[7] This corresponds to hypothesis 4 in Bernard, Jensen, and Schott (2006).
[8] This corresponds to hypothesis 5 in Bernard, Jensen, and Schott (2006).

means that the results are consistent with expectations. There is statistical significance in four of the eight industries. To the extent that trade costs do not explain the decline in market share, it's possible that it can be explained by increasing numbers of Korean firms (in addition to increasing numbers of foreign firms selling there).

The variant specifications include firm characteristics as explanatory variables and reveal some interesting connections to the changes in share of the domestic market. In five of the eight industries, smaller firms (as given by employment), tended to have an increase in domestic market share (this result was statistically significant for all five industries). In six of the eight industries, firms with a higher capital intensity tended to have a positive change in market share. The results on capital intensity, however, were typically not statistically significant. So the main result of this section is that smaller firms were the ones to typically increase in their market share over the period of interest.

3.4.7. Changes in Firm Productivity[9]

Hypothesis 7 is that increasing foreign competition due to lower trade costs will increase the overall productivity of individual firms in Korea. Regression results are reported in Table 3.15. There are results for each of the eight industries, including a base and variant specification. For each industry, the sign on trade costs is the same for both the base and variant specifications. For five of the industries, the sign on trade costs is positive, which is consistent with the theory. An unexpected negative sign is found for three of the industries (chemicals, electronics, and other transport). The coefficient is statistically non-zero in exactly half of the 16 total specifications. The results, therefore, are mixed – we find small amount of support for the theory.

[9] This corresponds to hypothesis 6 in Bernard, Jensen, and Schott (2006).

As above, the variant specifications include firms' size of labor force and capital-labor ratio as explanatory variables. In the variant specification, we find a negative association between firm size (given by Log(employment)) and changes in firm-level productivity in all sectors except the precision instruments sector. There was statistical significance in half of these cases. This implies that small firms are more likely to improve their productive efficiency. In four of the eight industries, firms with a higher capital intensity had a positive change in the total factor productivity of individual firms. Few of these results are statistically significant, however, and so the results concerning capital intensity are inconclusive.

3.5. Summary and Conclusions

This essay tests the implications of heterogeneous-firm models of trade in the case of Korea. Korea is an interesting case because it is Asian country at a mid-level of development, and is quite different in economic structure than the U.S., the only other country for which these specific theories have been tested (Bernard, Jensen, and Schott, 2006). This essay also considers a number of additional hypotheses that have never been tested before.

One implication of falling trade costs is a rise in the level of foreign competition in domestic markets. By way of this mechanism, lower trade costs increase the productivity of *industries* in Korea (Hypothesis 1), as well as the productivity of *individual* firms (Hypothesis 7). Lower trade costs also increase the probability of exit by Korean firms (Hypothesis 2), and reduce the domestic market share of those firms that survive (Hypothesis 6). Another implication of falling trade costs is that Korean firms may have an easier time penetrating foreign markets. In this vein, lower trade costs make it easier for Korean firms to become exporters (Hypothesis 4).

Moderate to strong support is found for all of the above hypotheses. There is really only one hypothesis for which the results are clearly inconsistent with the theory: the prediction that falling trade costs will increase export sales at existing exporters (Hypothesis 5). The results do not necessarily nullify this hypothesis, it is just that there is no clear pattern in the signs and significant of the estimated coefficients.

All of the above hypotheses were considered in Bernard, Jensen, and Schott (2006) in the case of the U.S. Something entirely new that was tested here is hypothesis 3, which is that falling trade costs decrease the probability of entry by new firms due to increased foreign competition in local markets. The results found here are consistent with this hypothesis.

In addition, the essay investigates how the dependent variables of interest are affected by the size of firms, and the ratio of capital-to-labor that is used in production. Similar to the predictions of heterogeneous-firm models and the findings of Bernard, Jensen, and Schott (2006), large firms are less likely than small firms to exit the market (die) in response to changes in trade costs. In addition, newly entering firms tend to be smaller in size than incumbents. However, Korea appears to differ from model predictions and results for the U.S. in certain other respects. In Korea over the time period of interest, large firms were *less* likely to be a new exporter. Rather, smaller and less capital-intensive firms tended to enter the export market. In turn, the firms that were able to increase their market share tended to be smaller than average. These results tended to hold regardless of industry.

Some of these unique results are likely due to the particularly dynamic nature of manufacturing in Korea over the time period of interest. Firm entry rates were quite high due to a surge of entrepreneurial activity. Exit rates were high due to the Asian financial crisis and emergence of new competitors from China and India.

Overall, this study shows that changing trade costs over the period 1991-2003 had important consequences for the structure of manufacturing activity in Korea. Some of these effects were somewhat “negative” in nature, in that declines in trade costs appear to have caused a number of firms to go out of business. On the other hand, firms that survived tended to have increases in productivity and success in export markets, leading to a stronger overall manufacturing sector.

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Table 3.1. Number of Firms to Exit

	No. of exiting firms (all industries)	Total No. of firms (all industries)	Proportion of firms that exited (all industries)
1992	121	1778	0.068
1993	123	1679	0.073
1994	135	1782	0.075
1995	132	2055	0.064
1996	271	3611	0.075
1997	266	5021	0.052
1998	623	6351	0.098
1999	910	7489	0.121
2000	1376	8062	0.170
2001	1552	8210	0.189

Table 3.2. Number of Firms to Enter

	No. of Entering Firms (all industries)	Total No. of Firms (all industries)	Proportion of Firms that exited (all industries)
1992	226	1778	0.127
1993	137	1679	0.081
1994	264	1782	0.148
1995	463	2055	0.225
1996	1712	3611	0.474
1997	1844	5021	0.367
1998	1611	6351	0.253
1999	1986	7489	0.265
2000	1655	8062	0.205
2001	1436	8210	0.174
2002	2049	9195	0.222

Table 3.3. Number of New Exporters

	No. of New Exporters (all industries)	Total No. of Firms (all industries)	Proportion of New Exporters (all industries)
1992	96	1778	0.053
1993	53	1679	0.031
1994	63	1782	0.035
1995	83	2055	0.040
1996	140	3611	0.038
1997	181	5021	0.036
1998	210	6351	0.033
1999	268	7489	0.035
2000	223	8062	0.027
2001	182	8210	0.022
2002	215	9195	0.023

Table 3.4. Average Size and Capital intensity of Firms to Enter

	Firm Size (# of Employees)	Ratio of Capital/Labor
Industry 1	42.01 (406)	69509.3
Industry 2	44.21(636)	76174.4
Industry 3	22.77(1849)	29505.7
Industry 4	35.56(110)	23753.0
Industry 5	47.60(747)	33226.1
Industry 6	20.92(364)	23035.2
Industry 7	61.77(569)	55364.0
Industry 8	88.11(211)	49914.4
All Entering Firms	36.62	40341.4
All Incumbent Firms	161.90	62201.6
All Firms Together	133.72	57563.2

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
Figure in parenthesis is average number for all firms in the industry.

Table 3.5. Average Size and Capital intensity of Firms to Exit

	Firm Size (# of Employees)	Ratio of Capital/Labor
Industry 1	122.37(406)	95025.7
Industry 2	91.23(636)	112065.8
Industry 3	49.48(1849)	45379.0
Industry 4	74.92(110)	35258.3
Industry 5	158.35(747)	48435.9
Industry 6	33.40(364)	31873.1
Industry 7	154.25(569)	112551.4
Industry 8	422.72(211)	57137.0
All Exiting Firms	100.42	65544.0
All Incumbent Firms	158.86	56023.3
All Firms Together	133.72	57563.2

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
Figure in parenthesis is average number for all firms in the industry.

Table 3.6. Average Size and Capital intensity of New Exporters

	Firm Size(# of Employees)	Ratio of Capital/Labor
Industry 1	187.74(406)	79616.5
Industry 2	191.89(636)	120286.1
Industry 3	53.78(1849)	41017.3
Industry 4	104.06(110)	37605.9
Industry 5	175.13(747)	49161.4
Industry 6	70.63(364)	37156.0
Industry 7	170.31(569)	117285.3
Industry 8	68.32(211)	45527.4
New Exporters	117.04	62251.5
All Firms Except New Exporters	134.20	57425.3
All Firms Together	133.72	57564.2

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
Figure in parenthesis is average number for all firms in the industry.

Table 3.7. Total Factor Productivity

	Industry 1		Industry 2		Industry 3		Industry 4	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1992	0.4783	0.5284	0.733	0.7854	0.4579	0.5007	0.0869	0.1358
1993	0.4295	0.4825	0.7698	0.8264	0.4377	0.4884	0.0739	0.0801
1994	0.3635	0.4223	0.7766	0.8389	0.4711	0.5272	0.0878	0.1586
1995	0.4083	0.4546	0.6721	0.7378	0.5862	0.6588	0.1256	0.1908
1996	0.3644	0.4033	0.5351	0.6162	0.5814	0.6380	0.1377	0.1659
1997	0.3679	0.3812	0.5390	0.6112	0.5783	0.6281	0.2656	0.3240
1998	0.4803	0.5337	0.5651	0.6249	0.5886	0.6242	0.3513	0.4196
1999	0.5498	0.6212	0.5157	0.5587	0.614	0.6553	0.4108	0.4786
2000	0.5922	0.6846	0.4746	0.5154	0.6379	0.6774	0.4453	0.5181
2001	0.6169	0.6984	0.5531	0.6177	0.6448	0.6777	0.4398	0.5003
2002	0.5969	0.6768	0.6332	0.7052	0.6591	0.6901	0.4422	0.5162
2003	0.5647	0.6613	0.5989	0.6771	0.6445	0.6901	0.3692	0.4478
	Industry 5		Industry 6		Industry 7		Industry 8	
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
1992	0.4179	0.4640	0.2632	0.3112	0.2795	0.3109	0.0531	0.0496
1993	0.5311	0.5719	0.2012	0.2705	0.2894	0.3288	0.0753	0.0903
1994	0.4832	0.5332	0.1709	0.2060	0.3588	0.4055	0.0820	0.0935
1995	0.4891	0.5295	0.2106	0.2353	0.4081	0.4541	0.0675	0.0984
1996	0.5276	0.5890	0.2696	0.2824	0.3776	0.4082	0.1457	0.1387
1997	0.5472	0.6095	0.4233	0.4660	0.3840	0.4093	0.2868	0.3242
1998	0.5950	0.6546	0.4441	0.4925	0.4404	0.4538	0.3038	0.3495
1999	0.6299	0.6864	0.4676	0.5176	0.4411	0.4537	0.3217	0.3682
2000	0.6362	0.6952	0.5459	0.5966	0.5267	0.5875	0.3096	0.3828
2001	0.6655	0.7376	0.5169	0.5584	0.6430	0.7408	0.2942	0.3330
2002	0.6900	0.7503	0.5301	0.5554	0.6244	0.7232	0.3003	0.3600
2003	0.6472	0.6965	0.5103	0.5570	0.5714	0.6358	0.2953	0.3437

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment

Table 3.8. Estimates of Korea's bilateral trade costs, 1993 and 2003

	Tariff equivalent τ (%)		
Partner Country	1993	2003	Percentage Change
Taiwan	0.79	0.61	-22.7
Germany	0.87	0.83	-3.5
U.S	0.662	0.668	0.9
Singapore	0.61	0.57	-6.2
U.K	1.00	0.94	-5.1
Japan	0.65	0.60	-7.1
China	0.70	0.49	-29
Weighted average	0.66	0.59	-10.6

Table 3.9. Industry productivity growth, 1991-2003

	Change in TFP(Median)		Change in TFP(Mean)	
Change in trade costs	0.391	0.391	0.447	0.447
	(0.302)	(0.302)	(0.174)	(0.168)
Intercept	0.024***	0.307**	0.022***	0.026**
	(0.000)	(0.048)	(0.000)	(0.048)
Industry fixed effects	No	Yes	No	Yes
Observations	80	80	80	80
R^2	0.014	0.105	0.024	0.138

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Table 3.10. Probability of exit, 1991-2001

	Logit Industry 1		Logit Industry 2		Logit Industry 3		Logit Industry 4	
Intercept	-1.56***	2.33***	-2.00***	1.08	-1.83***	-1.07***	-1.51***	-0.18
	(0.000)	(0.003)	(0.000)	(0.108)	(0.000)	(0.003)	(0.000)	(0.892)
Change in trade costs	-5.04	-5.69	-13.43***	-14.88***	-6.18	-6.38	6.10	6.11
	(0.326)	(0.320)	(0.003)	(0.002)	(0.146)	(0.163)	(0.667)	(0.693)
Log(employment)		-1.04***		-0.95***		-0.56***		-0.56**
		(0.000)		(0.000)		(0.000)		(0.050)
Log(K/L)		-0.38**		-0.25*		0.01		-0.07
		(0.018)		(0.074)		(0.905)		(0.823)
Observations	1330	1330	2323	2323	4634	4634	248	248
Log Likelihood	-610.4	-563.8	-842.4	-802.4	-1852.2	-1831.4	-117.3	-114.9
	Logit Industry 5		Logit Industry 6		Logit Industry 7		Logit Industry 8	
Intercept	-2.11***	0.07	-1.74***	-1.22	-2.30***	1.11	-2.20***	-0.64
	(0.000)	(0.913)	(0.000)	(0.103)	(0.000)	(0.291)	(0.000)	(0.646)
Change in trade costs	-0.07	0.74	-6.86	-6.59	-6.20	-7.45	-8.06	-8.68
	(0.989)	(0.909)	(0.455)	(0.520)	(0.317)	(0.287)	(0.594)	(0.583)
Log(employment)		-0.82***		-0.84***		-1.18***		-0.24
		(0.000)		(0.000)		(0.000)		(0.406)
Log(K/L)		-0.14		0.17		-0.22		-0.25
		(0.354)		(0.331)		(0.315)		(0.424)
Observations	1920	1920	869	869	1807	1807	445	445
Log Likelihood	-656.4	-633.3	-364.7	-354.3	-547	-518.6	-143.4	-142.5

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic Components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
p-value is in parenthesis. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Table 3.11. Probability of entering the domestic market, 1991-2003

	Logit Industry 1		Logit Industry 2		Logit Industry 3		Logit Industry 4	
Intercept	-1.18***	5.14***	-1.45***	1.76***	-0.76***	2.95***	-0.66***	4.41***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in trade costs	-0.75	11.75***	-7.37**	12.13***	29.55***	33.30***	22.68***	22.56***
	(0.834)	(0.003)	(0.015)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(employment)		-1.58***		-2.01***		-0.95***		-1.26***
		(0.000)		(0.000)		(0.000)		(0.000)
Log(K/L)		-0.82***		-0.002		-0.59***		-0.77***
		(0.000)		(0.400)		(0.000)		(0.000)
Observations	4190	4190	6487	6487	22671	22671	1304	1304
Log Likelihood	-2289.6	-1954.6	-3263.3	-2738.1	-12532	-11810	-772.7	-691.5
	Logit Industry 5		Logit Industry 6		Logit Industry 7		Logit Industry 8	
Intercept	-0.79***	4.55***	-0.72***	2.63***	-1.22***	5.38***	-0.90***	3.44***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Change in trade costs	19.53***	23.12***	24.58***	29.48***	18.14***	26.29***	21.25***	22.97***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(employment)		-1.35***		-1.14***		-1.62***		-0.90***
		(0.000)		(0.000)		(0.000)		(0.000)
Log(K/L)		-0.74***		-0.46***		-0.82***		-0.68***
		(0.000)		(0.000)		(0.000)		(0.000)
Observations	8698	8698	4458	4458	6277	6277	1857	1857
Log Likelihood	-4968.5	-4374.5	-2544.9	-2386.9	-3060.5	-2651.3	-1013.9	-947.1

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic Components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
p-value is in parenthesis.   *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Table 3.12. Probability of entering the export market, 1991-2003

	Logit Industry 1		Logit Industry 2		Logit Industry 3		Logit Industry 4	
Intercept	-4.23***	-1.916	-4.347***	-3.538**	-3.714***	-4.064***	-3.744***	-6.511**
	(0.000)	(0.345)	(0.000)	(0.030)	(0.000)	(0.000)	(0.000)	(0.036)
Change in trade costs	8.64	10.288	-2.987	-2.014	8.013	6.424	-15.121	-10.539
	(0.482)	(0.415)	(0.757)	(0.836)	(0.116)	(0.207)	(0.440)	(0.596)
Log(employment)		-0.307		-0.214		0.314**		-0.634
		(0.316)		(0.439)		(0.050)		(0.302)
Log(K/L)		-0.36		-0.078		-0.026		0.884
		(0.399)		(0.824)		(0.868)		(0.217)
Observations	1712	1712	3020	3020	7612	7612	384	384
Log Likelihood	-125.9	-125	-208.3	-207.9	-824.4	-822.4	-46	-45
	Logit Industry 5		Logit Industry 6		Logit Industry 7		Logit Industry 8	
Intercept	-4.212***	-2.977**	-3.849***	-3.335**	-4.095***	-0.694	-3.369***	-0.577
	(0.000)	(0.029)	(0.000)	(0.022)	(0.000)	(0.686)	(0.000)	(0.729)
Change in trade costs	-3.565	-3.169	-2.609	-3.257	-8.432	-7.547	-2.489	-2.171
	(0.699)	(0.737)	(0.824)	(0.783)	(0.335)	(0.393)	(0.854)	(0.875)
Log(employment)		-0.18		0.1		-0.261		-0.179
		(0.503)		(0.777)		(0.361)		(0.659)
Log(K/L)		-0.201		-0.158		-0.617		-0.558
		(0.533)		(0.665)		(0.103)		(0.151)
Observations	3015	3015	1414	1414	2772	2772	681	681
Log Likelihood	-233.7	-233.2	-145.2	-145.1	-241.8	-239.8	-100.5	-99.1

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic Components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
p-value is in parenthesis. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

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Table 3.13. Change in log export, 1991-2003

	OLS Industry 1		OLS Industry 2		OLS Industry 3		OLS Industry 4	
Intercept	-0.02	0.52	0.02*	0.14	0.1***	0.32	0.13	0.53
	(0.626)	(0.326)	(0.080)	(0.408)	(0.000)	(0.280)	(0.129)	(0.582)
Change in trade costs	0.77	0.08	0.57	0.55	-0.19	-0.27	1.19	4.04
	(0.761)	(0.975)	(0.553)	(0.567)	(0.898)	(0.860)	(0.818)	(0.436)
Log(employment)		0.06		-0.0004		0.002		-0.35**
		(0.264)		(0.988)		(0.958)		(0.024)
Log(K/L)		-0.15		-0.02		-0.04		0.09
		(0.165)		(0.523)		(0.454)		(0.66)
Observations	135	135	508	508	545	545	49	49
R^2	0.000	0.023	0.000	0.001	0.000	0.001	0.001	0.048

	OLS Industry 5		OLS Industry 6		OLS Industry 7		OLS Industry 8	
Intercept	0.002	0.48*	0.03	1.58***	0.04**	0.15	0.09*	0.19
	(0.912)	(0.051)	(0.497)	(0.008)	(0.022)	(0.672)	(0.087)	(0.758)
Change in trade costs	2.23**	2.30**	1.00	1.37	2.06*	2.20**	0.19	-0.03
	(0.039)	(0.033)	(0.743)	(0.646)	(0.062)	(0.049)	(0.955)	(0.991)
Log(employment)		-0.07**		-0.09		-0.05		0.01
		(0.042)		(0.290)		(0.195)		(0.849)
Log(K/L)		-0.06		-0.31**		0.006		-0.02
		(0.189)		(0.018)		(0.932)		(0.827)
Observations	541	541	82	82	468	468	83	83
R^2	0.007	0.018	0.001	0.018	0.007	0.011	0.000	0.001

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic Components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
p-value is in parenthesis. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

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Table 3.14. Change in domestic market share, 1991-2001

	OLS Industry 1		OLS Industry 2		OLS Industry 3		OLS Industry 4	
Intercept	0.751*	-0.0005	-0.0001***	0.0007***	-0.222***	0.0001**	-0.001***	0.002
	(0.078)	(0.224)	(0.000)	(0.001)	(0.000)	(0.031)	(0.000)	(0.285)
Change in trade costs	-0.002	-0.002	0.001	0.001	0.0003	0.0004	0.062**	0.058**
	(0.487)	(0.499)	(0.261)	(0.211)	(0.501)	(0.367)	(0.033)	(0.021)
Log(employment)		0.634		-0.0003***		-0.0001***		-0.004***
		(0.293)		(0.000)		(0.000)		(0.000)
Log(K/L)		0.0001		-0.00002		0.786		0.0008
		(0.264)		(0.561)		(0.496)		(0.150)
Observations	1330	1330	2323	2323	4634	4634	248	248
R^2	0.000	0.002	0.000	0.033	0.000	0.020	0.018	0.270

	OLS Industry 5		OLS Industry 6		OLS Industry 7		OLS Industry 8	
Intercept	0.00005	0.0005**	0.0002	-0.004	0.00002	0.0004	0.0004	-0.006***
	(0.776)	(0.013)	(0.545)	(0.218)	(0.196)	(0.167)	(0.031)	(0.001)
Change in trade costs	-0.013***	-0.013***	0.2418***	0.243***	0.003*	0.003**	0.032	0.027
	(0.000)	(0.000)	(0.000)	(0.000)	(0.054)	(0.044)	(0.113)	(0.155)
Log(employment)		-0.0001***		0.0008		-0.0002***		0.001***
		(0.000)		(0.299)		(0.000)		(0.000)
Log(K/L)		-0.000005		0.0007		0.000001		0.0006
		(0.266)		(0.355)		(0.792)		(0.122)
Observations	1920	1920	869	869	1807	1807	445	445
R^2	0.024	0.033	0.036	0.039	0.002	0.023	0.005	0.093

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic Components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
p-value is in parenthesis. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Table 3.15. Plant TFP Growth, 1991-2003

	OLS Industry 1		OLS Industry 2		OLS Industry 3		OLS Industry 4	
Intercept	0.006	0.259	-0.075***	0.023	0.036***	0.116**	0.026	0.42**
	(0.602)	(0.101)	(0.000)	(0.752)	(0.000)	(0.038)	(0.146)	(0.024)
Change in trade costs	0.647	0.765	-3.571***	-3.357***	1.447***	1.653***	2.245**	2.254**
	(0.387)	(0.307)	(0.000)	(0.000)	(0.000)	(0.000)	(0.036)	(0.034)
Log(employment)		-0.03*		-0.078***		-0.04***		-0.008
		(0.065)		(0.000)		(0.000)		(0.764)
Log(K/L)		-0.036		0.015		-0.001		-0.083**
		(0.252)		(0.302)		(0.912)		(0.042)
Observations	196	196	634	634	806	806	61	61
R^2	0.003	0.027	0.107	0.158	0.024	0.045	0.071	0.143
	OLS Industry 5		OLS Industry 6		OLS Industry 7		OLS Industry 8	
Intercept	0.003	0.158**	-0.02*	-0.205	0.016***	0.284***	0.003	0.018
	(0.565)	(0.013)	(0.059)	(0.178)	(0.004)	(0.003)	(0.748)	(0.884)
Change in trade costs	-1.814***	-1.85***	0.75	0.746	0.074	0.241	-1.135	-0.985
	(0.000)	(0.000)	(0.388)	(0.393)	(0.825)	(0.469)	(0.123)	(0.194)
Log(employment)		-0.006		0.026		-0.07***		-0.023
		(0.510)		(0.335)		(0.000)		(0.259)
Log(K/L)		0.03**		0.029		-0.02		0.007
		(0.024)		(0.403)		(0.298)		(0.793)
Observations	694	694	118	118	583	583	117	117
R^2	0.048	0.056	0.006	0.024	0.000	0.053	0.020	0.031

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Computers and Office machinery
Industry 5 : Manufacture of Electronic Components, Radio, TV and Communication Equipment
Industry 6 : Manufacture of Medical, Precision and Optical Instruments, Watches and Clocks
Industry 7 : Manufacture of Motor vehicles, Trailers and Semitrailers
Industry 8 : Manufacture of Other Transport Equipment
p-value is in parenthesis. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

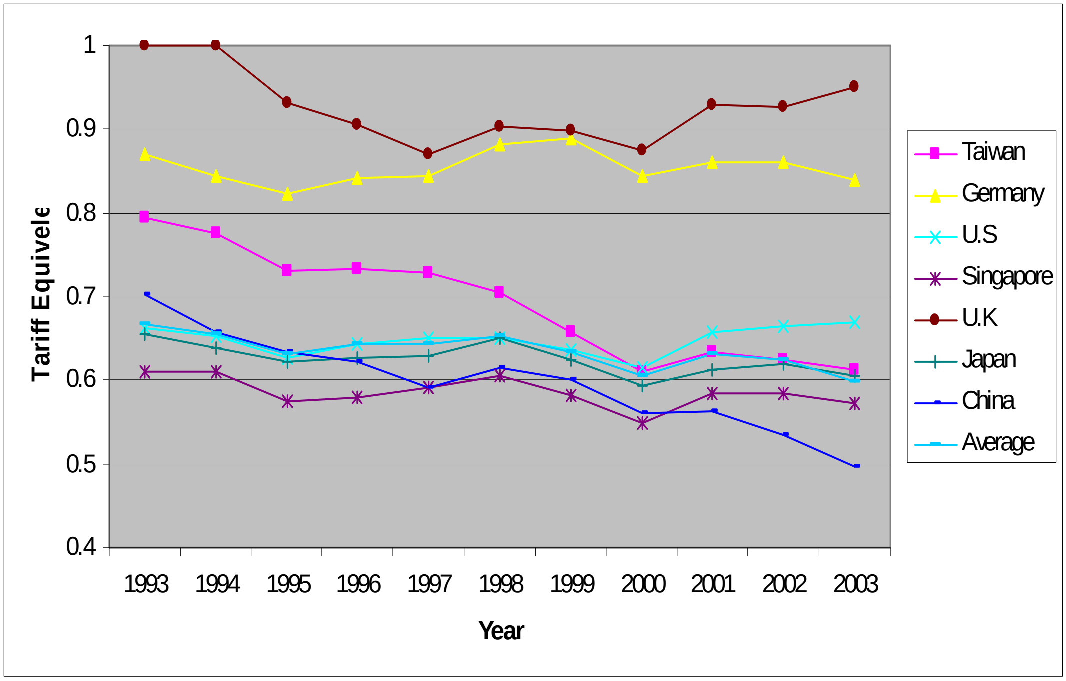

Figure 3.1. Estimates of Korea's bilateral trade costs, 1993-2003

CHAPTER FOUR

Trade and Scale Economies in Korean manufacturing

4.1. Introduction

A key argument in favor of free trade is the potential economic gains from the realization of scale economies. That is, increasing the scale of production to serve foreign markets leads to lower average cost of production (Kemp and Negishi 1969; Eaton and Panagariya 1979; Panagariya 1980). When trade increases the output of industries in which scale economies are most significant, countries can benefit from trade (Krugman, 1980; Abayasiri-Silva and Mark Horridge 1996; Jason and Liu 2005; Svend 2007). In contrast, explanations based on the assumption of constant returns to scale imply that when competitive conditions prevail, gains from trade only accrue when countries are fundamentally different in terms of their endowments (factors of production) or the technologies available to them.

Few studies address scale economies at the firm or plant level (Pratten, 1988). As noted in the previous two essays, firms' export behavior has received significant research attention. In that context, approximations of scale economies, e.g., plant size or number of employees per $100 of output, are used to estimate their effect on the export decision or entry/exit. Furthermore, few have formally explored the difference in economies of scale between exporting and non-exporting firms within an industry. The objective of this essay is to examine returns to scale in Korean manufacturing industries. In particular, it addresses whether or not exporting firms have different scale economies than non-exporters within an industry. For this purpose, a matching technique is used to compare the estimates of a production function between two groups of firms.

The next section presents an outline of the empirical framework: production function, the derivation of returns to scale and the matching techniques. The following sections describe data, results and implications. The final section provides a summary and draws conclusions.

4.2. Empirical Framework

4.2.1. Production Function and Economies of Scale

The most common way to describe the technology of an organization such as a business firm is the production function. For the estimation of a production function, previous literature has proposed a stochastic-frontier production function of the Cobb-Douglas type (Aigner, Lovell and Schmidt, 1977; Meeusen and van den Broeck, 1977). The log-linear specification of a stochastic-frontier production function postulates the existence of technical inefficiency of production of firms (Reifschneider and Stevenson, 1991; Huang and Liu, 1994). The standard specification of a production function incorporating technical inefficiency is as follows:

(1) $$y_i = x_i^{'}\gamma + \varepsilon_i ,$$

where y_i is the logarithm of output of firm *i* and x_i is a (*1*x*k*) row vector including a constant and the *i*-th firm's inputs. The error term, ε_i, is the difference of two independent random variables: a classical error term, v_i, and a random variable associated with technical inefficiencies of production, u_i,

(2) $\varepsilon_i = v_i - u_i$

The v_i s are assumed to be *iid* ($N(0, \sigma_v^2)$) random errors and the u_i s are assumed to be non-negative and independently distributed. The distribution for u_i can be the truncated normal, or gamma and exponential distributions.

Using the ordinary least squares (OLS) procedure for estimation of equation (1) can yield biased estimates of the production function because it assumes $u_i = 0$. To avoid this problem, the production function might be estimated by using the maximum likelihood procedure. The use of panel data, an extension of equation (1) as follows:

(3) $y_{it} = x_{it}\gamma' + \varepsilon_{it}$,

creates an additional issue that technical inefficiency or productivity may change over time.

Considering the above issues, this essay makes use of the value of technical inefficiency for each firm computed by using DEA technique in the previous essays. The DEA technique measures how far the input-output vector is from the frontier technology, and does not involve stochastic elements. In addition, a time trend is included to reflect change in productivity over time. Industry dummies are used to account for the difference in productivity across industries. Under these assumptions, the log-linear type of Cobb-Douglas production function to be estimated is:

(4) $\ln(Y_{it}) = \gamma_0 + \gamma_1 \ln(A_{it}) + \gamma_2 \ln(K_{it}) + \gamma_3 \ln(L_{it}) + \gamma_4 t + \gamma_5 D_i + \varepsilon_{it}$,

where Y_{it}, A_{it}, K_{it}, and L_{it} represent a firm's *t*-th period output, total factor productivity, capital, labor, respectively. The variable t denote the time trend, while industry dummies are indicated by D_i.

Based on the Cobb-Douglas production function, economies of scale (or returns to scale) can be derived as $\hat{\gamma}_2 + \hat{\gamma}_3$, where a $\hat{}$ denotes estimated parameters. If $\hat{\gamma}_2 + \hat{\gamma}_3 > 1$, there are economies of scale (or increasing returns to scale); if $\hat{\gamma}_2 + \hat{\gamma}_3 = 1$, no economies of scale (or constant returns to scale); and when $\hat{\gamma}_2 + \hat{\gamma}_3 < 1$, there exist diseconomies of scale (decreasing returns to scale). Scale economies provide insights into cost savings or dissavings or proportional change in inputs when a firm increases its output. For the purpose of comparing exporters and nonexporters, equation (4) is separately specified for each of these two groups. Their results, in particular the scale economies, are then compared by a technique described in the following sub-section.

4.2.2. Matching Method

The matching method has a long history in non-experimental statistical evaluation (Heckman, Ichimura and Todd 1998; Rosenbaum and Rubin 1985, 1983; Rubin 1979). Matching has been proposed as a nonparametric solution to problems of bias that emerge in observational studies, and has become an increasingly popular method of causal inference in many fields including economics (Abadie and Imbens 2006; Galiani, Gertler, and Schargrodsky 2005; Dehejia and Wahba 2002, 1999).

A primary goal of matching is to estimate the average causal effect of a binary treatment variable, T, on an outcome variable, Y. In observational studies, researchers typically invoke the strong ignorability assumption (, which then requires controlling for a vector of observed covariates X (Rosenbaum and Rubin 1983). Matching is used to adjust nonparametrically for possibly confounded treatment assignment, by dropping, repeating, and/or grouping observations, so that the relationship between X and T are eliminated or reduced. Adjusting the sample introduces no selection bias so long as the matching method is based on a function of X and T and not Y. In the best case, the data after matching satisfy

(5) $\tilde{p}(X \mid T=1) = \tilde{p}(X \mid T=0)$,

where $\tilde{p}$ is the empirical density of the observed data, rather than the population density.

In the best case, T and X are unrelated in the matched sample, and no further adjustments for X are necessary. Indeed, the average treatment effect can be estimated by a simple difference in means of Y between the treated ($T = 1$) and control ($T = 0$) groups. When the sample relationship between T and X is reduced but not eliminated, further adjustment for X may be necessary, by using parametric methods. Then, the immediate goal of matching is to choose an algorithm that satisfies the equation (5) as best as possible.

Choosing the most appropriate algorithm for a given problem involves assessing how well equation (5) holds in the matched samples. The employed algorithm is expected to compare the joint distributions of all covariates X between the treated and control groups. However, when X's dimension is high, such comparisons are infeasible and thus, lower-dimensional measures of balance are instead used. The most commonly used method is to evaluate equation (5) for the chosen matching algorithm by conducting t-tests for the difference in means for each variable in X between the matched treated and control groups. Other hypothesis tests, such as χ^2 and F, are also sometimes used for each covariate.

There are different versions of the *t*-test depending on whether the two samples are independent of each other or paired: in the latter case, each member of one sample has a unique relationship with a particular member of the other sample. Dependent *t*-tests are used for paired samples and independent *t*-tests for independent samples. Under the supposition that exporter and non-exporter groups are independent of each other, the analysis in this essay uses an independent two-sample *t*-test. To illustrate an independent two-sample *t*-test, consider two groups under experiment, $A=(A_1,\ldots,A_{n_1})$ and $B=(B_1,\ldots,B_{n_2})$. The research hypothesis is that two groups show different effects, so the null hypothesis is that they do not have different effects. Its immediate implication is that any difference we find between the means of the two groups should not be significantly different from zero. That is, for two groups, the difference between the means of the two groups, $\bar{A}-\bar{B}$, should equal to the difference between the means of the two source populations, $\mu_{\bar{A}-\bar{B}}$. Hence, the null hypothesis is $(\bar{A}-\bar{B})-\mu_{\bar{A}-\bar{B}}=0$. Then, the *t* statistic is given by:

$$(6)\qquad t = \frac{(\bar{A}-\bar{B}) - \mu_{\bar{A}-\bar{B}}}{s_{\bar{A}-\bar{B}}},$$

where

$$(7)\qquad s_{\bar{A}-\bar{B}} = \sqrt{s^2\left(\frac{1}{n_1}+\frac{1}{n_2}\right)},\ s=\sqrt{\frac{\sum(A-\bar{A})^2+\sum(B-\bar{B})^2}{n_1+n_2-2}}.$$

In equation (7), $s_{\bar{A}-\bar{B}}$ denotes the pooled estimate of standard deviation of the two groups and s^2 is the variance of the source population. While the *t*-test compares the means of two groups, the *F*-test compares the variances of the groups. Letting SST and SSE represent the treatment sum of squares and residual sum of squares respectively, the *F* statistic is:

$$(8)\qquad F = \frac{SST}{SSE/(n_1+n_2-2)},$$

where

$$(9) \qquad SST = n_1\left(\overline{A} - \frac{\sum(A_i + B_i)}{n_1 + n_2}\right)^2 + n_2\left(\overline{B} - \frac{\sum(A_i + B_i)}{n_1 + n_2}\right)^2,$$

$$(10) \qquad SSE = \sum_{i=1}^{n_1}(A_i - \overline{A})^2 + \sum_{i=1}^{n_2}(B_i - \overline{B}_i)^2 .$$

4.2.3. Data and Total factor productivity

Firm level data on Korean manufacturing are obtained from the Korea Information Service (KIS) as in the previous two essays. Dataset for the analysis contains output, labor, capital, and total factor productivity (TFP). The output of the firm is denoted by its total sales in domestic and foreign markets, both of which are deflated using a manufacturing price index. Inputs into production are denoted by labor (employment) and capital: capital is also deflated by a price index. Data for output, labor and capital are compiled for eight industries between 1992 and 2003. For estimation by industry, data are compiled for five industries because there is not enough data on exporting firms for estimation in the remaining three industries.

As in the first essay, total factor productivity (TFP) is calculated using the Data Envelopment Analysis (DEA) approach. DEA is a non-stochastic, linear programming-based technique for evaluating the relative efficiency. For most of the analysis TFP will be calculated as a change over a period of two years. The frontier changes from year to year, and in a given year, a firm's TFP is measured relative to the frontier. Larger values indicate inefficiency, while a zero value indicates that the corresponding firm is efficient given the frontier technology.

4.3. Results and Implications

This section describes the results from the estimation of a production function for exporters and non exporters in Korean manufacturing with emphasis on respective scale economies. It is followed by an examination of the difference in the scale economies between exporters and non-exporters using the matching methods.

4.3.1. Regression Results and Returns to Scale

Table 4.1 reports the estimates of the production function, equation (4) for exporters and non-exporters. The estimated coefficients on two traditional inputs, labor and capital, have the expected positive sign and statistical significance at the 1% level for both exporters and non-exporters. In the case of non-exporters, the sum of the coefficients on labor and capital (0.981) appears to be closer to one. This implies that the production function of non-exporters exhibits constant returns to scale, i.e., scale economies are absent. In other words, output increases by the same proportional change in all inputs. In contrast, the sum of the coefficients on labor and capital for exporters seems different from one (0.938). The latter suggests that Korean exporters face decreasing returns to scale or diseconomies of scale. This result appears consistent with claims of Korean exporters selling their products in the foreign markets at below cost or a price lower than that in domestic markets.[10] The coefficients on Log(TFP) have the expected negative sign and statistically significant at the 1% level for both exporters and non-exporters, which means that efficient firms produce more. Recall that the larger the value of the TFP index, the greater is the inefficiency of firms in our application of DEA. The coefficient on the time trend, *t*, which captures the technological change over time, is positive and

[10] One good example is that Korean steel and DRAMs manufacturers had been indicted for dumping in the 1990s. Up to 2006, Korea shows 218 indictments by other countries for dumping. In addition, Korean products' price competition with Chinese products has become keener in foreign markets, which hinders Korean firms from increasing their export prices.

statistically strongly significant for both exporters and non-exporters. However, non-exporters show a higher rate of change in technology than exporters (0.026 > 0.019).

Regression results for disaggregated Korean manufacturing industries are presented in Table 4.3. The estimated coefficients on labor and capital are positive, as expected ,and statistically significant at the 1% level in every industry. However, the sum of the coefficients on labor and capital varies by industry. The food processing and tobacco industry shows decreasing returns to scale or diseconomies of scale for both exporters and non-exporters, but the formers' returns to scale is larger than that of the latter (0.924 > 0.899). In contrast, the results of the other four industries show a larger returns-to-scale estimate for non-exporters relative to exporters. According to trade information provided by Korea Agro-Fishery Trade Corporation, Korean processed food products are believed to be less exposed to price competition in the foreign market unlike other industrial products because they are demanded by foreign consumers who have tastes for them.[11] Thus, Korean food processing firms have focused more on the product quality and taste than the export price.

In the case of chemical manufacturing, (industry 2 in table 4.3) non-exporters exhibit increasing returns to scale (1.055), while exporters appear to face decreasing returns to scale (0.938). The machinery and equipment industry, which is labeled as industry 3 in table 4.3, reports decreasing returns to scale for both exporters and non-exporters (0.902 and 0.944). The electronics, TV and communication equipment industry, which corresponds to industry 4 in table 4.3, also shows almost constant returns to scale for non-exporters (1.012), but exporters exhibit decreasing returns to scale (0.937). In the

[11] Unlike other manufactured products, processed food products have not been faced dumping charges from other WTO members.

case of the motor vehicles and trailers industry, increasing returns to scale are observed for exporters and non-exporters (1.024 and 1.039): but the difference in the returns to scale between two groups is relatively lower than in any other industry.

With respect to productivity, the coefficients on Log(TFP) have the expected negative sign for both exporters and non-exporters in all five industries. These coefficients also show statistical significance at the 1% level. Similarly, the coefficients on time trend show a positive sign with statistical significance for both exporters and non-exporters in all industries. The food processing and tobacco industry shows the same coefficient estimate on the time trend for exporters and non-exporters (0.02), but other four industries present a larger difference between the two groups. The chemicals industry reports the lowest rate of change in technology, while the motor vehicles and trailers industry reports the biggest coefficients among five industries.

To summarize, exporters do not appear to exhibit economies of scale, except those in the motor vehicles and trailers industry. In addition, exporters' returns to scale are lower than that of non-exporters in all industries other than the food processing and tobacco industry. While these results suggest that scale economies may be less important for gains from trade in Korean manufacturing, the evidence is not entirely contradictory. As noted in the previous essays, there has been a serious shock to the Korean economy from the Asian financial crisis of 1997. Since then, many new exporters have been found to be smaller in size relative to nonexporters. Moreover, size had a relatively lower effect on the export probability of a firm relative to sunk costs or other forms of heterogeneity (productivity).

4.3.2. Matching Results

As mentioned earlier, the matching technique involves *t*-test (independent two-sample *t*-test) for the difference in means for targeted variables between two groups: other hypothesis tests, such as χ^2 and F, can also be used for evaluation. In this analysis, we conduct the *t*-test and F test simultaneously. The null hypothesis of this essay is that exporters and non-exporters have the same returns to scale in production. The null hypothesis has the implication that for exporters and non-exporters, the difference between the average economies of scale of the two groups, $\bar{X} - \bar{Y}$, should equal the population difference, $\mu_{\bar{X}-\bar{Y}}$. Hence, the null hypothesis can be expressed as

$\mu_{\bar{X}-\bar{Y}} = \mu_{\bar{X}} - \mu_{\bar{Y}}$.

The test results are reported in Table 4.5. The first column of the table presents the *t* and *F* test results for the whole industry. The *t* statistic is 4.88, and so rejects the null hypothesis that exporters and non-exporters have similar returns to scale. Note that the critical *t* values at the 5% and 1% level are 2.07 and 2.81 respectively. The *F* test also rejects the null hypothesis, calculated value of 23.89 exceeds the critical F values at the 5% and 1% level (4.30 and 7.88).

Examining the null hypothesis by industry, the results from the food processing and tobacco industry shows similarities in the returns to scale between exporters and non-exporters. Both *t* and *F* statistics are lower than respective critical value. As noted earlier, firms in the motor vehicles and trailers industry exhibited increasing returns to scale, but the matching tests do not reveal a significant difference in scale economies between exporters and non-exporters. In the other three industries – chemicals, machinery and equipment, and electronics, TV and communication equipment - both tests reject the hypothesis that exporters and non-exporters have the same returns to scale in production at the 1% level.

4.4. Summary and Conclusions

This essay examines returns to scale in Korean manufacturing industries. In particular, it addresses whether or not exporters and non-exporters within an industry have different returns to scale in production. For this purpose, a Cobb-Douglas production function is estimated using the log-linear functional form. In addition to traditional inputs, the production function included productivity estimated from a nonparametric and nonstochastic approach, a time trend and industry-specific dummies. Regression results show a positive and statistically significant relationship between traditional inputs and output for both exporters and non-exporters. It appears that exporters face diseconomies of scale, but in motor vehicles and trailers industry they exhibit increasing returns to scale. In addition, exporters' returns to scale are in general lower than that of non-exporters except in two industries: food processing and tobacco; motor vehicles and trailers. Less returns to scale of exporters are mainly because Korean firms have exported their products to the foreign markets at below cost price or very low price. The exception may arise if Korean processed food products are less exposed to price competition in the foreign market in that they are demanded by foreign consumers with tastes for them.

To compare the difference in the returns to scale between exporters and non-exporters, this essay employs a matching technique. The primary goal of matching is estimating the average causal effect of a binary treatment variable. The standard practice of matching is to conduct statistical tests for the difference in means for targeted variables between two groups. The test results show that exporters and non-exporters exhibit different returns to scale in three industries: chemicals; machinery and equipment; and electronics, TV and communication equipment. The other two industries - food processing and tobacco, motor vehicles and trailers- do not show statistically significant difference in returns to scale between exporters and non-exporters.

The result that scale economies may be less important for gains from trade in Korean manufacturing should be considered in a broader context. The Korean economy has witnessed a a serious shock from the Asian financial crisis of 1997. Since then, many new exporters have been found to be smaller in size relative to nonexporters. In the first essay, size had a relatively lower effect on the export probability of a firm relative to sunk costs or other forms of heterogeneity (productivity). The evidence that size and hence, scale economies may be less important for trade participation and gains from overseas market, bodes well for small or medium exporters.

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Table 4.1. Regression Results and Economies of Scale in Korean Manufacturing

	Exporters	Non-Exporters
Intercept	3.719***	3.634***
	(0.000)	(0.000)
Log(TFP)	-0.365***	-0.49***
	(0.000)	(0.000)
Log(Labor)	0.7001***	0.782***
	(0.000)	(0.000)
Log(Capital)	0.238***	0.199***
	(0.000)	(0.000)
Trend	0.019***	0.026***
	(0.000)	(0.000)
Industry fixed effects	Yes	Yes
Observations	36248	5605
R-square	0.889	0.852
Economies of Scale	0.938	0.981

p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

Table 4.2. Economies of Scale in Korean Manufacturing by Year

	Exporters	Non-Exporters
1992	0.94	0.96
1993	0.93	1.01
1994	0.92	1.00
1995	0.89	0.98
1996	0.89	0.94
1997	0.88	0.95
1998	0.87	0.98
1999	0.89	0.93
2000	0.90	0.94
2001	0.88	0.95
2002	0.91	0.95
2003	0.98	1.01

Table 4.3. Regression Results and Economies of Scale by Industry

	Industry 1		Industry 2		Industry 3		Industry 4		Industry 5	
	Exporters	Non-Exporters	Exporters	Non-Exporters	Exporters	Non-Exporters	Exporters	Non-Exporters	Exporters	Non-Exporters
Intercept	3.134***	3.077***	3.689***	3.550***	4.349***	4.029***	3.784***	3.861***	3.344***	3.038***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(TFP)	-0.324***	-0.480***	-0.364***	-0.400***	-0.486***	-0.665***	-0.376***	-0.559***	-0.268***	-0.389***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(Labor)	0.521***	0.484***	0.614***	0.775***	0.756***	0.786***	0.679***	0.844***	0.734***	0.727***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log(Capital)	0.403***	0.415***	0.324***	0.280***	0.146***	0.158***	0.258***	0.168***	0.290***	0.312***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Trend	0.020***	0.020***	0.008***	0.013***	0.014***	0.026***	0.018***	0.029***	0.033***	0.044***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	324	2997	1065	4594	1680	14994	1148	5110	914	4201
R^2	0.890	0.824	0.899	0.867	0.853	0.795	0.837	0.818	0.907	0.883
Economies of Scale	0.924	0.899	0.938	1.055	0.902	0.944	0.937	1.012	1.024	1.039

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Electronic components, Radio, TV and Communication Equipment
Industry 5 : Manufacture of Motor vehicles, Trailers and Semitrailers
p-value is in parenthesis.
*, **, *** denote significance at the 10%, 5%, and 1% level, respectively.

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Table 4.4. Economies of Scale by Industry by Year

	Industry 1		Industry 2		Industry 3		Industry 4		Industry 5	
	Exporters	Non-Exporters	Exporters	Non-Exporters	Exporters	Non-Exporters	Exporters	Non-Exporters	Exporters	Non-Exporters
1992	0.92	0.86	0.97	0.98	0.73	0.83	0.97	1.05	0.87	0.98
1993	0.93	0.87	0.96	1.05	0.82	0.98	0.97	1.03	0.92	1.11
1994	0.92	0.91	0.93	1.01	0.83	1.08	0.84	0.95	1.03	1.13
1995	0.93	0.90	0.85	1.00	0.91	1.06	0.82	0.92	1.03	0.97
1996	0.87	0.91	0.75	0.90	0.80	0.96	0.92	0.97	1.02	1.02
1997	0.89	0.78	0.80	1.04	0.90	0.91	0.93	0.98	1.02	1.03
1998	0.90	0.80	0.88	1.08	0.87	0.92	0.84	1.05	0.98	0.91
1999	0.83	0.96	0.91	1.03	0.81	0.89	0.93	1.03	1.02	0.94
2000	0.86	0.95	0.91	1.00	0.87	0.87	0.90	0.96	0.98	1.02
2001	0.83	0.91	0.96	1.08	0.85	0.90	0.85	0.98	1.01	1.04
2002	0.89	0.85	1.00	1.05	0.82	0.89	1.00	1.01	0.95	1.00
2003	0.96	1.09	0.99	1.10	0.86	0.95	1.10	1.03	0.97	1.05

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Electronic components, Radio, TV and Communication Equipment
Industry 5 : Manufacture of Motor vehicles, Trailers and Semitrailers

Table 4.5. The Matching Test Results

	Whole Industry	Industry 1	Industry 2	Industry 3	Industry 4	Industry 5
t statistic	4.88	0.21	4.36	3.78	2.80	1.43
F statistic	23.89	0.04	19.05	14.32	7.88	2.05

Industry 1 : Manufacture of Food products, beverage and Tobacco
Industry 2 : Manufacture of Chemicals and Chemical products
Industry 3 : Manufacture of Machinery and Equipment
Industry 4 : Manufacture of Electronic components, Radio, TV and Communication Equipment
Industry 5 : Manufacture of Motor vehicles, Trailers and Semitrailers

CHAPTER FIVE

CONCLUSION

This dissertation's three essays have analyzed trade and productivity effects on firm behavior based on new trade models in the context of the Korean manufacturing firms. In chapter two (essay 1), the export behavior of Korean manufacturing firms is examined by testing the self-selection and learning-by-exporting hypotheses. Estimation results suggest that sunk costs are key determinants of the export decision in all industries, which is consistent with the findings for the United States and few other developing countries. Previous export experience significantly and positively affects the current period decision to export. Evidence of self-selection is found in only three industries (machinery and equipment, computers and office machinery, and electronic components manufacturing), where Korea appears to have a comparative advantage. In some other industries serving mostly domestic markets, high productivity does not encourage export participation. The latter situation may arise if technology used by firms in these industries comes with limitations on market access. Sunk-cost or previous –experience effects on the predicted export probability are relatively larger than that of firms' productivity and size. Evidence of learning-by-exporting is found only in the machinery and equipment industry, a situation similar to many studies seeking insights on this hypothesis. This essay suggests that Korean government's export promotion strategies such as providing information on foreign markets and lowering cost of accessing overseas markets may have been effective in their manufacturing firms' export participation.

Chapter three (essay 2) investigates the implications of heterogeneous-firm models of trade in the case of Korea by testing seven hypotheses. Results for the productivity-related hypotheses do not show clear evidence that falling trade costs improve firm or overall industry productivity. However, results for the hypotheses on firm entry and exit, the number of exporting firms, and changes in market share provide strong support to new trade theories. The results for one hypothesis are clearly inconsistent with the theory: the prediction that falling trade costs will increase export sales at existing exporters. Large firms appear less likely than small firms to exit the market in response to changes in trade costs. Moreover, newly entering firms tend to be smaller in size than incumbents. However, Korean manufacturing appears to differ from model predictions, especially in the result that large firms are less likely to be a new exporter. Rather, smaller and less capital-intensive firms tended to enter the export market. In turn, the firms that were able to increase their market share tended to be smaller than average. In general, the results of this essay show that changing trade costs had important consequences for the structure of manufacturing activity in Korea.

Chapter four (essay 3) analyzes the difference in returns to scale between exporters and nonexporters in five Korean manufacturing industries. Results from estimating a production function show that exporters face diseconomies of scale in four of five industries, an exception being the motor vehicles and trailers industry. For comparing the difference in economies of scale between exporters and non-exporters, a matching technique is employed. Results show that exporters and non-exporters have different returns to scale in three of five industries. In the other two industries, the returns to scale does not vary between exporters and non-exporters. The result that scale economies may be less important for gains from trade in Korean manufacturing should be considered in a broader context. The Korean economy has witnessed a serious shock from the Asian financial crisis of 1997. Since then, many new exporters have been found to be smaller in size relative to nonexporters. In the first essay, size had a relatively lower effect on the export probability of a firm relative to sunk costs or other forms of heterogeneity (productivity). The evidence that size and hence, scale economies may be less important for trade participation and gains from overseas market, bodes well for small or medium exporters.

In summary, this dissertation has improved the understanding of the relationships among trade, productivity and firm behavior. The key determinant of firms' export behavior in the Korean context appears to be previous experience in overseas market. Not surprisingly, the Korean government has invested heavily in lowering their firms' cost of accessing foreign markets. In industries where Korea has a comparative advantage, high productivity of firms appears to promote trade participation. However, productivity growth in other industries is low and falling, in some cases. A balanced approach to investments in productivity and export promotion would sustain and improve Korean manufacturing's competitiveness in global markets.