1 Introduction

Finding the source of technological growth has long been a challenge for economists because technological progress is undoubtedly a critical factor in long-run growth. Solow (1956) introduced a neoclassical growth model of technological growth in which an economy without technological progress cannot sustain growth in excess of the rate of population growth. Solow used total factor productivity (TFP)[1] as a measure of technology in his model. Since then, it has been popular to use TFP growth as a measure of technological growth. Furthermore, to overcome the exogenous property of technological growth in Solow growth model, recent endogenous growth theories has argued that openness to trade, FDI, human capital accumulation, and R&D efforts could have a significant impact on increasing TFP growth [Romer (1986), Lucas (1988), and Grossman and Helpman (1991)]. In particular, openness to trade and FDI inflow induce an increased TFP growth, as they tend to enhance competitiveness, to enlarge production scales, to bring in new technology, and to lower costs. Success in economic growth in turn promotes further export expansion and import liberalization as well as FDI inflow. This kind of economic interaction has been called the "virtuous cycle of trade and growth."

Considerable research has been devoted to examining the relationship between openness to trade, FDI and TFP growth. Feder (1983) proposes a theoretical two-sector model in which the export sector not only is more productive than the non-export sector but also generates external effects that enhance the productivity of the non-export sector. As exports expand, both the resources reallocation effect and externality effect lead to an overall productivity increase. The World Bank (1993) endorses this view by arguing that the active promotion of manufactured exports is a significant source of rapid growth in what it called the High Performance Asian Economies. Kavoussi (1984), using a sample of 73 countries in the 1960-1978 period, finds that in groups of both low- and middle-income countries, export expansion is associated with better economic performance and that a crucial cause of this association is the favorable impact of exports on TFP. Nishimizu and Robinson (1984) also observe the existence of an important link between trade regimes and industrial productivity growth at the two-digit industry-level data of four countries: Japan, Korea, Turkey, and Yugoslavia. Dollar and Sokoloff (1990) study South Korean manufacturing industries and find a positive relationship between growth rates of TFP and exports, but it was not clear what was cause and what was effect.

Using seven measures of openness, Harrison (1996) applies the Extreme Bound Analysis (EBA) approach to panel data of a large number of developing countries. His findings shows a positive association between GDP growth and openness. Using EBA, Hwang (2002) investigates the sources of technological progress of Korean aggregate manufacturing as measured by TFP growth. His results are that only trade sectors have a robust relationship with technological progress. Edwards (1998) uses panel data of 93 countries for 1960-90 and reaches robust positive results of openness on TFP growth by using different openness indicators, estimation techniques, time periods, and functional forms. Hejazi and Safarian (1999) measure the relative influence of the trade and FDI channels as mechanisms for the diffusion of technology from the six leading industrial nations to the remaining Organization for Economic Cooperation and Development nations. The main result is that the coefficient estimates for FDI are higher than those for trade in a standard model; the importance of trade is much reduced once FDI is considered. In a study of the Asia-Pacific Economic Cooperation countries from 1980 to 1987, Wu (2000) decomposes TFP growth into technological progress, technical efficiency, and scale efficiency. By using national data, he finds that openness to trade has a positive impact on both technological progress and technical efficiency. Miller and Upadhyay (2000) also employed pooled time-series and cross-section data with EBA method to examine the links between trade orientation and TFP growth. They find that higher openness benefits TFP growth and that outward-oriented countries experience higher TFP over and above the positive effect of openness. In addition to the studies using aggregate economy-wide or industrial data, recent research has begun to use firm/plant level data. Most these studies have found a significant link between trade openness and production efficiency. Such works include Au, Chung, and Roberts (1998) regarding the export decision of Taiwan and South Korea firms, Bernard and Jensen (1999) examining U.S. manufacturing plants, and Hay (2001) investigating the Brazilian firms.

In contrast to these positive results, other researchers have found a negative or inconclusive relationship between openness to trade, FDI, and TFP growth. Authors such as Krugman (1994) and Rodrik (1995) are skeptical of the trade liberalization--TFP growth nexus. Rodriguez and Rodrik (1999) suggest that the empirical studies do not provide convincing evidences and further argue that the effect of openness on growth is, at best, very tenuous, and at worst, doubtful. Chen and Tang (1990), using the TFP of Taiwanese manufacturing industries, indicated that although scale economies are a reliable factor in explaining the productivity growth for majority of industries, export expansion has an ambiguous effect on productivity. Similar conclusions are shown in a study by Wang (1995) which examines Taiwanese manufacturing industries. In a study performed by the Institute of Developing Economies (IDE) in Japan, Urata (1994) finds that the impact of trade liberalization on TFP growth turns out to be positive for five Asian countries -- Korea, Thailand, Malaysia, Indonesia, and the Philippines--but their relationship is not always stable or statistically significant. By contrast, trade liberalization is shown to have a negative influence on TFP growth for Taiwan. Okuda (1994) examines the relationship between TFP and trade and FDI policies of Taiwanese manufacturing. Regressions with pooled time-series and cross-industry data were carried out. Major findings include: (1) it is hard to identify a uniform statistical relationship between export ratios and TFP; (2) an increase in the export ratio tends to improve sector productivity only if a sector becomes very capital-intensive or import competitive; and (3) progress in horizontal international specialization could improve sectoral TFP. Kim (2000) performs a test on 36 Korean manufacturing industries and finds that while scale efficiency is prominent, the positive impact of trade liberalization on productivity is insignificant. Oczkowski and Sharma (2001) also find an inconclusive relationship between trade reform and TFP change on in seven Australian manufacturing industries. Using the EBA method, Hwang and Wang (2004) use data from 35 Japanese industries to investigate the impact of trade on TFP growth. They do not find robust relations between TFP growth and several trade variables.

In the voluminous empirical literature focusing on the connection between trade and growth, most studies that use cross-country data with average or initial values of time-series tend to find a significant positive relation between trade expansion and TFP growth.

However, there are at least two shortcomings of applying such data. First, the use of cross-section data makes it impossible to control for unobserved country-specific differences, possibly biasing the results. Second, long run average or initial values for trade policy variables ignore important changes which have occurred in the country. In this paper, we use time-series data of manufacturing industries from two countries, Taiwan and Korea. Taiwan and Korea are highly prominent economies in East Asia. They have many common economic characteristics. Taiwan and Korea have been very dynamic and highly regarded as two of the 'Little Tigers' in Asia, together with two tiny city economies--Singapore and Hong Kong. Their rapid and successful economic growth has been credited to their outward looking economic policies.

The main objective of this study is to empirically test the effects of trade expansion, FDI, and R&D on TFP growth by examining individual manufacturing industries of Taiwan and Korea, which are two of the World Bank's High Performance Asian Economies that have adopted trade-oriented development policies and enjoyed fast growth in the past few decades. More precisely, we follow a two-stage method by first estimating the TFP growth of each industries and then performing a sensitivity test. We apply a variant of Leamer's regression technique of using Extreme-Bounds-Analysis (EBA) to examine the impacts of changes in export, import penetration, total trade volume, as well as FDI on TFP growth for the cases of Taiwan and Korea. The rest of this paper is constructed as follows. In Chapter 2, a brief review of the TFP growth of Taiwan and Korea is presented. Chapter 3 introduces the econometric methodology of EBA and the empirical model of TFP growth used in this study. Chapter 4 reports the main empirical results of TFP growth of Taiwanese and Korean manufacturing sectors. The last Chapter is for concluding remarks.

2 The Growth and Trade of Taiwan and Korea

The last four to five decades have generally been a period of strong economic growth for Asian countries. Taiwan and Korea, two of the major economies, have enjoyed not only fast growth of industrialization and of trade but also a relatively stable macro-environment. They have many aspects in common that are full of interest for study. Generally, they are poor in natural resources and thus have to rely on foreign trade to sustain economic growth. Taiwan and Korea are two of the so-called East Asian 'Little Tigers', which demonstrate successful development experiences, from take-off to maturity. These two countries are viewed as at the first and second tiers of the 'flying geese'[2] pattern. They have some dynamic similarities. First, the per capita GDP in Taiwan between 1980 and 2000, which grew from about US$2500 to about US$12,500, was comparable to that of Japan between 1960 and 1985. That of Korea between 1980 and 2000, which grew from about US$1,600 to about US$10,000, was comparable to that in Japan between 1950 and 1980. Second, a vast mobilization of capital and labor resources as well as a significant strength in foreign trade played a major role in the massive economic expansions of these two countries in the respective periods. Third, the periods under study were dominated by a powerful upward thrust in the level of economic activity in three countries. It is hoped that this study will add to the already substantial body of literature regarding the linkage of trade and TFP growth. The empirical results will have policy implications.

2.1 Growth and Trade of Taiwan

Taiwan is a small island with high density of population but few natural resources. It relies heavily on imports of raw materials and intermediate inputs and exports of manufacturing products to sustain its growth. Its economy has undergone a successful transition in the post-war period, from agriculture to industry and from a backward to a modern economy. Industrialization and export expansion have brought higher per capita income, stable prices, full employment, equality of distribution, and better quality of life. Today it is renowned for its international trade strength as well as its huge foreign exchange reserves. Table 1.1 lists the major development indicators, such as aggregate GDP, per capita GNP, economic growth rate, gross investment, and the unemployment rate, as well as trade values, and their shares in GNP for selected years. It can be seen that both production and trade are growing fast.

In the late 1950s, Taiwan started to abandon the import-substitution policy that had been implemented by means of tariff protection and import control. Many reforms were announced in 1960 to promote the establishment of export-oriented industries. During the mid-1960s, the export expansion policy was further promoted by setting up bonded factories and export processing zones. Two major reasons explain why Taiwan had to convert to a more aggressive export-promotion policy in the 1960s. First, U.S. financial aid was slated to terminate in 1965 and Taiwan had to earn its own foreign exchange for importing necessary investment goods. Second, import-substitution was reaching a dead end in the island because the domestic market was too small to sustain development. The mid-1960s marked the period of economic 'take-off' in Taiwan.

After 1970, internal and external pressure called for policy adjustments again. On the one hand, the international situation changed tremendously and Taiwan had to adapt accordingly. The first worldwide energy crisis in 1973 and the subsequent recession caused Taiwan to suffer severely. Trade friction with a number of advanced industrial countries and competition from other LDCs increased. On the other hand, the domestic environment changed as well. Growing exports and the subsequent increase of industrial production generated an expanding demand for infrastructure such as highways, seaports, and utilities. in order to keep up with international competition, Taiwan had to improve infrastructure, promote management skills, and pursue scientific research. At the same time, it was recognized that imported parts and components were important in manufacturing. A secondary 'import-substitution program' was initiated, in which domestic parts and components substituted for imports.

The successful formation by 1980 of high-tech sectors such as semi-conductors and the personal computer industries marked the beginning of 'the science and technology-oriented development'era. Since that time, industries have been strongly encouraged to upgrade their productivity by pursuing R&D and by automating production. Today, high-tech industries have become major sectors in national production and exports. During the 1980s, Taiwan faced an even more severe foreign trade environment as symbolized by its 1988 exclusion from the U.S. General System of Preferences. To alleviate foreign pressure, Taiwan had to modify various export promotion schemes and to liberalize imports. Although export-promotion continued, the extent of government support was gradually reduced. As for import liberalization, tariff reduction and the abolishment of non-tariff barriers proceeded rapidly in 1980s. Along with its efforts to join GATT (the General Agreement on Tariffs and Trade), the predecessor of the World Trade Organization, Taiwan adopted almost all the necessary policies to open its door to its trading partners in 1990s and the beginning of twenty-first century. In addition, Taiwan maintained a quite open attitude towards FDI. By 2000, prohibited types of foreign investment had been reduced tremendously to include only pollution-causing industries.

Taiwanese trade policies in the past three decades can be summarized as follows. (1) The export-promotion policy continued throughout the 1970s and 1980s, but was gradually phased out in the 1990s. (2) Efforts to expand imports proceeded in the late 1970s and accelerated after the mid-1980s. (3) Openness towards inflows of FDI remained a constant for decades. (4) Technology-intensive industries were promoted and became major components of trade in recent years.

To show the history of Taiwanese trade evolution, Table 1.2 gives the ratio of total trade to production in manufacturing industries and their ranking in the 1981-2002 period. Industry #18 (Machinery excluding. Electrical Equipment) has the largest ratio of 402%, followed by the #21 (Precision Equipment) of 256%. Machinery ranked at the top because of huge imports.

2.2 Growth and Trade of Korea

Korea is a medium size country in terms of population located in the northeast Asia.[3] Due to its fast economic growth and strength in industrialization and international trade, it has been treated as one of the 'Little Tigers' in Asia since the late 1980s. Korea in the

1950s, with a per capita GNP of less than US$80 in nominal terms and more than two thirds of its population engaged in the primary sector, possessed all the familiar characteristics of an underdeveloped economy. With the energetic execution of an export-oriented growth strategy beginning in the early 1960s, the Korean economy expanded at an average annual rate of nearly 9 percent during 1960-1995. Nominal per capita GDP grew from about US$90 in 1960 to $9818 in 2000. At the same time, the proportion of GDP originating in the manufacturing sector increased from 13.8% in 1960 to 31.3% in 2000. Most importantly, commodity exports rose from US$33 million in 1960 to $172.3 billion in 2000. During this period of rapid industrialization, there were several commonly cited serious problems in Korean economy. First, discretionary credit allotment during the government's promotion of heavy and chemical industries during the 1970s distorted resource allocation. Second, an undesirable side effect of this policy was the concentration of economic power in large business or 'chaebols'[4], as opposed to small and medium sized companies as in Taiwan. Third, as a result of the large role of foreign savings in financing investment, Korea gradually become a major indebted developing nation and its economy become vulnerable to external shocks. During the 1997-98 Asian financial crisis, Korea was one of the countries that suffered the most.

Beginning in 1960, Korean industrial policy and trade policy can be divided into several periods. The first period is characterized as export-led growth of light-industries during 1961-1971. In 1961, the new government of the Third Republic put top priority on a growth first strategy by using export oriented policy. The essence of this strategy was the promotion of labor-intensive manufacturing exports in which Korea had a comparative advantage. To encourage the inflow of foreign capital to make up for insufficient domestic savings, the government enacted a comprehensive Foreign Capital Promotion Act in 1966. The comprehensive changes in Korean growth strategy and institutional structure transformed Korea into one of the fastest growing economies in the world, after years of stagnation and rebuilding during the 1950s. Average annual growth of real GNP for the period of 1961-72 was about 8.2%. The manufacturing sector increased its share of GDP from 13.6% in 1961 to 22.2 % in 1972. The most important point was that Korean rapid growth and structural change was largely the result of the surge in foreign trade. The ratio of total exports to GNP rose from 2.0% in 1961 to 15.9% in 1972. Most of the exports were labor-intensive manufacturing products.

The second period was characterized by strong promotion of heavy and chemical industries (HCI) during 1973-1980. The development strategy in this period again included government intervention. First of all, this period could be represented by government's strong drive to develop HCI, development of new strategic industries and promotion of intermediate materials and capital goods. The motivation of these policies was concern over losing Korean comparative advantage in light manufacturing industries to other LDCs. In 1973, the government announced a plan to develop (HCI) such as shipbuilding, automobiles, steel products, nonferrous metals, and petrochemicals. At the same time, expansionary monetary and fiscal policies supported this drive. Most of the short fall in domestic saving was filled by heavy foreign borrowing. Even in the years of world recession in 1979-1980, Korean GDP and exports continued to grow but at a much slower rate than in the 1960s. The average annual growth of per capita GDP and the ratio of exports to GDP became 2.3% and 25.1% during 1974-80, respectively. At the same time, intermediate and capital good imports increased more rapidly than exports as a consequence of the drive to develop HCI. The ratio of imports to GDP reached 30.7% and the ratio of intermediate and fuels imports to total imports was 62.2% between 1974 and 1980. The growing volume of imports hence aggravated the current account deficit during this period. As a consequence, expansionary policies for HCI caused undesirable side-effects to the Korean economy. Excess capacity appeared in the HCI, the government deficit and foreign debt increased, and the rapid growth of a few but large conglomerates (*chaebols*) was fostered. In addition, an overheated labor market caused real wages increases in manufacturing and export activities. In late 1978-79, the Korean government undertook partial measures to tackle the undesirable side effects from the policies to expand HCI. It announced the Comprehensive Measures for Economic Stabilization program, which marked a striking change in both the philosophy and mode of national economic management: a redirection of government policy from rapid growth and public intervention in the economy toward more concern with stabilization and reliance on market forces.

The third period featured stabilization and liberalization policies during 1981-1986. In the early 1980s, the Korean economy was characterized by slow growth, rapidly expanding foreign debt, and high inflation. The Comprehensive Measures for Economic Stabilization program in late 1978 established the basis for the reform efforts of the new Fifth Republic government. In 1981, the reformers launched a development strategy directed toward achieving three related goals: price stability, market liberalization, and balanced economic growth. During 1981-86, the Korean economy resumed rapid economic growth amid better macroeconomic conditions created by these reforms and policy directions. Per capita GDP grew at an average annual of 3.04% in this period, which was greater than 2.30% during 1974-80. The most significant achievement was the success in curbing inflation. In addition, Korean economy for the first time achieved a trade surplus in 1986, a favorable balance of US$4.2 billion. It is true that after 1982 Korea faced an increasingly favorable external environment. World trade picked up once again, particularly in the US and commodity prices declined significantly after 1983. The important point is that Korea took full advantage of these opportunities. In addition, there was great increase in the growth of total factor productivity in manufacturing. Its rate of growth increased from 0.28% during 1974-80 to 1.91% during 1981-86. Manufacturing became more capital-intensive. This feature is reflected in the product composition of exports: in 1981-86 light industry and heavy industry accounted for 45.4% and 52.1% respectively of all exports.

The fourth period is the deregulation and external liberalization policies beginning in 1987. In the early 1980s, Korea took a gradual approach to opening its market and to external liberalization. Since 1983, the process has been more rapid, as the government has accelerated the liberalization of imports, foreign direct investment, current and capital accounts transactions, and the reduction of tariffs. The broad policy direction was to enhance the efficiency and strengthen the international competitiveness of Korean economy by reforming the free enterprise market system. These policies resulted in a new phase of high economic growth, stable prices, an increasing trade surplus, and decreasing foreign debt in a period beginning in 1987. The real economic growth rate (at 1995 prices) was 8.10% in the 1987-1993 period and was 7.23% in 1994-97. The Korean economy, like most other economies in Asia, did not escape damages from the 1997 Asian financial crisis. Its economic growth rate dropped to -6.69% in 1998 and then rapidly recovered back to an average of 7.31% in the period of 1999-2002.

The industry structure in Korean economy also changed in the period since 1987. The share of agriculture in GDP dropped rapidly from over 10% in 1987 to only 4.12% in 2002. The share of manufacturing was 31.88% in 1988 and 28.51% in 2002. The current account remained positive in 1986 to 1989 and turned negative during 1990-1992. It turned back to positive in 1993, followed by a four years of deficit in 1994-97. In 1998-2002, it showed a positive balance again. By and large, Korean economy has moved from strong government regulation in the 1960s to 1970s toward liberalization and free markets since 1981. Its industry and trade policy was led by government policies before 1980, and it then moved toward deregulation and external liberalization policies in the 1980s. It enjoyed rapid economic growth and stable prices as well full employment and trade surpluses in most of the post war period.

Table 1.3 lists the major development indicators of Korea, such as aggregate GDP, per capita GDP, the real economic growth rate, gross investment, and the unemployment rate, as well as trade values, and their shares in GDP for selected years beginning in 1980. With the background of Korean trade policy evolution, Table 1.4 enumerates the trade composition of its manufacturing industries during the period of 1992-2001. The ratio of each industry's export to total exports and that of imports to total imports are listed for the major manufacturing groups. It is seen that, as in the case of Japan, machinery is the industry group with largest shares of both exports and imports. Its share of total exports was around 50% and that of total imports was 35.3%. Among them, miscellaneous electrical machinery contributed the most in both exports and imports. In addition, mineral fuels formed the largest share of non-manufacturing imports--18.76% during the period of 1992 to 2001. Korea is a country short of supply of fossil fuels relative to its demand and has to rely heavily on imports.

3 Trade, TFP Growth, and TFP Measurement

3.1 Basic Arguments for Trade and TFP Growth

The hypothesis that openness to international trade accelerates economic growth has been widely discussed and tested. Many economists have argued that, with other things given, countries that have liberalized their foreign trade and have reduced their impediments to international competition will outperform those countries that have failed to do so. Feder (1983) proposed a theoretical two-sector model to support the hypothesis that the export sector not only is more productive than the non-export sector but also generates external effects that enhance the productivity of the non-export sector. As exports expand, both the resources reallocation effect and externality effect lead to an overall productivity increase, TFP growth. The World Bank (1993) pointed out that manufacturing exports have a positive effect on productivity through the introduction of new equipment, technology licensing, transfer of non-proprietary technology, acquisition of information from overseas customers, and enhancement of domestic R&D activities. It also pointed out that relaxation or abolishment of tariff and non-tariff barriers contributes to productivity through reducing cost of capital goods and raw materials. However, one must be careful not to overstate the argument. For example, export promotion policies such as excessive export subsidies may distort incentives and lead to inefficiency. It is important to focus on the causal mechanism assumed to be working. Export expansion and import substitution policies may increase or decrease TFP depending on their impact on competitive, cost-reducing incentives to producers in the long run.

Ample empirical research has proven a strong positive relationship between exports and GDP growth as suggestive evidence of the benefits of exports. Two major approaches are adopted in empirical literature. One is bivariate correlation method by Michaely (1977) and Heller and Porter (1978). The other uses regression in a production framework in which exports are introduced as an additional argument. It is employed in the work of, among others, Balassa (1985), Moschos (1989), Levine and Renelt (1992), Yaghmaian (1994), and Wu (2000). The meaning of total factor productivity (TFP) is the average product of all inputs used in production. Its growth implies a more efficient use of production factors, progress of technology, enlargement of scale, and improvement in management skill, among other causes. It can be seen as a way of measuring the contribution of the quality, rather than the quantity, of production factors. New growth theories argue that factors such as human capital accumulation, R&D efforts, liberalization on trade, and FDI could have a significant impact on increasing TFP.

On theoretical grounds, there are at least two forces cited to explain the connection between productivity growth and trade expansion. One is the supply-side and the other is the demand-side. Looking at the supply-side factors first, the scale economy and externality arguments emphasize the benefits that can be derived by means of expanding the scale of operations and improving production efficiency. The positive relationship between output growth and productivity change has been postulated in Verdoorn's law after P.J. Verdoorn, who suggested it in 1949. The argument is usually made in terms of the benefits of expansion in demand through promoting exports. Output expansion enables both static and dynamic economies of scale to come into play, thus resulting in higher TFP. In those economies whose domestic markets are small in size, exporting becomes an essential force of achieving scale economies. Further, import liberalization enables firms to use high-quality parts, components, and machines at lower cost resulting in greater productivity. In addition, liberalization of FDI contributes positively to the recipient countries, as multinational enterprises bring in not only technologies and management know-how, but also financial resources used for fixed investment. All of these resources, which are in short supply in recipient countries, contribute to improvement in productivity.

Turning to the demand-side factors, the competition argument emphasizes the merits of competition through international trade. With liberalization in trade and foreign capital, imports as well as foreign firms operating in the recipient country increase, leading to greater competitive pressure on domestic firms. This is an implicit 'challenge-response' mechanism induced by competition, forcing domestic firms to adopt new technologies, to reduce managerial slack, and generally to reduce costs wherever possible. According to this argument, import liberalization is as good as export promotion. A policy of enlarging imports increases competition and hence induces greater efficiency; even it may restrict the market for domestic goods. The converse might also be asserted. Protection policies designed for import substitution reduce competitiveness and lead to inefficiency in production. Specifically, opening to international trade leads to a higher TFP growth through the following channels among others: (1) offering greater economies of scale due to an enlargement of market size, (2) affording greater capacity utilization in industries in which the minimum efficient plant size is larger relative to that of the domestic market, (3) exposing domestic firms to world competition that provides the incentive to lower costs, (4) forcing domestic producers to improve quality and to reduce management inefficiencies, and (5) increasing the possibilities of technological progress as well as the rate of reinvestment.

The preceding discussion sets out a case where the 'virtuous cycle of trade and growth' is demonstrated. Trade liberalization and FDI inflow induce improvement in TFP, as they tend to enhance competitiveness, to enlarge production scales, to bring in new technology, and to lower costs. The increase in TFP in turn leads to greater production and thus greater exports, as it achieves increases in efficiency. With foreign exchange earned from increased exports, the economy can import high-quality components, parts, and machinery that result in higher productivity and output growth. Success in economic growth in turn promotes further export expansion and import liberalization as well as FDI inflow.

3.2 Definitions and Measurement of TFP

Real output growth of an economy, an industry, or a firm can be determined by two factors: one is the tangible increase in productive resources; the other contains many intangible elements that raise factor productivity. These factors include progress in technology, knowledge, product quality, as well as change in production scale, market structure, and externalities. As far as the measure of overall technical progress is concerned, total factor productivity (TFP) is one of the most commonly used indices. Grossly put, TFP is the average product of all inputs used. More precisely, it is the ratio of the output to an index of combined inputs. It measures the economic and technical efficiency with which resources are converted into products. The analytical framework for TFP measurement is embedded in the economic theory of production and cost. It includes duality theory, theory of index numbers, and the development of flexible functional forms such as the translog form. The change in TFP, which can be defined as a residual of output change obtained by ruling out the effect of input changes, is considered to be a pure measure of technology improvement, if economies of scale can be disregarded.[5] Technology improvement so defined has a wider meaning, which includes production methods, management knowledge, and labor expertise. But the effects of changes in such given conditions as production scale, extent of market competition, and trade environment are also reflected in individual industries.

Assume that there is an aggregate production function in an industry of which actual input utilization depends on time *(t)*:

$$Y(t) = f[X(t), t] \qquad (1)$$

where $Y(t)$ is the aggregate real output and $X(t)$ is an n-dimensional input vector. It is assumed that this function follows the usual properties of a well-behaved production function. Total differentiation of (1) with respect to t yields

$$\frac{dY}{dt} = \sum_j \frac{\partial f}{\partial X_j}\frac{dX_j}{dt} + \frac{\partial f}{\partial t} \qquad j = 1,\ldots, n \qquad (2)$$

Dividing through by *Y* and performing algebraic manipulation, it gives

$$\frac{d\ln Y}{dt} = \sum_j \varepsilon_j \frac{d\ln x_j}{dt} + T(x,t) \tag{3}$$

where denotes the output elasticity of input *j* and *T(x,t)* the technical change along time *t*. This expression has *n+1* observable terms ($d\ln Y / dt$ and $d\ln x_j / dt$) and *n+1* unobservable terms (*T(x,t)* and *n* output elasticity ε_j). Under the profit maximization assumption, output elasticity equals input share in total revenue. Hence, when profit are maximized, one has

$$\frac{d\ln Y}{dt} = \sum_j \frac{w_j x_j}{pY} \frac{d\ln x_j}{dt} + T(x,t) \tag{4}$$

or

$$T(x,t) = \frac{d\ln Y}{dt} - \sum_j s_j \frac{d\ln x_j}{dt} \tag{5}$$

where $s_j = \frac{w_j x_j}{pY}$ denotes the share of input *j* in total revenue with w_j being the price of input *j* and *p* being the price of output. Equation (5) states that one can measure *T(x,t)* by subtracting a weighted sum of change in input utilization rate from the rate of output change. *T(x,t)* can be calculated without estimation if all the data listed are given. However, this method only applies to the case of continuous data. In empirical work, a commonly used Tornqvist expression of TFP growth that is a discrete approximation to the equation (5) can be written as:

$$\ln\left(TFP_t / TFP_{t-1} \right) = \ln\left(Y_t / Y_{t-1} \right) - \sum_j \left[\frac{1}{2} \left(S_{j,t} + S_{j,t-1} \right) \ln\left(X_{j,t} / X_{j,t-1} \right) \right] \tag{6}$$

This formula shows that real output growth can be divided into two portions. One is due to input growth and another is due to TFP growth. In interpreting the meanings of TFP growth, at least two things have to be noted. First, this interpretation holds only in the case where long-run equilibrium is realized in production. In other words, the supposition is that production always takes place along the production efficiency frontier. However, in the short-run, it is not always in equilibrium due to the presence of adjustment costs. In such cases, short-run changes in capacity utilization exert an influence on the estimated value of TFP. Inefficient management also makes it difficult for a firm to carry on production along the frontier. Therefore, a rise in TFP might indicate a reduction in inefficiency, not only technical progress. Second, with changes over time, expansion in the scale of production can lead to an improvement in efficiency. Moreover, and connected with that, a rise in efficiency due to economies of scope, which benefit from diversification, also contributes to a rise in TFP. By and large, an increase in TFP should be interpreted broadly as an indication of improvement in production efficiency, reflecting not only achievement of technical progress, but also reduction in managerial inefficiency and exploitation of scale economies.

3.3 TFP Growth of Taiwan and Korea

In an official publication by DGBAS (2003) regarding TFP measurement of Taiwanese manufacturing, a widely used translog production model was built for estimating TFP and factor intensities. The translog form is characterized by varied elasticity of input substitution and is subject to less constraint than other models. According to the DGBAS report, for the period of 1981-2001, the rate of TFP growth of manufacturing in Taiwan was 2.25 per annum. The annual change rate of TFP for each of the 22 manufacturing industries was listed in column 1 of Table 2.1. It can be seen that within the sample period, only 6 sectors--mainly light industries-- showed a decline in TFP. It is also noted that most sectors revealed an enormous variation in TFP growth rate.

In case of Korea, manufacturing data set used in Park and Kwon (1995) is used to estimate TFP measurement. The data of Park and Kwon (1995) are using three factors inputs (capital stock, labor, and material goods) for 28 Korean manufacturing sectors over the period 1966-89.[6] Korean manufacturing, light industry is the sum of #1 (food, beverages and tobacco industry), #2 (Textile, wearing apparel and leather industry), #3 (wood and wood products), #4 (Paper and paper products, printing and publishing), and #9 (other industry). Heavy industry is the sum of #5 (Chemical, petroleum, coal, rubber, and plastic), #6 (Non-metallic, mineral products), #7 (Basic metal), #8(Fabricated metal products and machinery). Table 2.2 records the average annual change rates of TFP, production, and R&D expenditure of Korean manufacturing between 1967 and 1996. For all manufacturing, the average growth rates were 2.5%, 6.4%, and 5.6%, respectively. Interestingly, the TFP growth rates in light industry and heavy industry were nearly equal, as were R&D growth rates in these two groups. However, the average annual growth rate of heavy industry was slightly greater than that of light industry. Other statistics worth mentioning were the TFP change rates of Food, Beverage, and Tobacco (#29), which was only 0.13%, and of Chemicals, etc. (#33), which was a negative 0.24%. As far as the growth rates of R&D were concerned, most industries had an average greater than 4.0%, except Paper &

Products, etc. (32) which had only 0.165%. In general, Korean manufacturing showed a normal growth pattern in TFP, production, and R&D in most industries.

4 TFP Growth Model and EBA Test

4.1 Basic TFP Growth Model

TFP growth calculated in equation (5) is generally a factor decomposition of output growth. This analysis can link to the optimal behavior of producers. Under the assumptions of linear homogeneity of the production function and producer's profit maximization, the degree of growth in TFP depicts a degree of shift in production function. However, in general, linear homogeneity and the stability of the aggregate production function as well as perfect markets cannot be assumed. TFP as the residual necessarily includes a variety of elements other than technical change. Such elements enumerated in the existing studies include: (1) economies of scale, (2) quality improvements in labor and capital input (e.g. improvement of educational level and changes in the vintage of capital stock), (3) imperfect product and factor markets, and (4) X-inefficiency due to government regulations or other factors.

Although there does not exist a consensus theory to guide empirical work on TFP growth, in this paper we set up a simple TFP growth model by including scale economies and R&D efforts as explanatory variables. The argument for scale economies emphasizes the benefits that can be derived by means of expanding the scale of operations. In the case of countries whose domestic markets are small in size, TFP can be improved through exporting, which enlarges the scale of production. This argument was stressed by Chen and Tang (1990) and

Kwon (1986) in empirical studies on Taiwan and Korea, respectively. Effort devoted to R&D as measured by expenditure is considered a good proxy for domestic technical progress, which explicitly contributes to TFP growth. Kim (2003) found a significant impact of the ratio of R&D investment to output on the growth of TFP in Korean information technology industries. The basic model of our sensitivity test can be specified as below:

$$W = \beta_0 + \beta_1 GOP + \beta_2 GRD + u \tag{7}$$

where W is the growth rate of TFP, GOP is the growth rate of output, and GRD is the growth rate of R&D expenditure. In this study, we run regressions for manufacturing industry.

4.2 EBA Test Methodology

In a widely cited paper, Cooley and LeRoy (1981) argued that economic theory "... ordinarily does not generate a complete specification of which variables are to be held constant when statistical tests are performed on the relation between the dependent variable and the independent variables of primary interest." Existing empirical models regarding TFP growth, by the same token, do not completely specify the variables that should be held constant, while conducting statistical inference on the connection between TFP growth and the variables of primary interest. To provide evidence, like other researchers of the past who have employed small alternations on the explanatory variables, we use a variant of the Extreme-Bound-Analysis (EBA) of Levine and Renelt (1992), which was first proposed by Leamer (1983, 1985) and Leamer and Leonard (1983). Levine and Renelt (1992) used the

EBA method to investigate whether there exists a robust or fragile relationship between per capita income growth and a variety of macro-variables, even in the changes of conditional information set. The specification of EBA equation can be written as

$$W = \beta_i I + \beta_m M + \beta_z Z + u \qquad (8)$$

where **W** is the growth rate of TFP of each sub-industry, ***I*** is a set of variables always included in the regression, which were specified as GOP and GRD in equation (7), ***M*** is a vector of trade related variables, which are of primary interest, and ***Z*** is a subset of variables chosen from a pool of macroeconomic variables, which are considered as potentially important explanatory variables.

The core of EBA method involves varying the subset of ***Z***-variables included in the regression to find the widest range of coefficient estimates on the variables of interest, ***M***, that standard hypothesis tests do not reject. We first chose ***M***-variable that has been the focus of past empirical studies and ran a basic regression that includes only the ***I***-variables and the ***M***-variable. We then computed the regression results for all possible linear combinations of up to three ***Z***-variables and identified the highest and lowest values for the coefficient on the variable of interest, β_m , that cannot be rejected at the 10 percent significant level. Thus, the extreme bound is defined by the group of ***Z***-variables that produces the maximum (minimum) value of β_m, plus two standard errors. The degree of confidence that one can have in the partial correlation between the ***W*** and ***M*** variables can be inferred from the extreme bounds on the coefficient β_m. If β_m remains significant and of the same sign within the extreme bounds, then one can maintain a fair amount of confidence in that partial correlation. In such case, the result is referred as "robust." If the coefficient does not remain significant or if the coefficient changes sign, then one might feel less confident in the relationship between the ***M*** and ***W*** variables, because alternations in the conditioning information set change the statistical inferences that one draws regarding the ***M-W*** relationship. In this case, the result is seen as "fragile." [7]

The main interest of this paper is to test the robustness of effects of trade and FDI expansion on TFP growth of manufacturing industries for Taiwan and Korea. The ***M***-variables chosen for each industry were the growth rate of ratio of export to production (GEXP), the growth rate of import penetration ratio (GIPN), growth rate of total trade to production (GTRP), and growth rate of foreign direct investment (GFDI).[8] By these indicators, larger the ratio greater the trade expansion is implied. Six macroeconomic variables were considered as Z-variables in this report for the case of Taiwan. They are real economic growth rate (RECGR), wholesale price index change rate (WPICR), annual growth rate of money supply M1B (GRMS), change rate of balance of payment in current account (BOPCBCR), annual change rate of manufacturing employment (MFGEMCR), and change rate in the ratio of surplus-deficit to government net revenue (SUDFGNRC). These variables reflect the monetary side and the real side of an economy, domestic and external factors, as well as government and private sectors. In each of the EBA tests, three of the ***Z***-variables were used as was done in Levine and Renelt (1992) and Hwang (1998). For the case of Korea, the M-variables chosen were the same as in the case of Taiwan, except FDI. FDI was not included due to data unavailability for each sub-industry. The ***M***-variables are GEXP, GIPN, and GTRP.

Identical six macroeconomic variables were chosen as ***Z***-variables for both Japan and Korea. They were the consumer price index (DCP), which indicates the inflation rate, the growth rate of ratio of government consumption to GDP (DCG), the growth rate of ratio of exports to GDP (DEX), the growth rate of ratio of imports to GDP (DIM), the growth rate of ratio of M1 money to GDP (DM1), and the rate of change in unemployment (DUN). Annual data are used for all country studies. Time periods under study are 1981-2002 for Taiwan, 1974-1998 for Japan, and 1967-1996 for Korea. It is understandable that the regression results of using equation (8) imply no causal relationship between the right-hand-side variables and TFP growth rate. This type of study requires a long string of time-series data, which are not available in this study.[9]

5 EBA Test Results

Empirical estimation carried out in this study covers aggregate manufacturing as well as its sub-industries. All variables are in real terms and expressed in the form of change rate, mainly for the consideration of data stationarity.

5.1 Results for Taiwan

In the case of Taiwan, sector #2 (Tobacco) and sector #9 (Printing and Publication) are excluded from study for the reason of unavailability of trade and FDI data. Column 2 of Table 3.1 lists output growth for each of the 22 industries, which is used as I-variable in the EBA model. The real growth of production of manufacturing as a whole was 6.9% per year during the sample period. There are only two sub-industries (#4, Wearing Apparel and #6, Wood & Bamboo) whose production shows a negative growth. Probably the most significant characteristic in Taiwanese manufacturing during the past two decades was the effort in R&D. Table 3.1 presents the correlation between the TFP growth rate and the growth rates of production, R&D expenditure, total trade, and FDI of Taiwan. The TFP growth rate has a significant positive correlation with real production change rate in all industries, except #11 (Chemical Products) and #12 (Petroleum & Coal). Surprisingly, the rate of change in real R&D expenditure does not have a significant positive relation with the growth rate in TFP, except in #8 (Paper & Pulp) and #11(Chemical Products). Even more unexpectedly, the relation between the growth rate of total trade and that of TFP is not significant for most industries and #5 (Leather & Fur), #8 (Paper & Pulp), #10 (Industrial Chemicals) and #14 (Plastic Products) show a negatively significant correlation coefficient. Finally, GFDI does not significantly relate to TFP growth except in #5 (Leather & Fur).

Empirical results of EBA tests for each of Taiwanese manufacturing industries are compiled in Appendix B. and a summary is shown in Table 3.2. The real rate of output growth of each industry is a good I-variable in explaining the TFP growth in Taiwanese manufacturing. It shows a robust positive effect on TFP growth in 10 out of 20 sectors examined. Unexpectedly, real R&D expenditure with data lagging one period does not contribute to the TFP growth at all. It shows a robust negative impact on TFP growth in the #4 industry (Wearing Apparel), while a fragile effect on all other industries. As far as the trade variables are concerned, the EBA test results of Taiwanese manufacturing do not support the hypothesis of the 'virtuous cycle of trade and growth.' The results for testing

(1) the growth rate in the ratio of export to production (GEXP), (2) the growth rate of import penetration ratio (GIPN), and (3) the growth rate of FDI (GFDI) are fragile for all 20 sub-sectors. They are either insignificant or varying in sign when various combinations of Z-variable are included in the sensitivity test. Only the variable GTRP, which is defined as growth rate in total trade (export + import) value to production value, shows a robust positive effect in the sector #21 (Precision Equipment), which is ranked second in trade ratio as seen in Table 1.2. Further, in the case of manufacturing in general, the test results are also fragile for I-variables and M-variables.

The above empirical results show that only variables regarding scale efficiency are significant in explaining TFP change in half of the industries tested and variables regarding trade are not significant at all. This finding that output growth can better explain TFP growth is similar to that found in Chen and Tang (1990) and Okuda (1994) about Taiwan and Kim (2000) about Korea. We suspect that for those industries where the scale variable is robust, when both scale and trade expansions are taken into account, the scale effect stands out as the dominant explanatory variable for TFP growth and the direct trade effects fade out. This seems to imply that trade expansion leads to scale enlargement, thereby contributing to productivity growth. Aside from its contribution to production scale, export expansion has a rather ambiguous and weak linkage to TFP growth in Taiwan. Presumably openness to trade forces firms to operate in a more competitive environment, which is conducive to productivity growth. However, competing in foreign markets requires adjustments in the whole chain of production process, from product design to after-sales service. This imposes an extra burden on production costs and is thereby detrimental to

TFP growth. Therefore, it is unclear a priori that trade openness always enhances productivity.

5.2 Results for Korea

In the case of Korea, in addition to the categories of Total Manufacturing, Light industry and Heavy industry, seven 2-digit industries are tested for the robustness of the effect of trade on TFP change. Table 3.3 presents the correlation between change rate in TFP versus change rate in real production, R&D expenditure, and total trade. Empirical results of EBA tests for each of Korean manufacturing industries are compiled in Appendix C and the summary is in Table 3.4. As in the case of Taiwan, GOP (output growth rate) is a robust I-variable in explaining the TFP change, but GRD (R&D growth rate) is not a robust variable. Among the M-variables, GEXP (growth rate of the ratio of export to output) is not a robust variable in all industries tested.

The growth rate of import penetration ratio (GIPN) is positively robust in #30 (Textile cum Wearing Apparel and Leather) industry, but strangely negatively robust in #32 (Paper and Printing) and also in #36 (Fabricated Metal Products and Machinery) industry. It is not robust in other industries tested as shown in Table 3.4. The negatively robust results indicate that the more domestic-market opening to foreign competition, the lower TFP growth. We suspect that the Paper related industry and the Fabricated Metal and Machinery industries are still in their infant stage and thus need to be protected from foreign competition in the sense of TFP growth. Finally, the growth rate of total trade to production (GTRP) is not robust in most cases tested, but is negatively robust in the case of Heavy

Industries and in the case of Fabricated Metal and Machinery, which is one of the major heavy industries. The negatively robust results in this Metal cum Machinery industry clearly come from the strongly negative effect of import penetration (GIPN) of foreign products into Korean domestic market, which can be seen in Table C.07 in Appendix C.

5.3 Summary and Comparison

It is highly curious and interesting to see the similarities and differences in the test results between Taiwan and Korea regarding the effects of scale and R&D variables and of trade variables on the TFP change. First, the growth rate of real production, which represents scale variation, has a robust positive effect on TFP growth in most industries of Taiwan and Korea. It seems to imply that enlarging production scale in these three countries is a direct approach for improving factor productivity. Second, in contrast, the growth rate of real R&D expenditure, the second ***I***-variable, displays either fragile effect or negative robust effect on TFP change in the industries tested in three countries. This result is contrary to the common understanding and deserves further analysis. We believe that R&D expenditure itself is not an accurate indicator to describe technological progress. R&D investment is only the necessary, not the sufficient condition, for promoting productivity. The efficiency of combining R&D capital with R&D manpower is probably more crucial in solving this puzzle. Third, as far as the ***M***-variables are concerned, the rate of change in the ratio of export value to production value shows no robust effects on TFP growth in either Taiwan or Korea. We suspect that for those industries in which the scale variable is robust, when both scale and export expansions are taken into account, the scale effect stands out as the dominant explanatory force for TFP growth and the direct export effects fade out. This seems to imply that export expansion leads to scale enlargement, thereby contributing to productivity growth in these three countries studied. Fourth, the ***M***-variable that shows a little bit inconsistent result from two countries is the import penetration variable, which is defined as [(import value) / (import value + production value – export value)]. This variable shows no robust effects on TFP growth in any Taiwanese industries. But three industries are robust effects on TFP growth in case of Korea. Among three, one industry is positive significant and the others are negative significant.

In summary, the final results from the EBA tests on the manufacturing industries of Taiwan and Korea do not strongly support the 'virtuous cycle of trade and growth' hypothesis. The only way in which trade tends to improve TFP in these three countries is that export expansion results in a larger production scale and raises TFP indirectly.

6 Conclusion

In light of much debate about the growth experience of the High Performance Asian Economies, this study examines the significance of the effects of openness to trade, R&D, and FDI on factor productivity growth using segregated data of 22 Taiwanese and 7 Korean manufacturing industries. The growth accounting method was employed to define and calculate total factor productivity growth. The EBA test was employed to perform a sensitivity analysis along with a variety of all possible macroeconomic indicators as exogenous information variables.

The EBA test results in the two countries are not consistent with the hypothesis of 'virtuous cycle of trade and growth.' First, regarding the I-variables, only the growth rate of real production imposes robust effects on TFP growth in the two countries. The R&D variable does not have robust effects at all. Second, regarding the M-variables, all variables related to openness to trade show almost no robust effects upon TFP growth in the two countries. The above results imply that for those industries production scale variable is robust, trade expansion leads to scale enlargement, thereby contributing indirectly to TFP growth. Although it is conceivable in economies like Taiwan and Korea that trade growth and output growth are usually highly correlated, it is hard to conclude that both contribute to productivity growth. Simply saying that a country that performs well in trade, particularly in exporting, also achieves an impressive record of TFP growth and economic growth does not convey much information. Our investigation of Taiwanese and Korean industries revealed that the scale economies are a more reliable factor in explaining the productivity growth for some industries than other trade expansion variables. The relatively small size of an individual country's market makes expansion into the overseas market indispensable if scale economies are to be exploited. Given our findings that trade expansion has an insignificant and ambiguous effect on TFP growth; there may be a price to pay in order to achieve a desirable scale of output. Due to limited information, other factors that might contribute to the productivity growth in Taiwan and Korean industries still remain unclear and deserve further search in the future.

Notes

[1] The meaning of TFP is the average product of all inputs used in production. Its growth implies the progress of technology, efficiency increase in using production factors, enlargement of scale, and improvement in management skill, etc. With these theoretical interpretations, TFP has been frequently adopted as a measure of technology in the literatures of growth empirics.

[2] The famous 'flying geese' hypothesis, proposed by Akamatsu in 1943, is intended to describe the phenomenon of disparity among Asian countries. In the aspect of growth and trade structure, see Ezaki (1995) for reference.

[3] The country in Korea peninsula was split into two parts in 1950 after the Korean War. The north is People's Republic of Korea and the south is the Republic of Korea. In this study, we mention only the South Korea.

[4] A *chaebol* in Korea is a group of firms owned and controlled primarily by a single entrepreneur and usually his family members. Sakong (1993) reported that top 46 *chaebols*' share in GDP rose from 9.8% in 1973 to 17.1% in 1978.

[5] The meaning of change in TFP and its implications are not without dispute. While Abramovitz (1956) used the name of TFP, Solow (1957) called it as technological progress and Domar (1961) considered it as residuals in growth accounting.

[6] See Park and Kown (1995) for more details.

[7] For the possible drawbacks of EBA method, see Levine and Renelt (1992).

[8] Following Okuda (1994), import penetration is defined as [(import value)/(import value + production value – export value)].

[9] For a few studies regarding causality between openness and growth, see Harrison (1996) and Bernard and Jensen (1999) for explanation.

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Table 1.1

Major Indicators of Taiwanese Economy and Foreign Trade

(selected years)

Year	GDP (Mil. $US)	GNP Per Capita ($US)	Economic growth rate (Mil. $NT)	Gross Invest- (%)	Unemp-loyment rate (%)	Trade Value & Share in GDP: Export (Mil. $US (%))	Trade Value & Share in GDP: Import (Mil. $US (%))
1961	1751	152	6.70	13983	4.01	198 (11.3)	327 (18.7)
1965	2816	217	9.48	25546	3.32	450 (15.9)	556 (19.7)
1970	5670	389	9.82	57886	1.70	1481 (26.1)	1524 (26.9)
1975	15517	964	8.95	179047	2.40	5309 (34.2)	5952 (38.2)
1980	41418	2344	10.70	503911	1.23	19810 (47.8)	19733 (47.6)
1985	62062	3297	7.12	471359	2.91	30726 (49.5)	20102 (32.4)
1990	160173	8111	8.34	994119	1.67	67214 (63.3)	54716 (34.2)
1995	260175	12686	7.11	1777496	1.79	111660 (42.9)	103550 (39.8)
2000	309426	14188	5.73	2212350	2.99	148321 (47.9)	140011 (45.2)
2002	281921	12916	0.71	1644168	5.17	130597 (46.3)	112530 (39.9)

Notes: 1. Economic growth rate is the average annual rate of the previous five/two years.
2. Values are in current prices.

Sources: 1. DGBAS: *Statistical Abstract of National Income in Taiwan Area, ROC,* Taipei, various issues.
2. DGBAS: *Quarterly National Economic Trends, Taiwan Area, ROC,* Taipei, various issues.
3. CEPD: *Taiwan Statistical Data Book, 2003,* Taipei, various issues.

Table 1.2
Import & Export Ratio and Rankings of Taiwanese Manufacturing Sectors
(1981-2002)

	Sector	Import & Export to Production	Ranking
0	Aggregate Manufacturing	106.213	n.a.
1	Food & Kindred Products	33.193	20
2	Tobacco Manufacturing	n.a.	n.a.
3	Textile Mill Products	60.348	15
4	Wearing Apparel & other Textile Products	92.312	09
5	Leather, Fur & Related Products	76.278	10
6	Wood & Bamboo Products	155.950	05
7	Furniture & Fixture Products	75.148	11
8	Pulp and Paper Products	45.871	18
9	Printing & Kindred Products	n.a.	n.a.
10	Industrial Chemicals	43.514	19
11	Chemical Products	97.840	07
12	Petroleum & Coal Products	66.703	13
13	Rubber Products	64.938	14
14	Plastic Products	67.855	12
15	Nonmetallic Mineral Products	155.990	04
16	Primary Metal Industries	47.650	17
17	Fabricated Metal Products	93.087	08
18	Machinery exc. Electrical Equipment	402.630	01
19	Electrical & Electronic Equipment	97.840	06
20	Transportation Equipment	58.618	16
21	Precision Equipment	255.980	02
22	Misc. Manufacturing Industries	209.110	03

Notes: 1. Time period is 1981-2002.
2. n.a. indicates not available due to data shortage.

Sources: *Monthly Statistics of Exports and Imports, Taiwan Area, ROC*, Taipei: Ministry of Economic Affairs, various issues.

Table 1.3

Major Indicators of Korean Economy and Foreign Trade

(selected years)

Year	GDP (Bil. $US)	GDP Per capita ($US)	Economic growth rate (%)	Share of Investment in GDP (%)	Unemp-loyment rate(%)	Trade Value & Share in GDP: Export (Mil. $US(%))		Import (Mil. $US(%))	
1980	63	1647	-2.68	32.05	5.18	17446	33.93	22228	41.35
1985	94	2311	6.55	28.56	3.99	30283	34.08	31119	32.81
1988	182	4336	11.27	29.61	2.51	60503	38.41	51708	30.47
1990	254	5917	9.51	37.08	2.45	64837	29.78	69581	30.31
1993	333	7555	5.75	36.02	2.78	81942	29.26	83398	28.81
1995	456	10142	8.94	36.55	2.02	122625	33.06	132376	34.12
1998	317	6850	-6.69	29.77	6.81	132302	49.72	93281	36.26
2000	462	9818	9.33	28.39	4.05	172267	44.79	160479	41.74
2001	422	8917	3.03	27.06	3.69	150435	42.91	141097	40.56
2002	461	9677	6.00	26.41	2.97	157944	39.50	147342	38.42

Sources: *East Asian Economic Perspectives, Recent Trends and Prospects for Major Asian Economies,* Kitakyushu, Japan: The International Centre for the Study of East Asian Development, various issues.

Table 1.4
Trade Compositions of Korean Manufacturing Sectors
(1992 to 2001, %)

Sector	Average Share in Total Exports	Average Share in Total Imports
Chemical manufactures	7.095	9.087
Machinery manufactures	50.983	35.295
General machinery	5.540	12.690
Office & computing machinery	5.689	2.947
Telecommunications machinery	7.695	2.565
Other electrical machinery	17.959	13.601
Road vehicles	8.393	1.173
Other transport equipment	5.705	2.314
Textiles	9.350	2.773
Apparel	4.553	0.741
Leather products	1.300	0.681
Footwear	1.147	0.111
Wood products	0.090	0.570
Furniture	0.171	0.187
Paper products	0.994	0.571
Rubber products	1.287	0.231
Non-metallic mineral manufactures	0.633	1.035
Iron & steel	4.768	3.858
Non-ferrous metals	0.993	2.948
Metal products	2.281	1.142
Professional & scientific instruments	0.870	2.957
Photographic & optical, watches	0.649	1.299
Miscellaneous manufactures	3.910	1.984
Mineral fuels	3.366	18.759

Notes: 1. Time period is 1992-2001.
2. n.a. indicates not available due to data shortage.
3. Other major export and import items in Korea are Agriculture products and Crude materials, etc.

Sources: ICSEAD: *East Asian Economic Perspectives, Recent Trends and Prospects for Major Asian Economies*, Kitakyushu, Japan: The International Centre for the Study of East Asian Development,
various issues.

Table 2.1
TFP and Output Growths of Taiwanese Manufacturing
(1981-2001, annual average %)

	Sector	TFP Growth	Output Growth
0	Aggregate Manufacturing	2.256	6.901
1	Food & Kindred Products	2.595	1.640
2	Tobacco Manufacturing	3.478	0.469
3	Textile Mill Products	-0.105	2.306
4	Wearing Apparel & other Textile Products	-1.932	-2.893
5	Leather, Fur & Related Products	-2.423	2.220
6	Wood & Bamboo Products	1.320	-6.005
7	Furniture & Fixture Products	2.424	1.658
8	Pulp and Paper Products	-1.979	5.311
9	Printing & Kindred Products	-0.446	4.905
10	Industrial Chemicals	4.677	8.386
11	Chemical Products	5.242	5.978
12	Petroleum & Coal Products	-0.045	5.829
13	Rubber Products	0.482	2.188
14	Plastic Products	2.093	3.098
15	Nonmetallic Mineral Products	3.698	4.392
16	Primary Metal Industries	3.348	8.557
17	Fabricated Metal Products	1.539	7.270
18	Machinery exc. Electrical Equipment	3.654	8.852
19	Electrical & Electronic Equipment	4.335	13.694
20	Transportation Equipment	0.688	6.694
21	Precision Equipment	0.611	6.002
22	Misc. Manufacturing Industries	2.423	1.329

Source: 1. DGBAS (2003), *The Trends in Multi-factor Productivity of Industrial Sector, Taiwan Area, ROC*, Taipei: Director-General of Budget, Accounting and Statistics.
2. MOEA (2002), *Industrial Production Statistics Monthly, Taiwan Area, ROC*, Taipei: Ministry of Economic Affairs.
3. NSC (2003), *Indicators of Science and Technology, ROC*, Taipei: National Science Council.

Table 2.2 TFP, Output, and R&D Growths of Korean Manufacturing
(1967-1996, annual average %)

Sector	TFP Growth	Output Growth	R&D Growth
00 Aggregate Manufacturing	2.525	6.397	5.631
38 Light Industry	2.450	5.276	5.558
39 Heavy Industry	2.302	6.822	5.544
29 Food, Beverage and Tobacco	0.132	4.865	4.036
30 Textiles, Wearing Apparel & Leather	2.954	5.580	4.020
32 Paper & Products, Printing & Publishing	3.308	2.780	0.165
33 Chemical, Petroleum, Coal, Rubber & Plastic	-0.236	4.136	4.671
34 Non-metallic Mineral Products	1.044	5.145	4.637
35 Basic Metal	2.018	6.597	4.114
36 Fabricated Metal Products & Machinery	3.454	8.881	6.074

Sources: KNSO: *The Reports on Mining and Manufacturing Survey and Industrial Census*, Seoul: Korea National Statistical Office, various issues.

Table 3.1 Correlation Coefficient of TFP Growth with other Variables, Taiwan

	TFP Growth with:	Real Output	Real R&D	Total Trade	FDI
0	Aggregate Manufacturing	0.841 *** (0.000)	0.331 (0.165)	-0.152 (0.534)	-0.002 (0.991)
1	Food & Kindred Products	0.500 ** (0.029)	-0.005 (0.982)	-0.035 (0.886)	0.092 (0.706)
3	Textile Mill Products	0.654 *** (0.002)	0.066 (0.786)	-0.371 (0.117)	0.236 (0.330)
4	Wearing Apparel	0.782 *** (0.000)	0.223 (0.357)	-0.263 (0.275)	-0.085 (0.729)
5	Leather & Fur	0.620 *** (0.004)	0.337 (0.157)	-0.611 *** (0.005)	0.422 * (0.071)
6	Wood & Bamboo	0.843 *** (0.000)	0.039 (0.871)	-0.367 (0.121)	0.088 (0.718)
7	Furniture & Fixture	0.662 *** (0.002)	0.035 (0.883)	-0.059 (0.807)	n.a.
8	Pulp & Paper	0.600 *** (0.006)	0.398 * (0.090)	-0.525** (0.020)	0.093 (0.704)
10	Industrial Chemicals	0.441 * (0.058)	0.262 (0.277)	-0.509 ** (0.025)	n.a.
11	Chemical Products	0.212 (0.383)	0.450 * (0.052)	0.135 (0.580)	-0.199 (0.413)
12	Petroleum & Coal	0.086 (0.726)	-0.281 (0.243)	-0.030 (0.900)	n.a.
13	Rubber Products	0.626 *** (0.004)	-0.060 (0.805)	0.131 (0.591)	0.038 (0.875)
14	Plastic Products	0.721 *** (0.000)	0.049 (0.840)	-0.388* (0.100)	0.012 (0.960)
15	Nonmetallic Mineral	0.675 *** (0.001)	0.354 (0.136)	-0.429 (0.066)	0.004 (0.986)
16	Primary Metal Industries	0.585 *** (0.008)	-0.018 (0.938)	0.005 (0.983)	0.095 (0.698)
17	Fabricated Metal Products	0.771 *** (0.000)	0.117 (0.631)	0.162 (0.507)	-0.225 (0.352)
18	Machinery exc. Electrical	0.755 *** (0.000)	0.166 (0.496)	0.019 (0.937)	0.381 (0.106)
19	Electrical & Electronic	0.669 *** (0.001)	0.259 (0.283)	-0.035 (0.886)	0.346 (0.146)
20	Transportation Equipment	0.897 *** (0.000)	0.187 (0.441)	-0.241 (0.319)	-0.115 (0.638)
21	Precision Equipment	0.486** (0.034)	0.277 (0.249)	0.199 (0.413)	0.029 (0.904)
22	Misc. Manufacturing	0.560 ** (0.012)	0.248 (0.305)	0.086 (0.723)	n.a.

Notes: 1. Probability > |r| under H_0: $\rho = 0$ is in parenthesis.

2. ***, **, and * indicate significance at 1%, 5%, and 10% level, respectively.

3. n.a. indicates not available.

Table 3.2 Correlation Coefficient of TFP Growth with other variables, Korea

TFP Growth with:	Real Output	Real R&D	Total Trade
00 Aggregate Manufacturing	0.722***	-0.304	-0.203
	(0.000)	(0.102)	(0.281)
38 Light Industry	0.766***	-0.020	0.131
	(0.000)	(0.915)	(0.489)
39 Heavy Industry	0.755***	-0.027	-0.394
	(0.000)	(0.888)	(0.031)
29 Food, Beverage and Tobacco	0.846***	0.101	-0.278
	(0.000)	(0.595)	(0.137)
30 Textiles, Wearing Apparel & Leather	0.705	0.379	0.241
	(0.000)	(0.039)**	(0.199)
32 Paper & Products, Printing &	0.733***	-0.245	-0.022
Publishing	(0.000)	(0.191)	(0.907)
33 Chemical, Petroleum, Coal, Rubber	0.885***	-0.248	-0.621***
& Plastic	(0.000)	(0.187)	(0.000)
34 Non-metallic Mineral Products	0.627***	0.215	0.089
	(0.000)	(0.253)	(0.639)
35 Basic Metal	0.657***	0.012	0.350
	(0.000)	(0.095)	(0.058)*
36 Fabricated Metal Products & Machinery	0.793***	0.185	-0.342*
	(0.000)	(0.328)	(0.064)

Notes: 1. Probability > | r| under H_0: $\rho = 0$ is in parenthesis.
2. ***, **, and * indicate significance at 1%, 5%, and 10% level, respectively.

Table 3.3 Summary of EBA Test on Taiwanese Manufacturing

	Sector	I-variable		M-variable			
		GOP	GRD	GEXP	GIPN	GTRP	GFDI
0	Aggregate Manufacturing	F	F	F	F	F	F
1	Food & Kindred Products	R(+)	F	F	F	F	F
3	Textile Mill Products	F	F	F	F	F	F
4	Wearing Apparel & other Textile	F	R(-)	F	F	F	F
5	Leather, Fur & Related Products	R(+)	F	F	F	F	F
6	Wood & Bamboo Products	R(+)	F	F	F	F	F
7	Furniture & Fixture Products	F	F	F	F	F	n.a.
8	Pulp and Paper Products	F	F	F	F	F	F
10	Industrial Chemicals	R(+)	F	F	F	F	n.a.
11	Chemical Products	R(+)	F	F	F	F	F
12	Petroleum & Coal Products	F	F	F	F	F	n.a.
13	Rubber Products	F	F	F	F	F	F
14	Plastic Products	R(+)	F	F	F	F	n.a.
15	Nonmetallic Mineral Products	F	F	F	F	F	F
16	Primary Metal Industries	F	F	F	F	F	F
17	Fabricated Metal Products	R(+)	F	F	F	F	F
18	Machinery exc. Electrical Equipment	R(+)	F	F	F	F	F
19	Electrical & Electronic Equipment	F	F	F	F	F	F
20	Transportation Equipment	R(+)	F	F	F	F	n.a.
21	Precision Equipment	R(+)	F	F	F	R(+)	F
22	Misc. Manufacturing Industries	F	F	F	F	F	n.a.

Notes: 1. GOP indicates growth rate of real production value,
GRD: growth rate of real R&D expenditure,
GEXP: growth rate of ratio of export value to production value,
GIPN: growth rate of import penetration ratio,
GTRP: growth rate of total trade to production,
2. R stands for Robust and F for Fragile; -- indicates the test is not available.
3. Sector 2 and 9 are eliminated due to data inadequacy.
4. n.a. implies not available.

Table 3.4 Summary of EBA Test on Korean Manufacturing

Sector	I-variable		M-variable		
	GOP	GRD	GEXP	GIPN	GTRP
40 Total Manufacturing	R(+)	F	F	F	F
38 Light Industry	R(+)	F	F	F	F
39 Heavy Industry	R(+)	F	F	F	R(-)
29 Food, Beverage and Tobacco	R(+)	F	F	F	F
30 Textiles, Wearing Apparel & Leather	R(+)	F	F	R(+)	F
32 Paper & Products, Printing & Publishing	R(+)	F	F	R(-)	F
33 Chemical, Petroleum, Coal, Rubber & Plastic	R(+)	F	F	F	F
34 Non-metallic Mineral Products	R(+)	F	F	F	F
35 Basic Metal	R(+)	F	F	F	F
36 Fabricated Metal Products & Machinery	R(+)	F	F	R(-)	R(-)

Notes: 1. GOP indicates growth rate of real production value,
GRD: growth rate of real R&D expenditure,
GEXP: growth rate of ratio of export value to production value,
GIPN: growth rate of import penetration ratio,
GTRP: growth rate of total trade to production,
2. R stands for Robust and F for Fragile.

Appendix A: Variable Definitions and Data Sources

Taiwan:

TFP: Total Factor Productivity
DGBAS: *The Trends in Multi-factor Productivity of Industrial Sector, Taiwan Area, ROC, 2001,* Taipei, 2003.

QP: Real Production Index
DGBAS: *Statistical Yearbook of the ROC, 2002,* Taipei, 2002.
MOEA: *Industrial Production Statistics Monthly, Taiwan Area of ROC,* Taipei, various issues.

R&D: Real R&D Expenditure
NSC: *Indicators of Science and Technology, ROC,* Taipei, 2002

EXP: Export Values
MOF: *Monthly Statistics of Exports and Imports, Taiwan Area, ROC,* Taipei, various issues.

IMP: Import Values
MOF: *Monthly Statistics of Exports and Imports, Taiwan Area, ROC,* Taipei, various issues.

FDI: Foreign Direct Investment
MOEA: *Annual Statistics on Overseas Chinese & Foreign Investment, Outward Investment, and Indirect Mainland Investment of ROC,* Taipei, 2002.

ECGR: Real Economic Growth Rate
DGBAS: *National Income in Taiwan Area, ROC,* Taipei, various issues.
CEPD: *Taiwan Statistical Data Book 2002,* Taipei, 2002.

WPI: Wholesale Price Index
DGBAS: *National Income in Taiwan Area, ROC,* Taipei, various issues.
CEPD: *Taiwan Statistical Data Book 2002,* Taipei, 2002.

GRMS: Annual Growth Rate of Money Supply M1B
CEPD: *Taiwan Statistical Data Book 2002,* Taipei, 2002.

BOPCB: Balance of Payment in Current Account
DGBAS: *Quarterly National Economic Trend, Taiwan Area, ROC,* Taipei, various issues.

MFGEM: Manufacturing Employment
DGBAS: *Quarterly National Economic Trend, Taiwan Area, ROC,* Taipei: various issues.

SUDFGNR: Ratio of Surplus-Deficit to Government Net Revenue
DGBAS: *Statistical Yearbook of the ROC, 2002,* Taipei, 2002.

***M*-variables:**

GEXP: the growth rate of ratio of export to production
GIPN: the growth rate of import penetration ratio
GTRP: growth rate of total trade to production
GFDI: growth rate of foreign direct investment

Z-variables:
RECGR: They are real economic growth rate
WPICR: Wholesale price index change rate
GRMS: Annual growth rate of money supply M1B
BOPCBCR: Growth rate of balance of payment in current account
MFGEMCR: Annual growth rate of manufacturing employment
SUDFGNRC: Growth rate of surplus-deficit to government net revenue

Korea:
East Asian Economic Perspectives, Recent Trends and Prospects forMajor Asian Economies, Kitakyushu, Japan: The International Centre for the Study of East Asian Development, various issues.
The Reports on Mining and Manufacturing Survey and Industrial Census, Seoul: Korea National Statistical Office, various issues.

M-variables:
GEXP: the growth rate of ratio of export to production
GIPN: the growth rate of import penetration ratio
GTRP: growth rate of total trade to production

Z-variables:
DCP: Inflation rate, Consumer Price Index
DCG: Growth rate of Government Consumption/GDP.
DEX: Growth rate of ratio of Exports to GDP
DIM: Growth rate of ratio of Import to GDP
DM1: Growth rate of Money Supply M1 to GDP
DUN: Change rate of Unemployment Rate

Appendix B: EBA Results of Taiwanese Manufacturing Industries

Table B.00 EBA Test Results for I-variables and M-variables (Taiwan)/ Manufacturing 000 (Aggregate)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.655	0.132	0.013	0.732	GRMS BOPCBCR MFGEMCR	Fragile
	base	0.377	0.085	0.000	0.645		
	low	-0.467	0.172	0.493	0.803	RECGR WPICR SUNDFGDPC	
GRD	high	0.067	0.032	0.921	0.790	WPICR GRMS BOPCBCR	Fragile
	base	-0.013	0.036	0.711	0.645		
	low	-0.112	0.034	0.236	0.803	RECGR WPICR SUNDFGDPC	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.178	0.084	0.905	0.820	RECGR GRMS SUDFGDPC	Fragile
	base	-0.129	0.058	0.043	0.748		
	low	-0.238	0.057	0.056	0.826	GRMS BOPCBCR MFGEMCR	
GIPN	high	0.093	0.059	0.678	0.854	RECGR BOPCBCR SUDFGDPC	Fragile
	base	-0.118	0.040	0.010	0.791		
	low	-0.208	0.045	0.026	0.824	WPICR MFGEMCR SUDFGDPC	
GTRP	high	11.402	6.576	0.795	0.852	RECGR BOPCBCR SUDFGDPC	Fragile
	base	-12.792	4.473	0.013	0.786		
	low	-22.859	5.147	0.034	0.817	WPICR MFGEMCR SUDFGDPC	
GFDI	high	0.008	0.006	0.491	0.859	RECGR BOPCBCR SUDFGDPC	Fragile
	base	-0.013	0.005	0.042	0.749		
	low	-0.032	0.009	0.140	0.784	RECGR WPICR MFGEMCR	

Table B.01 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 001 (Food & beverage)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.387	0.160	0.000	0.778	RECGR MFGEMCR SUDFGDPC	Robust
	base	0.842	0.189	0.000	0.580		
	low	0.453	0.171	0.000	0.683	WPICR GRMS BOPCBCR	
GRD	high	0.040	0.017	0.732	0.700	RECGR WPICR BOPCBCR	Fragile
	base	-0.007	0.016	0.663	0.580		
	low	-0.061	0.019	0.261	0.666	GRMS MFGEMCR SUDFGDPC	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.212	0.067	0.270	0.689	WPICR MFGEMCR SUDFGDPC	Fragile
	base	0.072	0.064	0.285	0.618		
	low	-0.061	0.042	0.583	0.869	RECGR GRMS MFGEMCR	
GIPN	high	0.124	0.066	0.906	0.847	RECGR GRMS MFGEMCR	Fragile
	base	-0.092	0.084	0.296	0.610		
	low	-0.271	0.082	0.229	0.723	RECGR WPICR SUNDFGDPC	
GTRP	high	16.266	7.402	0.847	0.820	RECGR GRMS SUDFGDPC	Fragile
	base	-6.421	9.533	0.512	0.587		
	low	-23.838	8.365	0.415	0.770	RECGR MFGEMCR SUDFGDPC	
GFDI	high	0.019	0.004	0.029	0.857	RECGR WPICR GRMS	Fragile
	base	0.007	0.005	0.202	0.631		
	low	-0.007	0.006	0.425	0.699	GRMS MFGEMCR SUDFGDPC	

Table B.03 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 003 (Textile mill)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.767	0.367	0.016	0.579	RECGR WPICR GRMS	Fragile
	base	0.919	0.257	0.003	0.486		
	low	-0.264	0.355	0.234	0.670	RECGR BOPCBCR SUDFGDPC	
GRD	high	0.031	0.012	0.538	0.571	RECGR WPICR MFGEMCR	Fragile
	base	0.006	0.011	0.550	0.486		
	low	-0.054	0.014	0.091	0.769	BOPCBCR MFGEMCR SUDFGDPC	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.417	0.172	0.686	0.588	RECGR WPICR GRMS	Fragile
	base	-0.038	0.150	0.800	0.488		
	low	-0.372	0.156	0.710	0.577	RECGR WPICR MFGEMCR	
GIPN	high	0.362	0.187	0.948	0.615	WPICR BOPCBCR SUDFGDPC	Fragile
	base	-0.113	0.176	0.529	0.494		
	low	-0.628	0.208	0.333	0.586	RECGR WPICR SUNDFGDPC	
GTRP	high	44.066	21.442	0.957	0.579	RECGR WPICR GRMS	Fragile
	base	-9.580	18.293	0.609	0.493		
	low	-47.001	16.738	0.437	0.676	WPICR MFGEMCR SUDFGDPC	
GFDI	high	0.024	0.009	0.557	0.681	RECGR BOPCBCR SUDFGDPC	Fragile
	base	-0.000	0.009	0.935	0.486		
	low	-0.024	0.009	0.625	0.636	RECGR GRMS MFGEMCR	

Table B.04 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 004 (Wearing apparel)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.030	0.214	0.0170	0.584	GRMS BOPCBCR MFGEMCR	Fragile
	base	0.519	0.136	0.0019	0.556		
	low	-0.045	0.192	0.1055	0.608	RECGR GRMS SUDFGDPC	
GRD	high	-0.000	0.013	0.0893	0.583	RECGR WPICR GRMS	Robust
	base	-0.026	0.011	0.0364	0.556		
	low	-0.061	0.014	0.0428	0.613	RECGR BOPCBCR SUDFGDPC	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.177	0.186	0.318	0.609	WPICR GRMS SUDFGDPC	Fragile
	base	-0.187	0.159	0.261	0.596		
	low	-0.836	0.209	0.073	0.693	BOPCBCR MFGEMCR SUDFGDPC	
GIPN	high	12.479	2.815	0.035	0.687	WPICR GRMS SUDFGDPC	Fragile
	base	3.878	2.510	0.146	0.606		
	low	-4.027	3.808	0.368	0.620	RECGR WPICR BOPCBCR	
GTRP	high	18.356	4.502	0.064	0.658	GRMS MFGEMCR SUDFGDPC	Fragile
	base	5.419	4.085	0.207	0.589		
	low	-11.595	8.042	0.588	0.599	RECGR WPICR BOPCBCR	
GFDI	high	0.003	0.002	0.534	0.609	RECGR WPICR MFGEMCR	Fragile
	base	-0.001	0.001	0.365	0.583		
	low	-0.008	0.002	0.161	0.662	BOPCBCR MFGEMCR SUDFGDPC	

Table B.05 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 005 (Leather & fur)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.949	0.110	0.000	0.812	RECGR WPICR MFGEMCR	Robust
	base	0.501	0.088	0.000	0.673		
	low	0.320	0.097	0.000	0.735	WPICR BOPCBCR SUDFGDPC	
GRD	high	0.012	0.003	0.163	0.754	RECGR WPICR SUNDFGDPC	Fragile
	base	0.002	0.003	0.484	0.673		
	low	-0.003	0.002	0.564	0.831	GRMS BOPCBCR MFGEMCR	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.122	0.159	0.246	0.756	WPICR BOPCBCR SUDFGDPC	Fragile
	base	-0.256	0.138	0.086	0.727		
	low	-0.528	0.141	0.112	0.791	RECGR WPICR GRMS	
GIPN	high	8.767	11.929	0.234	0.853	GRMS BOPCBCR MFGEMCR	Fragile
	base	-26.785	10.694	0.026	0.777		
	low	-50.266	13.024	0.092	0.794	RECGR BOPCBCR SUDFGDPC	
GTRP	high	4.322	6.236	0.220	0.851	GRMS BOPCBCR MFGEMCR	Fragile
	base	-14.489	4.916	0.011	0.798		
	low	-24.579	5.474	0.032	0.826	RECGR BOPCBCR SUDFGDPC	
GFDI	high	0.000	0.000	0.070	0.858	BOPCBCR MFGEMCR SUDFGDPC	Fragile
	base	0.000	0.000	0.415	0.691		
	low	-0.000	0.000	0.996	0.760	WPICR GRMS BOPCBCR	

Table B.06 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 006 (Wood & bamboo)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.992	0.304	0.000	0.817	BOPCBCR MFGEMCR SUDFGDPC	Robust
	base	0.946	0.155	0.000	0.794		
	low	0.437	0.235	0.002	0.799	WPICR GRMS MFGEMCR	
GRD	high	0.022	0.006	0.197	0.803	RECGR WPICR GRMS	Fragile
	base	0.008	0.005	0.177	0.794		
	low	-0.009	0.006	0.567	0.817	BOPCBCR MFGEMCR SUDFGDPC	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.425	0.214	0.983	0.793	RECGR WPICR GRMS	Fragile
	base	-0.021	0.185	0.910	0.787		
	low	-0.702	0.218	0.253	0.826	BOPCBCR MFGEMCR SUDFGDPC	
GIPN	high	0.823	0.305	0.500	0.837	GRMS MFGEMCR SUDFGDPC	Fragile
	base	0.060	0.242	0.806	0.794		
	low	-0.928	0.400	0.756	0.798	WPICR GRMS BOPCBCR	
GTRP	high	47.401	16.720	0.423	0.822	RECGR MFGEMCR SUDFGDPC	Fragile
	base	4.198	12.860	0.749	0.794		
	low	-44.704	22.000	0.975	0.780	GRMS BOPCBCR MFGEMCR	
GFDI	high	0.037	0.014	0.556	0.797	RECGR GRMS BOPCBCR	Fragile
	base	0.006	0.010	0.526	0.801		
	low	-0.032	0.014	0.828	0.809	RECGR MFGEMCR SUDFGDPC	

Table B.07 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 007 (Furniture & fixtures)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.451	0.243	0.002	0.680	WPICR MFGEMCR SUDFGDPC	Fragile
	base	0.698	0.147	0.000	0.596		
	low	-0.545	0.290	0.906	0.748	RECGR GRMS BOPCBCR	
GRD	high	0.000	0.000	0.450	0.603	BOPCBCR MFGEMCR SUDFGDPC	Fragile
	base	0.000	0.000	0.368	0.596		
	low	-0.000	0.000	0.837	0.764	WPICR GRMS MFGEMCR	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.839	0.246	0.188	0.804	WPICR GRMS SUDFGDPC	Fragile
	base	0.188	0.289	0.527	0.611		
	low	-0.680	0.329	0.951	0.711	RECGR WPICR MFGEMCR	
GIPN	high	10.534	3.745	0.435	0.669	WPICR BOPCBCR MFGEMCR	Fragile
	base	1.764	3.264	0.598	0.604		
	low	-7.133	3.518	0.978	0.703	RECGR MFGEMCR SUDFGDPC	
GTRP	high	15.116	5.538	0.482	0.758	WPICR GRMS BOPCBCR	Fragile
	base	1.618	5.826	0.785	0.599		
	low	-18.648	6.423	0.387	0.732	RECGR MFGEMCR SUDFGDPC	

Table B.08 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 008 (Paper & pulp)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.086	0.215	0.0114	0.709	WPICR BOPCBCR SUDFGDPC	Fragile
	base	0.573	0.180	0.0068	0.663		
	low	-0.260	0.250	0.3572	0.647	BOPCBCR MFGEMCR SUDFGDPC	
GRD	high	0.015	0.011	0.4799	0.784	WPICR BOPCBCR MFGEMCR	Fragile
	base	-0.032	0.009	0.0034	0.663		
	low	-0.056	0.011	0.0164	0.658	RECGR WPICR SUNDFGDPC	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.099	0.072	0.549	0.637	WPICR MFGEMCR SUDFGDPC	Fragile
	base	-0.048	0.053	0.387	0.649		
	low	-0.260	0.079	0.238	0.554	RECGR GRMS BOPCBCR	
GIPN	high	0.089	0.113	0.254	0.801	WPICR BOPCBCR MFGEMCR	Fragile
	base	-0.193	0.108	0.099	0.630		
	low	-0.530	0.126	0.054	0.666	RECGR WPICR GRMS	
GTRP	high	8.377	8.869	0.316	0.795	WPICR BOPCBCR MFGEMCR	Fragile
	base	-13.875	8.426	0.123	0.628		
	low	-43.485	10.050	0.042	0.664	RECGR WPICR GRMS	
GFDI	high	0.012	0.003	0.205	0.765	WPICR GRMS BOPCBCR	Fragile
	base	0.000	0.003	0.910	0.663		
	low	-0.010	0.004	0.867	0.637	GRMS MFGEMCR SUDFGDPC	

Table B.10 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 010 (Chemical materials)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.638	0.171	0.000	0.848	RECGR GRMS BOPCBCR	Robust
	base	1.034	0.169	0.000	0.741		
	low	0.587	0.188	0.000	0.774	WPICR BOPCBCR SUDFGDPC	
GRD	high	0.049	0.012	0.067	0.848	RECGR GRMS BOPCBCR	Fragile
	base	0.002	0.010	0.830	0.741		
	low	-0.024	0.012	0.968	0.769	WPICR BOPCBCR MFGEMCR	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.234	0.123	0.916	0.838	RECGR GRMS MFGEMCR	Fragile
	base	-0.067	0.101	0.516	0.750		
	low	-0.361	0.117	0.306	0.795	WPICR MFGEMCR SUDFGDPC	
GIPN	high	0.194	0.116	0.749	0.876	RECGR WPICR GRMS	Fragile
	base	-0.159	0.098	0.128	0.784		
	low	-0.435	0.117	0.116	0.802	GRMS MFGEMCR SUDFGDPC	
GTRP	high	21.417	12.255	0.805	0.876	RECGR WPICR GRMS	Fragile
	base	-19.251	11.695	0.123	0.785		
	low	-46.081	12.985	0.152	0.797	GRMS MFGEMCR SUDFGDPC	

Table B.11 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 011 (Chemical products)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	3.206	0.589	0.005	0.629	RECGR WPICR MFGEMCR	Robust
	base	0.799	0.305	0.020	0.521		
	low	0.071	0.344	0.049	0.548	GRMS BOPCBCR SUDFGDPC	
GRD	high	0.067	0.034	0.950	0.596	RECGR BOPCBCR MFGEMCR	Fragile
	base	-0.008	0.033	0.791	0.521		
	low	-0.145	0.040	0.132	0.695	RECGR WPICR GRMS	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.288	0.177	0.712	0.572	WPICR GRMS BOPCBCR	Fragile
	base	-0.123	0.114	0.299	0.560		
	low	-0.511	0.122	0.053	0.712	RECGR WPICR SUNDFGDPC	
GIPN	high	0.540	0.235	0.770	0.551	GRMS BOPCBCR SUDFGDPC	Fragile
	base	0.018	0.195	0.926	0.520		
	low	-0.884	0.268	0.225	0.679	RECGR WPICR MFGEMCR	
GTRP	high	30.751	13.836	0.828	0.544	GRMS BOPCBCR MFGEMCR	Fragile
	base	-0.479	11.161	0.966	0.520		
	low	-52.188	15.376	0.193	0.687	RECGR WPICR MFGEMCR	
GFDI	high	0.010	0.012	0.278	0.641	RECGR GRMS BOPCBCR	Fragile
	base	-0.018	0.008	0.058	0.640		
	low	-0.062	0.014	0.032	0.686	WPICR MFGEMCR SUDFGDPC	

Table B.12 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 012 (Petroleum & coal)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.534	0.510	0.336	0.258	RECGR GRMS MFGEMCR	Fragile
	base	0.318	0.422	0.464	0.259		
	low	-1.020	0.564	0.851	0.311	WPICR GRMS BOPCBCR	
GRD	high	0.002	0.000	0.168	0.311	WPICR GRMS BOPCBCR	Fragile
	base	0.000	0.000	0.172	0.259		
	low	-0.000	0.000	0.448	0.258	RECGR GRMS MFGEMCR	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.586	0.271	0.874	0.276	WPICR MFGEMCR SUDFGDPC	Fragile
	base	-0.021	0.195	0.915	0.260		
	low	-0.703	0.271	0.568	0.309	RECGR GRMS BOPCBCR	
GIPN	high	0.747	0.365	0.964	0.261	RECGR MFGEMCR SUDFGDPC	Fragile
	base	-0.059	0.275	0.833	0.262		
	low	-0.889	0.363	0.663	0.300	GRMS BOPCBCR MFGEMCR	
GTRP	high	51.897	25.789	0.990	0.261	RECGR MFGEMCR SUDFGDPC	Fragile
	base	-5.003	19.221	0.798	0.263		
	low	-68.941	25.719	0.511	0.323	RECGR GRMS BOPCBCR	

Table B.13 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 013 (Rubber)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.029	0.255	0.067	0.412	RECGR GRMS BOPCBCR	Fragile
	base	0.332	0.174	0.078	0.339		
	low	-0.098	0.168	0.185	0.506	WPICR BOPCBCR SUDFGDPC	
GRD	high	0.059	0.013	0.042	0.515	RECGR WPICR SUNDFGDPC	Fragile
	base	0.019	0.012	0.150	0.339		
	low	-0.010	0.013	0.254	0.407	WPICR GRMS BOPCBCR	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.464	0.153	0.327	0.643	GRMS MFGEMCR SUDFGDPC	Fragile
	base	0.022	0.152	0.883	0.340		
	low	-0.353	0.169	0.927	0.408	WPICR GRMS BOPCBCR	
GIPN	high	43.165	17.417	0.642	0.560	RECGR WPICR MFGEMCR	Fragile
	base	0.674	17.072	0.969	0.339		
	low	-42.403	19.120	0.832	0.510	RECGR BOPCBCR SUDFGDPC	
GTRP	high	11.175	5.325	0.923	0.551	RECGR WPICR MFGEMCR	Fragile
	base	-0.670	5.446	0.903	0.340		
	low	-15.645	6.274	0.632	0.520	RECGR BOPCBCR SUDFGDPC	
GFDI	high	0.009	0.004	0.998	0.510	RECGR BOPCBCR SUDFGDPC	Fragile
	base	-0.001	0.003	0.680	0.348		
	low	-0.010	0.004	0.782	0.503	WPICR BOPCBCR SUDFGDPC	

Table B.14 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 014 (Plastic)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.774	0.289	0.001	0.757	RECGR WPICR MFGEMCR	Robust
	base	0.683	0.132	0.000	0.658		
	low	0.007	0.158	0.065	0.814	GRMS BOPCBCR SUDFGDPC	
GRD	high	0.027	0.011	0.670	0.713	RECGR WPICR BOPCBCR	Fragile
	base	0.000	0.010	0.958	0.658		
	low	-0.018	0.007	0.715	0.839	GRMS MFGEMCR SUDFGDPC	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.296	0.125	0.724	0.869	WPICR GRMS MFGEMCR	Fragile
	base	-0.162	0.153	0.308	0.683		
	low	-0.512	0.176	0.387	0.701	RECGR WPICR SUNDFGDPC	
GIPN	high	0.237	0.110	0.893	0.747	BOPCBCR MFGEMCR SUDFGDPC	Fragile
	base	-0.031	0.108	0.775	0.660		
	low	-0.285	0.095	0.348	0.824	WPICR GRMS SUDFGDPC	
GTRP	high	21.841	12.212	0.836	0.845	GRMS BOPCBCR MFGEMCR	Fragile
	base	-18.479	14.654	0.229	0.693		
	low	-51.479	16.953	0.324	0.707	RECGR WPICR SUNDFGDPC	

Table B.15 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 015 (Non-metallic mineral)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.914	0.132	0.000	0.755	GRMS MFGEMCR SUDFGDPC	Fragile
	base	0.534	0.129	0.001	0.681		
	low	-0.152	0.221	0.215	0.771	RECGR BOPCBCR MFGEMCR	
GRD	high	0.041	0.010	0.074	0.708	RECGR WPICR GRMS	Fragile
	base	0.021	0.009	0.042	0.681		
	low	-0.008	0.010	0.268	0.752	BOPCBCR MFGEMCR SUDFGDPC	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.059	0.049	0.442	0.801	GRMS BOPCBCR MFGEMCR	Fragile
	base	-0.068	0.047	0.173	0.721		
	low	-0.182	0.053	0.185	0.743	RECGR WPICR SUNDFGDPC	
GIPN	high	0.194	0.085	0.777	0.744	RECGR GRMS BOPCBCR	Fragile
	base	-0.020	0.072	0.784	0.682		
	low	-0.241	0.083	0.391	0.753	RECGR WPICR MFGEMCR	
GTRP	high	7.291	3.640	0.997	0.742	RECGR GRMS BOPCBCR	Fragile
	base	-1.421	3.097	0.653	0.686		
	low	-10.330	3.477	0.354	0.756	RECGR WPICR MFGEMCR	
GFDI	high	0.004	0.003	0.698	0.739	RECGR WPICR MFGEMCR	Fragile
	base	-0.001	0.002	0.572	0.684		
	low	-0.007	0.002	0.414	0.773	BOPCBCR MFGEMCR SUDFGDPC	

Table B.16 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 016 (Basic metal)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.143	0.294	0.085	0.419	RECGR GRMS BOPCBCR	Fragile
	base	0.536	0.194	0.015	0.391		
	low	-0.207	0.218	0.317	0.524	WPICR GRMS MFGEMCR	
GRD	high	0.142	0.041	0.188	0.524	WPICR GRMS MFGEMCR	Fragile
	base	0.024	0.036	0.513	0.391		
	low	-0.077	0.041	0.876	0.460	GRMS BOPCBCR SUDFGDPC	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.355	0.142	0.633	0.550	WPICR MFGEMCR SUDFGDPC	Fragile
	base	-0.070	0.097	0.481	0.397		
	low	-0.353	0.135	0.552	0.424	WPICR GRMS BOPCBCR	
GIPN	high	0.563	0.159	0.156	0.633	WPICR GRMS MFGEMCR	Fragile
	base	0.092	0.132	0.496	0.417		
	low	-0.261	0.156	0.746	0.449	RECGR GRMS SUDFGDPC	
GTRP	high	44.263	13.797	0.254	0.602	WPICR GRMS MFGEMCR	Fragile
	base	2.844	10.781	0.796	0.395		
	low	-24.283	12.539	0.950	0.439	RECGR GRMS SUDFGDPC	
GFDI	high	0.015	0.006	0.679	0.466	RECGR WPICR SUNDFGDPC	Fragile
	base	-0.000	0.004	0.860	0.393		
	low	-0.018	0.006	0.519	0.470	RECGR GRMS MFGEMCR	

Table B.17 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 017 (Fabricated metal)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.294	0.147	0.000	0.878	RECGR WPICR BOPCBCR	Robust
	base	0.663	0.094	0.000	0.788		
	low	0.416	0.098	0.000	0.838	WPICR BOPCBCR SUDFGDPC	
GRD	high	0.066	0.022	0.343	0.878	RECGR WPICR BOPCBCR	Fragile
	base	-0.011	0.021	0.616	0.788		
	low	-0.07	0.023	0.331	0.881	GRMS BOPCBCR MFGEMCR	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.240	0.087	0.480	0.900	RECGR GRMS BOPCBCR	Fragile
	base	-0.094	0.104	0.383	0.799		
	low	-0.424	0.139	0.320	0.810	WPICR GRMS BOPCBCR	
GIPN	high	0.176	0.043	0.068	0.918	RECGR WPICR BOPCBCR	Fragile
	base	0.013	0.064	0.833	0.789		
	low	-0.176	0.082	0.883	0.831	GRMS BOPCBCR SUDFGDPC	
GTRP	high	15.415	4.141	0.116	0.909	RECGR WPICR BOPCBCR	Fragile
	base	0.430	5.678	0.940	0.788		
	low	-15.629	7.099	0.844	0.831	GRMS BOPCBCR SUDFGDPC	
GFDI	high	0.001	0.002	0.268	0.922	RECGR GRMS MFGEMCR	Fragile
	base	-0.004	0.002	0.065	0.835		
	low	-0.011	0.002	0.035	0.864	WPICR GRMS BOPCBCR	

Table B.18 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 018 (Machinery & equipments)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.202	0.161	0.000	0.802	BOPCBCR MFGEMCR SUDFGDPC	Robust
	base	0.703	0.134	0.000	0.689		
	low	0.246	0.176	0.006	0.724	WPICR GRMS SUDFGDPC	
GRD	high	0.069	0.025	0.514	0.709	WPICR BOPCBCR SUDFGDPC	Fragile
	base	0.010	0.022	0.642	0.689		
	low	-0.053	0.019	0.461	0.847	WPICR GRMS MFGEMCR	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.506	0.153	0.223	0.760	RECGR GRMS SUDFGDPC	Fragile
	base	-0.009	0.107	0.928	0.690		
	low	-0.300	0.110	0.484	0.814	BOPCBCR MFGEMCR SUDFGDPC	
GIPN	high	1.242	0.480	0.571	0.852	RECGR GRMS MFGEMCR	Fragile
	base	-0.372	0.518	0.485	0.702		
	low	-1.579	0.619	0.593	0.713	RECGR WPICR BOPCBCR	
GTRP	high	25.155	10.267	0.662	0.851	RECGR GRMS MFGEMCR	Fragile
	base	-11.388	9.848	0.268	0.719		
	low	-40.921	14.187	0.397	0.727	RECGR WPICR SUNDFGDPC	
GFDI	high	0.059	0.026	0.834	0.174	WPICR GRMS BOPCBCR	Fragile
	base	0.003	0.023	0.885	0.690		
	low	-0.109	0.043	0.617	0.732	RECGR GRMS SUDFGDPC	

Table B.19 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 019 (Electrical & electronic machinery)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.044	0.151	0.000	0.810	GRMS BOPCBCR MFGEMCR	Fragile
	base	0.491	0.102	0.000	0.689		
	low	-0.814	0.176	0.023	0.839	RECGR WPICR BOPCBCR	
GRD	high	0.226	0.081	0.453	0.738	WPICR GRMS SUDFGDPC	Fragile
	base	0.013	0.060	0.821	0.689		
	low	-0.183	0.049	0.120	0.869	WPICR MFGEMCR SUDFGDPC	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.447	0.201	0.832	0.702	RECGR BOPCBCR SUDFGDPC	Fragile
	base	-0.160	0.113	0.179	0.734		
	low	-0.420	0.156	0.506	0.724	GRMS BOPCBCR SUDFGDPC	
GIPN	high	0.283	0.118	0.700	0.839	RECGR WPICR BOPCBCR	Fragile
	base	-0.098	0.073	0.203	0.729		
	low	-0.223	0.070	0.277	0.841	GRMS BOPCBCR MFGEMCR	
GTRP	high	42.834	17.951	0.707	0.839	RECGR WPICR BOPCBCR	Fragile
	base	-14.937	10.911	0.194	0.731		
	low	-33.131	10.740	0.303	0.839	GRMS BOPCBCR MFGEMCR	
GFDI	high	0.057	0.014	0.068	0.862	RECGR BOPCBCR MFGEMCR	Fragile
	base	0.003	0.013	0.823	0.688		
	low	-0.053	0.020	0.591	0.845	RECGR WPICR BOPCBCR	

Table B.20 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 020 (Transport equipments)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.404	0.176	0.000	0.912	RECGR BOPCBCR MFGEMCR	Robust
	base	0.682	0.076	0.000	0.864		
	low	0.499	0.084	0.000	0.884	WPICR BOPCBCR SUDFGDPC	
GRD	high	0.034	0.011	0.284	0.923	RECGR GRMS MFGEMCR	Fragile
	base	0.002	0.011	0.838	0.864		
	low	-0.024	0.012	0.937	0.884	WPICR BOPCBCR SUDFGDPC	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.164	0.086	0.927	0.912	RECGR BOPCBCR MFGEMCR	Fragile
	base	-0.006	0.084	0.941	0.864		
	low	-0.196	0.071	0.477	0.933	WPICR MFGEMCR SUDFGDPC	
GIPN	high	0.166	0.071	0.752	0.909	WPICR BOPCBCR MFGEMCR	Fragile
	base	-0.001	0.046	0.978	0.864		
	low	-0.201	0.073	0.464	0.882	RECGR BOPCBCR SUDFGDPC	
GTRP	high	15.535	7.290	0.898	0.911	WPICR BOPCBCR MFGEMCR	Fragile
	base	-0.201	5.343	0.970	0.864		
	low	-21.549	8.057	0.515	0.880	RECGR BOPCBCR SUDFGDPC	

Table B.21 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 021 (Precision instruments)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.095	0.164	0.000	0.715	RECGR MFGEMCR SUDFGDPC	Robust
	base	0.532	0.157	0.004	0.462		
	low	0.223	0.176	0.007	0.508	WPICR BOPCBCR SUDFGDPC	
GRD	high	0.050	0.018	0.492	0.552	RECGR WPICR GRMS	Fragile
	base	0.007	0.018	0.691	0.462		
	low	-0.027	0.015	0.849	0.711	WPICR MFGEMCR SUDFGDPC	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.585	0.188	0.292	0.672	GRMS BOPCBCR MFGEMCR	Fragile
	base	0.177	0.177	0.335	0.501		
	low	-0.353	0.201	0.811	0.596	RECGR WPICR SUNDFGDPC	
GIPN	high	1.703	0.506	0.202	0.599	GRMS BOPCBCR SUDFGDPC	Fragile
	base	0.582	0.357	0.127	0.554		
	low	-0.511	0.354	0.591	0.721	RECGR MFGEMCR SUDFGDPC	
GTRP	high	38.577	7.657	0.012	0.800	RECGR GRMS MFGEMCR	Robust
	base	17.742	8.622	0.060	0.592		
	low	1.164	6.961	0.055	0.803	BOPCBCR MFGEMCR SUDFGDPC	
GFDI	high	0.000	0.000	0.043	0.721	RECGR GRMS SUDFGDPC	Fragile
	base	0.000	0.000	0.161	0.532		
	low	-0.000	0.000	0.314	0.663	WPICR BOPCBCR MFGEMCR	

Table B.22 EBA Test Results for I-variables and M-variables (Taiwan)
Manufacturing 022 (Miscellaneous industry)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.900	0.197	0.026	0.547	WPICR MFGEMCR SUDFGDPC	Fragile
	base	0.363	0.137	0.019	0.501		
	low	-0.076	0.175	0.146	0.564	WPICR GRMS BOPCBCR	
GRD	high	0.017	0.008	0.985	0.574	RECGR WPICR GRMS	Fragile
	base	-0.002	0.008	0.770	0.501		
	low	-0.021	0.009	0.736	0.537	BOPCBCR MFGEMCR SUDFGDPC	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.450	0.174	0.576	0.577	WPICR GRMS BOPCBCR	Fragile
	base	-0.009	0.139	0.946	0.501		
	low	-0.372	0.157	0.723	0.546	RECGR MFGEMCR SUDFGDPC	
GIPN	high	0.476	0.190	0.631	0.556	WPICR BOPCBCR SUDFGDPC	Fragile
	base	0.007	0.150	0.961	0.500	RECGR MFGEMCR SUDFGDPC	
	low	-0.464	0.186	0.636	0.551	RECGR MFGEMCR SUDFGDPC	
GTRP	high	36.522	9.990	0.128	0.647	WPICR GRMS BOPCBCR	Fragile
	base	5.391	8.345	0.529	0.506		
	low	-14.497	9.376	0.659	0.535	RECGR MFGEMCR SUDFGDPC	

Appendix C: EBA Results of Korean Manufacturing Industries

Table C.01 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 29 (Food, beverage and tobacco)

I-variable			standard error	p-value	R^2	Other variables	Robust/ Fragile
GOP	high	1.091	0.181	0.000	0.720	DCP DIM CUN	Robust
	base	0.498	0.114	0.000	0.716		
	low	0.960	0.142	0.000	0.740	DCG DM1 DUN	
GRD	high	0.021	0.093	0.819	0.739	DCP DCG DUN	Fragile
	base	-0.23	0.087	0.979	0.716		
	low	-0.002	0.094	0.980	0.719	DCP DEX DUN	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	-0.115	0.218	0.599	0.743	DCG DEX DUN	Fragile
	base	-0.037	0.198	0.851	0.716		
	low	-0.142	0.219	0.524	0.741	DCG DIM DUN	
GIPN	high	-0.012	0.010	0.286	0.735	DCP DEX DIM	Fragile
	base	-0.011	0.010	0.270	0.730		
	low	-0.013	0.010	0.226	0.752	DCG DIM DUN	
GTRP	high	-0.184	0.191	0.346	0.746	DCG DIM DUN	Fragile
	base	-0.102	0.179	0.574	0.720		
	low	-0.184	0.191	0.346	0.746	DCG DIM DUN	

Table C.02 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 30 (Textiles, wearing apparel and leather)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	High	0.650	0.107	0.000	0.734	DCP DM1 DUN	Robust
	Base	0.498	0.113	0.000	0.499		
	Low	0.384	0.143	0.013	0.545	DCP DCG DEX	
GRD	High	-0.047	0.087	0.598	0.723	DM1 DEX DUN	Fragile
	Base	0.033	0.107	0.761	0.499		
	Low	-0.047	0.087	0.598	0.723	DM1 DEX DUN	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	-0.182	0.133	0.184	0.606	DCP DM1 DEX	Fragile
	base	-0.181	0.136	0.196	0.531		
	low	-0.211	0.126	0.107	0.652	DCG DM1 DEX	
GIPN	high	0.018	0.007	0.024	0.651	DCG DEX DIM	Robust
	base	0.013	0.008	0.096	0.551		
	low	0.013	0.006	0.041	0.770	DCG DM1 DUN	
GTRP	high	0.123	0.055	0.037	0.746	DEX DIM DUN	Fragile
	base	0.091	0.069	0.198	0.530		
	low	0.114	0.055	0.050	0.740	DCG DIM DUN	

Table C.03 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 32 (Paper and paper products, printing and publishing)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.818	0.154	0.000	0.578	DCP DIM DUN	Robust
	base	0.775	0.141	0.000	0.555		
	low	0.742	0.142	0.000	0.617	DCP DEX DIM	
GRD	high	-0.055	0.051	0.290	0.636	DCP DEX DUN	Fragile
	base	-0.054	0.053	0.308	0.555		
	low	-0.065	0.055	0.253	0.584	DCP DCG DUN	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.135	0.158	0.400	0.569	DCG DM1 DIM	Fragile
	base	0.119	0.132	0.378	0.570		
	low	-0.212	0.208	0.320	0.651	DCP DEX DUN	
GIPN	high	-0.02	0.009	0.049	0.677	DCP DEX DIM	Robust
	base	-0.021	0.009	0.044	0.655		
	low	-0.023	0.010	0.033	0.642	DCP DCG DM1	
GTRP	high	-0.240	0.241	0.328	0.651	DM1 DEX DUN	Fragile
	base	0.021	0.211	0.921	0.554		
	low	-0.240	0.241	0.328	0.651	DM1 DEX DUN	

Table C.04 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 33 (Chemical, petroleum, coal, rubber and plastic)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	1.022	0.106	0.000	0.831	DCP DM1 DUN	Robust
	base	0.923	0.097	0.000	0.783		
	low	0.791	0.098	0.000	0.846	DCP DCG DIM	
GRD	high	0.147	0.121	0.237	0.831	DCP DM1 DUN	Fragile
	base	0.033	0.119	0.782	0.783		
	low	0.147	0.121	0.237	0.831	DCP DM1 DUN	

M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	0.399	0.199	0.057	0.852	DM1 DCG DEX	Fragile
	base	0.211	0.205	0.313	0.792		
	low	0.375	0.203	0.078	0.849	DM1 DEX DUN	
GIPN	high	-0.026	0.012	0.048	0.854	DCP DCG DEX	Fragile
	base	0.794	-0.015	0.012	0.248		
	low	-0.026	0.012	0.048	0.854	DCP DCG DEX	
GTRP	high	-0.141	0.255	0.585	0.848	DCP DCG DIM	Fragile
	base	-0.033	0.281	0.906	0.784		
	low	-0.141	0.255	0.585	0.848	DCP DCG DIM	

Table C.05 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 34 (Non-metallic mineral product)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.957	0.215	0.000	0.529	DCP DEX DUN	Robust
	base	0.871	0.212	0.000	0.411		
	low	0.739	0.227	0.003	0.489	DCP DCG DIM	
GRD	high	0.209	0.156	0.194	0.529	DCP DEX DUN	Fragile
	base	0.145	0.161	0.375	0.411		
	low	0.203	0.148	0.184	0.571	DCP DEX DUN	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.193	0.140	0.184	0.604	DCP DM1 DUN	Fragile
	base	-0.023	0.128	0.860	0.412		
	low	0.193	0.140	0.184	0.604	DCP DM1 DUN	
GIPN	high	-0.014	0.016	0.390	0.504	DCG DM1 DEX	Fragile
	base	-0.007	0.016	0.683	0.415		
	low	-0.015	0.016	0.369	0.498	DCP DCG DM1	
GTRP	high	0.612	0.231	0.014	0.658	DCP DIM DUN	Fragile
	base	0.302	0.227	0.196	0.449		
	low	0.418	0.197	0.045	0.663	DM1 DIM DUN	

Table C.06 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 35 (Basic metal)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.648	0.132	0.000	0.515	DCP DM1 DUN	Robust
	base	0.573	0.126	0.000	0.432		
	low	0.591	0.132	0.000	0.489	DCP DCG DIM	
GRD	high	-0.067	0.097	0.494	0.491	DCG DM1 DIM	Fragile
	base	-0.024	0.088	0.783	0.432		
	low	-0.075	0.097	0.449	0.483	DM1 DIM DUN	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.448	0.782	0.292	0.513	DCG DEX DIM	Fragile
	base	-0.252	0.202	0.224	0.464		
	low	-0.271	0.216	0.629	0.486	DCG DIM DUN	
GIPN	high	0.013	0.013	0.307	0.512	DCP DCG DUN	Fragile
	base	0.010	0.012	0.467	0.444		
	low	0.012	0.013	0.378	0.475	DCP DIM DUN	
GTRP	high	0.211	0.158	0.197	0.495	DCP DIM DUN	Fragile
	base	0.192	0.152	0.218	0.466		
	low	0.208	0.153	0.187	0.527	DCP DCG DUN	

Table C.07 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 36 (Fabricated metal products and machinery)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.855	0.112	0.000	0.721	DM1 DI1 DUN	Robust
	base	0.758	0.114	0.000	0.635		
	low	0.775	0.118	0.000	0.723	DCP DEX DUN	
GRD	high	-0.162	0.140	0.261	0.731	DCP DM1 DUN	Fragile
	base	-0.103	0.15	0.495	0.635		
	low	-0.181	0.142	0.214	0.721	DM1 DEX DUN	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.515	0.248	0.049	0.701	DCP DCG DIM	Fragile
	base	0.296	0.226	0.201	0.657		
	low	0.487	0.228	0.044	0.755	DCP DIM DUN	
GIPN	high	-0.021	0.009	0.040	0.776	DCP DM1 DUN	Robust
	base	-0.028	0.010	0.008	0.722		
	low	-0.026	0.010	0.018	0.731	DCP DCG DIM	
GTRP	high	-0.295	0.172	0.100	0.722	DCG DIM DUN	Robust
	base	-0.336	0.161	0.048	0.687		
	low	-0.303	0.167	0.083	0.711	DCP DCG DEX	

Table C.08 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 38 (Light industry)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.761	0.109	0.000	0.754	DCP DM1 DUN	Robust
	base	0.604	0.093	0.000	0.609		
	low	0.491	0.095	0.000	0.725	DCP DCG DIM	
GRD	high	-0.059	0.033	0.089	0.703	DCP DEX DUN	Fragile
	base	-0.048	0.039	0.223	0.609		
	low	-0.065	0.033	0.059	0.755	DCG DIM DUN	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	-0.216	0.119	0.081	0.741	DCP DCG DM1	Fragile
	base	0.629	-0.155	0.246	0.629		
	low	-0.216	0.119	0.081	0.741	DCP DCG DM1	
GIPN	high	0.005	0.004	0.280	0.758	DCP DIM DUN	Fragile
	base	0.003	0.005	0.560	0.614		
	low	0.005	0.004	0.280	0.758	DCP DIM DUN	
GTRP	high	0.076	0.114	0.516	0.764	DEX DIM DUN	Fragile
	base	-0.035	0.130	0.786	0.611		
	low	-0.076	0.123	0.532	0.707	DCP DCG DM1	

Table C.09 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 39 (Heavy industry)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.961	0.141	0.000	0.671	DM1 DEX DUN	Robust
	base	0.789	0.131	0.000	0.574		
	low	0.73	0.136	0.000	0.651	DCP DCG DIM	
GRD	high	0.047	0.064	0.470	0.652	DCP DEX DIM	Fragile
	base	0.035	0.067	0.607	0.574		
	low	0.041	0.058	0.487	0.721	DCG DIM DUN	
M-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GEXP	high	-0.247	0.154	0.123	0.717	DCP DCG DUN	Fragile
	base	-0.317	0.161	0.060	0.629		
	low	0.292	0.195	0.149	0.636	DCP DCG DM1	
GIPN	high	-0.011	0.009	0.198	0.705	DCG DM1 DUN	Fragile
	base	-0.012	0.010	0.191	0.601		
	low	-0.015	0.009	0.112	0.656	DCG DM1 DEX	
GTRP	high	-0.211	0.122	0.099	0.722	DCP DCG DUN	Robust
	base	-0.272	0.121	0.035	0.642		
	low	-0.262	0.134	0.063	0.657	DCP DCG DM1	

Table C.10 EBA Test Results for I-variables and M-variables (Korea)
Manufacturing 40 (Total manufacturing)

I-variable			standard error	p-value	R^2	other variables	Robust/ Fragile
GOP	high	0.905	0.132	0.000	0.698	DCP DM1 DUN	Robust
	base	0.637	0.123	0.000	0.543		
	low	0.611	0.122	0.000	0.616	DCP DCG DIM	
GRD	high	-0.087	0.099	0.386	0.700	DCG DIM DUN	Fragile
	base	-0.130	0.112	0.259	0.543		
	low	-0.111	0.112	0.333	0.616	DCP DCG DIM	
M-variable			**standard error**	**p-value**	**R^2**	**other variables**	**Robust/ Fragile**
GEXP	high	0.142	0.234	0.550	0.699	DCG DEX DUN	Fragile
	base	-0.176	0.209	0.406	0.555		
	low	-0.132	0.226	0.564	0.578	DCP DCG DM1	
GIPN	high	-0.008	0.006	0.195	0.695	DCG DM1 DUN	Fragile
	base	-0.008	0.006	0.179	0.574		
	low	-0.010	0.006	0.114	0.630	DCG DM1 DEX	
GTRP	high	-0.166	0.117	0.169	0.698	DCG DM1 DUN	Fragile
	base	-0.200	0.126	0.126	0.583		
	low	0.212	0.134	0.130	0.613	DCP DCG DM1	