



## WORKING PAPERS

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Investment and Exports:  
A Trade Share Perspective

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# **Investment and Exports: A Trade Share Perspective**

by

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## **1. Introduction**

The relationship between investment and trade competitiveness has long intrigued economists. For many years the following story has been told: capital investment leads to improved productivity and more reliable state-of-the-art products. Improved productivity means either lower prices or larger returns to capital, labor or even all three. The ability to make products that are on the cutting edge of technology, and, are highly reliable increases a country's market share.

The focus of this paper is an attempt to evaluate this cutting-edge-reliability influence of investment upon export performance. The measuring rod of the influence will be what is called a trade share: the exporting (investing) country's share of the imports of another country. We will try to measure how a trade share responds to higher investment. We will do this using INFORUM's new model of bilateral trade that is, for the first time, being used as the linkage mechanism for INFORUM's international system of models. We will not examine, in this paper, the effect of investment on lowering the prices of the exporter and so influencing these trade shares, nor will we examine the macroeconomic questions regarding investment, savings and the balance of trade.

Section two of the paper will very briefly review INFORUM's Linked System of International Models. Part three will summarize the INFORUM's Bilateral Trade Model(BTM). Section four will examine the role of investment in trade shares and trade performance. The last section will summarize some conclusions to be drawn from the work.

## **2. Background: National Models**

INFORUM has been in the process of constructing a linked system of multisectoral models for more than 25 years. The process began in 1971 with interest in Austria. Significant advancement occurred around 1980 with an expansion that included Germany (west), France, Italy and Japan. The system has been operational since the early 1980s. Ten years later it had expanded to include some nine countries (Nyhus, 1991). Today, it links, at the level of individual industries, models of some thirteen countries: USA, Canada, Mexico, Japan, Korea, China, Germany, France, Italy, the UK, Spain, Austria and Belgium. Each of these models uses price and import information from the other models as input data in the calculation of its own prices, production, imports, investment, employment, etc. The sectoral detail varies from 44 sectors (Spain) to 100 sectors (Japan). These

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models are all macroeconomic dynamic multisectoral models, where:

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- *macroeconomic* means that the models produce the usual results of a macroeconomic model - GDP, inflation, employment, unemployment - in an econometrically estimated system of equations;
- *dynamic* as originally employed by Leontief, means that investment depends upon, among other things, output and the rate of growth of output;
- *multisectoral* means that models use input-output matrices with coefficients that change over time as an integral part of the determination of production and prices by sector, and, that macroeconomic aggregates are generally derived as the sum of the sectoral detail.

### **3. Background: The Bilateral Trade Model**

The current bilateral trade model is a major extension of INFORUM's first comprehensive trade model (Nyhus, 1975,1978). The linked international system, as envisaged in the Nyhus study, would work like a solar system, as depicted in Figure one, in which the trade model is treated as the sun and the country models as the planets. The "sun" draws imports and export (or domestic) prices to itself and radiates exports and import prices back to the "planets." Thus export prices and imports together with import prices and exports are determined simultaneously through an iterative solution process of the trade model and the national models.

**Figure 1**  
**Linked International System**

The “solar system” plan, the initial trade model of 20 years ago, was very ambitious because of the modest country models then in existence. The trade model placed a very heavy reliance on the role of prices in the determination of the country of origin for imports. Then, the main emphasis in the national models was on the “real” or constant-price part of the model. Price forecasts, therefore, needed to be developed in the national models. It was a major undertaking. Indeed, eight years later, at the end of 1984, only the models of the United States, Japan and Italy had domestic prices as an integral part of the forecasts that each produced. Today, by contrast, domestic price projections are available in all of INFORUM’s national models. After twenty years, it was time for a new model of trade with an updated data base that reflected the country makeup of the current INFORUM system that the new model would address. It would continue to follow the “solar system” outline of its predecessor.

The central role of the Bilateral Trade Model (BTM) in INFORUM’s Linked System of input-output models is to produce forecasts of bilateral trade by commodity in which global exports equal global imports at the commodity level. BTM begins with a series of 120 trade flow matrices for commodities covering all of merchandise trade. The trade data is based primarily on import statistics. For each commodity, there is a separate matrix for each year from 1974-1991. Table one, on the next page, shows such a matrix for the Basic Chemicals sector for the year 1990. In Table one we see that the USA’s exports to Japan (USA row, Japanese column) amounted to \$2629 million US dollars in 1990. Generalizing, the rows of the matrices show exports of the row country flowing to the column country. Again, in Table one, we see that there is the corresponding trade share matrix for the trade flow matrix. The trade share matrix is calculated by dividing each cell (or flow) by the sum of all of the flows in the trade flow matrix column. In our example from Table one, we divide 2629 by 7879 to obtain the .334 shown in the trade share matrix. Thus, these trade shares show, for the importing country, for a specific commodity, the proportion received from each exporter. BTM’s job is to allocate each country’s forecasts of imports to their source countries in accordance with forecasts of the commodity trade-shares matrices. Summing the allocated imports of a particular product across a row then yields a forecast of exports of that country that is consistent with the imports of the other countries.

BTM is a multisectoral world trade model for 16 trading partners and 120 commodity categories. The 16 trading partners are Canada, USA, Mexico, Japan, Korea, China, Taiwan, Austria, Belgium, France, Germany, Italy, Spain, UK, Rest of the OECD (e.g., Sweden, Switzerland, Australia, etc.) and Rest of the World. This model was built by Qiang Ma and for a complete listing of the commodities see Ma(1995).

In BTM, the trade shares are not constant. Each element of the trade-shares matrix is a function of relative price, relative capital stock growth and other factors. The main task of the bilateral trade model is to forecast the share, here denoted by  $S$ , matrices. Mathematically, the typical equation for the  $S_{ijt}$  element of the trade-shares matrix for a given commodity is written as follows:

$$S_{ijt} = \beta_{ij0} * \left(\frac{P_{it}}{PW_{jt}}\right)^{\beta_{ij1}} * \left(\frac{K_{it}}{KW_{jt}}\right)^{\beta_{ij2}} * e^{\beta_{ij3}T_t}$$

where,

- $S_{ijt}$  = the share of country  $i$  in the imports of a product into a country  $j$  in year  $t$  (0 denotes the base year 1990);
- $P_{it}$  = the effective price of the good in country  $i$  (exporter) in year  $t$ , defined as a moving average of domestic market or export prices for the last three years;
- $PW_{jt}$  = the world price of the good in question as seen from country  $j$  (importer) in year  $t$ ;
- $K_{it}$  = an index of effective capital stock in the industry in country  $i$  in year  $t$ , defined as a moving average of the capital stock indices for the last three years;
- $KW_{jt}$  = an index of world average capital stock in the industry as seen from country  $j$  in year  $t$  with the country weights being  $S_{ij0}$ ;
- $T_t$  = the so-called Nyhus trend variable, set to zero in the base year;
- $\beta_{ij0}$ ,  $\beta_{ij1}$ ,  $\beta_{ij2}$ ,  $\beta_{ij3}$  are estimated parameters.

Several items shown above need a further explanation. The world price is the weighted average price of all exporters of the good to country  $j$  where the weights are from the 1991 trade share matrix. Thus, because shares vary by country, the world price varies by country. The Nyhus trend is logistic in nature. For the usual linear time trend the increment from one period to the next is one. In the Nyhus trend, the increment is one less the value of the share in the previous year ( $1 - S_{ijt-1}$ ). For small trade shares, the value of the usual normal trend and the Nyhus trend are nearly identical; for large values of the trade shares the Nyhus trend grows more slowly. Thus, as the trade share grows, it appears, under the Nyhus trend, that the trend itself “slows” down.

The capital term needs a fuller explanation. Individual exporting country capital stock indices are derived from investment data. Capital investment has been cumulated with a rather short life-span. A depreciation rate of 8% per year is assumed, i.e., an average life of about 12 years. Thus, these capital stock terms show the presence of relatively new capital. One further note is in order here. Since there is often little knowledge of the capital stock in the first period, the capital stock estimates were adjusted by the “unit-bucket” method (Almon, 1994, pp87ff). Finally, by using the same method of calculating the capital stock for all countries, we avoid the many variances in historical estimation inherent in using capital stock data from different countries.

The technique employed by Ma to estimate the trade share equation is to accept only coefficients with “appropriate” signs. By appropriate, we mean a negative for  $\beta_{ij1}$ , the price term, and a positive for  $\beta_{ij2}$ , the capital stock term. The equation is first estimated with prices and capital stocks without a trend term. If both terms are of the “right” sign, those coefficients are chosen. If not, the trend variable is added to the equation, if both now correct, stop. Again, if not, try price alone and, if correct, chose this one. If not, try the capital term in the same manner. If nothing else works, use the trend term alone. See Ma (1995) for complete results.

#### 4. The Role of Investment in Trade Shares

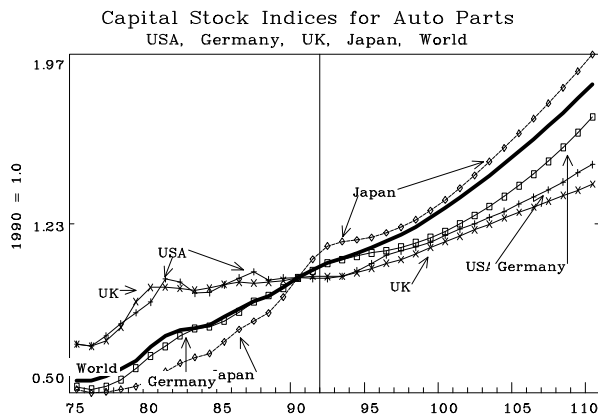
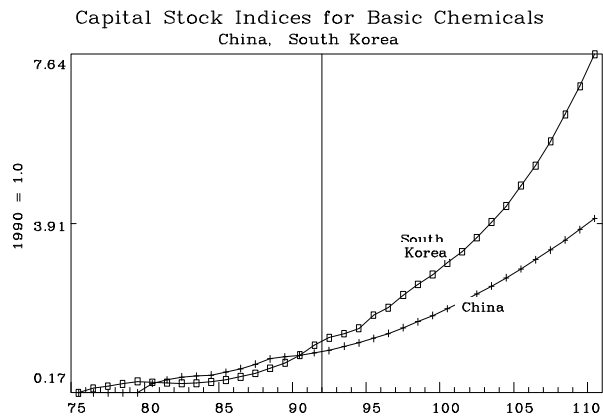
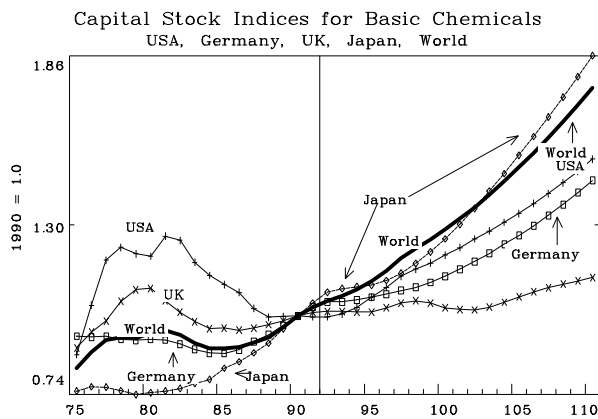
Let us begin by examining the capital stock indexes, the  $K_{it}$ , used in the bilateral trade equation given in the previous section. Figures two and three show the capital indices for Basic Chemicals,

one of the 120 sectors of trade in BTM. The indices for the USA, Germany, Japan, the UK, South Korea and China are shown. In addition, a world index also has been calculated. It is the weighted average of all of the country indices with 1990 exports used as weights. The vertical line placed after the year 1991 shows that BTM will be forecasting trade shares after that date. Some of the Investment data used to make up the indices is known after that date. Figure two illustrates the fact that capital investment in the USA, in particular, and in Europe slowed dramatically during the 1980's. That was not so for Japan, Korea or China as seen in Figure three. Our forecasts show a recovery in the USA and Germany but not much expansion in the UK. The growth in China and Korea is particularly strong - note that the scales of the two figures are very different.

Figure 2  
Figure 4

Figure 3

In Figure 4 we have the same country indices but the commodity this time is Auto Parts. Here the growth in the capital stock has been much steadier than that for the chemical sector. Inspection shows that the slowing of investment in the 1980's is also apparent here but in a much more muted



form than that found in the Chemical industry. Again we see that the Japanese index rose more rapidly than the world average in the past but, in our forecast, Japan grows at about the rate of the world average for the next fifteen years. The UK forecast, while the slowest of this group of countries, remains only slightly slower than the average.

Figures five and six show some overall averages of the capital stock data. To form these averages we begin by weighting the sector-specific indexes (some 120) by their respective sector exports to compute a country specific, trade-weighted capital stock index. A world average capital

stock index also is computed by weighting the country indices (again using 1990 exports as weights). Such indices are shown in the first two graphs below for the same six countries which were shown earlier and the world average.

Figure 5

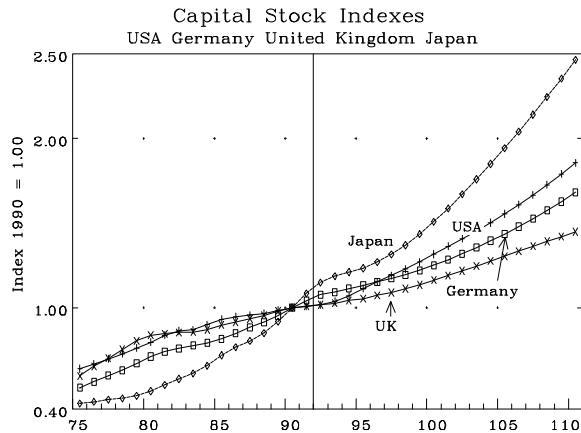
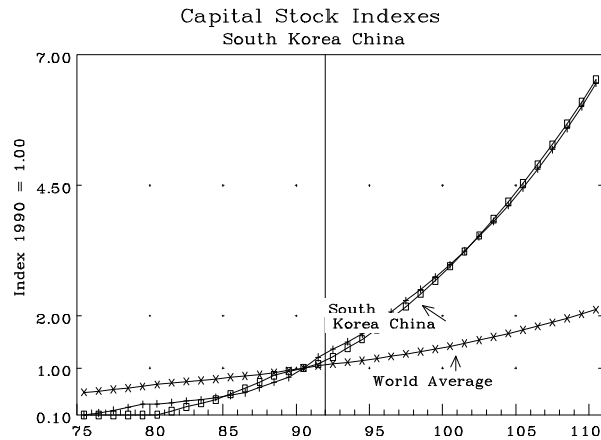


Figure 6



The four fully developed economies have capital stock indexes (1990 = 1.0) of between 1.3 (UK) and 2.5 (Japan) by 2010; the two quickly developing economies have indexes more than two and a half times (6.5) that of Japan by 2010. Also note that only Japan's index among the fully developed countries shown here grows faster than the world's average index.

The role of these capital stocks in influencing trade shares clearly depends on the rapidity of investment growth and the absolute size of the capital coefficients,  $\beta_{ij2}$ . Therefore, let us now examine these estimated parameters.

Since there are 28,800 such parameters (15 exporters X 16 markets X 120 commodities) we cannot examine them by inspection. It seems that the best method would be to alter our estimate of the capital stock and see what happens to the forecasts of the forecast of exports. Therefore, we are led to examine the question of what would happen to exports for country  $i$  if the capital stock of country  $i$  were to grow 1 percent per year faster, *ceteris paribus*? Please note that we are specifically not looking into investment effects on prices or import demands.<sup>2</sup> Thus, for example, when we look at the South Korean experiment, we will not consider the results of this increased investment demand on total import demand or even sector import demand or how that investment might raise capital and labor productivity so that prices might be reduced. Rather, we will concentrate strictly the effect of

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<sup>2</sup>These effects are modeled in the national models. Thus, there could be a different effect of an increase in investment on exports depending upon whether one is using the BTM alone, as is being done here, or in conjunction with the national models.

increased investment demand *within the trade model itself*. We will show how the effects of changes in the capital stock alter trade shares which in turn alter exports.

The technique employed here is simple and direct. For each country, in turn, we replaced its capital stock term by one in which there was no capital stock change. Next, we use BTM to estimate the trade shares and to calculate the resulting exports. We then measured the percentage change in the exports of that country against a reference forecast of exports in which we used INFORUM's country models for the source of the investment figures. An aggregate capital stock index was derived using 1990 sector exports as weights on the sector specific capital stock indexes. Then we calculated the percentage change in the overall capital stock index. Dividing the percentage change in exports by the percentage change in the capital stock index, we derived an aggregate elasticity of exports with respect to capital stock. The precise figures shown below are an average of the yearly (2000-2010) point estimates. A sampling of aggregate and sectoral results is shown below.

**Table 2**

**Trade Weighted Capital Stock Elasticities**

Country	Aggregate	Furniture	Basic Chemicals	Iron & Steel	Auto- parts	Aircraft
United States	.58	.82	.37	.80	.40	.36
Japan	.50	1.32	.50	.48	.32	.00
Germany	.49	.32	.27	.37	.28	.55
United Kingdom	.24	.24	.32	.30	.36	.02
South Korea	.54	.23	.11	.10	.06	.11
China	.28	.05	.02	.16	.07	.00

One thing is clear from the first column of figures: investment is a significant factor in the determination of trade shares and yet none of the estimates is unreasonably large. There is some variance in the elasticity estimates across countries and across commodities. It is interesting that the estimates for South Korea, Germany, Japan and the USA are rather close together while those for China and UK while close to each other, are rather far from the first group. On a sectoral level there is more variation. The rather low estimates for China and Korea are most likely the result of the fact that during the estimation period these industries had huge increases (several times over) in their capital stocks since, as developing countries, they were starting from such low bases. For them, exports increased but not nearly as much as the stock of capital. In addition, prices undoubtedly also have played a major role. Remember that our experiment looks at investment in isolation from prices.

The next series of figures will help us see the possible effects of investment upon trade. In Figures 2-6 we saw the indices of the capital stock for a select group of commodities and countries. In Table two we have just observed the capital stock elasticities. Let us suppose that a country's capital stock had not grown as it had but rather at the rate of the "world average." What, then, would exports have been? Clearly, if a particular country's index is greater than that of the "world average,"



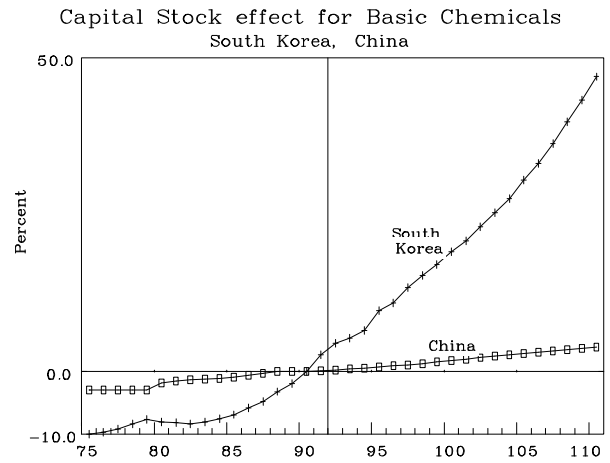
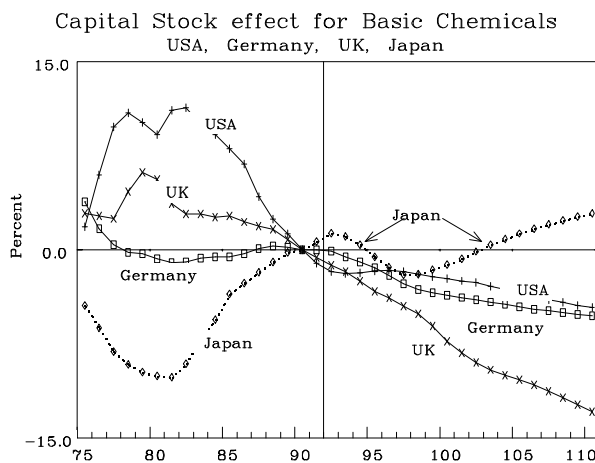
its exports are greater than they would have been if its index had only been equal to the average.<sup>3</sup> That difference in capital stock, combined with elasticity gives us an impression of the capital effect on trade.

Figures 7-9 show how much a particular country's greater than average investment rate will help exports or less than average investment rate will hinder exports for two selected commodities, Basic Chemicals and Auto Parts.

Figure 7

Figure 8

The Japanese line is particularly interesting in Figure seven. Japan's investment history during the 1970s obviously is quite different from that of the other developed countries. The relative



investment slowdown of the late 1970s shows up rather strongly; then followed by the investment boom of the late 1980s. The early 1990s have been a period of rather high investment (as a level) but no growth. Thus, since our measure of the capital stock is for new machinery, the capital stock dips slightly in the mid-1990s when investment stagnates. The result is that there is now a "capital" drag on exports. The pickup after 1998 is part of a general Japanese surge in growth arising from the expected restructuring of its wholesale and retail trading mechanisms.

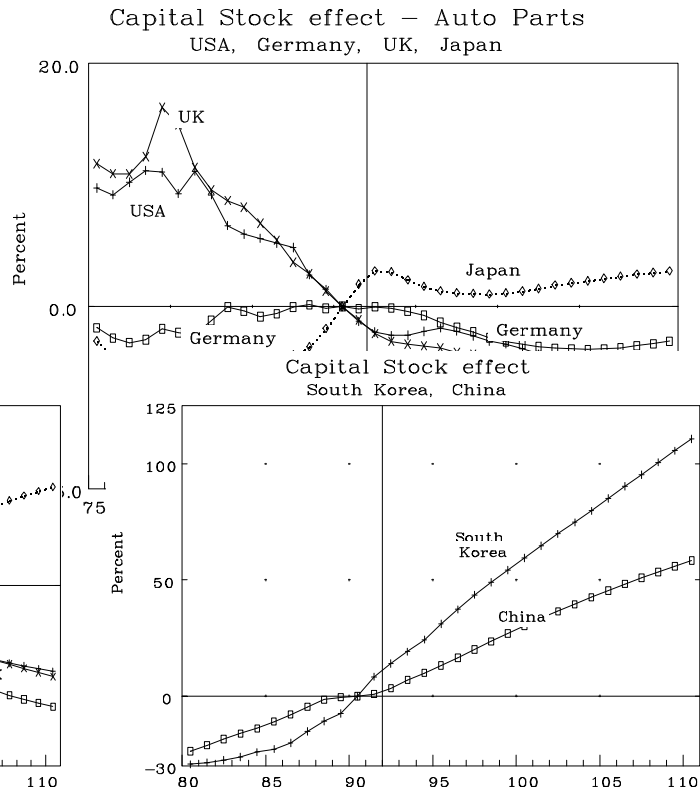
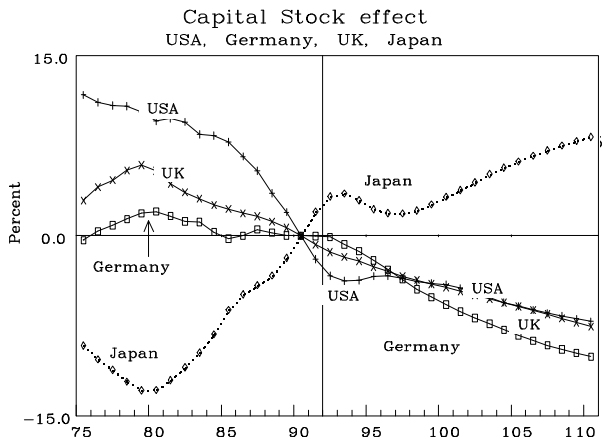
The sluggish growth in British investment appears, by our forecast, to be cutting significantly into the UK's export potential. Conversely, tremendous growth in Korean investment appears ready to continue Korea's rapid penetration of export markets. The capital effects on the USA and German exports appear to be rather modest, and reflect mature economies with gradually shrinking potential for growth.

<sup>3</sup>This is true since all of the individual share capital stock elasticities (16 per commodity for each exporting country) are constrained to be zero or positive in the estimation.

Figure 9

Figure nine shows the capital stock effect for Auto Parts. The Japanese line is generally similar to its counterpart for Chemicals except that here the stock effect remains positive throughout the forecast period. It is interesting that the forecast periods are not merely straight lines but rather curves that may and sometimes do change direction. A case in point is the turnaround in the German forecast.

Figure 10  
Figure 11



Figures ten and eleven show the estimated effects at an aggregate level. The startling thing is that this capital stock effect is roughly the same size for the UK, the USA and Germany, though the capital stock elasticities shown in Table two above are quite different. The difference in elasticity is evidently about equally compensated for by the projected growth of the trade-weighted capital stocks. Another important result is that the capital stocks affect the overall projection of exports. The fact that the German and American forecasts are about 10% lower because of slower capital stock growth is important. The positive effect of investment that we observed in two of the detailed sectors is even more strongly apparent in the aggregate picture.

In comparing the two figures, observe that the scales of the two graphs are different. The evident reliance of South Korean and China on investment growth is equally significant.

**5. Conclusion**

What conclusions should we draw from this analysis? First, capital investment has had and will continue to have a significant influence on the dynamics of bilateral merchandise trade. Therefore, the influence of investment extends beyond the scope of purely domestic economic affairs of prices and productivity into the sphere of the foreign sector. Second, investment is clearly a major factor in the ability of newly industrializing economies to penetrate foreign markets. Third, INFORUM forecasts and policy studies will now be able to consider the influence of policies that affect investment on trade performance and industrial competitiveness.

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