A THREE COUNTRY COMPARISON OF THE IMPACT OF SLOWER GROWTH ON THREE INDUSTRIES USING INPUT-OUTPUT ANALYSIS

Douglas E. Nyhus

March 1979
WP-79-21

Prepared for the Seventh
International Conference on
Input-Output Techniques
Innsbruck, Austria 9-13 April 1979

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria

A THREE COUNTRY COMPARISON OF THE IMPACT OF SLOWER GROWTH ON THREE INDUSTRIES USING INPUT-OUTPUT ANALYSIS

INTRODUCTION

Western Europe has, in the 1970's, entered a period of reduced real growth. During the boom times of the 1960's, nearly all industries were growing at a rate allowing employment to remain, at worst, relatively constant. During this present decade, Western European industry first experienced a recession and is now in the process of a recovery in which output growth seems to be substantially below that of the 1960's. Some industries have made the change to the reduced growth rates with relative ease while others have encountered severe adjustment difficulties.

Were warning flags in evidence in the 1960's pointing to industries which would be particularly sensitive to a slowdown in overall real growth? If so, what were these flags? Where can we see them most clearly? Do they have any bearing on the outlook for

Western Europe in 1985?

This paper is divided into three main parts. Section I will discuss why Input-Output analysis is particularly well suited to the examination of the patterns of industrial growth. This section will also discuss the particular choice of countries and industries in this paper. Section II will discuss some of the equations used in each of the national models and the particular warning flags associated with each. This section will also discuss the various sources of data. Section III contains detailed cross-country comparisons of three industries. International differences and similarities are highlighted. Finally, a short summary of the findings will be made in a table comparing past with projected growth rates to 1985 of the industries discussed.

I. WHY INPUT-OUTPUT ANALYSIS

Even in the simplest Input-Output model, the sales of an industry are derived from at least two sources - sales to itself and to other industries, and sales to final demand. A decline in the rate of growth of sales to either of these sources will cause a decline in the rate of growth of output unless compensated by increases in the other one. On the other hand, it is quite possible for the rate of growth of one source, say intermediate sales, to slow and the rate of growth of the other, final demand sales, to grow and so leave the total output growth unchanged.

In more detailed models, such as the ones which are discussed in this paper, final demand is broken into several parts. These parts are: sales to government; sales to capital equipment pur-

chasers; sales to consumers; sales to inventory change; sales to foreigners (exports); and, finally, purchases (negative sales) from foreigners (imports). In this paper, the sales of an industry will be divided into four categories - sales to intermediate users, sales to exports, sales from imports, and sales to other components of final demand. We will then be able to discuss whether a sharp decline in the rate of growth of industrial output is due to a decline in rate of growth of sales to one, two or any combination of the four categories. Specifically, one industry might be highly vulnerable to import substitution, another to a decline in export markets, and yet another to substitution of other commodities in the production process itself. In short, Input-Output analysis can address itself directly to such questions. If the reason for an industry's problem can be isolated, appropriate economic policy is much more likely to be applied than in the situation where all we see is declining output and all we hear from industry sources is that imports are driving firms out of production.

The list of potential industries of choose to examine is long. However, for expositional purposes, only three have been chosen - iron and steel, shoes (leather products) and plastics. The first two are clearly identified as industries in trouble. Since one, shoes, sells primarily to private consumers while the other, iron and steel, sells primarily to other industries, that the causes of their problems may be different. The third industry, plastics, is presented to show the contrast between industries with many prob-

lems and one which seems to be adjusting well.

Input-Output models for the USA (Almon,et al 1974), Japan (Lee, 1976), Belgium (Vanwynsberghe,Nyhus,Almon, 1977), France (Lee, 1978), and the Federal Republic of Germany (Nyhus, 1977) were available for national comparison. Models for the Netherlands, Hungary, Canada and the United Kingdom, while under construction as part of the IIASA-INFORUM international system of Input-Output models (Almon,Nyhus, 1977; Reimbold,Nyhus,1977), are not yet complete enough for full comparison. Models of Italy, Sweden, Poland which are planned as part of the system were also not available. Since this paper is concentrating on European industry the three functioning models in Europe have been selected for cross-country comparisons. The three actually make a good selection. They have common borders substantial foreign trade among themselves as well as with outsiders and similar industrial problems. The relative importance of the three industries varies substantially within the countries. Steel is very important in Belgium but less so (relatively at least) in France and the FRG. Similarly, the plastics industry is relatively larger in the FRG than in the other countries and the same can be said for the shoe industry in France.

II. METHODS AND DATA

As we mentioned earlier, Input-Output analysis allows us to divide the sales of an industry into four categories. The methods used to explain the first three of these - intermediate sales, imports and exports will now be discussed in more detail.

Intermediate sales

Time series data on individual cells of an input-output matrix are usually not available. Even when time series of input-output tables are available, an investigation into the sources of these data shows that the table for only one, or perhaps two, years is truly based on independently derived data. In the other years only the matrix row and column sums are known; and the individual flows are derived from the base year by a RAS or similar method. In all three national models we have studied change in Input-Output coefficients by entire rows.

In estimating the changes across an entire row, we first define the intermediate usage, U, as the sales to all other industries. So we have

$$U(i,t) = Q(i,t) - FD(i,t) - a(i,i)Q(i,t)$$

where

Q(i,t) is the constant price output of industry i in year t
FD(i,t) is the sum of all final demands in year t in constant prices
a(i,i)Q(i,t) is the estimated diagonal sale of industry i to itself where a(i,i) is from the base year table.

The diagonal term is excluded from the changes because it is primarily an accounting term. For instance if spark plugs are made in an automobile plant they appear as an input in the diagonal cell. On the other hand, if they are purchased from a spark plug manufacturer they appear as an input into automobiles from a non-automobile sector. Thus, the diagonal can vary a great deal depending on how such data are reported. The French input-output

table has no diagonal flows. At the other extreme, the Belgian and German tables have large diagonal flows.

The second step in looking at coefficient change is to construct an indicator of what the intermediate sales would have been if the coefficients had not changed. Thus, we define the Constant Coefficient Indicator, CCI, as follows:

$$CCI(i,t) = \sum_{\substack{j \\ j \neq i}} a(i,j)Q(j,t)$$

where a(i,j) is the base year input-output coefficient.

Note that we have again excluded the diagonal.

The third step is to construct and analyze the ratio

$$R(i,t) = U(i,t)/CCI(i,t) \quad .$$

A rising R over time implies, with a base year table late in the period of study, that constant coefficients underestimated the actual usage in the early years. Therefore, on the whole, the coefficients must have been growing. Another way of stating this is to say that industry i's intermediate sales were increasing proportionally faster than were the total sales of its buyers. Of course, for an industry in trouble the opposite will be the case. Indeed, a falling R is one clear warning flag for an industry. We will use our forecast of R to forecast the coefficients changes used in the model. The equation used to forecast R is logistic. We begin with the differential equation

$$(dR/dt) \quad (1/R) = b(s - R) \ ,$$

where s and b are parameters.
Specifically, s is the asymptote of the logistic function. The solution of the differential equation is

$$R(t) = s/ \ (1 + A \, e^{-bst})$$

where A is a constant of integration.

Some properties of the above equation must be noted. The first is that the percentage change in R slows down as R approaches the asymptote "a". Thus the percentage movement in R is always lower for a future period than for a past one. The parameter b determines how fast the decline in the rate of change will be. Large b's imply a rapid movement toward the asymptote, s, and hence a rapid slowing in the rate of change of R. Since R is simply a function of time it is easy to project it into the future.

Imports

Imports, the second of the three categories of sales we will examine, play an important part in the determination of output. The reaction of the imports to demand and to relative prices can even cause an industry whose intermediate sales are growing to experience severe problems.

In our import equation, which follows later, the demand term, USE, meaning domestic use, needs some preliminary discussion. We define it as follows:

$$USE(i,t) = Q(i,t)/PD(i,t) + M(i,t)/PF(i,t) - X(i,t)/PD(i,t)$$

where

M(i,t) is the imports of product i in year t in current prices
Q(i,t) is the domestic output of i in year t in current prices
X(i,t) is the exports of i in year t in current prices
PF(i,t) is the price of imports of i in year t
PD(i,t) is the domestic price of i in year t

For Belgium we have modified USE so that re-exports are directly accounted for and therefore subtracted from M. Further, imports allocated to the diagonal cell are treated separately and therefore their amounts are likewise subtracted from M. Re-exports are generally small but the diagonal terms can be large as in the diamond and automobile sectors. The re-export amounts are forecast as a constant proportion of exports. The diagonal imports are forecast as constant proportion of the diagonal flow. For steel, shoes, and plastics the diagonal import proportions was 14%,12% and 2% respectively and there were no re-exports from these sectors.

The foreign price term, PFM, used in our equation is defined as follows:

$$PFM(i,t) = \sum_{j} (m(j)/M)\ PD(j,t)\ F(j,t)$$

where

the index j refers to each of the countries in the system of models namely Canada USA, Japan, Belgium, Germany, Italy, Netherlands, United Kingdom, and the Rest of the World;
m(j) is the import from country j in the base year
M is the total import of the product i in the base year
PD(j,t) is the appropriate corresponding domestic price

index in country j in year t;
F(j,t) is an index of the price of currency j expressed in the importer's currency

The equation we use for imports is

$$M(i,t) = (a + bUSE)\ (PFM(i,t)/PD(i,t))^{n}$$

The form above yields a demand elasticity of bUSE/(a+bUSE) which means that as USE grows the point elasticity tends toward unity. Particularly in forecasting is this a desirable property. It means, for example, that there exists some upper or lower bound on the proportion of imports to use. This upper or lower bound is the estimated parameter b. While the point elasticities tend toward unity, their paths may be quite different. The faster the growth in USE, the stronger is the tendency toward unitary import demand elasticity. Thus, industries with rapidly growing USE will see the proportion of that USE supplied by imports stabilize more quickly than will slower growing industries.

The price elasticity is, clearly enough n, but its ultimate effect depends on the movement of the relative price ratio. For instance, n may be quite large but if the price ratio remains stable, prices will have little effect on changing the imports-to-use ratio. A clear warning flag of a potentially troubled industry would be a significant responsiveness of imports to relative prices coupled with a downward movement of import prices relative to domestic prices. Note also the presence of the price of foreign exchange in the formulation of the price term. It may well be that

one country, for instance the FRG, may have lower rates of domestic price change for all products than another; but, because of constant revaluation of its own currency some industries may find that competing imports are getting cheaper.

The relative price ratio is forecasted with a time trend. We have estimated the trend with a single time trend and also with two trends, the first through the whole period and the second through the late 1960's. The two sets were compared and if there appeared to be a major shift in the relative price movements then the second form (with two trends) was chosen. Further, in some cases we put in our own estimates of the future trend.

Exports

The export functions are intended for temporary use only. Once direct linking of the models, through a world trade model (Nyhus, 1975), is accomplished these equations will be discarded. In the meantime, we use an equation similar in form to the import equation, namely

$$X(i,t) = (a + bD(i,t)) \ (PD(i,t)/PFX(i,t))^{n}$$

The demand term, D, is defined as follows

$$D(i,t) = \sum_{j} (x(j)/X) \ IP(j,t)$$

where

x(j) is the export to country j in base year
X is the total exports in the base year
IP(j,t) is a closely related industrial production or output index in country j

The foreign price is defined as follows:

$$PFX(i,t) = \sum_{j} (X(j)/XS)\ PD(j,t)\ F(j,t)$$

where

X(j) is the total exports of country j of the product i
XS is the sum of OECD exports (less that of our model country
PD and F are the same as in the import equation

The weights for the foreign prices are a country's proportion of global exports (exclusive of our home country) - they are not related to the destination of our home country's exports. Thus, the foreign price reflects the overall competitive price which our home country encounters when it markets its products abroad.

A point demand elasticity which is inelastic generally means that a country's export share is falling for reasons other than price. Such an inelastic demand elasticity may well mean we have a warning flag for the industry. On the price side, a warning flag should also be hoisted if their exists a rising domestic to foreign price ratio.

Data

Two factors should be noted with regard to the data used. The data is all rather old. More recent data were available but because of limited resources our efforts have been directed toward the extension of the system of models to more countries rather than updating existing models. The laborous, albeit necessary, task of

updating has been temporarily set aside. In retrospect this may actually be a good thing. With none of our data more recent than 1974, some of it not even that recent, we can truly evaluate the estimated equations to see if they really do exhibit the warning flags described earlier.

FRG. A remarkable and consistent set of input-output tables has been constructed by the Rheinisches-Westfaelisches Institut fuer Wirtschaftsforschung Essen for the years 1962-1975 (Hillebrand, Rettig, 1978). We have used a preliminary set of these tables covering the years 1962-1973.

France. Our data source here is GAPSET (Groupe d'Analys Prospectives des Systemes Economiques et Technologiques) which is affiliated with CESA (Centre des Etudes Superieur des Affaires) of the Chambre de Commerce et d'Industrie de Paris. It has supplied us with a set of current and constant price input-output tables for the year 1959-1974.

Belgium. The 1970 Input-Output table was published by the National Institute of Statistics (NIS). Unpublished detailed series on 150 primary and secondary industries from the NIS provided the basis for historical outputs for the period 1953 to 1974. The Planning Bureau provided imports and exports in current and constant prices for the years 1961 to 1972 (1973 for imports). All of the above data was substantially reworked by the Regional Planning Council of Brabant so that they were consistent with the input-output table.

III. INDUSTRY ANALYSIS

In this section some of the equations for three industries will be examined.

Steel

In the FRG, in 1970, intermediate sales had nearly fourtimes more effect on output than did either exports or imports. It seems clear that, in viewing the German steel industry, we should first look at the past coefficient changes and at those we project into the future.

The average coefficient change observed from 1965-72 was -5.6% per year. This means that steel's domestic markets had to grow at an average of 5.6% per year just for steel's intermediate sales to remain constant. In fact, steel's intermediate markets grew faster than 5.6%. The equation used to forecast the coefficient changes, R, begins the forecast period, 1972-3, with the coefficients falling 3.7%. The rate of decline falls to 2.3% in 1984-5. The problem for the FRG steel industry is that its domestic markets are no longer growing as fast as in the 1960's and hence its interindustry sales are declining.

In analyzing the foreign trade equations, the export equations show that the export share has fallen and that, while the average price effect in the 1960's aided FRG exports, it did not in the early 70's. On the basis of the trends of relative prices observed in the past and on the assumption of a continuing revaluation of the Deutchmark, we project, based on past trends, that relative prices will have a modestly positive effect for the 80's. Imports

report nearly the opposite picture - high demand elasticity, prices retarding import growth in the 60's and aiding import growth in the 70's. Prices, in the 80's, we project, again based on past trends, will have a slightly negative impact on imports.

The main reason, on the basis of this analysis, for the current trouble in the German steel industry lies in falling intermediate sales.

The French situation is similar to that in the FRG. The rate of coefficient decrease is, however, much smaller. The rates of change for 1972-3 and 1984-5 are -1.3% and -1.1% respectively. Intermediate sales nearly equal output (99% to be more accurate) because exports and imports are nearly equal. This is not to say, though, that the foreign sector is not important. In fact, it is more important for France than for Germany. Exports in 1972 as a proportion of output were 33% (11% in FRG) and imports, 32% (9% in FRG). The French export situation is similar to the German one. A low export demand elasticity indicating falling shares in the world market indicates low potential growth. Price effects are not so pronounced as for the FRG and seem to be favorable to the French producer in both the export and import markets. The French steel case could be summed up as follows: the basic cause for low rate of growth is reduced intermediate sales followed, to a lesser extent, by a low export potential.

The Belgian steel industry has nearly the same results as the others for each category of sales (intermediate, export, import) but because the export sector is so large (61% of output) it dominates the results. The low rate of growth of export demand,

caused primarily by the low growth rate in the FRG, means increased trouble for Belgian steel. The rate of decline in the input-output coefficients is smaller than Germany's in 1972-3 (-3.6%) but we project it to be more (-3.5% vs -2.3%) in 1984-5. Since intermediate sales are only 26% of Belgian steel sales, these declines, while important, are not as important to Belgian steel as were the coefficient declines to German steel. Recalling that the basic cause of low growth in the German steel industry is falling inter-industry steel usage, we can say that the reason for Belgian steel problems is the falling inter-industry steel usage in Belgium and Germany.

What were the warning flags observed in the steel industry equations? The most important flag we saw was certainly that of falling input-output coefficients. We see also how falling coefficients in one country can directly affect the same industry in other country.

Shoes

We now move our discussion from an industry with high intermediate sales to one with virtually no inter-industry sales. The rate of growth of domestic demand, basically governed by personal consumption expenditures, has slowed down some; but, because shoe consumption is inelastic with respect to income, the slowdown is not as great as the slowdown in the general economic growth rate.

In the FRG we have one warning flag raised by the export equation and two from the import equation. Exports are small and are not expected to grow while imports have grown substantially in the

past -- a six-fold increase from 1962 to 1973. The average price effect over this same period was to increase imports 14% per year. Examination of the relative price movements shows that falling relative prices of foreign shoes has contributed substantially to this increase.

In Belgium, shoe imports grew at an estimated 4% per year on the basis of price alone. Since imports account for about half of total domestic use the price effect will severely limit output growth of the industry. Our projection is that this price effect will continue through this next decade.

The French shoe industry appears to be in much better shape. In the estimation period, prices were calculated to have aided exports and to have averaged no net effect on imports. The outlook for the shoe industry is therefore much brighter in France than in the other two countries.

For both the FRG and Belgium the chief warning flag to be noted is the strongly falling relative price of imports. As long as this trend continues imports will gradually increase its share of the domestic market leaving a smaller share for domestic production.

Plastics

The plastics industry is still a growing, vibrant industry. Does it exhibit a warning flag as well? The answer is yes, but only a small one. The one negative flag -- namely that imports seem to be somewhat demand elastic, is vastly overshadowed by strengths visible elsewhere - in upward coefficient change, in

relative price trends and in export demand elasticities.

In the FRG, intermediate sales were 73% of total sales in 1970. The input-output coefficients are forecasted to grow at .9% per year during 1972-3 and then slowing to .4% by 1984-5. Since intermediate sales are so important, the fact that the relative price trends in the foreign trade favor domestic production is only a bonus. The picture is roughly the same in France and Belgium.

The contrast between two industries, steel and plastics, both strongly oriented toward intermediate sales is striking. Of course we can see these changes going on around us, new plastic lamps vs older steel ones etc, but it is reassuring to have the equations conform and to quantify what we can observe firsthand.

IV. SUMMARY

The previous section was a analysis of three industries. The table at the end of this section gives a short comparison of the past and future growth rates of output for these industries. The 1965-70 rates are based on actual data. In all of the models 1975 is a forecast year and, hence, the 1970-1975 and 1975-1980 growth rates may not fully correspond to actual data. The 1980-1985 growth rates most accurately reflect the long term growth rates in the models. The industry discussion will, therefore, concentrate on comparing the 1965-70 actual rates with the 1980-1985 forecast rates.

We see why there are now problems in employment in the steel industry. Output growth is substantially below that of earlier periods. The adjustment to slower growth and the accompanying loss

of employment is surely not a short-run problem of the 1970's.

The Shoe industry, on the basis of the forecasts, has probably sustained the worst of the onslaught of imports. While output growth is still not high enough for employment growth, we forecast the rate of decrease to fall in the 1980's.

The Plastics industry also has reduced growth rates but they still remain relatively high. Employment is forecast to continue to increase in this industry.

COMPOUND ANNUAL GROWTH RATES OF OUTPUT

	FRG	France	Belgium
Steel			
1965-1970	3.9	4.3	3.1
1970-1975	-4.0	1.1	1.8
1975-1980	-0.3	3.2	.3
1980-1985	1.2	3.1	2.5
Shoes			
1965-1970	-1.3	2.9	-2.2
1970-1975	-5.1	3.1	2.6
1975-1980	-2.2	4.0	3.2
1980-1985	-0.2	3.5	2.8
Plastics			
1965-1970	9.0	11.2	9.2
1970-1975	1.5	7.3	9.0
1975-1980	5.6	6.2	7.7
1980-1985	3.5	5.9	9.8

References

Almon,Buckler,Reimbold,Horwitz,(1974), 1985: Interindustry Forecasts of the American Economy, D.C.Heath & co. Lexington, Mass.

Almon,Nyhus (1977) "The INFORUM International System of Input-Output Models and Bilateral Trade Flows", IIASA Fifth Global Modeling Conference, International Institute for Applied Systems Analysis, Laxenburg, Austria

Hillebrand,Rettig (1978) "Input-Output-Tabellen fuer die Bundesrepublik Deutschland 1962 bis 1975", Miltteilungen Heft2/1978, Rheinisch- Westfaelisches Institut fuer Wirtschaftsforschung Essen

Lee,Y.S.,(1976) An Input-Output Model of the Japanese Economy, Unpublished Ph.d thesis, University of Maryland, College Park, Maryland

Lee,Y.S. (1978) "An Input-Output Model of France", INFORUM Research Report No. 25, University of Maryland, College Park, Maryland

Nyhus,D.E. (1975) "The Trade Model of a Dynamic World Input Output Forecasting System", INFORUM Research Report no. 14, College Park, Maryland

Nyhus,D.E. (1977) "An Input-Output Model of Germany", INFORUM Research Report No. 19, College Park, Maryland

Reimbold,T.C. and Nyhus,D.E. (1977) "A Dynamic System of National Input- Output Models, in W.F. Gossling, Medium-Term Dynamic Forecasting, Input-Output Publishing Company, London

Vanwynsberghe,D.,Nyhus,D.,Almon,C.(1977) "An Input-Output Model of Belgium", INFORUM Research Report No.22, College Park, Maryland