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The American Economic Review, Volume 57, Issue 2, Papers and Proceedings of the Seventy-ninth Annual Meeting of the American Economic Association (May, 1967), 325-332.

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This session, according to its organizer, was designed to see what individuals studying growth by different approaches have learned. My approach is to try to isolate the sources of observed growth of real national income between selected dates and quantify their contributions. The contribution of each source is expressed as the number of percentage points it contributed to the growth rate.

I used this approach a few years ago to analyze United States growth from 1909 to 1957.[1] My paper today concerns an application of similar techniques to nine countries in the 1950-62 period and 1950-55 and 1955-62 subperiods. J. P. Poullier assisted me throughout this study. The countries covered and their growth rates from 1950 to 1962 are West Germany 7.3, Italy 6.0, France 4.9, Netherlands 4.7, Denmark 3.5, Norway 3.5, United States 3.3, Belgium 3.2, United Kingdom 2.3. In several countries growth rates were quite different in the two subperiods. In some, 1950-55 was quite disturbed by recovery from World War II.

My method of analyzing growth distinguishes broadly between the contribution of changes in inputs and the contribution of changes in output per unit of input. To measure the contribution of labor, capital, and land the change in each of these inputs, subdivided as necessary and possible among components, must first be measured. The growth rate of each input is then multiplied by its share of national income to obtain its contribution to the growth rate of national income.[2] The contribution of all inputs together is the growth rate of total factor input when the separate inputs are combined by use of income share weights. The contribution of output per unit of input is the amount of the growth rate that is not explained by the growth of inputs. To divide the contribution of output per unit of input among its sources required a separate technique for each source. Broadly speaking, I have tried to isolate the contributions made by important changes in resource allocation, by economies of scale, and by a few sources, such as the change in the average age of capital and the balancing of the capital stock in the early years in Germany, that were either not very important or im-

[1] Edward F. Denison, *The Sources of Economic Growth in the United States and the Alternatives before Us* (C.E.D., 1962).

[2] A different procedure was adopted for dwellings and international assets.

portant only in a particular country. I have also tried to isolate the effect on growth rates of output per unit of input of differences between the years compared with respect to the pressure of demand upon employed resources and, insofar as it affected farm output, of weather. A couple of adjustments were also made for differences in deflation techniques. I was left with a residual representing the contribution of advances in knowledge, any catching-up of technique, the contribution of all changes not explicitly measured such as in how hard people work, and, of course, noncompensating errors in the growth rates themselves and in the estimates for the sources dealt with explicitly.

Since the Econometric Society is a joint sponsor of this session, I had better state that my methodology makes almost no use of correlation analysis. It is quantitative, however, and thus qualifies as econometric according to the charter of the Society.

To measure labor input I took account, sequentially, of changes in employment, changes in hours worked annually by employed persons, changes in the distribution of man-hours among individuals classified by age and sex, and changes in the composition of weighted man-hours classified by amount of education of the individuals working. I shall say a few words about each.

The United States had the second largest employment increase among the nine countries from 1950 to 1962. Germany had the largest. If there had been no change in the composition of employment, its increase would have contributed 1.5 percentage points to the growth rate in Germany, 0.9 in the United States, 0.8 to 0.4 in the Netherlands, Denmark, the United Kingdom, Italy, and Belgium, and as little as 0.1 in France and Norway.

Annual hours worked by full-time nonfarm wage and salary workers dropped least—almost not at all—in the United States and France. They dropped most, about 13 percent, in Germany, and by intermediate amounts elsewhere. But in the United States much of the increase in employment consisted of women and students voluntarily working part time, most of them very few hours a week. This pulled down the average hours of all workers. In Italy, in contrast, involuntary part-time employment was reduced as job opportunities expanded. Elsewhere changes in part-time employment were minor. I have estimated the net effect on the work done in a year of changes in full-time hours, an assumed partial productivity offset, and changes in the importance of part-time employment. It subtracted 0.2 from the United States growth rate and about as much in five of the eight European countries. The subtraction was larger in Germany. It was negligible in France and the contribution was slightly positive in Italy.

The effect of changes in age-sex composition upon average labor

quality was measured by use of hourly earnings weights. The change was most unfavorable in the United States where the share of female man-hours rose most. I estimate it subtracted 0.1 from the United States growth rate. In several countries the contribution was positive —as much as plus 0.1 in France and Italy.

Education is a very important aspect of labor quality. In the United States the education of the labor force has been rising rapidly for several decades. In the 1950-62 period it was rising more in the United States than in any of the European countries and much more than in most of them. Based on a modification of the technique used in my previous study, I estimate that the increased education of the labor force raised the average quality of labor enough to contribute 0.5 percentage points to the United States growth rate from 1950 to 1962. The amount was 0.4 in Belgium and Italy, 0.3 in France and the United Kingdom, 0.2 in the Netherlands and Norway, and only 0.1 in Denmark and Germany. These estimates are based on the use of different weights for the various education levels in the United States and Europe. The United States margin over Europe in the increase in education as such is even greater than these numbers suggest.

When all four aspects are combined, I find that the increase in labor input contributed 1.1 percentage points to the United States growth rate and that only in Germany, where employment increased much more, was the contribution of labor input larger than this.

Capital was divided among four components in this study. The contribution of dwellings to the growth rate can be measured directly by turning to the details of the national accounts to obtain the net value of housing services. The contribution was greatest, 0.25, in the United States. Germany followed with 0.14. The contribution of international assets can also be measured directly. It was 0.05 in the United States, and this amount was exceeded only in the Netherlands. Increases in the stocks of nonresidential structures and equipment and of inventories contributed 0.5 to growth in the United States and this was less than in the European countries except Belgium and the United Kingdom. Germany obtained by far the largest contribution from these sources, 1.4.

All types of capital together contributed 0.8 to the 1950-62 growth rate in the United States and about the same amount in the European countries as a group. The contribution was much larger than this, 1.4, in Germany, moderately higher in the Netherlands and Denmark than in the United States, and appreciably lower in Belgium and the United Kingdom.

The quantity of land was estimated not to have changed significantly, and land therefore made no contribution to growth.

If growth depended only on increases in inputs and if all countries operated under constant returns to scale, 1950-62 growth rates would have been as follows: Germany 2.8, United States 2.0, Netherlands 1.9, Italy 1.7, Denmark 1.6, France and Belgium 1.2, United Kingdom 1.1, and Norway 1.0.

The most pervasive reason that there is so little correspondence between a ranking of countries by growth rates of national income and by growth rates of factor input in this period is to be found, according to my analysis, in the reallocation of resources. I tried to deal with three aspects: the contraction of agriculture, the contraction of nonfarm self-employment, and the reduction of barriers to international trade.

All the countries had in 1950, and still have, a larger proportion of total resources, but mainly people, in agriculture than the proportion that would provide a maximum national income. From 1950 to 1962 the percentage of employment devoted to agriculture declined by 30 to 47 percent in each of the nine countries. These are enormous declines to occur in only twelve years. The percentage decline was big everywhere but the importance of agricultural employment, and therefore the effect upon nonfarm employment, varied greatly. In 1950 agricultural employment ranged from 5 percent of total employment in the United Kingdom, 11 in Belgium, and 12 in the United States to 25 to 29 in Germany, Denmark, and France and 43 in Italy.

National income per unit of input is generally much lower in agriculture than in nonfarm industries. In addition, given time for adjustment, the addition of inputs to nonagricultural industries could raise nonagricultural national income, excluding income from dwellings and abroad, about proportionately, whereas agriculture was so overmanned that elimination of labor in agriculture had only a small adverse effect on agricultural output. My estimates of the contribution to the 1950-62 growth rate that was obtained by shifting agricultural resources to nonfarm activities range from less than 0.1 in the United Kingdom and 0.2 in the United States and Belgium to 0.7 in France, 0.8 in Germany, and 1.0 in Italy.

There is overallocation of labor to nonfarm self-employment that is generally similar to the situation in agriculture. Nonfarm proprietors and unpaid family workers represent very different proportions of total nonfarm employment in different countries, and the proportion in each of the nine countries declined from 1950 to 1962. This group, of course, includes a core of professionals, proprietors of substantial establishments, repairmen, and the like, who do well enough operating as proprietors and in no sense are misallocated. But it is not this group who account for differences between places and dates but a fringe

group, usually much larger, who are very inefficiently employed or underemployed. As large numbers were eliminated and transferred to wage and salary employment, the work they did could be replaced by those remaining or by a disproportionately small increase in paid employment in larger establishments. Gains from this transfer, I estimate, ranged from 0.04 percentage points in the United States and United Kingdom to 0.22 to 0.26 in Italy, France, Norway, and the Netherlands.

My estimates of gains from reductions in barriers to international trade, which are very crude, ranged from nothing in the United States and 0.02 in the United Kingdom to 0.15 or 0.16 in Belgium, the Netherlands, Norway and Italy.

The combined contributions made to 1950-62 growth rates by these three aspects of resource reallocation were as follows: United Kingdom 0.1, United States 0.3, Belgium 0.5, Netherlands 0.6, Denmark 0.7, Norway 0.9, France and Germany 1.0, and Italy 1.4. The differences are big.

In the 1955-62 subperiod the contributions of inputs and resource allocation together pretty well established the ranking of the nine countries by growth rates, aside from the effects on output per unit of input of incomparability of the years 1955 and 1962 with respect to demand pressures and weather. In France and perhaps Italy, however, there appears to have been an added ingredient. To discuss it requires reference to the residuals I obtained after deducting from growth rates the contributions made by all sources of growth explicitly estimated. In the United States itself the residual contributed 0.76 in both 1950-55 and 1955-62. After minor adjustments for procedural comparability, my former study yields about the same amount for the period since the 1920's. I think this residual for the United States can be used as a tolerable estimate of the contribution made to growth by advances in knowledge. In 1955-62 I obtained residuals in the narrow range of 0.75 to 0.97 for seven of the nine countries. In addition to the United States they were Belgium, Denmark, the Netherlands, Germany, the United Kingdom, and Norway. Since these are residuals, I do not regard the small differences among these countries as significant. For France, however, I obtained a residual of 1.56 and for Italy of 1.30. The French residual also exceeded that for the United States by about the same amount in 1950-55. I am inclined to believe that the large French residuals indicate that France was obtaining an appreciable contribution to growth from sources I have not isolated—perhaps a catching up of technological and managerial techniques toward the United States level as a result of deliberate efforts and the pressure of increased competition, elimination of redundancy in nonfarm wage and

salary employment, improvement of resource allocation in ways I have not measured, better incentives and harder work, or perhaps something else.

In the 1950-55 period, Germany and, to a lesser extent, Italy were apparently securing large increases in output per unit of input from the elimination of wartime distortions. I tried to estimate the effects of one or two aspects of this, but for the most part my techniques are inadequate to deal with so disturbed a situation and it is reflected in large residuals for Germany and Italy in 1950-55.[3]

My general conclusion thus far is that the ranking of countries with respect to growth rates in the 1950-62 period as a whole was determined by changes in inputs, gains from resource reallocation, some catching up of technique or other unisolated source in France and possibly Italy, and recovery from war distortions in the early postwar years in Germany and Italy.

The size of the differentials among countries in growth rates was, however, widened by economies of scale. To some extent this was simply because gains from economies of scale depend on the rate at which the size of markets increase, so that the more national income rises for other reasons the greater are gains from scale economies. There is, however, a much more important reason, one that I rather despair of describing even sketchily in the time available.

I have estimated the amount by which European growth rates would be reduced if the components of consumption were reweighted by use of United States rather than European prices. For 1950-62 as a whole the amounts range from 0.1 in Belgium, Norway, and the United Kingdom and 0.2 in Denmark and the Netherlands to 0.5 in France, 0.6 in Italy, and 0.9 in Germany. The reason rates are reduced is that, for different products, the ratio of the volume of European to United States consumption is lower and the ratio of European to United States prices is higher the greater is the income elasticity for a product. As European per capita consumption has risen, the increases have been concentrated in products that have high income elasticity and high relative prices in Europe as compared with the United States. The larger the rise in per capita consumption the larger is this dispersion. The greater the increase in per capita consumption and the lower the level of per capita consumption the more a shift to United States weights reduces the growth rate. I used an indirect method of estimate that picks up only this systematic tendency but checked the results against those obtained by direct reweighting.

If you prefer, you can consider the estimates just given as simply a

[3] The residual in 1950-55 is also particularly large in the Netherlands and small in Denmark. I have no special explanation.

statistical adjustment required to place all the national income estimates on a common basis with respect to consumption price weights. I believe, however, that it is predominantly an economies-of-scale phenomenon. As per capita consumption in the fast growing European countries increased, increases were concentrated in products produced in particularly small volume and at particularly high unit cost in Europe as compared with the United States. Techniques of large-scale production were already available in the United States and could be adopted as soon as markets developed to sufficient size.

In addition to sources of growth, I have tried to isolate the sources of difference in levels of national income per person employed. Measured in United States prices, national income per person employed in all the European countries covered except Italy was 58 to 65 percent of the United States level in 1960. In Italy it was 40 percent.

I now offer two groups of observations that emerge from a comparison of sources of growth with sources of difference in income levels.

My first comments concern resource allocation. France and Germany had a much greater potential to raise national income by increasing nonfarm wage and salary employment at the expense of agricultural and self-employment than did the United States, and this provides an important part of my explanation of why output per unit of input rose more in France and Germany. Greater overallocation is also one reason the level of income is lower in France and Germany than in the United States but it is a relatively minor reason. France and Germany are exhausting this source of growth very rapidly, and its complete elimination would go only a small way to narrow their income gap with the United States.

Reallocation of resources also provides much of the explanation of why French and German growth rates were above the British rate. But the level of national income per person employed was as high in the United Kingdom as in France and Germany in 1960 only because the United Kingdom had much less misallocation. In nonfarm industries alone output per person was appreciably lower in the United Kingdom and, indeed, not greatly above Italy. Reduction of misallocation is opening an income gap between France and Germany, on the one hand, and the United Kingdom, and closing the gap between the United Kingdom and Italy.

Agricultural and self-employment depressed the Italian income level most, and this was a principal reason income in Italy was below the other European countries. Their eventual contraction to the same proportions as in the other countries would eliminate much of the gap in income levels. However, education and capital also contribute to the gap.

My second comment concerns what I can only describe as residual productivity. My estimates imply that if there were no difference in the quantity and quality of labor per worker, the amount of capital and land per worker, the size of markets, the cost of misallocation of resources of the types mentioned, or the pressure of demand upon resources, residual productivity in the European countries as a group, except Italy, would still have been 28 percent below the United States in 1960. Whatever other changes may occur, European income per worker cannot approach the American level unless this gap is greatly reduced. My estimates of growth sources indicate that up to 1962, at least, the gap was not being cut much except in France, and even in France the amount seems small compared to the apparent potential.

The United States in 1925 had already reached the level of national income per person employed that was attained by the European countries except Italy, as a group, in 1960. One striking statistic emerging from my study is that residual productivity was lower in Europe in 1960 than it was in the United States in 1925. The gain in the United States from 1925 to 1960 was mainly due, I believe, to advances in knowledge that accumulated over a 35-year period. But disparities in the availability of knowledge as to how to produce cannot explain the 1960 gap between the United States and Europe. One can hardly avoid speculating as to what is responsible, but I shall not do so today.

I shall close with one final generalization. My study indicates that the continental countries did not obtain higher growth rates than we after 1950 because they were doing more to obtain growth. We were drawing more additional workers, particularly women, into employment than any of the other countries. The education of our labor force increased more. Only we and the French did not reduce the hours of full-time workers significantly. We did the most research and development. We cut down farm employment and fringe nonfarm self-employment as much, proportionately, as the European countries. We did not increase the capital stock as much, in percentage terms, as most of the European countries but this situation is less clear than it may seem, and in any case only Germany obtained much more growth than we from this source. The reasons that European growth rates were higher in the postwar period must be sought primarily in differences in initial conditions.

In conclusion, let me state that I keenly regret that I have been unable to provide here the evidence for my conclusions or to introduce the cautions that are usual and appropriate. A book will remedy these omissions in the near future.[4]

[4] Edward F. Denison with the assistance of Jean-Pierre Poulliet, *Why Growth Rates Differ: Postwar Experience in Nine Western Countries* (to be published by the Brookings Institution, 1967).