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February 12, 1987

To: Members of the Executive Board

From: The Secretary

Subject: World Economic Outlook - Staff Studies - Potential Output in the Major Industrial Countries

The attached staff study has been prepared in response to requests by some Executive Directors during earlier world economic outlook discussions. It is intended to serve as background material for the Executive Board discussion on Monday, March 16, 1987 of the world economic outlook.

Mr. Larsen (ext. 4613) or Mr. Adams (ext. 8984) is available to answer technical or factual questions relating to this paper.

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INTERNATIONAL MONETARY FUND

World Economic Outlook: Staff Studies

Potential Output in the Major Industrial Countries

Prepared by the Research Department
(In consultation with other Departments)

Approved by Jacob A. Frenkel

February 11, 1987

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I. Introduction

For more than a decade, a fundamental question has been whether the industrial countries can be expected eventually to return to the rapid rates of economic growth that prevailed during the 1950s and 1960s. This question is particularly relevant in light of the decline in oil prices in 1986, which more than halved the price of internationally traded oil. Indeed, in view of the role that has been attributed to higher energy prices as a major factor behind the growth slowdown in the 1970s, it is hardly surprising that the recent price reduction has been widely perceived as being beneficial for growth in the industrial countries, not only in the short run but possibly allowing also a return to more rapid growth rates in the medium run.

To address some of the many questions related to the recent and prospective growth performance of the industrial countries, this study analyzes developments in the growth of output over the past 20 to 25 years and presents tentative projections of potential output growth for the decade to 1995. While previous cross-country studies by the staff on potential output have focused on the manufacturing sector (J. Artus (1977), J. Artus and Turner (1978) and Turner (1987)), this study provides economy-wide measures that are based on econometric estimates for the business sector as a whole, with simple additive adjustments for production by the public sector.

Some notion of the level and growth of potential output plays an important role in many areas of the Fund's work, and particularly in the context of its surveillance activities. For example, assessments of the short-term outlook for output, inflation, and the balance of payments take account of the likely "gap" between actual and potential output. Likewise, the Fund's monitoring of exchange rates involves the computation of cyclically adjusted indicators of countries' external competitiveness or real exchange rates which are based on the estimates of potential output in the manufacturing sector mentioned above. Policy indicators such as the Fund's fiscal impulse measures are founded on assumptions about economy-wide potential output. Finally, in generating projections and scenarios for the medium term, assumptions about the behavior of potential output are essential as a benchmark for projections of actual output and in order to help identify possible tensions and policy inconsistencies.

Even though the concept of potential output is widely used for economic analysis, views differ considerably about its precise definition and, even more so, about its measurement. In line with many other studies, and given the strong emphasis on inflation control in the industrial countries since the beginning of the 1980s, this study defines potential output as the maximum output level that can be sustained without risking an acceleration of inflation. The inflation constraint is based on estimates of the "natural" unemployment rate at any given point in time.

An important rationale for using a natural concept of potential output is that the resulting measure can be interpreted as an indicator of overall supply conditions. The gap between actual and potential output can thus be viewed as an indicator of inflationary or disinflationary pressures in an economy, depending on whether actual output is above or below potential. Because supply conditions are influenced not only by the growth of the capital stock and the labor force but also by changes in oil and commodity prices as well as by wage behavior and by structural policies, the approach serves to underline the essentially endogenous character of aggregate supply. Alternative approaches to the estimation of potential output, whether based simply on trends in actual output or on a constant rate of structural unemployment, typically result in potential output estimates that do not take into account the implications of shifts in supply conditions and, hence, appear to be largely exogenous in the short run.

The study is organized as follows. Section II reviews the long-term growth performance of the major industrial countries and discusses some of the many factors that have been identified as possible sources of the marked slowdown in growth since the early 1970s. Section III discusses alternative ways of measuring potential output and outlines the approach adopted. Historical estimates of potential output are presented in Section IV together with the gaps between actual and potential output and between the actual and natural rates of unemployment. Section V presents tentative projections of potential output for the period to 1995, and discusses the sensitivity of the results to changes in the main assumptions underlying the projections. Finally, Section VI summarizes the main findings of the study. 1/

II. Why Has Growth Slowed?

There is now substantial agreement that the marked slowdown in the growth of output that occurred in all the advanced industrial countries during the first half of the 1970s reflected more than the effects of cyclical downturns in the wake of the abrupt increase in oil prices in 1973. There is continued disagreement, however, about the underlying causes of the slowdown and what the prospects for output might be over the medium term. The disagreement may be illustrated by two rather extreme interpretations of the causes of the slowdown. According to one interpretation, it reflected an inevitable deceleration from the exceptionally rapid rates of growth of the preceding two decades which were simply unsustainable. According to the other, the slowdown was primarily the result of a number of special and temporary events of the

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1/ Details of the estimates underlying the natural unemployment rates used in the study and of the demographic assumptions are contained in the accompanying appendices A and B, respectively. Definitions and sources of the data used in the empirical analysis can be found in Appendix C.

1970s, such as the oil price increases, the rise in raw material prices and the acceleration of inflation. This view suggests the hypothesis that once these influences have been fully absorbed, or reversed, the industrial countries should be able to return to rates of growth similar to those experienced in the 1950s and 1960s or, at least, higher than those of the 1970s and early 1980s.

The evidence suggests that there is some truth in both views and that a balanced interpretation is called for. This section first reviews the growth and productivity performance of the major industrial countries during the postwar period and then discusses some of the most commonly advanced reasons for the slowdown.

1. The growth record

There can be no doubt that output growth slowed markedly and suddenly in all the industrial countries in the early 1970s, with 1973 marking the end of the strong post-war expansion phase for most countries. 1/ As can be seen from the shift in the trend of GNP--estimated over the periods 1950 to 1973 and 1974 to 1985, respectively--the slowdown in growth among the major countries was most pronounced in Japan [illegible]ly, but was nevertheless quite marked in each of the other coun[illegible]s well (Chart 1). It is also apparent, notwithstanding the [illegible]y from the 1980-82 recession, that none of the major countries [illegible]t shown signs of returning to the rapid growth trends of the 1950s a[illegible]60s.

In view of the different demographic developments across countries, it is useful to break the growth of output down into changes in labor input and changes in labor productivity in order to obtain a basis for cross-country comparisons (Table 1). For all countries, this breakdown suggests that a major proportion of growth has traditionally been accounted for by labor productivity gains rather than by increases in labor input. A comparison of recent growth experience with the longer-term historical record shows that productivity growth over the period 1974-85 was generally--with the important exception of the United States--closer to the performance in the latter part of the 19th century and the first half of the 20th century that to the post-1950 period. Indeed, it is apparent that the growth of productivity and, hence output was exceptionally strong from 1950 to 1973; and it is hardly surprising that some economic historians have called the period from 1950 to 1973 "The Golden Age" (Maddison (1982)).

1/ Denison (1979) has argued that GNP growth in the United States began to slow modestly in 1966-67. For other industrial countries, there is no evidence of a significant slowdown in growth during the 1960s.

Table 1. Major Industrial Countries: Average Growth in Output, Employment, and Productivity, 1870-1985

(Percent, compound annual rates of change)

Canada	1870-1950	1951-73	1974-85
GDP/GNP	3.4	5.1	3.3
Employment (persons)	1.7	2.5	2.2
Hours per employee	-0.5	-0.4	-0.3
Employment (manhours)	1.2	2.1	1.9
Productivity (output per manhour)	2.1	3.0	1.4
United States			
GDP/GNP	3.5	3.6	2.3
Employment (persons)	2.0	1.6	1.9
Hours per employee	-0.6	-0.4	--
Employment (manhours)	1.4	1.1	1.9
Productivity (output per manhour)	2.3	2.6	0.4
Japan			
GDP/GNP	2.2	9.3	3.8
Employment (persons)	0.9	1.7	0.9
Hours per employee	-0.3	-0.1	-0.1
Employment (manhours)	0.6	1.6	0.7
Productivity (output per manhour)	1.6	8.0	3.0
France			
GDP/GNP	1.4	5.1	2.1
Employment (persons)	--	0.4	0.2
Hours per employee	-0.5	-0.4	-1.2
Employment (manhours)	-0.5	--	-1.0
Productivity (output per manhour)	1.9	5.1	3.2
Germany, Federal Republic of			
GDP/GNP	2.1	6.0	1.8
Employment (persons)	0.9	1.0	-0.2
Hours per employee	-0.3	-1.0	-0.8
Employment (manhours)	0.6	--	-1.1
Productivity (output per manhour)	1.5	6.0	2.9
Italy			
GDP/GNP	1.5	5.4	2.0
Employment (persons)	0.5	0.6	0.6
Hours per employee	-0.5	-0.9	-0.6
Employment (manhours)	--	-0.3	0.1
Productivity (output per manhour)	1.4	5.8	1.9
United Kingdom			
GDP/GNP	1.6	3.0	1.3
Employment (persons)	0.8	0.5	-0.5
Hours per employee	-0.5	-0.6	-0.7
Employment (manhours)	0.2	-0.1	-1.1
Productivity (output per manhour)	1.4	3.1	2.5

Sources: Maddison (1982) and staff estimates.

Chart 1. Major Industrial Countries: GDP/GNP Trends, 1950-85

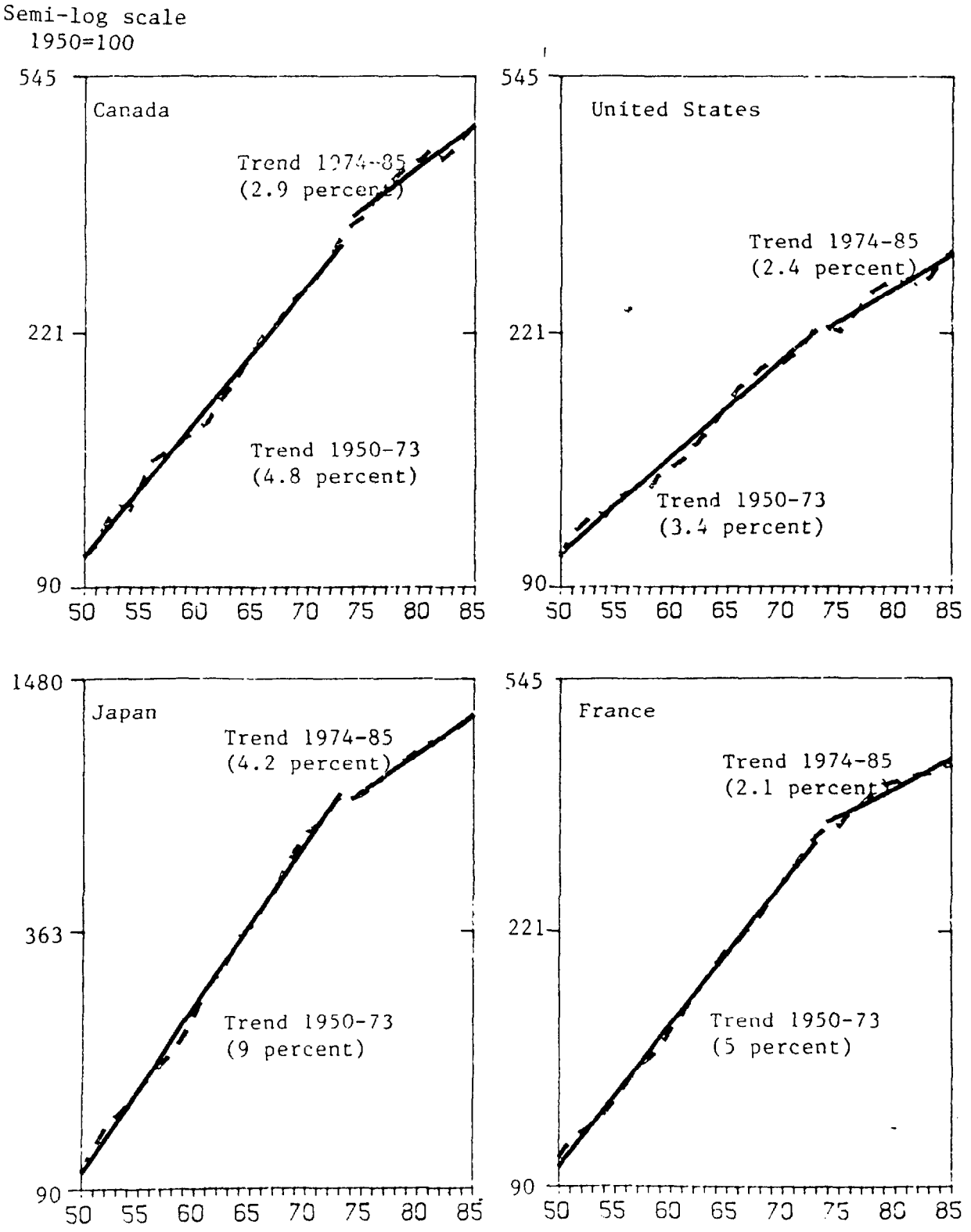
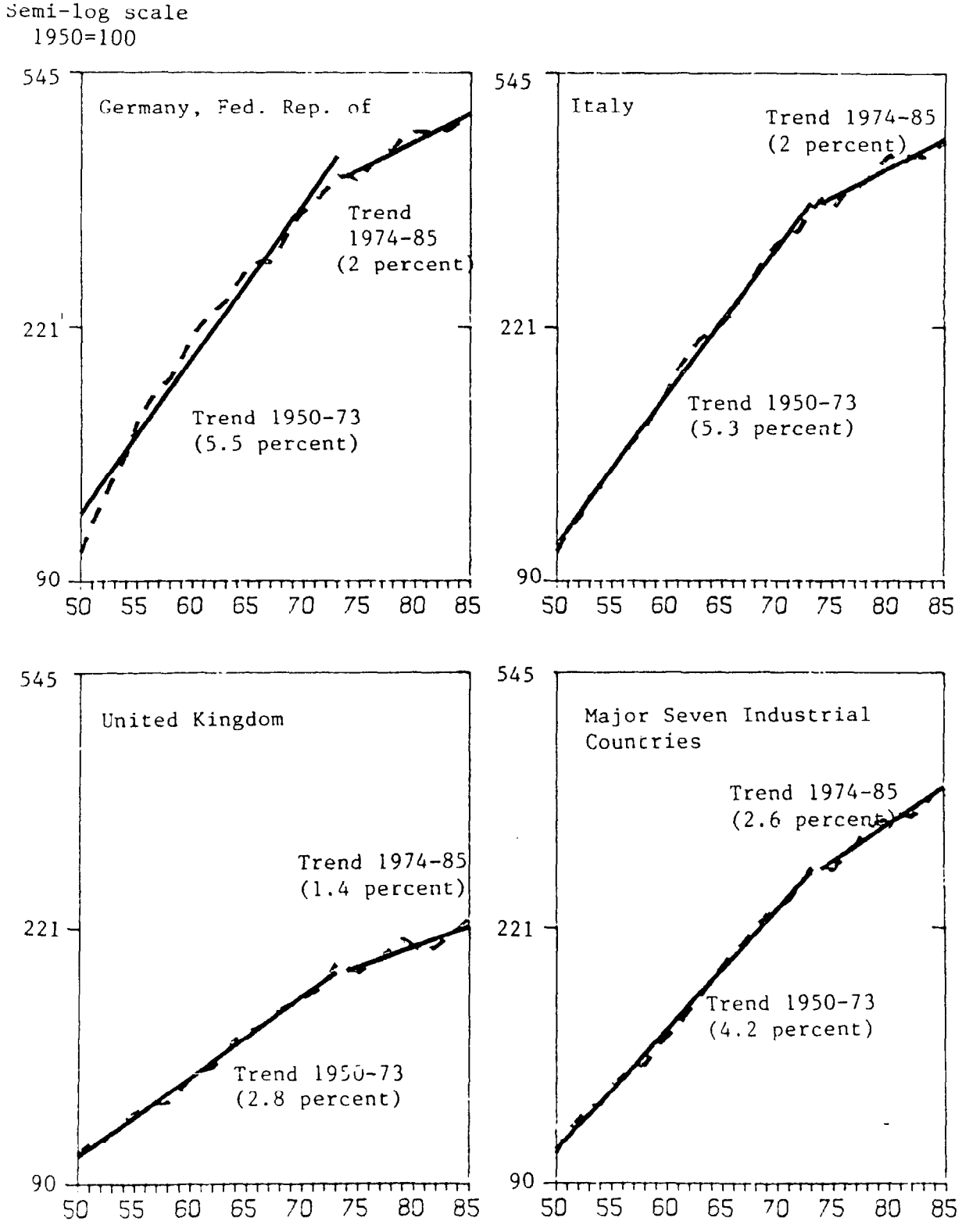


Chart 1. (continued)



2. Possible reasons for the slowdown

Even though growth since 1973 has not been out of keeping with long-term trends--the United States being the important exception--this in itself is obviously not an "explanation" of the slowdown, which should rather be sought in either cyclical or more deepseated factors. If the slowdown is more than cyclical, it is particularly important to distinguish between those factors that may have led to a downward shift in the output level--perhaps spread over a number of years--leaving the underlying rate of growth basically unchanged and those that may have led to a reduction in the trend rate of growth. The implications of these alternative explanations for future growth are quite different, but experience shows that it is extremely difficult to distinguish between them (see Berndt (1984) for a more complete discussion). It is therefore not surprising that most studies are rather inconclusive about the relative importance of the various factors behind the slowdown and the prospects for the medium term. 1/

As mentioned earlier, there now appears to be a consensus that the slowdown was caused by more than cyclical influences. However, views still differ considerably about the role of cyclical factors. The problem of measuring the cyclical contribution is particularly severe because of the sharp upward movements in unemployment rates that have occurred in most of the industrial countries and the low levels of capacity utilization that characterized most countries during the late 1970s and early 1980s. Taken at face value, these factors seem to indicate that cyclical influences may be a relatively important reason for the growth slowdown, implying that the recoveries from each of the major recessions since 1973 have been incomplete.

However, such an interpretation is contradicted by several indicators. In the first place, already by 1979 in the case of the 1974-75 recession, and by 1985 in the case of the 1980-82 downturn, capacity utilization rates in manufacturing in many industrial countries had almost returned to their historical peaks, with unemployment remaining markedly above the rates of the early 1970s. Moreover, there is evidence from a variety of sources that labor market rigidities and demographic factors, in particular, may have led to upward shifts in natural unemployment rates during the 1970s and early 1980s. (The definition of natural unemployment used in this study follows Friedman's concept of that unemployment rate that prevails when price expectations are realized and toward which an economy will converge after disturbances.) The hypothesis that natural unemployment rates have risen is corroborated by the relatively high real wage gains of recent years, particularly in some of the major European countries, despite high unemployment rates. There appear, therefore, to have been structural changes in the relationship between unemployment and capacity

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1/ See, for example, Denison (1979), Kendrick (1981) and Matthews (1982).

utilization rates. Finally, the underutilization of capacity over most of the period is not found generally to account for much of the growth slowdown (see Berndt and Hesse (1986)).

Under these conditions, a significant reduction in underlying rates of growth must have occurred. That reduction, however, may have reflected either a temporary or a permanent slowing of growth, and the major difficulty in determining which occurred, or whether some combination of the two took place, is the limited number of observations for the 1970s and early 1980s, which makes it hard to identify "long-term" trends econometrically. At the same time, the large number of factors at play during this period, including the virtual catching up of Japan and a number of European countries with U.S. technology, increased international competition, the oil and raw material price shocks, the generalized rise in inflation rates, and the growth of government, make it difficult to pinpoint causes.

The following paragraphs discuss some of the more important factors that may have contributed to the slowdown, distinguishing those with only temporary effects on growth from those with a more permanent impact. In addition, however, at least some part of the slowdown may be a statistical illusion, reflecting mismeasurement of output indices (Matthews (1982)). Three factors in particular have been suggested as possible causes of mismeasurement over this period. The first is the significant rise in inflation over the 1970s, which is likely to have led to some distortion of price and output indices. Denison (1979), however, has argued that the degree of mismeasurement on account of inflation is likely to be small. The second is the large increases in the prices of raw materials and energy, which may have led to a systematic mismeasurement of value added in material-intensive sectors such as manufacturing. Bruno and Sachs (1985) have been proponements of the view that much of the slowdown in the growth of value added in manufacturing was due to mismeasurement. 1/ Grubb (1986) and Bailey (1986), however, have shown that the type of mismeasurement identified by Bruno and Sachs cannot in practice account for much of the slowdown. Finally, the rapid growth of the government sector and of services, where productivity is hard to measure, has also been suggested as a source of mismeasurement even though it is unlikely to account for more than a small proportion. Overall, the general consensus is that mismeasurement is unlikely to explain much of the slowdown.

a. Temporary factors

Five factors, in particular, have been suggested as proximate causes of a temporary slowing of growth--implying a downward shift in

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1/ More specifically, Bruno and Sachs (1985) have argued that the double deflation method of computing value added led to a systematic undermeasurement of output when raw material prices rose in the mid-1970s.

the underlying path of output. These are: the sharp increases in oil and raw material prices during the 1970s; the sharp upward movement in inflation rates in the 1970s; a generally less favorable business climate accompanied by lower investment spending; the interaction of structural rigidities in labor markets with a series of adverse disturbances, particularly in Europe; and the rapid growth of the size and role of government. These factors do not, of course, exhaust the list of possible explanations for the slowdown, nor are they necessarily independent of each other. By and large, however, they encompass the major concerns of policymakers. 1/

(1) Commodity price increases

Most analysts seem to agree that the large increases in the price of internationally traded oil in 1973-74 and 1979-80, as well as the surge in raw material prices in the mid-1970s, contributed substantially to the deterioration of the industrial countries' overall economic performance. In addition to significant adverse short-term effects on demand and inflation, a number of effects on supply have also been identified, suggesting that these price increases may have led to a temporary slowing of growth. Following the first oil shock a number of studies concluded that the oil price increase was likely to have been the major factor behind the generalized growth slowdown. Subsequently, however, as a result of further research, it has proved extremely difficult to establish that the energy price increase was the only factor behind the growth slowdown. 2/

Increases in energy prices may affect aggregate supply through two major channels. These channels are related but it is convenient to

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1/ See Denison (1979) for a review of 16 different possible explanations for the slowdown in the United States, including also reductions in the quality of the work-force; increased government regulation; increased crime, with a diversion of resources to crime prevention; greater concern with pollution and safety, reflected in capital being diverted away from productive uses; and growth of the underground economy. While some of these factors have no doubt contributed to the slowdown, their individual effects are thought by Denison to be small. Moreover, the abrupt and generalized nature of the slowdown across countries appears to defy explanation in terms of factors that typically evolve slowly and differently across countries.

2/ In the immediate aftermath of the first oil shock, groups such as the Club of Rome saw diminished supplies of energy and other raw materials becoming a major constraint on future growth. Predictions of an imminent cessation of growth have not, of course, been borne out.

discuss them separately. 1/ The first type of effect occurs when there is complementarity in production between energy and (installed) capital. 2/ In such a case, an unexpected rise in the price of energy may render some fraction of the energy-using capital stock economically obsolete simply because it is unprofitable to use it. This would lead directly to a reduction in the level of potential output and a decline in labor productivity since the supply of capital services would effectively be lowered. Typically, however, the lower level of capital services would not be captured by standard techniques for measuring the capital stock which are based on constant rates of depreciation. The capital obsolescence argument is associated, in particular, with Bailey (1981) who attributed most of the slowdown in GNP growth and labor productivity in the United States in the second half of the 1970s to accelerated capital obsolescence following the first rise in oil prices. 3/ The capital obsolescence argument has also been applied to explain part of the slowdown in the growth of manufacturing output in other industrial countries (see, for example, J. Artus (1977) and Turner (1987)).

There are two considerations which suggest that the capital obsolescence effect might be relatively small, at least for a whole

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1/ Rasche and Tatom (1979), attribute most of the growth slowdown in the United States to the effects of higher energy prices operating through a third channel. They argue that substitution away from energy toward labor has been responsible for lower growth of labor productivity and, hence, lower output growth. However, because energy conservation (as distinct from inter-fuel substitution), even though it has been quite significant, has not been nearly as substantial as implied by Rasche and Tatom, this mechanism is not generally thought to be important (see Denison (1979) and Berndt (1984)). In addition, the conservation that has taken place has been gradual and cannot account for the sudden decline in growth that took place.

2/ Empirical findings generally support the hypothesis of complementarity between (installed) capital and energy (see Berndt and Field (1979)). Such complementarity can, of course, be consistent with ex ante substitutability between new capital and energy, implying that the impact of higher energy prices on new investment is not necessarily unfavorable. Indeed, as shown below, investment in most countries has held up well as a share of output in the 1970s and 1980s.

3/ Bailey's calculations, which are based on the decline in U.S. stock market values in the course of the 1970s, suggest that as much as 18 percent of the capital stock of U.S. corporations may have become prematurely obsolete during the second half of the 1970s as a result of higher oil prices. Many analysts regard this number as far too high (see Gordon (1981) and Bosworth (1982)) and are skeptical about attempting to infer too much from stock market valuations, which are themselves influenced by many other factors in addition to premature obsolescence and which began declining in the United States before the first oil price increase.

economy. First, the share of energy in costs is small and averaged only 7 percent in the major industrial countries during the 1970s and early 1980s, so that even a doubling of energy prices would have only a small impact on total costs. Second, there does not appear to be any independent evidence of a significant increase in the scrapping of capital after the two rounds of oil price increases, except, perhaps, in particular sectors such as transportation. Based on the evidence available, the staff would estimate that only 5 to 6 percent of the capital stock in the business sectors of the major industrial countries could have become prematurely obsolete after each oil price shock. This would imply that the obsolescence effect could account at most for a 1 to 1 1/2 percent reduction in the level of potential output in the business sectors of these countries following each round of oil price increases. 1/

The second major type of effect on supply arises when oil price increases interact with an inflexible real wage structure. If wage earners are unwilling to accept a reduction in the growth of real wages measured in terms of consumer prices, higher oil prices would reduce profits and create an incipient gap between warranted and actual product wages. Such a gap can arise either because the warranted level of product wages is reduced relative to its initial level (as a result, for example, of premature capital obsolescence leading to a reduction in the marginal product of labor) or because the product wage is raised relative to its initial level due to a rise of consumer prices relative to product prices. In either case, the incipient real wage gap would trigger an adjustment process which would lead to a reduction in employment, a rise in the natural unemployment rate, and a fall in the level of potential output (Gordon (1984); Lipschitz and Schadler (1984); and Bruno and Sachs (1985)).

Wage behavior in the face of energy price shocks appears to have differed considerably among the major industrial countries. 2/ For example, the relatively flexible nature of real wages in the United States suggests that the negative effects of the oil price increases on potential output through the wage-gap mechanism were relatively small. In contrast, in Europe, where real wages have been, and remain, relatively inflexible in the face of adverse disturbances, the negative impact on potential output may have been much larger, possibly of the order of 1-2 percent following each oil price shock. In Japan, a similar effect

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1/ This assessment is based on multiplying the assumed reduction in the capital stock (5 to 6 percent) by the average share of capital in costs. It should be noted that if technological change is embodied in new capital goods, an exogenous slowdown in technological progress such as may have occurred in the 1970s would act to lengthen the lives of capital goods and imply that the effective capital stock may have been undermeasured, thus working to offset the effects of higher oil prices.

2/ For an international comparison of wage behavior, see Bruno and Sachs (1985).

may have resulted from the first oil shock; however, with real wages becoming subsequently more flexible the impact of the second shock was much smaller. Taken together, the obsolescence and wage-gap effects may account for a 3-3 1/2 percent reduction in the level of potential output in Europe, a 1-1 1/2 percent reduction in the United States, and a 3 percent reduction in Japan, as a result of the two oil price shocks. Although these effects are significant, it is apparent that other factors also must have contributed to the slowdown, given its overall magnitude.

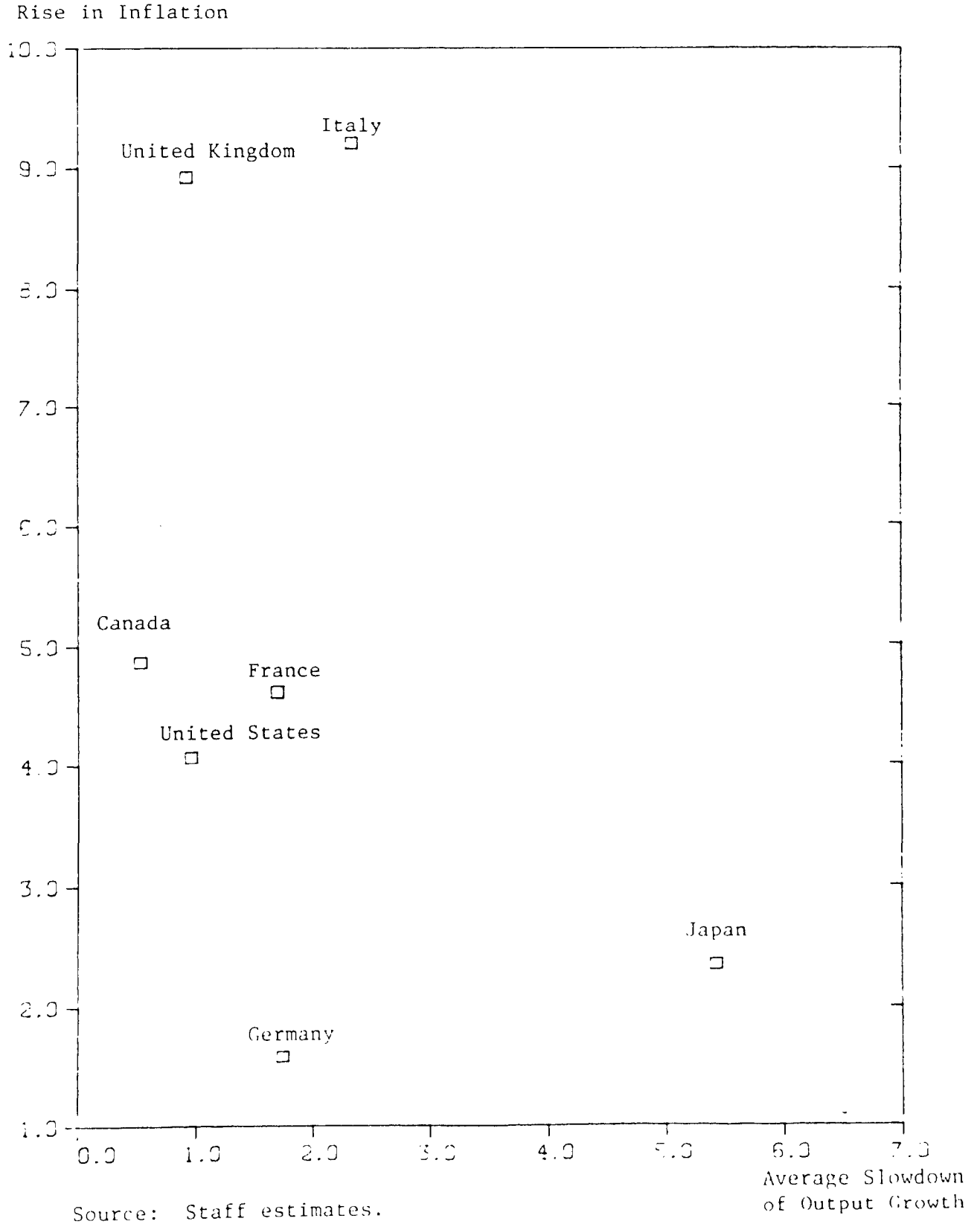
The evidence on the significance of oil prices for potential output is important not only for understanding the growth slowdown in the 1970s and early 1980s, but also for projecting growth in the medium term. Higher oil prices may shift the potential output path downward but should leave underlying rates of growth unchanged, once all adjustments are worked out. This forms the basis for some optimism about growth prospects in the medium term since the effects of the oil price shocks of the 1970s should by now have dissipated. Moreover, if the effects of lower oil prices are at least partially symmetric to those of higher prices, this might suggest that the halving of energy prices in 1986, if maintained, could result in an upward shift of potential output and, hence, temporarily raise growth rates. Section V discusses the possible implications of the recent oil price decline in more detail.

(2) Increase in the level and variability of inflation

The slowdown in industrial country growth has been widely associated with the increased rates of inflation of the 1970s (see Matthews (1982) for references). While stable and anticipated inflation would be expected to have almost neutral long-run effects on output, the inflation of the 1970s has been highly variable and was probably largely unanticipated. Under such conditions, growth may have been lowered temporarily, primarily due to distortions in relative price signals which would have led to misallocation of resources (Friedman (1968)). Higher inflation rates may also have hampered investment by raising the cost of capital in countries where the tax system does not provide for indexation of inflation gains.

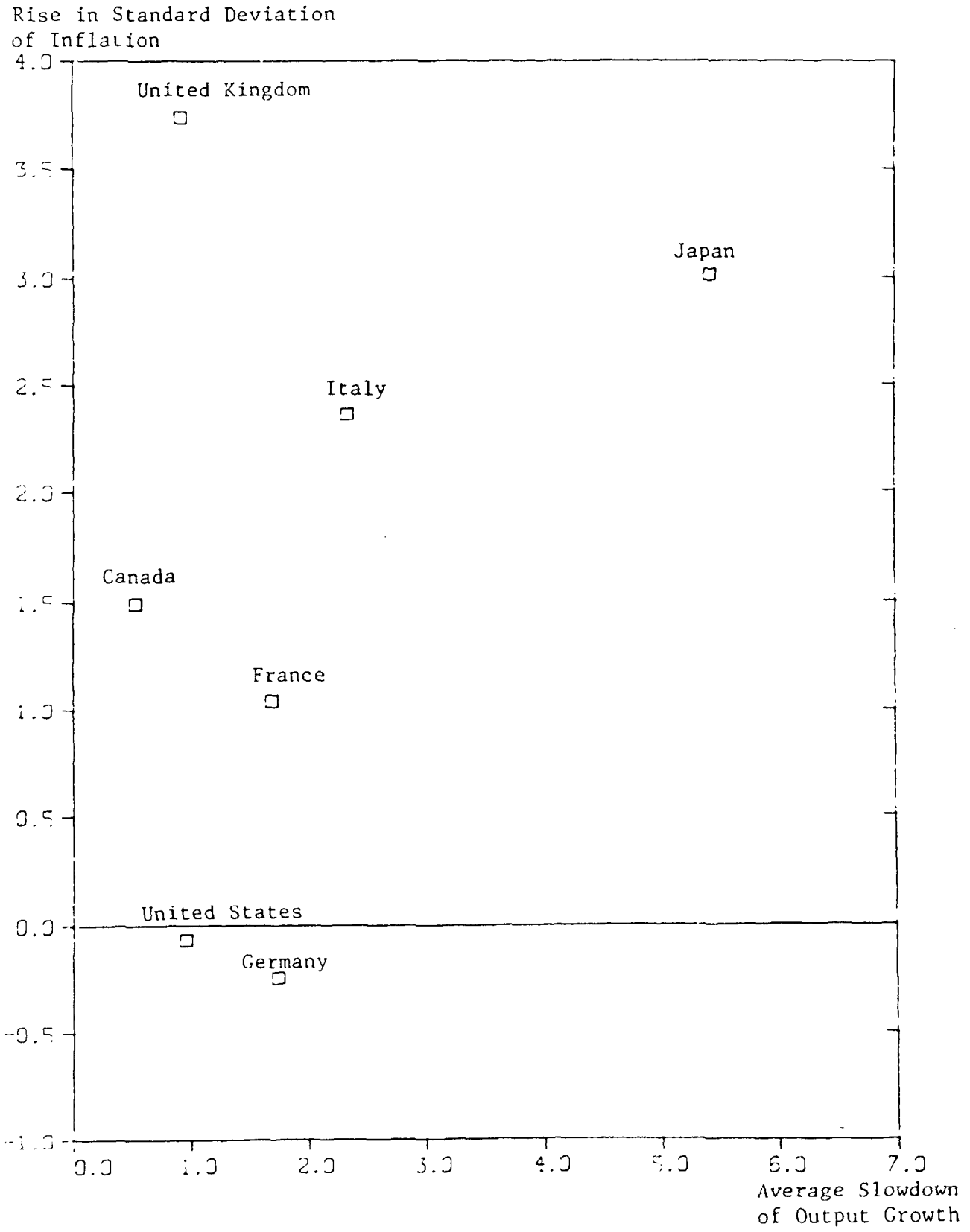
However, there is little evidence on the magnitude of the contribution of inflation to the slowdown in growth. While many authors have attributed part of the slowdown to higher inflation, others, including Denison (1979) and Bruno and Sachs (1985), have argued that the effects have probably been relatively small. The principal basis for this conclusion is the finding that the extent of the slowdown across countries is only loosely associated with increases in their inflation rates, or with increased variability of their inflation performance (Chart 2).

Chart 2. Major Industrial Countries: Inflation and Growth Slowdown, 1971-80 relative to 1961-70
(Percentage points, average annual rates)



Source: Staff estimates.

Chart 2. (continued)



Source: Staff estimates.

(3) Less favorable business climate and lower investment

Increased uncertainty, reflecting, in particular, changes in the international economic environment and the stop-go financial policies of several of the major countries during the 1970s, is frequently cited as a possible reason for the slowdown in growth, mainly through its impact on private investment. Apart from any such "independent" influences on investment, lower capital formation has of course been one of the most important channels through which some of the other explanations for the slowdown may also have operated.

Views differ widely on the role of investment in the growth slowdown. 1/ The disagreement concerns two major points: whether investment did in fact slow significantly in the 1970s and 1980s, and what the contribution of any investment slowdown to the deceleration of growth has been. Table 2 sheds some light on the behavior of investment in the 1970s and early 1980s. 2/ Measured in relation to output in the business sector, gross investment held up remarkably well in most countries during the 1970s and indeed rose in some, with Japan and to a lesser extent Germany being the exceptions. However, it is net investment that matters for the growth of capacity and output, and it is less clear how this measure behaved, given the uncertainties about the magnitude of any obsolescence effects of the sharp increases in energy prices, and in view of the general problems of measuring economic depreciation. 3/ There is, of course, no unambiguous way to measure net investment and the growth of the capital stock, and a number of approaches are used in practice to allow for the depreciation of capital goods. The estimates in Table 2, which are not corrected for premature obsolescence, suggest that the growth rate of the capital stock has declined in most countries, with a relatively large decline in Japan. A similar picture emerges from the evolution of the capital-labor ratio.

1/ In some early accounts of the growth slowdown (see Berndt (1984)), oil price increases were thought to contribute to lower growth by depressing new investment. It is not apparent, however, that higher oil prices will discourage new investment even when there is complementarity between installed capital and energy; indeed, higher oil prices may and probably did encourage investment in energy saving equipment over the 1970s.

2/ See Bosworth (1982) for a discussion of the experience in the United States which reaches the conclusion that investment did not slow significantly, but that the major problem in the 1970s was a failure of investment to rise sufficiently to prevent a small decline in the growth of the capital-labor ratio, in the face of more rapid growth in the workforce.

3/ Most calculations of the capital stock are based on constant rates of depreciation; they are not, therefore, well suited to situations of significant relative price changes that may induce changes in rates of economic depreciation.

Table 2. Major Industrial Countries: Gross Investment Ratio and Growth of Capital Stock and Capital-Labor Ratio 1/

(Private business sector; excluding residential construction; in percent)

	1966-73	1974-85
Canada		
Gross investment ratio	18.2	19.3
Growth of capital stock	5.3	4.9
Growth of capital-labor ratio	3.2	3.3
United States		
Gross investment ratio	12.9	13.8
Growth of capital stock	4.4	3.7
Growth of capital-labor ratio	2.4	1.9
Japan		
Gross investment ratio	26.2	21.5
Growth of capital stock	10.8	6.5
Growth of capital-labor ratio	10.4	5.5
France		
Gross investment ratio	18.7	17.3
Growth of capital stock	5.8	4.1
Growth of capital-labor ratio	5.9	5.8
Germany, Fed. Rep. of		
Gross investment ratio	16.3	14.6
Growth of capital stock	5.3	3.4
Growth of capital-labor ratio	6.1	5.3
Italy		
Gross investment ratio	17.9	18.5
Growth of capital stock	5.6	3.5
Growth of capital-labor ratio	8.0	4.2
United Kingdom		
Gross investment ratio	15.7	17.0
Growth of capital stock	3.8	2.8
Growth of capital-labor ratio	4.8	4.5

Source: See Appendix C.

1/ The gross investment ratio is the ratio of gross business investment to value added; the capital-labor ratio is expressed in relation to total manhours.

Views on the contribution of slower net capital accumulation to the deceleration in growth depend upon assessments of whether the efficiency of investment declined significantly after 1973 and on assumptions made about technological change and the embodiment of technical progress. 1/ A number of authors have argued that the efficiency of investment declined significantly after 1973--largely on the basis of the behavior of incremental capital-output ratios (ICORs). There continues to be disagreement, however, as to whether efficiency of investment did decline significantly (Denison (1979)). When embodiment effects are allowed for, the contribution of lower investment to the slowdown is typically small except in Japan (Lindbeck (1983) and Bayoumi (1986)).

(4) Labor market rigidities

There has been considerable discussion of the role of structural rigidities in labor markets in the growth slowdown, particularly in Europe. The list of rigidities thought to be important includes regulations governing hiring and firing; high unemployment insurance replacement ratios; high minimum wage levels; widespread, and in some instances state mandated, wage indexation schemes; and powerful labor unions.

Growth could have been temporarily retarded as a result either of an increase in the severity of labor market rigidities during the 1970s and early 1980s, or through the interaction of existing rigidities with large and adverse disturbances not experienced in the early postwar period. Such disturbances include the oil price increases discussed above, slower total factor productivity growth, rising social security contributions, and exchange rate depreciations. While there is evidence that rigidities became somewhat worse in the 1970s, a previous staff study concluded that it was mainly the interaction between existing rigidities and the unusually large disturbances of the period which explains Europe's poor labor market performance in the 1970s and early 1980s (Adams, Fenton and Larsen (1986)). 2/

Overall, even though market rigidities have contributed substantially to Europe's poor economic performance, they do not appear to have been a major independent cause of the growth slowdown. There are two

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1/ The embodiment question concerns whether capital's contribution to growth is adequately captured by its cost share. If new capital incorporates improved technology, its contribution could be much larger. Denison (1967) argues that in practice the embodiment issue is not important and that the contribution of capital to growth is adequately captured by its growth rate times its cost share.

2/ The extent to which wage rigidities and economic disturbances may have influenced natural rates of unemployment is analyzed in more detail in Appendix A; their contribution to the growth slowdown is discussed in Section IV.

reasons for this conclusion. In the first place, the reductions in the growth of labor input that were implied by the interaction of rigidities and disturbances and which were reflected in sharp upward movements in natural unemployment rates are not generally large enough to account for any major part of the slowdown in growth. 1/ In most countries, the deceleration of productivity growth appears to have been a much more important factor than reduced labor input. And, secondly, much of the reduction in labor inputs was the result of rigidities which prevented a moderation of real wages in response to the slowdown of the growth of productivity. Under these conditions, it may be more useful to regard labor market rigidities as complicating and possibly magnifying the adjustment problems associated with the growth slowdown rather than as constituting a substantial independent cause.

(5) Growth of the public sector

The rapid growth of the public sector during the 1960s and 1970s is frequently mentioned as a possible reason for the slowdown in growth. A large and rapidly growing public sector may hamper growth in the private sector through a number of channels. For example, high taxes, transfers, and subsidies may distort price signals and impede efficient resource allocation. Moreover, wage behavior may also be less sensitive to changes in economic conditions in countries where a large proportion of the population depend on public sector wages or transfers. A particularly serious impact of the public sector may also occur when large structural budget deficits put pressure on real interest rates and crowd out private investment. Of course, such potential impediments to growth stemming from the growth and the size of the public sector are hard to distinguish from other factors that affect private sector behavior.

Apart from any potential implications for the behavior of the private sector, the public sector is also a major employer that generates output or value added by providing public services. The growth of public services and, hence, public employment was quite rapid during the 1970s, particularly in Europe. Because public services are mostly provided at no or only small direct costs for the user it is often presumed that the expansion of the public sector has led to a loss of efficiency in the overall allocation of resources and, hence, a decline in the rate of output growth for the economy as a whole.

More recently, there has been some discussion about the role of public investments in infrastructure. Although such investments as a share of GNP have traditionally been relatively steady budgetary

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1/ The proximate contribution is equal to the cost share of labor times the reduced growth of labor input. More generally, of course, the interaction of rigidities and disturbances may have led to a slowdown in investment and distortions in resource allocation, lowering potential output further.

restraint in recent years has often meant proportionately larger cuts in public investments, particularly in infrastructure, than in current outlays. While such a reduction would, if maintained, ultimately affect potential output--essentially by lowering productivity growth in the private sector--this factor is unlikely to have played more than a marginal role in the overall growth slowdown given its relatively small weight in total capital formation.

Overall, it seems likely that the rapid expansion of the public sector has contributed to the slowdown. Whether such effects are permanent or whether a stabilization of the share of the public sector will lead to a return to higher growth rates is more difficult to determine. Nevertheless, to the extent that efficiency in the public sector can be improved, and that tax systems can be adapted to promote efficient resource allocation--which indeed is the objective of the tax reforms currently being implemented in several countries--there might be some scope for reversing this effect. Moreover, even though experience shows that it is extremely difficult to terminate expenditure programs, there does seem to be a growing understanding of the harm that is likely to result from government subsidies to inefficient producers, including state-owned enterprises. Cuts in subsidies and privatization of public enterprises should also help to restore higher rates of productivity growth.

b. Permanent Factors

Explanations for the slowdown which suggest a permanent reduction in rates of growth, particularly in Europe and Japan, generally focus on the impact of the slower rate of growth of productivity. The most prominent explanations for the reduction in productivity growth are the catch-up hypothesis and the impact of structural changes in the composition of output.

(1) Catch-up effects

A number of analysts have stressed that the slowdown in productivity growth appears to have been most pronounced in countries like Japan, Italy and, albeit to a smaller extent, France and Germany, which grew particularly rapidly, but from a low starting position, during 1950-73 (see, for example, Marris (1982)). As they gradually caught up with best-practice technology of the leading country--the United States--growth opportunities diminished and the rate of growth of productivity began to decline. 1/

1/ In terms of labor productivity levels, the United States has been the lead country since around 1890 (Maddison (1982)). In an even longer-term perspective, the Netherlands enjoyed the leadership in labor productivity levels during most of the 18th century; from 1785 to 1890, the United Kingdom assumed the productivity leadership following its industrial revolution.

Such catch-up factors are likely to have operated through several channels. The high rate of growth of the capital stock in Japan, for example, has both contributed to the expansion of capacity and has permitted a relatively rapid integration of best-practice technology into domestic production processes. In addition, the progressive elimination of trade barriers during the postwar period stimulated a rapid expansion of foreign trade which contributed to improved resource allocation and facilitated a rapid diffusion of best-practice technology internationally. Although it is difficult to quantify the contribution of catch-up effects, it does appear that these factors were on the wane among the major industrial countries by the early 1970s.

An indication of the reduced scope for catch up is provided by a comparison of labor productivity levels in the major industrial countries (Table 3). Notwithstanding substantial conceptual problems associated with such comparisons, suggesting that numbers should be treated as indicative of trends rather precise levels, labor productivity differentials appear to have narrowed dramatically during the postwar period and productivity levels now appear to be rather similar among the four largest countries. In some sectors there is even evidence that Japan now enjoys the highest productivity level. 1/ Nevertheless, rather than trying to attribute productivity leadership to any particular country, it is probably now more appropriate to characterize the situation as coming closer to collective technological leadership among most of the advanced industrial countries. It is interesting to note in this context that the catch-up explanation remains valid with respect to the growth performance of those developing countries that are usually classified as exporters of manufactures or newly industrializing.

The catch-up explanation clearly helps to explain the growth slowdown in Japan and most of Europe, and suggests that these countries' high growth rates in the 1950s and 1960s could not be sustained indefinitely. Nevertheless, it is apparent that other factors may have been important as well. Indeed, several arguments suggest that the role of catch-up factors should not be exaggerated. For example, the abrupt nature of the slowdown appears to be inconsistent with the gradual ending of catch-up possibilities. Moreover, the catch-up hypothesis cannot explain why productivity gains in the lead country, the United States, should also slow down.

1/ The data in Table 3 should be interpreted with caution. Comparisons of this type depend critically on the real exchange rates--here chosen somewhat arbitrarily as purchasing power parities in 1975--used to convert productivity data into a common currency and the data should be taken as indicating only rough orders of magnitude. Tentative calculations suggest that a more recent exchange rate assumption would essentially close the gap between the productivity levels in Japan and the United States.

Table 3. Major Industrial Countries: GDP Per Manhour at 1975 Purchasing Power Parities

(Expressed, in each year, as a percentage of U.S. productivity)

	1870	1950	1960	1973	1981	1985
Canada	87	78	84	87	88	96
United States	100	100	100	100	100	100
Japan	28	16	22	51	59	71
France	65	46	56	80	95	111
Germany, Fed. Rep. of	68	36	55	78	95	102
Italy	63	32	39	66	70	77
United Kingdom	121	59	58	68	78	85

Source: Maddison (1982) and staff estimates.

(2) Structural changes in the composition of output

The comparatively rapid growth of the services sector is often cited as an important reason for the slowdown in overall growth because labor productivity is thought to be lower and to grow less rapidly in this sector than in manufacturing in particular. 1/ This argument is related of course to the question of the role of the public sector discussed earlier.

Structural changes have been an essential part of the process of growth since the industrial revolution. Indeed, the past 100 years has seen a dramatic reduction in the share of agriculture in output and employment to the benefit of both industry and services. More recently, industry's share of employment appears to have begun to decline, having peaked typically during the decade from the mid-1960s to the mid-1970s (Table 4). Whereas the outflow of labor from agriculture since the end of the 19th century clearly had a beneficial influence on aggregate productivity, it is less obvious what the impact of the more recent shift from industry to services has been. In the United States, where employment in services has increased quite rapidly since the early 1970s, growth of output per manhour has in fact been significantly lower than in Europe where the services sector has been expanding less rapidly, despite the growth in public services. However, to some extent such differences in productivity growth may have reflected differences in wage behavior, with real wages in Europe generally having been more resilient--or rigid--in the face of adverse developments in countries' terms of trade during the 1970s. They may also have reflected the more rapid growth of the labor force in the United States. Europe's higher labor productivity growth may therefore reflect efforts to economize on labor. It may also reflect the fact that opportunities to expand employment in lower-productivity, low-wage branches of the service sector were considerably smaller than in the United States.

More recently, in the absence of convincing signs of a strong recovery in growth rates, particularly in Europe, the idea of hysteresis has been introduced to explain the continued poor growth performance. 2/ The argument here is that what may have begun as a temporary slowing of growth in the industrial countries, perhaps as a consequence of cyclical factors, may essentially have turned into a permanent slowdown via two major mechanisms: a long period of slow growth that may have led to a deterioration of human capital and to a slowing of physical investment, and thus to lower potential output; or low growth that may have hampered invention and innovation, thus reducing the growth of productivity and

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1/ For an early staff analysis of the relationship between the growth slowdown and structural change, see Tung (1980). This study was unable to establish a significant relationship between the slowdown and the structural changes that occurred in the 1970s.

2/ The concept of hysteresis refers to the dependence of an equilibrium on the initial state and path of the economy.

Table 4. Major Industrial Countries: Structure of Civilian Employment by Sector

(In percentage shares)

	1870	1950	1960	1973	1981	1985
Canada						
Agriculture	53.0	20.4	13.2	6.5	5.4	5.2
Industry	30.0	40.4	32.7	30.6	28.3	25.5
Services	17.0	39.2	54.1	62.8	66.3	69.3
United States						
Agriculture	50.0	9.8	8.5	4.2	3.5	3.1
Industry	24.4	35.8	35.3	33.2	30.1	28.0
Services	25.6	54.4	56.2	62.6	66.4	68.8
Japan						
Agriculture	72.6	38.5	30.2	13.4	10.0	8.8
Industry	n.a.	25.0	28.5	37.2	35.3	34.9
Services	n.a.	36.5	41.3	49.4	54.7	56.4
France						
Agriculture	49.2	25.9	23.2	11.4	8.4	7.6
Industry	27.8	37.9	38.4	39.7	35.2	32.0
Services	23.0	36.2	38.5	48.9	56.4	60.4
Germany, Fed. Rep. of						
Agriculture	49.5	16.9	14.0	7.5	5.5	5.5
Industry	28.7	47.2	47.0	47.5	43.4	41.0
Services	21.8	35.9	39.1	45.0	51.1	53.5
Italy						
Agriculture	62.0	37.4	32.6	18.3	13.4	11.2
Industry	23.0	34.2	33.9	39.2	37.6	33.6
Services	15.0	28.4	33.5	42.5	49.0	55.2
United Kingdom						
Agriculture	22.7	4.6	4.7	2.9	2.7	2.6
Industry	42.3	49.1	47.7	42.6	35.9	32.4
Services	35.0	46.3	47.6	54.5	61.4	65.0

Sources: Maddison (1982); OECD Labor Force Statistics.

technical progress. Under these conditions, countries may be trapped in a vicious circle of low growth. 1/ There is as yet little evidence on the significance of these arguments.

In summary, plausible explanations for the slowdown in growth are not lacking. Although the list discussed above could easily be expanded, it seems to be generally agreed that it covers the most likely causes of the slowdown. 2/ The problem is rather that the literature is divided on the relative importance of the identified factors and hence on the relative roles of those that are temporary and those that are permanent. These difficulties associated with the quantification of the sources of the slowdown reflect the fact that the relationships between the identified causes and the growth process are extremely complex; that such relationships are likely to vary over time; that most of the factors are highly interdependent; and that many possible factors came into play simultaneously, causing an unusually sharp deceleration in growth. Before assessing the contributions of the most important factors behind the slowdown, it is necessary to define more carefully what is meant by underlying or potential output.

III. Potential Output and the Inflation Constraint

As mentioned in the introduction, the Fund's need for economy-wide estimates of potential output should be seen in the light of its surveillance functions. These functions reflect, inter alia, the concern of Fund member countries that policies should seek to minimize the risk of a renewed upsurge in inflation. From this perspective it appears that a major requirement for a measure of potential output to be useful for the work of the Fund is that it should be consistent with the inflation objective. Other requirements are that the relationship between the basic determinants of growth and potential output should be reasonably transparent, and that the concept should be useful for forecasting.

In view of these considerations, the approach adopted in this study is to define the potential output of an economy as the level of output that can be sustained without risking a rise in inflation. This requirement is met by basing calculations of potential output on estimates of the natural rate of unemployment, which indicates the rate of unemployment which would prevail when expectations of inflation are realized (Friedman (1968)). The natural unemployment rate is the

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1/ The considerations discussed here fall also under the heading of Verdoorn's law. See Matthews (1982).

2/ For a discussion of the possible role of changes in labor quality, improvements in resource allocation, economies of scale, government regulations and other factors not discussed in this study, see Supplementary Note 6 to the April 1985 World Economic Outlook.

unemployment rate toward which economies will tend to converge following disturbances.

By defining potential output on the basis of inflation considerations, the study follows the majority of authors on this subject. 1/ Of course, potential output could be defined in a number of alternative ways. For example, it could be defined to indicate an absolute physical ceiling on output over a given period or, alternatively, as a "normal" level of production given average levels of factor utilization rates. (See Lucas (1981) for a critical discussion of alternative concepts of potential output). Nevertheless, most approaches define potential output as that level that is consistent with stable inflation. 2/

Any attempt to obtain an estimate of potential output that is consistent with the inflation objective requires, implicitly or explicitly, a view on the structure or functioning of markets, in particular those for labor. For example, in countries where market rigidities require high levels of unemployment to induce real wage moderation, potential output may fall considerably short of the level that would ordinarily seem consistent with high employment conditions. In such cases it is useful to distinguish between two potential output concepts based on different assumptions. The first is the "natural" concept used in this study which measures the level of potential output on the basis of the existing structure and imperfections of markets. The other, which may be called the "structural" concept, takes into account the possibility of tackling labor market rigidities, and permits a higher level of employment and potential output. While both concepts are useful for surveillance, the structural concept is essentially a longer-term concept that allows for structural changes to have worked through.

1. Traditional approaches

The simplest approaches to estimating potential output have usually involved some kind of smoothing of fluctuations in output over time, on the assumption that economies are generally functioning at their

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1/ See, for example, Okun (1962), and Perloff and Wachter (1978).

2/ In his seminal article on potential output Okun (1962) notes that "...potential GNP ... is not a measure of how much output could be generated by unlimited amounts of aggregate demand. The nation would probably be most productive in the short run with inflationary pressures pushing the economy. But the social target of maximum production and employment is constrained by a social desire for price stability and free markets. The full employment goal must be understood as striving for maximum production without inflationary pressure ...". Okun based his early estimates of potential output for the United States on the assumption that an unemployment rate of 4 percent (regarded as the "full-employment level of unemployment" in the 1950s and early 1960s) was consistent with the inflation objective.

potential over some period (see, for example, early attempts to estimate potential output by the Council of Economic Advisers in the United States as discussed in its 1978 annual report). 1/ Such approaches depend critically on judgments about the length of the average business cycle and are influenced strongly by historical experience. They typically result in estimates of potential output that closely track the series for actual output and ensure that any break in its trend is eventually reflected in the potential output series. When applied to the experience of the 1970s and early 1980s, the "smoothing" approaches have tended to translate the generalized slowdown in growth into a permanent one, reflected in a decline in trend rates of growth of potential output.

Another approach to the measurement of potential output is that of Okun (1962) which has also been widely used, particularly in the United States (see, for example, Clark (1977) and Gordon (1978)). This approach, as noted earlier, directly links the estimation of potential output to a judgment or estimate of the natural rate of unemployment. It is based on a simple relationship between two gaps: the gap between the natural and actual rates of unemployment (the unemployment gap) and that between actual and potential output (the output gap). That is, if Y and $\bar{Y}$ refer to actual and potential output and U and $\bar{U}$ to the actual and natural rates of unemployment then,

$$(Y/\bar{Y}-1) * 100 = \alpha \cdot (\bar{U}-U) \qquad (1)$$

where α is known as Okun's coefficient. On the basis of this equation potential output can be calculated given an estimate of the unemployment gap and the actual level of output. For the United States, Okun's coefficient usually has been assumed to be approximately constant in the range of 2 to 3 for the economy as a whole. This implies that for each percentage point by which the unemployment rate is above its natural rate, the level of GNP is about two to three percentage points below potential (see Gordon (1978) and Perloff and Wachter (1978)).

The coefficient, α, that underlies the Okun approach incorporates a variety of effects that come into play when an economy is away from potential, including effects associated with the hoarding of labor, changes in capacity utilization, as well as variations in labor force participation rates. Two weaknesses of the approach are that it does not identify the relative importance of each of these factors and it relies on a constant coefficient. Particularly in the European countries, there appear to have been significant changes in the relationship between capacity utilization rates and unemployment since the early 1970s (OECD (1986)), suggesting that it may be inappropriate to assume a fixed coefficient. (See Section IV for further discussion of this issue).

1/ These approaches include the various trend-through-peak methods of computing potential output (see Sachs (1979)).

Both the smoothing and Okun type approaches to the measurement of potential output need to be supplemented to project potential output. The most common approaches to such projections have involved either the extrapolation of past output trends or the separate forecasting of the growth of labor productivity and labor input. An example of the former is the work of Bruno and Sachs (1985). An example of the latter, the decomposition approach, is the method of potential output projection used for some time by the Council of Economic Advisors in the United States (See Dornbusch and Fisher (1978)). The decomposition approach is illustrated in equation (2) where $\bar{Y}$ and $\bar{L}$ refer to potential output and potential labor input, respectively, and g ( ) indicates the growth rate of a series.

$$g(\bar{Y}) = g(\bar{Y}/\bar{L}) + g(\bar{L}) \qquad (2)$$

The projections of potential productivity and labor input in this approach typically depend heavily on past trends, but they may be influenced also by judgments about special factors that are assumed to operate over the projection period.

The early approaches to the estimation and forecasting of potential output worked reasonably well until the latter half of the 1960s. However, the significant upward ratcheting of inflation in the late 1960s and early 1970s meant that the consistency with the inflation objective became increasingly difficult to preserve. Moreover, because these approaches tend to deal somewhat mechanically with any change in economic conditions, they are not well suited to separating permanent from transitory influences. These approaches also tend to extrapolate any change in growth automatically, provided it is maintained long enough, and, even when they produce correct judgments about historical developments in potential output, they do not explicitly identify the underlying determinants. Such methods are, therefore, unreliable for forecasting, particularly when the economic environment is undergoing substantial changes.

2. The production function approach

The measurement of potential output in the present paper follows a "production function" approach, and resembles the methodology adopted by OECD (1973), the Deutsche Bundesbank (1981) and P. Artus (1983) and Helliwell et al. (1985) in studies at the OECD. It is also in the spirit of and draws upon earlier studies within the Fund on potential output in manufacturing by J. Artus (1977) and J. Artus and Turner (1978). The essence of the production function approach is an explicit modeling of output in terms of underlying factor inputs, which involves the specification and estimation of production functions linking output to factor inputs, as well as the determination of the levels of inputs. The inflation constraint is introduced by relating the potential level of factor inputs to the natural rate of unemployment.

The production function approach has four building blocks: The

first is a two-factor production function that relates the output (value added) of the private business sector to the inputs of capital and labor, as well as to total factor productivity. This function identifies the relationships between output and inputs and allows an assessment of the contributions of changes in capital and labor to the growth of the business sector's output. The second element is a pair of equations that relates the intensities with which capital and labor are used over the business cycle to the ratio of actual to normal output. These equations capture cyclical variations in input use that are not adequately captured by measured changes in factor inputs. They thus take into account cyclical phenomena such as changes in labor hoarding and in rates of capacity utilization. The third component of the model is a pair of equations that is used ultimately to determine the potential inputs of factors. These equations relate the inputs of factors to the deviation of the unemployment rate from its natural rate, to the ratio of actual to normal output, and to a number of factor-specific influences. Potential inputs are found by determining the levels of input when unemployment is at its natural rate and output is at its normal level. This part of the approach serves to introduce the inflation constraint by relating potential inputs to the natural rate of unemployment. Finally, the fourth building block is an equation that relates the rate of unemployment to three sets of considerations: cyclical influences; demographic and structural influences; and warranted real wage influences (see Appendix A for details). This equation is used to solve for the natural rate of unemployment which, as mentioned earlier, is the rate that prevails when actual and expected inflation are equal and cyclical factors are absent.

The production function approach is a compromise between a full-scale modeling of the determinants of potential output, and the more traditional mechanical and judgmental approaches. The model relies heavily on the production function but does not require an explicit modeling of the demand and supplies for factors or of the influences on total factor productivity. The assumptions are that, in the short run, the potential inputs of factors can be determined principally on the basis of the behavior of unemployment relative to its natural rate, and the deviation of output from its normal level. It is also assumed that the growth of factors and multi-factor productivity that underlie the projections of potential output can be based on judgments about the macroeconomic environment supplemented by explicit views on key relationships.

The approach chosen in this study has four major advantages over traditional approaches to the measurement of potential output. First, it allows for an explicit accounting for growth in terms of the contributions of factor inputs and total factor productivity. Second, it explicitly describes the links between product and factor markets that underlie relationships such as Okun's law, yet does not impose a constant Okun coefficient. The latter is particularly important given the sharp changes in the relationship between unemployment and capacity utilization observed in most countries during the 1970s. Third, the

production function approach facilitates the analysis of the impact of various disturbances, including the effects of changes in energy prices. In particular, the approach helps to assess the contribution of energy price increases to the slowdown in growth, by allowing for both its effects via premature capital obsolescence--on the assumption that energy and (installed) capital are complementary--and via real wages and the natural rate of unemployment. Finally, for forecasting, the approach can be adapted to determine the underlying rates of economic growth that may be envisaged and the possible influences of factors such as the recent decline in energy prices and the possibility that natural rates of unemployment in most countries may now begin to decline, following significant increases in the 1970s and early 1980s.

The production function approach does, of course, have some disadvantages, especially when applied to a broad sector such as that studied here. In particular, the approach does not deal explicitly with the effects of changes in the composition of output between sectors; nor does it permit the identification of those sectors that are likely to be the engines of growth in the period ahead. The approach that could deal with such sectoral shifts would be highly disaggregated and extremely complex and is be beyond the scope of the present study.

IV. Empirical Results

In this section estimation results based on the production-function approach described in Section III are presented and combined with estimates of the potential inputs of production factors to compute historical estimates of potential output. The resulting output gaps are calculated for GNP for the economy as a whole and are compared to the unemployment gaps implied by the natural unemployment rates estimated in Appendix A. Finally, the economy-wide estimates of potential output presented in this study are compared to estimates for the manufacturing sector based on previous research within the Fund.

1. Estimation Results

The specific form of the production function that was estimated is given by equation (3) where Q refers to output (value added) in the business sector, L and K refer to the inputs of labor and capital, and π^L and π^K are the intensities with which these factors are employed over the business cycle. 1/ The term F(t) is included to capture the growth

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1/ The simple form of the production function was chosen to permit a clearcut identification of the roles of labor, capital, and total factor productivity. More sophisticated specifications would allow for a range of substitution possibilities between labor and capital but would be less transparent about the sources of growth.

of total factor productivity and (Σ_t) is included to capture random measurement errors. 1/

$$Q_t = A_o(\pi_t^L L_t)^{\alpha_L} (\pi_t^K K_t)^{\alpha_K} e^{[F(T) + \Sigma_t]} \quad (3)$$

The approach to estimation, which closely follows that of J. Artus and Turner (1978) and Turner (1987), is based on the simplifying hypothesis that the intensities with which labor and capital are used (π_t^L, π_t^K) over the business cycle are related to the deviation of output from its normal level according to equation (4).

$$(\pi_t^{L\alpha_L} \pi_t^{K\alpha_K}) = e^{[C(B)\ (\ln Q_t - \ln Q_t^N)]} \quad (4)$$

Here, C(B) indicates a polynomial in the lag operator B and Q_t^N is the normal level of output. 2/ In the estimations, the normal output level was approximated by a centered eight-year moving average of actual output.

Substituting equation (4) into (3) allows the production function to be rewritten as:

$$Q_t = A_o\ (L_t)^{\alpha_L} (K_t)^{\alpha_K} e^{[C(B)\ (\ln Q_t - \ln Q_t^N)) + F(T) + \Sigma_t]} \quad (5)$$

For estimation purposes, the parameters α_L and α_K were approximated by the average cost shares of labor and capital over the estimation period, $(\bar{\alpha}_L, \bar{\alpha}_K)$, while total factor productivity F(T) was represented by time trends, the details of which are provided below. With the approximations, the estimated production function can be written in logarithmic form as:

$$\ln Q_t = \ln A_o + \bar{\alpha}_L \ln L_t + \bar{\alpha}_K \ln K_t + C(B)\ (\ln Q_t - \ln Q_t^N) + F(T) + \Sigma_t \quad (6)$$

In carrying out the estimations, it was assumed that 5 percent of the

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1/ A seasonal dummy was also included in the estimated equations.

2/ The lag operator B is defined so that for any variable X, $B^n X_t = X_{t-n}$. In the estimations, an eight period lag was used for the intensity of factor use variables, combined with a second degree polynomial.

capital stock in each country was rendered prematurely obsolete in the wake of the two oil price shocks in 1973-74 and 1979-80. 1/

The results of estimating equation (6) are shown in Table 5. Each equation includes two time trends in order to capture the role of total factor productivity growth. The first trend covers the period from the early or mid-1960s through to 1973, and is intended to capture the rates of total factor productivity advance prior to 1973. The second covers the period 1974-1983 and captures any decline of productivity growth after 1973. 2/ For all countries, the equations were estimated using semi-annual data from the early or mid-1960s up to 1983.

The estimated equations fit the data well according to the usual statistical criteria. Two features of the estimation results stand out. The first is the role of total factor productivity. In all countries, there is a marked tendency for the rate of total factor productivity growth to decline after 1973 as captured by the estimated values of β_1 and β_2. The second is the importance of the intensity of use (or cyclical) variable, which is statistically significant in all countries other than the United Kingdom.

The levels of potential output implied by the estimated production functions are found by setting the actual level of output equal to its normal level ($Q_t = Q_t^N$), to give "normal" factor intensities, and by replacing the actual inputs of factors by their potential levels. To determine the potential inputs of factors, a two-step procedure was employed. In the first, estimates were made of developments in the natural rate of unemployment. In the second, the inputs of labor and capital were related to the deviation of the unemployment rate from its natural rate, to the deviation of output from its normal level, and to a number of factor-specific influences.

The determination of the natural rates of unemployment is critical for the approach. For the United States, Japan and Canada there is

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1/ Initially, an iterative procedure was employed, along the lines of Berndt and Wood (1985), in order to determine the degree of obsolescence that best fitted the data. This procedure led to degrees of obsolescence (e.g., 20-40 percent) that seemed to be far too high and it was necessary to restrict the degree of obsolescence. Turner (1987) assumes that 10 percent of the capital stock in manufacturing in each of the industrial countries became obsolete in the wake of each of the oil price increases. The figure of 5 percent assumed in the current study refers to the business sector as a whole and is, of course, well below the estimate by Bailey for the United States economy of 18 percent. (See the discussion in Section II).

2/ Attempts to include a third time trend were also made, to determine whether productivity growth changes in the 1970s. However, this trend was never statistically significant, suggesting that it is appropriate to model the period after 1973 with a single trend factor.

Table 5. Major Industrial Countries: Estimates of the Production Function

$$(\ln Q_t = \ln A_0 + \bar{\alpha}_L \cdot \ln L_t + \bar{\alpha}_K \cdot \ln K_t + \beta_1 \cdot T_1 + \beta_2 \cdot T_2 + \beta_4 \cdot D + C(L) * (\ln Q_t - \ln Q_t^N)$$

Country	Time Periods	$\ln A_0$	β_1 1/	β_2 2/	β_4 3/	C 4/	$\bar{R}^2$	S.E.E.
Canada	S2:1960-S2:1983	0.70 (69.22)	0.02 (22.86)	0.004 (3.85)	$0.04X10^{-2}$ (0.08)	0.67 (3.36)	0.99	0.02
United States	S2:1960-S2:1983	1.73 (213.11)	0.01 (12.80)	0.002 (1.04)	$0.26x10^{-2}$ (0.54)	1.27 (4.62)	0.99	0.02
Japan	S1:1966-S2:1983	4.42 (179.79)	0.07 (29.24)	0.02 (7.91)	$0.09X10^{-2}$ (0.10)	0.22 (1.99)	0.99	0.02
France	S2:1963-S2:1983	1.50 (120.73)	0.05 (45.75)	0.03 (36.34)	$0.3X10^{-2}$ (0.35)	0.64 (2.20)	0.99	0.01
Germany, Fed. Rep. of	S2:1960-S2:1983	1.53 (95.81)	0.05 (30.34)	0.02 (18.00)	$0.51X10^{-2}$ (0.80)	0.47 (2.00)	0.99	0.02
Italy	S2:1962-S2:1983	4.78 (441.40)	0.06 (55.24)	0.02 (15.34)	$0.21X10^{-3}$ (0.04)	0.24 (1.74)	0.99	0.02
United Kingdom	S2:1963-S2:1983	0.40 (31.40)	0.03 (23.79)	0.01 (9.64)	$0.19X10^{-2}$ (0.38)	-0.24 (0.77)	0.98	0.02

1/ Coefficient attached to a time trend that assumes the value of 0.5 in S1:1960 and is incremented by one annually up to 1973.

2/ Coefficient attached to a time trend that assumes the value of 0.5 in S1:1974 and is incremented by one annually up to 1983.

3/ Coefficient attached to seasonal dummy assuming value of 1 in the first half of each year.

4/ Sum of coefficients attached to polynomial distributed lag of output deviations variable. Here, a second degree polynomial with eight lags was used.

considerable agreement about the approximate magnitude of the natural unemployment rates and the factors determining them so the estimation of these rates did not cause any particular problems. For the major European countries, however, there is strong disagreement about the behavior of natural unemployment rates and, in particular, about the major influences upon them. For these countries, the estimates in this study rely on three compo: .cs: the unemployment equations described above; estimates of natural unemployment rates (or NAIRU's--Non-Accelerating Inflation Rates of Unemployment) from other studies; and the behavior of real wages over the period under review (see Appendix A for details). The particular focus was on the high levels of unemployment in Europe in the 1970s and early 1980s and on the implied degree of slack in European labor markets over this period.

Based on the evidence surveyed many studies have reached the conclusion that the degree of slack in European labor markets has been and remains relatively small. Actual and natural rates of unemployment have been very similar, notwithstanding extraordinarily high unemployment rates. Substantial differences of opinion exist, however, as to why natural rates of unemployment increased so much over the 1970s and early 1980s (Blanchard and Summers (1986)). In Appendix A, several of the factors that may have contributed to high natural unemployment rates are discussed, although it is clear that there are no complete explanations at present.

The estimates of the natural unemployment rates that were used in determining the potential inputs of factors are shown in Table 6 in Section V. As explained earlier, these estimates are based on unemployment equations that capture the impact of cyclical as well as demographic and structural influences on unemployment. An important feature of the approach is the inclusion of variables that represent disturbances which may affect the relationship between the actual and the warranted level of real wages in countries where real wage behavior is characterized by rigidities. Such variables are generally found to have contributed to the marked increase in natural unemployment rates in European countries since the early 1970s. In the United States, where real wages are generally relatively flexible in the face of disturbances, the rise in the natural unemployment rate is related to factors such as changes in the age and sex structure of the work force.

While the uncertainties that are necessarily associated with the estimation method used suggest that too much importance should not be attached to any point estimate of the natural unemployment rate, the resulting series for the natural rate are nevertheless consistent with other estimates available in the literature (see Appendix A). Obviously, different assumptions about the natural unemployment rate would result in different potential input and output estimates.

By setting unemployment at its natural level and output at its normal level as defined above, the equations for factor inputs were then

used to determine the potential levels of labor and capital. 1/ These were finally substituted into the production functions with factor intensities at their normal levels.

2. Sources of growth

The resulting estimates of potential output in the business sector are shown in Chart 3 along with the contributions to growth of changes in potential factor inputs and total factor productivity. In each case, the contribution of a factor input to growth is defined as its potential rate of growth times its average cost share over the estimation period. 2/

A first important feature of the potential output results is that most of the slowdown in actual growth since the early 1970s can be explained in terms of a deceleration of the rate of growth of potential output rather than by cyclical effects. The magnitude of the slowdown in the growth of potential output is largest in Japan and the European countries--i.e., countries that grew particularly rapidly in the 1960s--but is relatively small in the United States.

Three causes of the slowdown in the growth of potential output are identified in Chart 3. In the first place, in all countries there was a marked reduction in the growth of total factor productivity in 1973-74, which accounts for the bulk of the slowdown. These reductions were largest in Japan and Italy and relatively small in the United States. The significance of lower growth in total factor productivity for the slowdown has been widely noted (See Denison (1979) and Kendrick (1981)) and the reduced growth is believed to reflect principally a slowdown in technological advance in addition to reduced scope for catch-up effects in countries other than the United States. However, because total factor productivity obviously reflects all the influences on the growth of potential output not adequately captured by measured changes in factor inputs, it could also reflect the impact of changes in the sectoral shares of output, the rapid growth of public expenditures, or reduced scope for economies of scale and changes in market structures. Second, in all countries about 1 to 1 1/2 percentage points of the slowdown in growth was attributable to accelerated capital obsolescence following the two rounds of oil price increases in 1973-74 and 1979-80. Only in Japan, however, was this negative contribution superimposed on a marked trend slowdown in the contribution of capital to growth; in other countries it adds to a more moderate deceleration in the growth of the capital stock. Finally, in most countries, and particularly in Europe, reduced labor input also contributed to the growth slowdown as natural unemployment rates rose during the 1970s and

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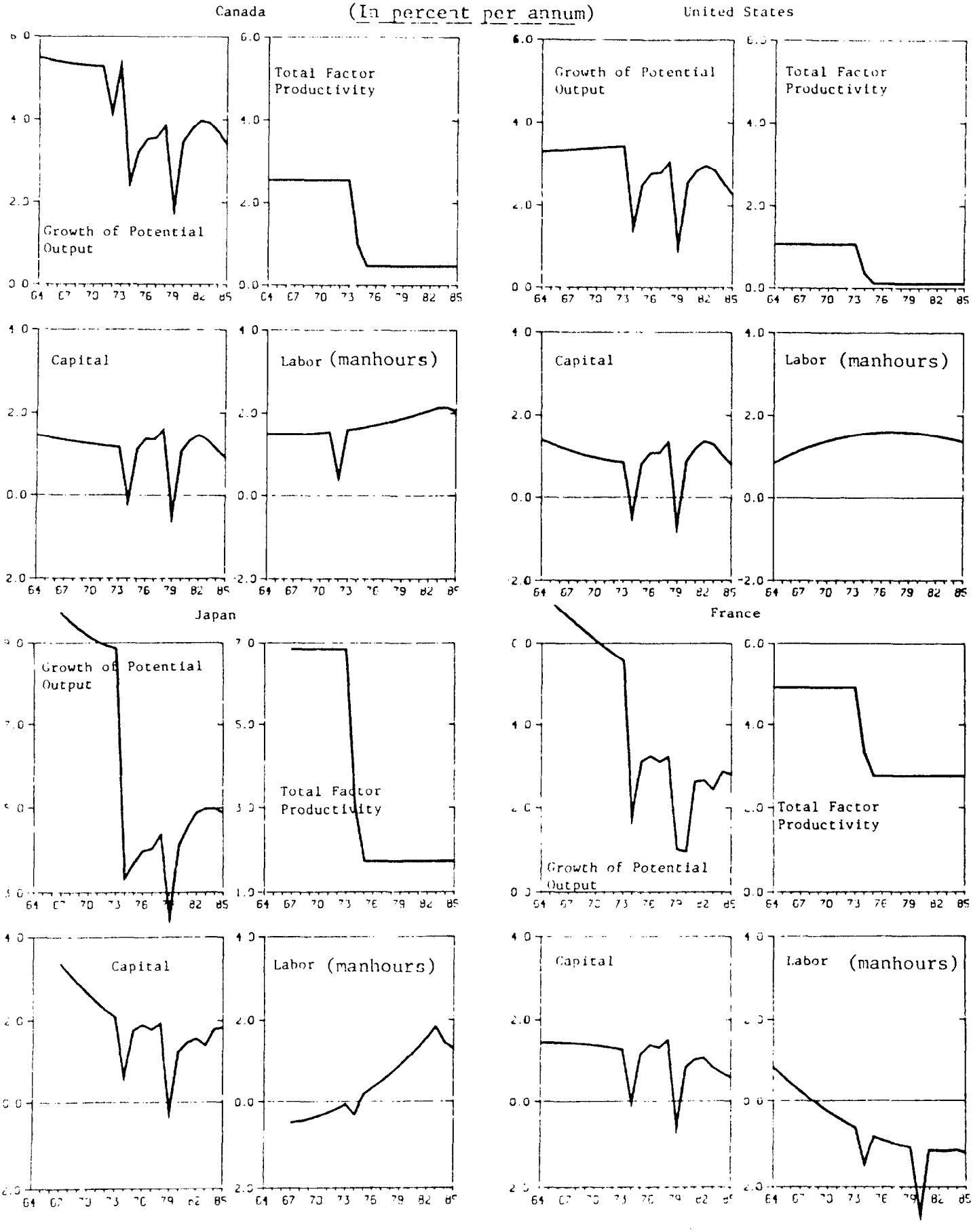
1/ Details of these equations and estimation results are not reported here but can be obtained from Current Studies Division.

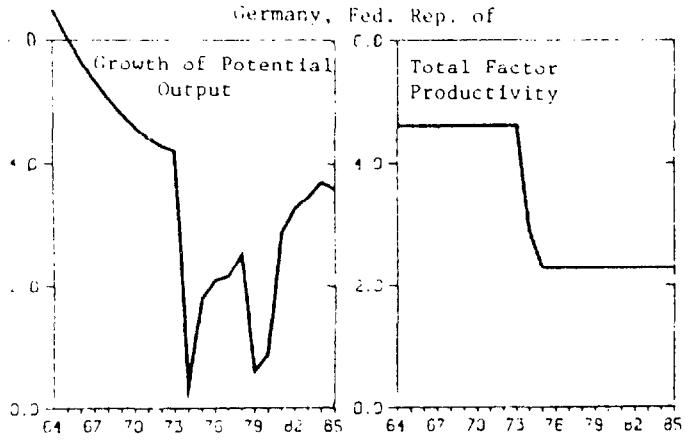
2/ This approach follows the growth accounting approach (Denison (1979)).

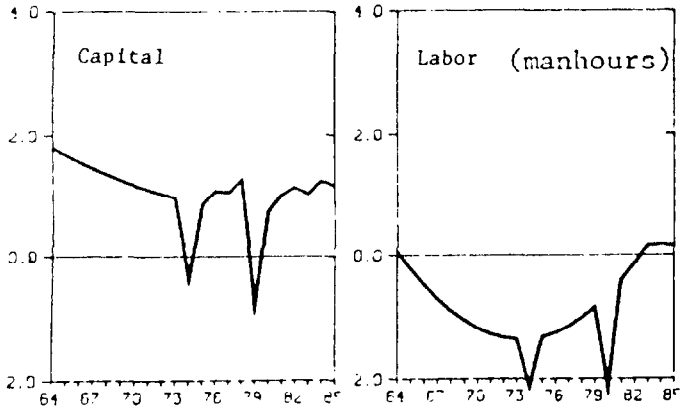
Chart 3. Major Industrial Countries: Estimated Growth of Potential Output in the Business Sector and Contributions of Factor Inputs and Total Factor Productivity

(In percent per annum)

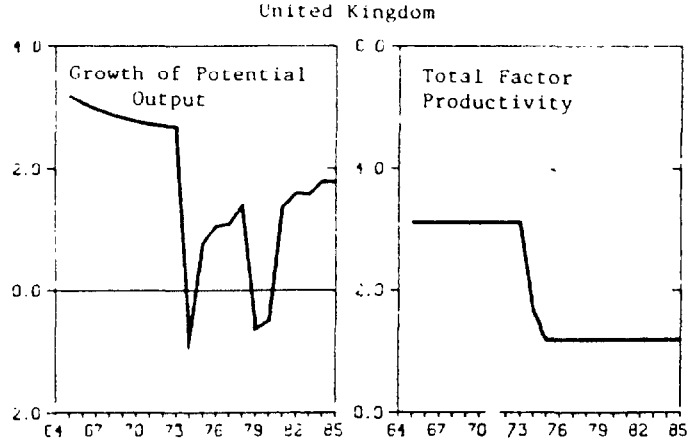


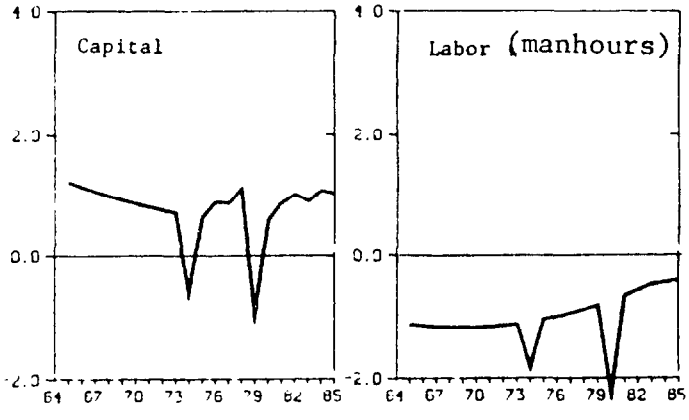
Germany, Fed. Rep. of



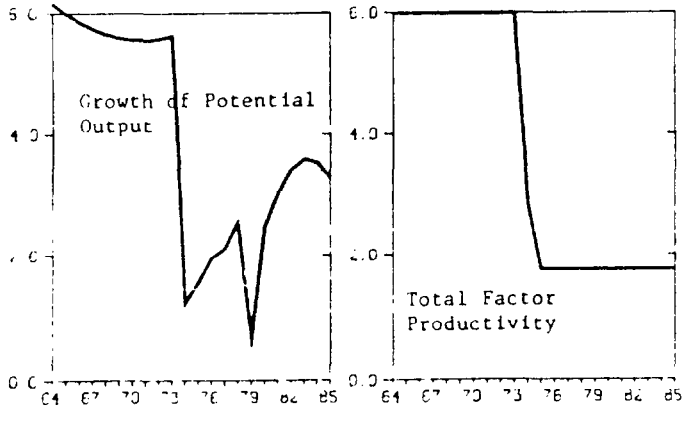


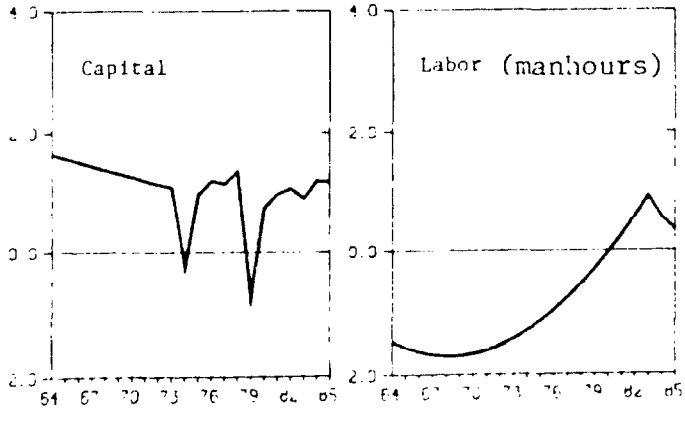
United Kingdom





Italy





early 1980s and because of a continued decline in average hours worked.

3. Output and Unemployment Gaps

The estimates of potential output and the series for actual output are compared in Chart 4, which shows the gaps between actual and potential output on an economy-wide basis (GNP), i.e., including an adjustment for production by the public sector. 1/ A positive gap indicates that actual output is above potential. Also displayed are the gaps between the actual and natural rates of unemployment.

The output and unemployment gaps suggest that after beginning the 1970s at different stages of the business cycle, most of the major industrial countries experienced some overheating by 1973 or 1974 as they operated at or above potential, adding to the severe inflationary pressures of the period. These boom conditions, however, were relatively shortlived and growth slowed markedly in all countries in 1974-75.

Although most countries experienced negative growth rates during the 1974-75 recession, the output gaps at the trough of the recession (1975) do not appear to have been unusually large, partly because growth in many countries in 1974-75 were slowing down from a position that was above potential and, hence, unsustainable. Some part of the slowdown therefore was a correction of the overheating in 1973. Moreover, the slowdown in actual output growth in 1974-75 was due in large part to a slowdown in the growth of potential output, reflecting both the impact of higher oil prices on the capital stock and on natural unemployment rates, as well as a deceleration of total factor productivity growth. Given the relatively small output gaps in 1974-75, the recovery of 1976-79 brought most countries back to potential by the end of the decade. In 1979 the industrial economies were subject again to an oil price shock which lowered potential output and helps explain the emergence of significant positive output gaps in 1979-80.

Focusing on the most recent period, it is apparent that the 1980-82 recession was very severe, with a sharp slowing of output growth. There were significant shortfalls of actual in relation to potential output in 1982-83, and marked rises in unemployment above its natural rate. By 1985, however, the output gaps in most countries had narrowed considerably. This also occurred in much of Europe, despite the historically high rates of unemployment that remain in these countries. The relatively small gaps in Europe by the mid-1980s reflect the finding that the natural unemployment rates appear to have been quite close to the actual unemployment rates and that potential output growth is now well below the high rates of the 1950s and 1960s.

1/ The treatment of the public sector's output follows Perloff and Wachter (1978).

The two sets of gaps shown in Chart 4 can be used to calculate the underlying Okun coefficients. As noted previously it is, of course, unlikely that these coefficients, which indicate the relationship between the output and unemployment gaps, should be constant over time as usually is assumed by "Okun's law", and Chart 4 confirms that the ratio of the two gaps has varied considerably. In particular, the output gap tends to increase relative to the unemployment gap, implying that the Okun coefficient tends to rise, at the trough of each recession, and fall during part of the recovery. This behavior reflects changes in the intensity with which factors are used over the business cycle as well as changes in labor force participation rates, and it implies that it is inappropriate to multiply an unemployment gap by a fixed Okun coefficient to arrive at the output gap. Notwithstanding the cyclical variability of the Okun coefficients, however, it is not apparent that they have varied significantly from one cycle to the next. Observed changes in the relationship between capacity utilization and unemployment rates appear therefore to have reflected shifts in natural rates rather than changes in Okun coefficients (see discussion in Section II).

Notwithstanding their limitations, Okun coefficients are a convenient summary statistic and Table 6 displays the average Okun coefficients implied by this study, along with confidence intervals. The results suggest average values for the Okun coefficient close to consensus values. A noteworthy feature is the tendency for the Okun coefficients in the United States and Canada to be below those for Japan and, with the exception of the United Kingdom, the European countries. 1/ Apart from differences in the cyclical sensitivity of participation rates, this could reflect higher firing and hiring costs in Europe and Japan than in the United States, which would result in relatively more labor hoarding over the business cycle in these countries.

4. Comparison with Estimates for Manufacturing

The economy-wide estimates of output gaps reported in this study differ in a number of respects from earlier estimates by the staff of output gaps in manufacturing (J. Artus (1977), J. Artus and Turner (1978), Turner (1987)). Most importantly, the output gaps in this study are significantly smaller than those estimated for manufacturing. There are two main reasons for this difference. First, the amplitude of cyclical fluctuations in manufacturing output has traditionally been some-

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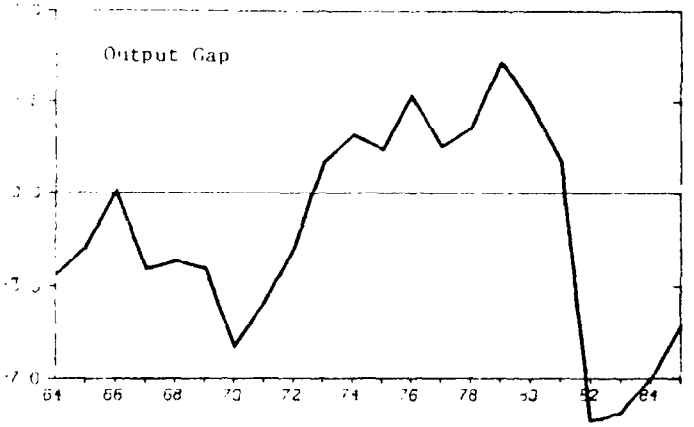
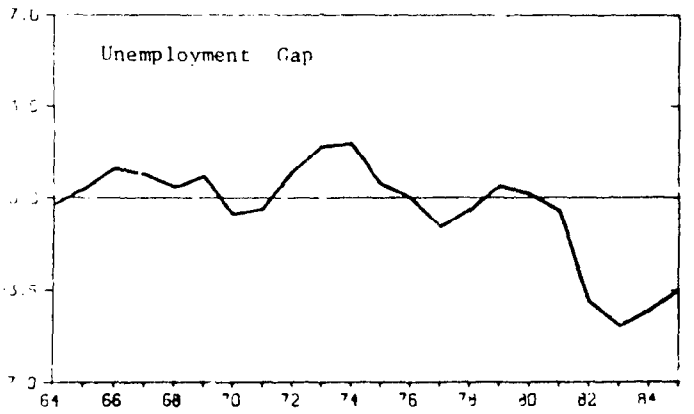
1/ The estimate for the United States is a little low compared with Okun's original estimate of 3. Perloff and Wachter (1978) report an Okun coefficient for the United States of 2.4. As noted earlier, in the case of the United Kingdom the intensity of use variable was not statistically significant in the estimated production functions. The estimated Okun coefficient for the United Kingdom should therefore be regarded as only broadly indicative of any relationship between the output and unemployment gaps.

Chart 4. Major Industrial Countries: Output and Employment Gaps

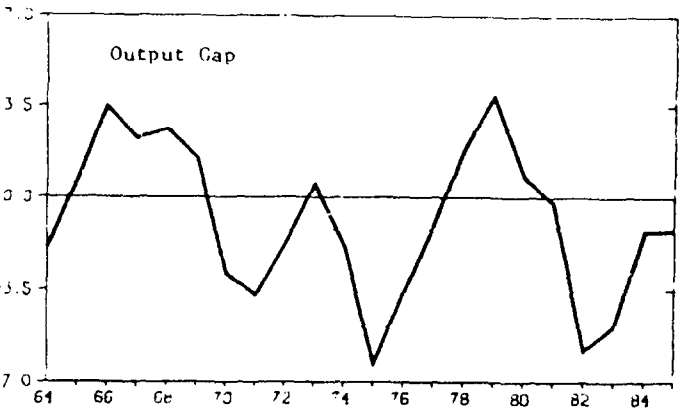
(In percent)

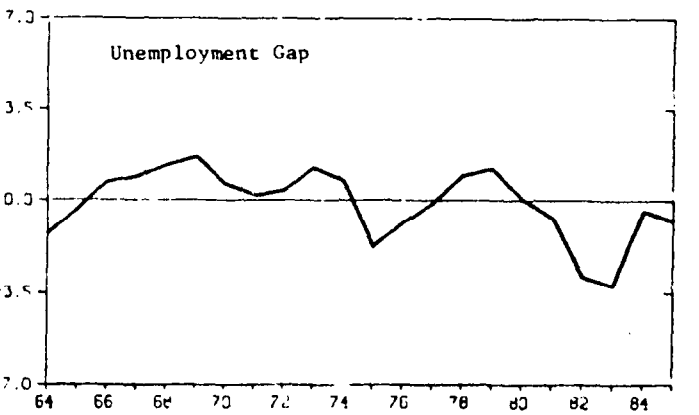
Canada



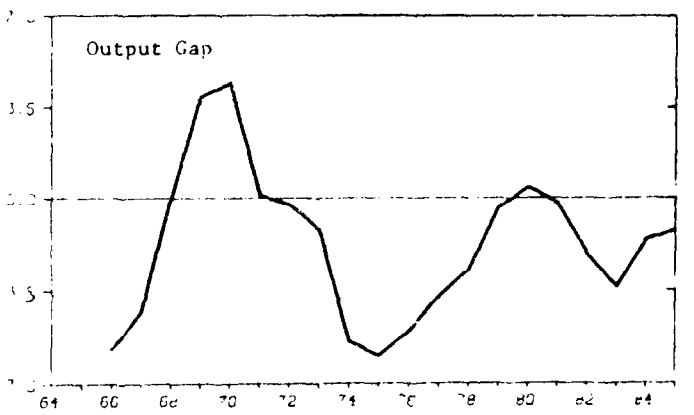


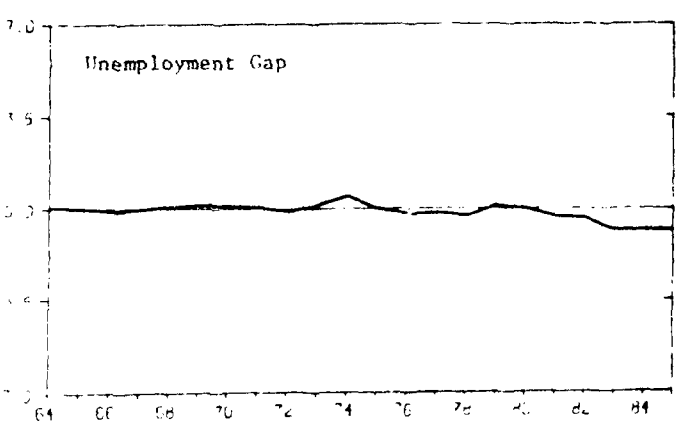
United States



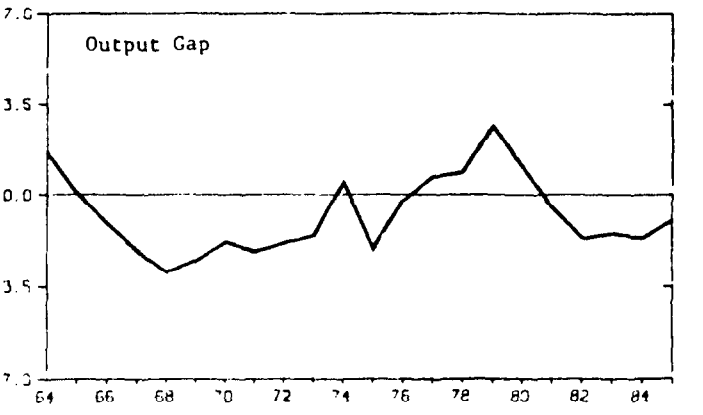


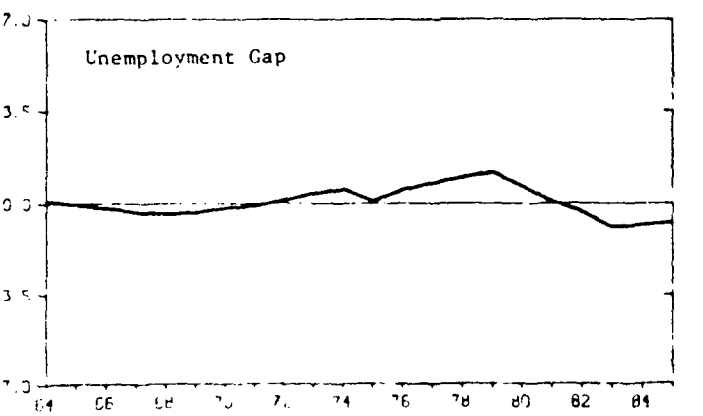
Japan





France





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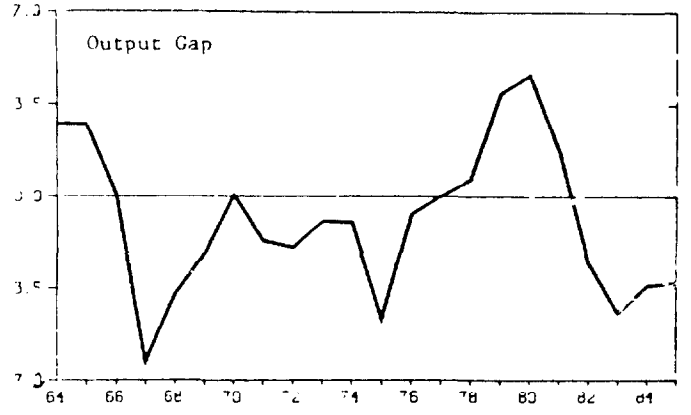
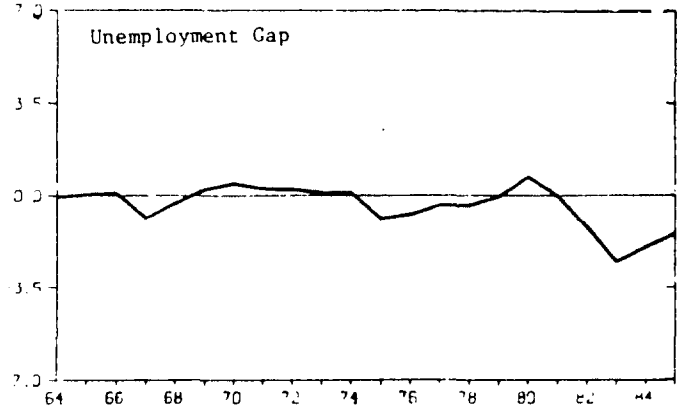
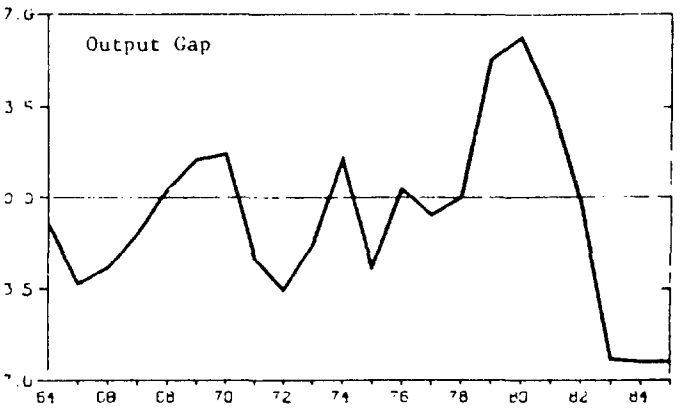
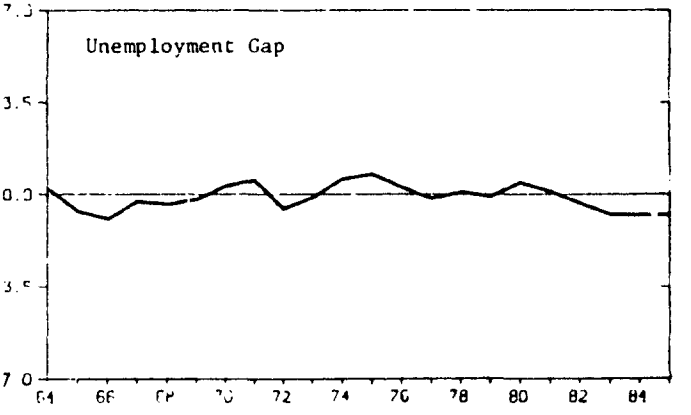


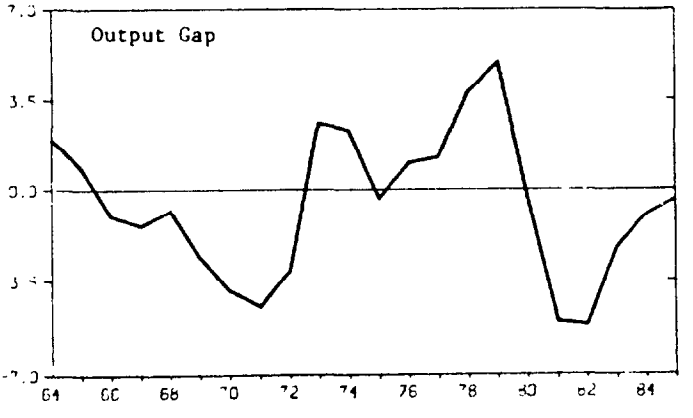


Italy





United Kingdom



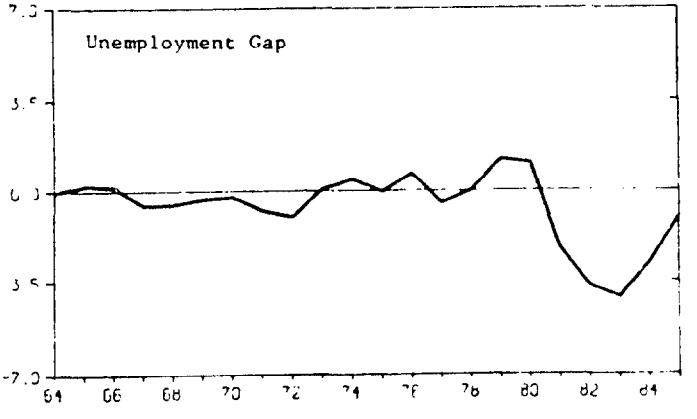


Table 6. Major Industrial Countries: Okun Coefficients Implied by the Estimated Output and Unemployment Gaps 1/

	Coefficient	Confidence Interval (95%)
Canada	1.5	0.8 - 2.3
United States	1.8	1.3 - 2.5
Japan	2.5	-2.5 - 5.0
France	2.8	2.2 - 3.4
Germany, Fed. Rep. of	2.7	1.5 - 3.9
Italy	2.7	0.0 - 5.4
United Kingdom	1.3	0.5 - 2.1

1/ The Okun coefficient is the slope coefficient in the regression of the output gap on the unemployment gap over the period 1965-1983.

what larger--on average by a factor of 1 1/2 to 2--than in the economy as a whole. The other reason is the differences in the concepts of potential output employed and the assumptions made about the "full-employment" rate of unemployment. The approach underlying the potential output estimates for manufacturing is akin to the "structural" potential output concept discussed in Section III, where the full-employment level of unemployment is estimated on the basis of labor market mismatches as reflected in the trade-off between vacancies and unemployment (the so-called Beveridge curve--see J. Artus (1984)). By contrast, the present study uses a "natural" rate approach in order to ensure consistency of potential output estimates with the inflation objective. This results in assumptions of the "full-employment" level of unemployment--natural rates--that are substantially higher in the first half of the 1980s, than implied by the approach underlying the earlier results for manufacturing.

V. Projections of Potential Output 1986-95

This section presents projections of potential output for the decade to 1995, applying the relationships estimated over the historical period, and incorporating the effects of the halving of international oil prices in 1986, on the technical assumption that oil prices will remain unchanged in real terms at a level of $15 (in 1987 prices). As with any analysis of this type, it must be stressed that the projections are no more realistic than the assumptions on which they are based. To underline the uncertainties attaching to the projections, the sensitivity of the results to changes in some of the underlying assumptions is also discussed.

1. Main assumptions

To project potential GNP, assumptions must be made about the future path of potential factor inputs and total factor productivity in the business sector, and about the evolution of the public sector.

a. Labor

The growth of potential labor inputs is determined by four elements: the growth of the population of working age; changes in labor force participation rates; changes in average hours worked per person; and variations in the natural rate of unemployment. The first three elements contribute to the underlying growth of potential labor input whereas shifts in the natural unemployment rate affect its level.

The assumed growth of the working age population is based on the medium variant of the most recent demographic projections by the United Nations (1985). These projections are summarized in Appendix B and confirm the well known deceleration in the growth of the population of working age that is expected in most industrial countries during the next decade. Labor force participation rates and average hours worked

were projected using a procedure similar to that used to generate historical estimates of the potential levels of total manhours. 1/ Whereas labor force participation rates are projected to change only slightly, the results imply a gradual decline in average hours worked over the projection period, in continuation of the trend observed during most of the postwar period.

The natural unemployment rate assumptions are an important element of the labor input projections. The assumptions in this paper were based on projections using the reduced-form unemployment equations shown in Appendix A. Those results were subsequently adjusted judgmentally to take into account the particular uncertainties about the impact of the recent oil price decline on real wage gaps and, hence, on the natural rates of unemployment, as well as about the possible impact of structural policies.

Because it is not at all evident that wage behavior in response to the decline in oil prices will be symmetric to the experience when oil prices rose, the staff has chosen to adopt a relatively cautious assumption about the extent to which natural unemployment rates in Europe are likely to decline as a result of the recent reduction in energy prices. Nevertheless, compared with the first half of the 1980s, the assumptions for the projection period imply a significant lowering of natural unemployment rates for France, Germany and Italy, reflecting both the fall in oil prices as well as demographic factors and changes in real exchange rates. (Table 7). 2/ For the United Kingdom, the possibility of hysteresis in the natural rate argued in favor of a smaller decline than in the other European countries. In the United States and Canada natural unemployment rates are projected to decline significantly, mainly reflecting a maturing of the labor force. However, in both cases the assumed declines are somewhat smaller than indicated by the equations in Appendix A, reflecting some uncertainty about the relationship between the age composition of the labor force and the natural rate. The natural unemployment rate in Japan was assumed to increase slightly over the projection period reflecting the possible influence of growing skills mismatches associated with structural changes in the composition of output.

1/ The relationships between participation rates and average hours, on the one hand, and the cyclical gaps in the goods and labor markets, as well as a trend, on the other were established econometrically to obtain an estimate of the underlying or potential paths. These paths were extrapolated over the projection period. The detailed results underlying this procedure can be obtained from Current Studies Division.

2/ The natural unemployment rates in Table 7 are indicated as ranges in view of the uncertainties attaching to point estimates of this concept.

Table 7. Major Industrial Countries: Historical Estimates of Natural Unemployment Rates and Assumptions for the Projection Period 1/

(Percent of potential labor force, annual averages)

	1970	1980	1985	1988	1995
Canada	4-5	7-8	6-7	5 1/2-6 1/2	4 1/2-5 1/2
United States	5-6	7-8	6 1/2-7 1/2	6-7	4 1/2-5 1/2
Japan	1-2	1 1/2-2 1/2	1 1/2-2 1/2	1 1/2-2 1/2	2-3
France	2-3	6 1/2-7 1/2	8-9	7-8	5-6
Federal Republic of Germany	1-2	4-5	6-7	4-5	3-4
Italy	5-6	8-9	9-10	8-9	6 1/2-7 1/2
United Kingdom	2-3	7-8	9-10	8 1/2-9 1/2	7 1/2-8 1/2

1/ For the purposes of calculating the potential output estimates in Chart 3 and Table 8, the midpoints of the ranges indicated in this table were used.

b. Capital

In making assumptions about the growth of the capital stock over the projection period, an "underlying" rate of growth was first determined on the basis of the behavior of net investment and capital-labor ratios in the 1970s and early 1980s. Those estimates were then adjusted to allow for the effects of the decline in oil prices in 1986 and any recent strengthening in investment growth. It was assumed that the implications of the decline in oil prices for capital would not be entirely symmetrical to those of higher prices, and would result only in an increase in the effective capital stock of 1 to 2 percent. This relatively cautious assumption was made because the scope for bringing back energy-intensive capital goods is now limited, given the length of time that has passed since the oil price increases of the 1970s.

The assumptions made about the capital stock generally imply a slightly higher growth rate of capital over the next decade than during the previous one. This reflects the unwinding of the capital obsolescence effects associated with the oil price increases of the 1970s, the small positive effects of the recent oil price decline, and the reduction of government budget deficits--already achieved or planned--which will reduce financial crowding out of business investment. Nevertheless, in all countries other than the United States, the growth rate of capital over the forecast period is assumed to be lower than its average growth during the 1960s. In the case of the United Kingdom, the expected depletion of oil resources and associated scrapping of oil sector investments suggested a slightly lower growth rate of the capital stock than in the other major countries.

c. Total factor productivity

In view of its historical importance, the assumption about the growth of total factor productivity is a crucial element of the potential output projections. The basic question is whether the relatively low rates of total factor productivity growth after 1973 are a reasonable guide to the future or whether there are factors which would suggest different rates of productivity advance over the decade ahead.

Because so little is known about the precise causes of the productivity slowdown in the 1970s, and because it has proved extremely difficult to relate the growth of total factor productivity to factors such as the age of the capital stock, structural policies and investment spending, a considerable amount of judgment was necessary in projecting total factor productivity. As a first step, the most recent data were examined in order to determine whether there was any evidence of a return to more rapid rates of productivity advance. The picture here was mixed and was clouded to some extent by the difficulties in distinguishing between cyclical productivity gains during the recovery from the 1980-82 recession and the underlying productivity performance

(see Clark (1984) and Mendis and Muellbauer (1984)). However, in Canada, the United States, and the United Kingdom there are some indications that underlying total productivity growth may have revived in recent years, and this was taken into account in establishing the assumptions for the projection period. For Japan and the major European countries, other than the United Kingdom, where no firm evidence could be found of a revival in the growth of total factor productivity advance, rates of productivity growth were assumed to be equal to those over the past decade. 1/

d. Public Sector

In arriving at projections of potential GNP for the economy as a whole, it was assumed that the share of public sector in GNP would remain at its 1985 level. This assumption was mainly adopted for purposes of simplification and may not necessarily correspond to the authorities' long-term projections of the share of government. Nevertheless, the assumption is broadly consistent with the objective of most countries to limit the growth of public expenditure and it implies that the rates of growth of output in the private and public sectors will be equal over the projection period.

2. Projections of Potential GNP

The projections of potential output growth implied by the above assumptions are displayed in Table 8. This table also shows the implied contributions to growth of the business sector and of the public sector; these contributions are calculated as the rate of growth of output in each sector times the sector's share in GNP in 1985. The projection period is divided into two subperiods, 1986-88 and 1989-95, in order to highlight the significance of some of the temporary influences mentioned earlier which are expected to principally affect potential output during the first of these periods.

In all the major countries other than Japan, potential output growth is projected to increase somewhat over the projection period relative to the rates of growth registered during the 1974-85 period. This tendency is particularly evident over the 1986-88 period when growth is temporarily raised as a consequence of lower oil prices, reflecting both the assumed small increase in the capital stock and a reduction of natural unemployment rates, particularly in Europe. The higher rates of growth over the projection period can also be attributed to the unwinding of the capital obsolescence effects associated with the oil price increases of the 1970s.

Despite the projected improvements in potential output growth

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1/ In the case of France, where it rose much faster than in the other major countries in the 1974-85 period, total factor productivity growth was assumed to decelerate slightly after 1988.

Table 8. Major Industrial Countries: Projections of Potential GNP Growth to 1995

(Percent changes or contributions, at annual rates)

	1966-73	1974-85	1986-88	1989-95
Canada				
Potential GNP Growth	5.2	2.9	3.0	2.7
Of which contributions of:				
Business Sector	4.0	2.5	2.6	2.3
Capital	0.9	0.7	0.9	0.8
Labor	1.1	1.4	1.0	0.8
Total Factor Productivity	2.0	0.4	0.7	0.7
Public Sector	1.2	0.4	0.4	0.4
United States				
Potential GNP Growth	3.4	2.3	2.7	2.6
Of which contributions of:				
Business Sector	2.7	2.1	2.4	2.3
Capital	0.8	0.6	0.8	0.7
Labor	1.0	1.3	0.7	0.7
Total Factor Productivity	0.9	0.2	0.9	0.9
Public Sector	0.7	0.2	0.3	0.3
Japan				
Potential GNP Growth	8.5	3.8	3.6	3.1
Of which contributions of:				
Business Sector	7.8	3.5	3.2	2.7
Capital	2.3	1.1	1.3	1.2
Labor	-0.3	0.7	0.3	-0.1
Total Factor Productivity	5.8	1.6	1.6	1.6
Public Sector	0.7	0.3	0.4	0.4
France				
Potential GNP Growth	5.4	2.2	2.8	2.6
Of which contributions of:				
Business Sector	4.8	1.9	2.4	2.2
Capital	1.1	0.7	0.8	0.7
Labor	-0.1	-1.0	-0.6	-0.5
Total Factor Productivity	3.8	2.2	2.2	2.0
Public Sector	0.6	0.3	0.4	0.4
Germany, Fed. Rep. of				
Potential GNP Growth	4.3	1.9	2.6	2.2
Of which contributions of:				
Business Sector	3.7	1.5	2.2	1.7
Capital	1.0	0.5	0.7	0.7
Labor	-0.8	-0.8	-0.3	-0.7
Total Factor Productivity	3.5	1.8	1.8	1.8
Public Sector	0.6	0.4	0.4	0.4
Italy				
Potential GNP Growth	5.1	2.2	2.6	2.5
Of which contributions of:				
Business Sector	4.6	1.8	2.1	2.0
Capital	1.0	0.6	0.8	0.8
Labor	-1.3	-0.3	-0.2	-0.4
Total Factor Productivity	4.9	1.5	1.5	1.5
Public Sector	0.5	0.4	0.5	0.5
United Kingdom				
Potential GNP Growth	2.8	1.1	2.2	2.0
Of which contributions of:				
Business Sector	2.1	0.5	1.5	1.4
Capital	0.7	0.4	0.6	0.5
Labor	-0.9	-0.9	-0.3	-0.3
Total Factor Productivity	2.3	0.9	1.2	1.2
Public Sector	0.7	0.6	0.7	0.6

Source: Staff Estimates.

Despite the projected improvements in potential output growth relative to the 1974-85 period, growth in Europe and Japan is projected to remain significantly lower than during the 1966-73 period and also lower than the average growth rate over the 1950-73 period. These differences are largely explainable because these countries now essentially have caught up with the United States and because projected low population growth and aging populations will lead to a reduction in potential labor input. In the United States, potential output is projected to grow approximately at the same pace as it did on average over the past 20 years.

A few comments may be useful on the projections for potential output in the United Kingdom. There are two basic reasons for these to turn out somewhat weaker than for the other major countries, despite the assumed revival of productivity growth. First, as mentioned earlier the acute labor market rigidities in the United Kingdom led the staff to assume only a small decline in the natural unemployment rate over the projection period. Secondly, the expected depletion of North Sea oil reserves and the associated scrapping of the oil sector's capital stock imply that the underlying growth of the net capital stock in the business sector as a whole is likely to be significantly lower than in other countries. On this basis, the growth of potential output in the United Kingdom is projected to decelerate to only about 2 percent annually in the first half of the 1990s. Nevertheless, this growth rate would still be significantly higher than that recorded from 1974 to 1985.

3. Sensitivity Analyses

In view of the uncertainties attaching to the projections, a brief discussion of the sensitivity of potential output estimates to variations in some of the key assumptions is in order.

Natural unemployment rates could turn out differently from those assumed in the baseline projection for a number of reasons. Asymmetries in wage behavior might imply that the recent oil price declines may reduce real wage gaps less than assumed. On the other hand, efforts of the authorities to improve the functioning of labor markets might reduce natural unemployment rates more than the baseline assumptions imply. The impact of demographic changes is also highly uncertain. While the projected shifts in the age composition of the labor force in most countries suggest that natural unemployment rates are likely to fall, the possibility of hysteresis effects associated with high youth unemployment could prevent natural rates from falling.

Because the baseline projections already assume that the economy is working at capacity, variations in the natural unemployment rate have only a small impact on the level of potential output. Indeed, for this type of calculation it is inappropriate to apply the average Okun coefficients shown in Table 6, which reflect cyclical variations in working time, participation rates and intensity of use of the employed

labor force. Instead, the impact on the level of potential output of changes in natural unemployment rates can be better approximated by the average cost share of labor in output which is about three fourths. In other words, a 1 percentage point variation in the natural unemployment rate would change the level of potential GNP only by about 3/4 of 1 percentage point, with the possibility of course of some additional effects on investment.

The impact on potential output of a future change in energy prices is more complicated to assess. In particular, the effects of another rise in oil prices would depend on its timing and on whether it would be expected to be permanent or transitory. On the assumptions that the change in oil prices is unanticipated, that it occurs after the capital stock has fully adjusted to the baseline oil price assumption of $15 per barrel (in 1987 prices), and that the changes are considered permanent, a hypothetical $5 (in 1987 prices) rise in oil prices--corresponding to an increase of 33 percent--might lower the level of potential output by between 1/2 and 1 percent through its impact on the capital stock. This estimate is based on the same assumptions as used in the estimation of potential output in Section IV. In addition, to the extent that such a rise in oil prices would lead to a renewed widening of real wage gaps in European countries, natural unemployment rates would tend to rise, perhaps by 1 percentage point on average. In the absence of significant changes in wage behavior, the level of potential output in these countries might thus decline by a total of 1 to 1 1/2 percentage points relative to the baseline projection as a result of an oil price increase from $15 to $20 (in 1987 prices).

Finally, it should be pointed out that in accordance with Fund practice, the projections of potential output presented here are based on the assumption of unchanged real exchange rates over the projection period. It is difficult to predict how changes in exchange rates would affect potential output. On the one hand, appreciation (depreciation) of a currency would tend to decrease (increase) the natural unemployment rate in countries characterized by real wage rigidity. This mechanism would thus tend to raise (lower) potential output growth temporarily. On the other hand, a change in real exchange rates would also have the effect of reallocating world demand and actual output, which might influence countries ability to grow in line with the ex ante projections of potential presented in this study. The second type of consideration would suggest that potential output measured ex post might grow slightly slower (faster) than projected, particularly if a country's currency were significantly overvalued (undervalued) for an extended period of time. The net effect might be positive or negative depending on the circumstances of a particular country, including the reasons for the currency being over- or undervalued. However, the effect would be likely to be small compared with the impact of supply side disturbances.

VI. Summary and Conclusions

While the unprecedented economic disturbances of the 1970s played an important role in the sudden and pervasive slowdown of growth in the industrial countries after 1973, the evidence presented in this study suggests that there was an inevitable deep-seated element of the slowdown as well, reflecting the winding down of a number of unique influences at work in the 1950s and 1960s. In particular, the virtual exhaustion of Europe's and Japan's scope for catching up with best-practice technology in the leading country, the United States, seems to have been a major factor behind the pronounced slowdown that occurred in these countries. Even though a number of temporary factors also played a role, their contribution appears to have been limited, except possibly in the United States. On this basis, and notwithstanding the recent significant decline in oil prices, tentative projections for the decade to 1995 point to only a small acceleration of potential growth rates in North America and Europe relative to the performance over the 1974-85 period. For Japan, the projections indicate a continued small deceleration of the growth of potential output which nevertheless is expected to remain somewhat higher than in the other major countries.

Another important conclusion emerging from this study is that the cyclical slack in the major countries at the present time appears to be relatively small despite the high rates of unemployment in most of these economies. This result stems from the finding that natural unemployment rates have generally increased significantly during the past 10 to 15 years. The rise in the natural unemployment rate in the United States has primarily reflected changes in the age composition of the labor force, while in Europe, the more pronounced increases can be largely attributed to the interaction of labor market rigidities with a series of adverse disturbances--such as the oil price increases--that called for a moderation of real wage gains if high employment was to be maintained. However, because of real wage rigidity, equilibrium levels of employment were lowered, natural rates of unemployment rose, and potential output in these countries declined below the levels that could have been achieved with more flexible labor markets.

The study has confirmed the conclusion of many previous studies that the slowdown in growth primarily reflected a sharp reduction in the rate of growth of total factor productivity. What caused this reduction is extremely difficult to determine precisely. However, as mentioned earlier it is likely that the virtual completion of the process whereby Europe and Japan gradually caught up with best-practice technology in the leading country--the United States--was a major factor. But many other factors, including the rapid expansion of government sectors, the growing share of services in output, government regulations and high inflation are also likely to have contributed and may help to explain ıy productivity growth slowed markedly in the leading country as well. Given the nature of most of these causes, it is difficult to avoid the conclusion that a major proportion of the productivity slowdown was of a deep-seated nature. Nevertheless, to the extent that it

may prove possible to arrest or reverse the rapid growth of government transfers, subsidies and other factors which have inhibited efficient resource allocation, there should be some scope for growth to accelerate in the future.

The results also indicate that the increases in energy prices during the 1970s contributed to the slowdown in growth in the industrial countries, both by reducing the effective capital stock through premature obsolescence, and by raising natural unemployment rates in countries with inflexible labor markets. While these influences served to shift the level of potential output downward it is unlikely that they contributed much to the reduction of underlying growth rates.

Even though the study suggests that the recent decline in oil prices may not have improved growth in the future in any fundamental way, it nevertheless points to the possibility of some once-and-for-all gains in the level of potential output. Of course, the impact on the capital stock of the oil price decline is extremely uncertain and is likely to be much smaller than when oil prices rose. However, to the extent that the oil price decline leads to a lowering of natural unemployment rates, particularly in Europe, potential output might for a period grow somewhat faster than its underlying trend. Tentative staff estimates suggest that this level shift in potential output could amount to some 1-1 $\frac{1}{2}$ percent spread over a period of two to three years. While such an effect would be quite significant it must be emphasized that it is based on the assumption of a symmetric response of wages to the decline in oil prices as compared with the response in the 1970s when nominal wage increases accelerated sharply in the face of rising energy prices. If nominal wage increases do not slow now that oil prices have declined--implying that most of the oil price induced terms of trade gain would accrue to existing wage earners--the assumed beneficial impact on employment and potential output in European countries, in particular, would not materialize.

Over the next decade, most of the major industrial countries are expected to experience a gradual reduction of natural unemployment rates, both as a result of slower population growth and as a result of ongoing efforts to improve the functioning of labor markets. If these reductions materialize, potential output would be raised somewhat relative to its underlying path throughout the projection period. Nevertheless, by the end of the 1980s and the first half of the 1990s the growth of potential output in both Europe and Japan will begin to be constrained by stagnating or declining labor forces. Under these conditions, a high level of investment and efficiency in the allocation of resources will be essential if potential growth rates are to be maintained at the rates currently envisaged.

Economic policy has a crucial role to play in ensuring that potential output grows at a higher rate than in the 1970s and early 1980s. As stressed throughout this study, potential output is an "endogenous" variable which is influenced by the behavior of enterprises, wage

earners and producers of raw materials. Their behavior may in turn be influenced by economic policies at both the macro and micro level. For example, rates of capital formation may fall short of the assumptions adopted in the elaboration of the projections if high or rising structural budget deficits led to financial crowding out of business investment. Structural policies--including tax reforms, privatization of public enterprises, and elimination of subsidies--aimed at enhancing the efficency of resource allocation are also subsumed to some extent in the projections of productivity growth. And the projected reductions in natural unemployment rates will partly depend on the success of government policies to improve the functioning of labor markets. If efforts to improve the supply side of the industrial countries ultimately prove to be more effective than assumed, potential output growth could strengthen more than envisaged in the these projections. However, if the implementation of these policies is delayed or if new setbacks occur which would impede efficient resource allocations, for example in the event of a massive increase in protectionism, potential output growth might fall significantly short of the projections presented in this study.

Estimation of the Natural Rate of Unemployment

The natural rate of unemployment is defined as the rate of unemployment which would prevail in equilibrium when expectations about inflation are realized. 1/ It reflects the institutional and structural characteristics of the economy, including the regulations governing goods and factor markets, demographics, and the incentives provided through the structure of taxes, transfers and subsidies. The gap between the actual unemployment rate and the natural rate is an indicator of the amount of cyclical slack in the labor market.

The purpose of this Appendix is to describe how the estimates of the natural unemployment rates for the major industrial countries used in the study were obtained. In view of the important role played by the natural unemployment rate, especially in determining the extent of cyclical slack, and the uncertainties associated with any point estimate of the natural rate, this Appendix also includes a comparison with estimates from other studies. This comparison is particularly important given the high estimates of the natural unemployment rate for European countries found in this study. However, while there appears to be a consensus that natural unemployment rates in Europe currently are high, there is still no agreement about the precise reasons. In particular, while many studies have indicated that real wage rigidities have been a significant problem in Europe, the reasons for such rigidities are not well understood. 2/

The appendix begins with a brief discussion of the choice of approach to estimating the natural unemployment rate. It then discusses the main determinants of the natural unemployment rate and the estimated equations. Finally the estimates of the natural rate used in this paper are presented and compared with those of other studies.

The Approach

Estimation of the concept of the natural unemployment rate that most economists have in mind ideally requires a structural general equilibrium approach. However, in practice, due to data limitations and other problems, most attempts are decidedly less ambitious. 3/ The two most commonly used approaches are (1) to estimate a Phillips curve or a

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1/ Friedman (1968).

2/ Recent research has increasingly focused on "hysteresis effects" in the unemployment rate. However, to date there is no compelling evidence for this phenomenon except perhaps in the United Kingdom.

3/ There are a number of different concepts of equilibrium unemployment in the literature, each requiring a different approach to estimation. Examples include equilibrium between labor market flows into and out of unemployment; Keynesian temporary equilibrium; and short-run and long-run Walrasian equilibrium. For a discussion of these issues see Tobin (1972) and Trivedi-Baker (1985).

two equation wage-price model, which is subsequently solved for the unemployment rate that would be consistent with a stable rate of inflation; 1/ or (2) to estimate directly a reduced-form equation for the unemployment rate, including cyclical and structural factors among the determinants. This equation can then be used to solve for the natural unemployment rate by eliminating the cyclical influences. Most, if not all, of the comparative international studies have taken the first route. The resulting estimates of the natural rate are generally referred to as the nonaccelerating inflation rate of unemployment or the NAIRU.

For the purposes of this study such NAIRU estimates have a number of limitations. The most important is that the NAIRU does not necessarily provide an estimate of the equilibrium position of the labor market in a specific period such as a year. The NAIRU is the level of unemployment that would bring actual real wage growth into line with warranted real wage growth after a shock to the economic system. Therefore, it is extremely difficult to interpret the gap between the actual unemployment rate and the NAIRU--it may or may not be a cyclical phenomenon. 2/ Inherent in the approach taken in this study is the assumption that the labor market has an equilibrium level of real wages, employment and unemployment in each period and that it will settle down at these levels when expectations are realized.

In addition, many approaches to estimating the NAIRU assume that wage-setting behavior in the manufacturing sector is representative of the entire economy 3/ and use time trends as a proxy for the structural determinants of the natural unemployment rate. For the purposes of this study an economy-wide measure which attempts to identify the influence of structural variables is required. For these reasons the second approach--the reduced-form approach--was adopted. However, the reduced-form approach also has a number of shortcomings, including the large number of explanatory variables that might be included and the wide variety of lag structures that are possible. In assessing the acceptability of the estimated equations and the resulting estimates of the natural unemployment rate it is essential to consider other available evidence. To this end a comparison with estimates of the natural unemployment rate or the NAIRU from other studies is included to help evaluate the results of this study.

1/ Since inflation expectations usually are modelled adaptively in this framework actual and expected inflation are equal only when the inflation rate is constant.

2/ For a discussion of the interpretation of the gap between the NAIRU and the actual unemployment rate see Adams, Fenton and Larsen (1986).

3/ Gordon (1986) has called this assumption in question.

Determinants of the Natural Unemployment Rate

As mentioned earlier, the natural unemployment rate reflects the structural features of the economy. However, a question arises as to which structural features are the most important. For North America, many studies using a reduced-form unemployment equation have focused on labor market flows--on factors which influence the frequency of job separations (usually the demographic composition of the labor force) and the length of the search period (for example, the level of real unemployment insurance benefits). 1/

The assumption underlying the North American type of approach is that the labor market is reasonably well functioning, with real wages relatively flexible in the face of adverse disturbances. In contrast, there appears to be significant evidence that real wages are slow to respond to disturbances in most European countries and that a significant proportion of the rise in unemployment in Europe since the early 1970s can be attributed to the interaction of real wage rigidity with adverse disturbances such as the oil price increases. As a result, significant gaps emerged in many European countries in the 1970s and early 1980s between the actual level of real wages and the level consistent with full employment (the warranted real wage level). While the reasons for these real wage rigidities are not well understood, the most frequently suggested explanations include pervasive union power, government regulations governing minimum wages and hiring and firing costs, and hysteresis effects arising from either the lack of influence of outsiders (the unemployed) on the wage determination process or the deleterious effects of long-term unemployment. In any event, a central element of this process appears to be that wage earners have rigid targets for their expected real wages measured in terms of the prices of the goods they consume, whereas firms are concerned with real wages measured in terms of the prices of the goods they produce. Under those circumstances adverse disturbances such as changes in relative import prices, in social security contributions and in underlying trend productivity growth may drive a wedge between the actual and warranted level of real wages. As a result, the equilibrium rate of unemployment--the natural rate--will rise. 2/

To allow for the impact of such rigidities, in addition to the usual cyclical and demographic-structural variables, the reduced-form equation used in this study includes variables which represent disturbances that may give rise to a real wage gap if real consumer wage

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1/ For an example of previous staff research using this approach, see Collyns (1984).

2/ For a more complete discussion of differences in wage and employment behavior between the United States and Europe, see Adams, Fenton and Larsen (1986).

targets are rigid--these variables will be referred to as warranted real wage factors. 1/ The estimated equation has the following general form:

$$U = \alpha_0 + \alpha_1 * CYCLE + \alpha_2 * DEM + \alpha_3 * UIB + \alpha_4 * RPE(-1) + \alpha_5 * REX(-1) + \alpha_6 * OTHER$$

where CYCLE is measured by either unexpected changes in policy variables and world trade or by the deviation of output from trend; DEM is the share of the youth population to the remaining population of working age; UIB is the ratio of average weekly unemployment insurance benefits to average weekly wages adjusted by the percentage of workers covered by unemployment insurance; RPE is the price of energy products relative to producer prices; REX is the real effective exchange rate calculated using GNP deflators, and OTHER is a term to capture residual influences. RPE and REX are lagged one year to allow for adjustment costs.

The expected signs of the reduced-form coefficients are $\alpha_2, \alpha_3, > 0$ and $\alpha_1 < 0$. The signs and significance of the remaining coefficients depend upon the existence of real wage rigidities. If real consumer wage targets are flexible, the warranted real wage factors would not be expected to be statistically significant. However, if real consumer wage targets are rigid, the expected signs of the coefficients are $\alpha_4 > 0$ and $\alpha_5 < 0$.

To calculate the natural unemployment rate from the estimated equations, the cyclical component of unemployment is set equal to zero. Implicit in this formulation is the view that the economy has an equilibrium level of real wages, unemployment, and output toward which it will converge in the absence of shocks, and that these equilibrium levels will change in response to changes in the incentive structure including taxes and transfer payments, the demographic structure, and the external environment that the economy faces. It must be emphasized that these equations do not model explicitly the reasons why real wage targets do not adjust (or adjust only very slowly) to disturbances to the warranted level of real wages. 2/ If the wage formation process were to change so that real wages became more flexible the natural rate of unemployment would decline accordingly.

It should also be pointed out that the interpretation of some terms in the equation is dependent upon the underlying view of the labor market. For example, if the real minimum wage is not above the market-clearing level in the United States but is in Europe, then the role of a

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1/ Wage earners are assumed to have a target level for real consumer wages for each period (in practice each year).

2/ Grubb, Jackman and Layard (1982) suggest that real wage targets adjust very slowly to changes in the rate of growth of warranted real wages. According to their estimates there is very little adjustment in the first seven years after a disturbance.

demographic variable in the equation may be different for the two countries. In the United States, under the above assumption, the demographic variable would be likely to capture effects such as increased labor market turnover and hence higher unemployment due to job search, whereas in Europe it would capture these effects as well as the increase in unemployment attributable to rigid real wages. In this regard it is interesting to note that in the case of France, which is the only country for which data on minimum wages relative to average wages were available, this variable plays a highly significant role in the unemployment equation and tends to overide the influence of demographic variables.

In this framework the natural unemployment rate is determined solely by "real" factors, including structural policies. For example, factors that prevent real wages from responding to changes in market forces or that encourage unemployed workers to lengthen their job search period will tend to raise the natural unemployment rate.

The influence of monetary and fiscal policies on unemployment rates is less clear cut. The approach adopted implies that unanticipated movements in either monetary or fiscal variables primarily have an effect on the cyclical component of unemployment. However, to the extent that changes in fiscal policy affect the real exchange rate they may also influence the natural unemployment rate. If, for example, the shift to a more expansionary fiscal stance in the United States in the early 1980s contributed to the real appreciation of the dollar during this period, this policy shift may also have contributed to the rise in natural unemployment rates in Europe in the early 1980s due to real wage inflexibility in these countries in the face of terms of trade deteriorations. With respect to monetary policy, in the short run a policy shift may influence the real exchange rate and thereby influence the natural rate temporarily in countries with pervasive real wage rigidities. In the longer run, the approach adopted implies that shifts in monetary policy only affect the inflation rate and nominal exchange rate, leaving the natural unemployment rate unchanged.

Estimation Results

The estimated equations underlying the calculation of the natural unemployment rates for the seven major industrial countries are set out in Table A1. The same specification of the reduced form was estimated for all countries initially. Variables or lag structures which were statistically insignificant were subsequently omitted. While the estimation results are encouraging, it should be stressed that there are a large number of alternative explanatory variables and lag structures. In some instances the presence of multicollinearity also makes it difficult to determine precisely the contribution of a particular variable to changes in the unemployment rate. Finally, the standard errors of estimate of the equations suggest a confidence interval of some magnitude for the European countries. For these reasons it is necessary to use the reduced form coefficients with caution.

Table A1. Major Industrial Countries: Reduced Form Unemployment Rate Equations

	Constant	Cyclical Variables	Structural Variables	Warranted Real Wage Factors	Other Variables	S.E.E.	D.W.	$\bar{R}^2$	Sample
Canada	-1.39 (3.6)	-3.24 -5.36 -3.46 1/ (3.6) (5.3) (3.0)	1.01 0.51 2/ (1.9) (4.2)	0.47 3/ (3.3)		0.09	1.58	.93	1963-83
United States	0.55 (2.2)	-5.07 -1.0 -1.22 1/ (9.5) (1.7) (2.5)	1.76 0.50 2/ (6.6) (2.4)			0.05	1.59	.98	1962-83
Japan	-7.20 (7.3)	-0.86 -1.46 -1.57 4/ (2.1) (3.9) (4.1)		0.22 0.66 5/ (2.6) (2.9)		0.07	1.83	.94	1962-83
France	1.22 (0.3)	-4.34 6/ (3.2)		0.15 1.50 -1.95 7/ (1.1) (4.5) (2.4)	3.37 -0.56 8/ (6.2) (2.7)	0.14	2.15	.95	1963-83
Germany, Fed. Rep. of	-4.13 (22.2)	-1.69 -4.15 9/ (1.5) (2.6)	22.0 10/ (4.3)	0.67 1.67 11/ (2.8) (3.8)		0.24	2.51	.94	1962-83
Italy	-4.77 (4.2)	-0.96 -0.73 -0.33 12/ (3.4) (2.0) (-1.0)		0.31 0.04 13/ (1.29) (13.3)		0.06	2.11	.94	1962-83
United Kingdom	-51.09 (3.8)	-6.89 14/ (3.8)	1.47 15/ (2.4)	0.28 -0.93 16/ (1.7) (1.7)	35.03 -0.28 17/ (4.5) (2.4)	0.13	1.98	.96	1964-83

1/ Coefficients associated with deviation from trend output growth rate in the current period, the previous period and two periods ago, respectively.
2/ Demographic variable measured as the population aged 15 to 24 years relative to the population of labor force age less the 15 to 24 year old age group; and unemployment benefit payments relative to average weekly wages adjusted by the percentage of workers covered by the unemployment scheme.
3/ The relative price of energy measured in log terms and lagged one period.
4/ Cyclical variables are measured as the residuals from an AR1 process on real government spending in the current and the previous period and the deviation from the trend of world trade.
5/ A dummy variable which takes on the value 0 prior to 1974 and 1 beginning in 1974 intended to capture level effects on the natural unemployment rate from other sources such as the interaction of increased uncertainty and the costs of hiring and firing workers; and the lagged value of the real exchange rate calculated using relative GNP deflators.
6/ Deviation from trend output in the current period.
7/ The dummy variable as for Japan (see footnote 5), the lagged relative price of energy and the lagged real exchange rate respectively.
8/ The minimum wage relative to the average weekly wage and an incomes policy dummy variable for the years 1982 and 1983.
9/ Cyclical variables measured as deviations from an AR1 process on the monetary base and real government spending.
10/ Demographic variable measured as the growth rate of the youth population (the 15 to 24 year old age group).
11/ The dummy variable as for Japan (see footnote 5) and the relative price of energy in the preceeding period.
12/ Cyclical variables measured as the deviations from an AR1 process on the monetary base and real government spending and the deviation from the trend of world trade, respectively.
13/ The real exchange in the previous period and a time trend, respectively.
14/ A cyclical variable measure as the deviation from trend output.
15/ Unemployment benefits relative to average weekly wages adjusted for the coverage of the unemployment insurance program.
16/ The dummy variable as for Japan (see footnote 5) and the real exchange rate from the previous period, respectively.
17/ The social security tax rate and an incomes policy dummy variable for the years 1976 and 1977, respectively.

The estimation results are generally consistent with the hypothesis mentioned earlier that real wage rigidities are a serious problem in Europe but not in North America and Japan. For the United States the results imply that changes in the natural unemployment rate depend only on changes in the demographic composition of the labor force and changes in unemployment benefits relative to market wages. Warranted real wage factors do not appear to have contributed significantly to unemployment developments in the United States during the period under examination. This also appears to be the case for Canada. Demographic factors and changes in real unemployment benefits account for most of the movement in the Canadian natural rate. Nevertheless, changes in real oil prices also have had some effect on the natural unemployment rate in Canada.

In Japan, which has a recent history of low and stable unemployment, there seems to have been relatively little change in the natural unemployment rate. However, the equation for Japan indicates an upward tendency in the natural unemployment rate in 1974 due to real wages not adjusting sufficiently to changes in labor market conditions at that time (this term may also be capturing the effects of the significant changes in the prices of oil and other industrial materials which occurred around this time). This result is consistent with the widely held view that there was a structural change in the wage formation process in Japan in the period between the two rounds of increases in world oil prices. According to a number of studies Japanese real wages did not adjust sufficiently in the period immediately following the sharp rise in world oil prices in the early 1970s causing an increase in unemployment. However, as wage earners and firms subsequently modified their behavior, real wages adjusted rapidly in the wake of the second major increase in oil prices at the end of the decade preventing a further rise in the natural unemployment rate. 1/

For the major European countries, the variables included to capture the effects of less than full adjustment of real wage targets to changes in the warranted real wage seem to have played a significant role. The oil price shocks raised the natural rate in France and the Federal Republic of Germany; and the real exchange rate enters with a negative coefficient in France and the United Kingdom. In addition, changes in social security tax rates seem to have contributed significantly to movements in the unemployment rate in the United Kingdom. 2/ With respect to other structural variables, changes in unemployment insurance benefits relative to average wages were found to have a significant influence on the unemployment rate in the United Kingdom, and demographic factors were found to be important in France and the Federal Republic of Germany. In France, changes in the minimum wage relative to the average wage appear to have had a very significant impact on unemployment while in the Federal Republic of Germany there was a strong

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1/ See, for example, Hamada and Hayashi (1985).

2/ This variable may have played an important role in other countries as well but the data were not available.

correlation between the growth of the youth population and the unemployment rate. Finally, it should be pointed out that the equation for Italy is less satisfactory than for other countries because it was necessary to use a time trend as a proxy for changes in the structural influences on the natural unemployment rate.

Natural Unemployment Rates and Comparison with Other Studies

The two most striking features of the estimated natural unemployment rates for the major industrial countries (Table A2, first column) are first, the substantial rise in the natural unemployment rates in all of these countries with the exception of Japan since the late 1960s, and second, the divergence in performance, especially in the 1980s, between the major European countries on the one hand and North America and Japan on the other. The principal reason for the sharp deterioration in underlying labor market conditions in Europe relative to North America and Japan appears to be greater rigidity of real wages in Europe in the face of disturbances which lead to a reduction in the warranted real wage level. However, as has been stated previously, the causes of this greater real wage rigidity in Europe are not well understood.

In all the major European countries the natural unemployment rate appears to have increased sharply in the late 1970s and again after 1980. The largest increases occurred in France and the United Kingdom where the natural unemployment rate rose by more than 6 percentage points from the late 1960s to the early 1980s. The United States and Canada also experienced a significant rise in their natural unemployment rates during the 1970s. However, in the United States and Canada the natural unemployment rate seems to have declined marginally in the early 1980s as a result of a decline in the youth component of the labor force. Thus the European countries went from a situation in the late 1960s where their natural unemployment rate generally was below that of the United States, to a situation in the early 1980s where their natural unemployment rate was typically above that of the United States. In France, Italy and the United Kingdom the natural unemployment rate appears to be in the 8-9 percent range at the end of the estimation period (1983). In Japan, which has by far the lowest natural unemployment rate among the major industrial countries, the level of the natural unemployment rate rose slightly after 1974, but subsequently seems to have stabilized.

Another feature of the estimated natural unemployment rates is the close correlation between changes in the natural unemployment rate and the actual unemployment rate for all countries. This correlation could arise for two quite different reasons which have very different implications for the functioning of the economy and the conduct of policy. In

Table A2. Major Industrial Countries: Estimates of the Natural Rate of Unemployment

Country	Time Period	This study	Coe	Layard	Others 1/		Actual Unemployment Rate
Type of estimate		Natural Rate	NAIRU	NAIRU			
					Kaliski	Samson	
Canada	1967-70	5.0			5.2	4.6	4.6
	1968-70		4.0				
	1974			6.5			
	1971-75	7.1	7.0		6.2	6.0	6.0
	1979			6.2			
	1976-80	7.5	8.5		6.5	7.7	7.7
	1981-83	7.0	7.5			10.2	9.9
					Collyns	Englander-Los	
United States	1961-67					4.4	
	1967-70	5.6	3.0		5.3		4.0
	1968-73					6.2	
	1970-73			6.0			
	1971-75	6.8	6.0		5.8		6.1
	1974-81			6.8			
	1974-82					7.2	
	1976-80	7.5	6.0		6.8		6.8
	1979			7.2			
	1981-83	7.3	6.5		7.6		9.0
Japan	1967-70	1.3					1.2
	1971-75	1.5	1.0				1.4
	1976-80	2.0	1.5				2.0
	1981-83	1.9	2.0				2.4
					Sachs-Wyploz		
France	1967-70	2.0 2/	2.5				2.1
	1971-75	3.5 2/	3.5				3.2
	1973				2.9		
	1976-80	6.0 2/	3.0	5.3			5.6
	1980				6.8		
	1981-83	8.1 2/	8.0	6.9	7.8		8.2
	1984				9.0		
					Franz		
Federal	1967-70	0.9	1.0				1.0
Republic of	1965-73				1.6		
Germany	1971-75	1.8	1.5				1.8
	1974-81				4.3		
	1976-80	3.5	3.0	3.7			3.7
	1981-83	5.3	8.0	5.3			6.6
Italy	1967-70	5.4	4.5				5.6
	1971-75	6.3	7.0				6.1
	1976-80	7.4	6.5	8.9			7.3
	1981-83	8.8	6.5	7.7			9.2
					Nickell	Minford	
United Kingdom	1967-70	2.6 3/	1.0				2.5
	1971-75	3.4 3/	7.5				3.2
	1976-80	5.9 3/	7.5	4.6			5.4
	1979				5.8		
	1980					7.3	
	1981-83	8.4 3/	6.0	9.5			11.2

Sources: Coe (1985), Collyns (1984), Englander-Los (1984), Franz (1983), Kaliski (1984), Layard et al (1984), Nickell (1979), Minford (1983), Sachs-Wyploz (1986), Samson (1984).

1/ The following studies are estimates of the natural unemployment rate for the country in question: Kaliski (1984), Samson (1985), Collyns (1984), Minford (1983). The estimates in Englander-Los (1984), Sachs-Wyploz (1986) and Franz (1983) are of the NAIRU. Nickell (1979) is an estimate of the equilibrium unemployment rate in terms of labor market flows.

2/ These estimates include the residuals from the reduced form equation.

3/ These estimates have been smoothed using a three year moving average.

view of its importance, some further discussion of this issue is warranted before turning to the comparison of this study's estimates of the natural unemployment rate with other estimates.

One potential reason for this correlation, which is the hypothesis implicitly underlying the model in this paper, is that market-based adjustment mechanisms in these economies are strong enough to ensure that, in the absence of unanticipated events, the actual unemployment rate will approach its natural level within a relatively short period of time. Another possible reason is that the natural unemployment rate may depend on the actual unemployment rate. This phenomenon is referred to as the hysteresis hypothesis. There are two underlying mechanisms that might give rise to hysteresis effects. First, as the duration of unemployment spells lengthens, the human capital of unemployed workers might depreciate significantly. The long-term unemployed would therefore exert progressively less pressure on real wages which would raise the natural unemployment rate. In addition, idle physical capital could depreciate as well with a similar result and investment spending might be reduced. Second, if real wages are determined primarily by firms and employed workers (insiders), the unemployed (outsiders) have only little influence on wage decisions. This would also imply that the natural unemployment rate would tend to rise in the wake of adverse disturbances.

All of the above theories of the labor market are consistent with the conclusion that monetary and fiscal policy can be used to close a gap between the actual unemployment rate and the natural unemployment rate. In the first model and in the decaying-capital hysteresis model structural supply-side policies (such as changes in labor market regulations, reduction of taxes on employment, retraining programs) are the main means of reducing the natural unemployment rate permanently. In contrast, in the insider-outsider hysteresis model unanticipated fiscal and monetary stimulus could also exert downward pressure on the natural unemployment rate. The evidence presented in this and other studies do not provide strong support for either hysteresis model. The United Kingdom appears to be the only major country for which there is evidence that hysteresis might be a serious problem. 1/

In view of the possible shortcomings of the reduced form approach, it is useful to compare the estimates of the natural unemployment rates in this study with some of the other estimates available in the literature. In making this comparison it should be kept in mind that most of the other estimates in Table A2 are of the NAIRU, which is a slightly different concept. Despite those differences there appears to be a high degree of consistency between the developments in the reduced-form

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1/ For example, Coe (1985) seems to find that only the short-term unemployed exert pressure on wage inflation in the U.K., and field surveys show that the job search activity of the unemployed drops dramatically as the duration of unemployment lengthens.

estimates of the natural unemployment rate of this study and the estimates of other studies. The other studies also imply a significant rise in the natural unemployment rate in the United States and Europe in the 1970s with a further increase in Europe in the early 1980s, while in Japan the natural unemployment rate is estimated to have increased only slightly since the late 1960s. The studies reviewed generally confirm that differences in real wage behavior played a significant role in the pronounced deterioration in labor market conditions in Europe relative to the United States and Japan.

It must finally be noted that while the similarity between the estimates of the natural unemployment rates used for the purposes of this study and other estimates is reassuring the relatively wide range of estimates available for any country for any particular period makes it clear that undue emphasis should not be placed on any point estimate of the natural unemployment rate. Even though the estimates of the natural unemployment rates in this study appear to provide a reasonable basis for calculating the level of potential labor input, these qualifications imply that there is a sizable confidence interval around the resulting estimates.

Demographic Assumptions

The rate of increase of the population of labor force age is one of the primary determinants of economic growth. The purpose of this appendix is to review the demographic assumptions underlying the medium term potential output projections. To place developments in perspective the appendix begins with a brief discussion of demographic developments from 1960 to 1985 and then proceeds with a description of the demographic trends that are expected over the next ten years.

The Historical Record

The data on the growth rates of the population of labor force age in Table B1 shows that the so called baby boom phenomenon occurred earlier and was much stronger in Canada and the United States than in the major European countries. The rate of growth of the population of working age accelerated during the 1960s in Canada and United States, peaking in the early 1970s before declining marginally in the late 1970s; it subsequently decelerated sharply to approximately 1 percent per year during the early 1980s. In contrast, in the major European countries the growth rate of the population of labor force age built up gradually over this period, peaking in the 1 percent range in the early 1980s. France recorded the strongest labor force population growth among the major European countries while the United Kingdom experienced the least growth. However, some of the European countries, notably the Federal Republic of Germany, also experienced a sizable influx of foreign workers in the period prior to the mid-1970s which was subsequently arrested or reversed. Japan experienced strong labor force population growth in the 1960s. However, since the early 1970s labor force population growth in Japan has averaged slightly less than 1 percent per year. Thus, after having followed widely different trends, the growth rates of the population of labor force age were remarkably similar among the major industrial countries during the early 1980s.

The Projection Period

The demographic projections underlying the medium term potential output projections are the medium variant of World Population Prospects Estimates and Projections as Assessed in 1982 published by the United Nations in 1985. 1/ According to these projections Canada and the United States are expected to experience much more rapid labor force population growth than the other major industrial countries during the

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1/ These projections assume that the same international migration flows which occurred from 1980 to 1985 will continue over the next ten years. Thus, the United States and Canada are expected to experience net immigration of 450,000 and 75,000 persons per year respectively, while the United Kingdom is expected to experience a net outflow of 29,000 persons per year. Net migration is assumed to be zero in the remaining major countries.

Table B1. Major Industrial Countries: The Rate of Growth of the Population of Labor Force Age

(Compound annual growth rates, in percent)

	1960-70	1970-75	1975-80	1980-85	1985-90	1990-95
Canada	2.3	2.2	2.1	1.2	0.8	0.9
United States	1.6	1.8	1.6	1.0	0.7	0.7
Japan	1.8	1.0	0.8	0.9	0.9	0.3
France	1.1	0.9	0.9	1.1	0.4	0.1
Germany, Fed. Rep. of	0.3	0.5	0.7	1.0	-0.2	-0.5
Italy	0.5	0.5	0.4	0.9	0.3	-0.1
United Kingdom	0.2	0.2	0.3	0.6	0.1	--

Source: United Nations (1985).

period to 1995 (Table B1). In North America, labor force population growth is therefore projected to decelerate very slightly over the next ten years whereas in the major European countries labor force population growth is expected to slow substantially in the second half of the 1980s. For the first half of the 1990s the labor force population in the Federal Republic of Germany is actually expected to decline by approximately 1/2 percent per year. In Japan, the growth rate of population of working age is projected to continue in the 1 percent per year range from 1985 to 1990 and then slow significantly in the first half of the 1990s.

In addition to the population of working age, the age distribution of the population may have an important impact on many aspects of the growth process. As is commonly expected, the median age of the population is projected to increase substantially in all countries between now and 1995 (Table B2). In most countries the median age of the population declined during the period 1950-1970 under the influence of the baby boom, but rose again from the mid-1970s to the mid-1980s reflecting the sharp declines in birth rates in the last 15 years. The two exceptions to this pattern are Japan and Italy where the median age of the population increased progressively from 1950 to 1985. Canada is expected to experience the greatest population aging in the next decade followed by Japan. However, Canada and the United States are expected to have the youngest population by a significant margin with a projected median age of just over 34 years in 1995. The Federal Republic of Germany is projected to have the oldest population with a median age of almost 40 years. Japan is projected to have the second oldest population which is remarkable in light of the fact that this country had the youngest population by a significant margin in 1950.

Another indicator of the aging of the population which is implied by the demographic assumptions is the projected decline in relative size of the youth component of the population of labor force age (Table B3). This change in the age structure of the population is particularly important because it may lead to a reduction in labor market turnover, thereby lowering the natural rate of unemployment in some countries. Again as a result of the baby boom the relative size of the youth labor force increased significantly during the past 25 years in all of the major countries except Japan and Italy. The relative size of the youth group peaked in the mid-1970s in North America and, hence, generally five to ten years earlier than in the major European countries. The relative size of the youth labor force is projected to decline substantially during the next decade in all of the major countries with the exception of Japan, where a slight increase is expected. The Federal Republic of Germany, the United States and Canada are expected to experience the largest declines in the relative size of the youth population. In Germany the share of the youth component of the labor force population is expected to decline from 23.4 percent in 1985 to only 15.7 percent in 1995.

Table B2. Major Industrial Countries: Median Age of the Population

(In years)

	1950	1960	1970	1980	1985	1990	1995
Canada	27.7	26.4	26.0	28.8	30.5	32.4	34.3
United States	30.2	29.4	27.9	30.0	31.3	32.8	34.2
Japan	22.3	25.5	29.0	32.7	35.1	37.1	38.5
France	34.5	33.0	32.3	32.5	33.7	35.0	36.2
Germany, Fed. Rep. of	34.6	34.4	34.3	36.6	37.8	38.6	39.7
Italy	29.0	31.3	32.7	34.3	35.4	36.2	37.1
United Kingdom	34.6	35.4	33.7	34.3	35.1	35.5	36.2

Source: United Nations (1985).

Table B3. Major Industrial Countries: Youth Population Relative to the Total Labor Force Population 1/

(In percent)

	1960	1970	1975	1980	1985	1990	1995
Canada	24.7	29.6	29.7	29.3	25.1	21.1	20.3
United States	22.8	28.8	29.4	28.4	25.1	21.7	20.2
Japan	29.5	27.6	22.7	20.4	20.8	21.8	21.2
France	20.0	26.3	25.7	24.8	23.3	22.3	20.6
Germany, Fed. Rep. of	23.5	20.1	22.0	23.4	23.4	19.9	15.7
Italy	23.4	23.0	22.5	23.5	23.5	22.4	20.1
United Kingdom	20.4	23.4	22.8	24.6	24.9	23.0	20.0

Source: United Nations (1985).

1/ The youth population is comprised of individuals between the ages of 15 and 24 years.

Data Definitions and Sources 1/

This appendix describes the data used in estimating the production technology and the natural rates of unemployment.

Business Sector Value Added

Value added in the business sector is measured as value added in the entire economy (GDP or GNP) less value added in the general government sector. The value added deflator for the business sector is calculated in an analogous manner. Source: OECD.

Business Sector Capital Stock

The capital stock in the business sector was calculated using the perpetual inventory method. In addition to government fixed investment, the housing stock is excluded from these capital stock estimates. Source: All countries except France: OECD. Data for France were based on information supplied by INSEE.

Business Sector Employment

Total employment less employment in general government. Source: OECD.

Average Hours Worked in the Business Sector

Data on average hours worked in the business sector are not available for most countries. Data on average hours worked for the manufacturing sector were assumed to be representative of the business sector as a whole. Source: National sources.

Unemployment Rate

The unemployment rates in this study follow national conventions. Generally speaking the unemployment rate is measured as the unemployed civilian population divided by the civilian labor force. Source: World Economic Outlook.

1/ The staff wishes to acknowledge the generous assistance of David Coe and Michael Feiner at the Organization for Economic Co-operation and Development in making the database for their supply modelling project available. These data were an essential component of the database for this project.

Labor Force Participation Rates

Estimates of labor force participation rates measured as the labor force relative to the population of labor force age are from various issues of OECD Labour Force Statistics.

Demographic Data

Data for the population aged 15-24 years and for the population aged 15-64 years for the historical period and the projection period are from the medium variant scenario reported in World Population Prospects Estimates and Projections as Assessed in 1982, United Nations (New York 1985).

Unemployment Benefit Replacement Rate

Average weekly unemployment transfer payments relative to the average weekly industrial wage adjusted by the percentage of unemployed workers who receive such payments. Source: All countries except the United States: OECD. Data for the United States are from Collyns (1984).

Monetary Surprise Variable

These data are calculated as the residuals from an AR1 process on the monetary base. Source: Data on reserve money according to IFS.

Fiscal Surprise Variables

These data are calculated as the residuals from an AR1 process on government spending in constant dollars. Source: Data on government spending in constant dollars on a national accounts basis were obtained from IFS.

The Deviation of World Trade from Trend

World trade is measured as the logarithm of the quantum index of world exports (WE) from the UN Monthly Digest of Statistics. The deviation from trend is given by the residuals from the regression

$$\log(WE) = 1.53 + \underset{(2.5)}{0.50}*time - \underset{(2.5)}{0.057}*time^2 + \underset{(2.7)}{0.0033}*Time^3 - \underset{(2.7)}{0.000086}*time^4 + \underset{(2.7)}{0.00000081}*Time^5$$

Source: Layard and Nickell (1986)

Real Effective Exchange Rate

To calculate the real effective exchange rate for each country the real dollar exchange rates, based on relative GNP deflators, of its trading partners are aggregated using MERM weights. Source: Current Studies Division of the Research Department.

The Price of Energy in the Business Sector

Price indices for energy input in the business sector were calculated by the OECD from primary data provided by the International Energy Agency and the United States Department of Energy. Source: OECD.

Minimum Wage--France

This variable is measured as the ratio of the minimum wage and the average wage rate. It is an index (1970=1.0). Source: "Banque de donnèes DMS", INSEE as cited in Malinvaud (1986).

Social Security Tax--United Kingdom

The social security tax rate is calculated using economy-wide data on total labor costs and on wages and salaries. Source: Layard and Nickell (1986).

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