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Discussion Paper No. 98

Verdoorn's or Okun's Law?

Employment and Growth Experiences in OECD Countries, 1960 - 1993

by
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Summary

The paper studies the significance of Okun's and Verdoorn's law for all countries of the OECD area. Its aim is to find out to what extend long-term output growth contributed to changes in unemployment rates and labor productivity growth during the period from 1960 to 1993. A first result shows that for the majority of countries both relations have significant explanatory power. To improve the results some extensions in both relations are introduced. For Okun's law an asymmetric behavior of changes in unemployment rates with respect to fluctuations around the long-term output growth trend is statistically significant. For Verdoorn's law the introduction of the catch-up hypothesis has explanatory power for a number of countries to explain a convergence in labor productivity growth rates during the last decades. However, the results show as well that there is a significant variety of parameter estimates, especially of the output elasticities of Okun's and Verdoorn's law. It confirms that high output growth will be insufficient to create enough jobs in the OECD countries facing a severe unemployment problem to return to similar conditions prevailing before the first oil price shock, where unemployment rates were around 3 per cent. Taking into account that for a large number of OECD countries asymmetric reactions with high absolute elasticities on changes in unemployment rates for negative deviations from the long-term output growth trend lead to a fast build-up of high unemployment and positive deviations have low absolute elasticities the most successful policy rule under these conditions should try to avoid severe fluctuations around the long-term growth path. An economic policy trying to assure a more steady output growth would support lower unemployment than a boom and bust policy, which amplifies or at least does not dampen cyclical fluctuations. Furthermore economies especially in Western Europe which have followed a productivity driven growth strategy should consider a more employment driven growth after having caught up more or less with the level of the past and present leader in productivity, the United States.

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Introduction

Verdoorn (1949) published an article in 1949 in which he demonstrated that productivity growth in industries of the Italian economy depended significantly on changes in output growth. This empirical relationship which showed to be fairly stable over time in a number of other studies for different countries was therefore named as Verdoorn's law by Kaldor.

In the 1960s Okun studied the relationship between changes in unemployment rates and output growth rates. He demonstrated that output growth is an important determinant to accomplish significant reductions in the rate of unemployment. Until output growth rates exceed a certain positive minimum no substantial reduction in unemployment rates can be expected. This relationship subsequently became known as Okun's law. Recently Krugman (1994a, p. 114) stressed again that to his mind Okun's law is one of few macroeconomic relationships which have a sound empirical basis.

The following study on the one hand investigates to what extent both laws are closely related with each other and on the other how useful they are to explain long run unemployment and employment growth in OECD countries. Are they probably just two sides of the same medal? What distinguishes them if they are different? Are the experiences in OECD countries fairly homogenous with respect to growth and employment or how much do they differ? Who are the winners, who are

the losers in output and employment growth? Are there different political strategies attributable to the observed outcomes and are they adaptable for other countries by a policy shift?

Especially the current debate on strategies to turn around long-term trends of ever increasing unemployment in OECD countries (see e.g. OECD, 1994) - predicted to continue at least for the rest of this decade - shows that a better understanding of major causes and conditions of unemployment growth in industrialized countries is needed. Are Okun's or Verdoorn's law useful instruments to study current employment problems? Is Okun's law superior or inferior to Verdoorn's law in explaining current developments in OECD countries?

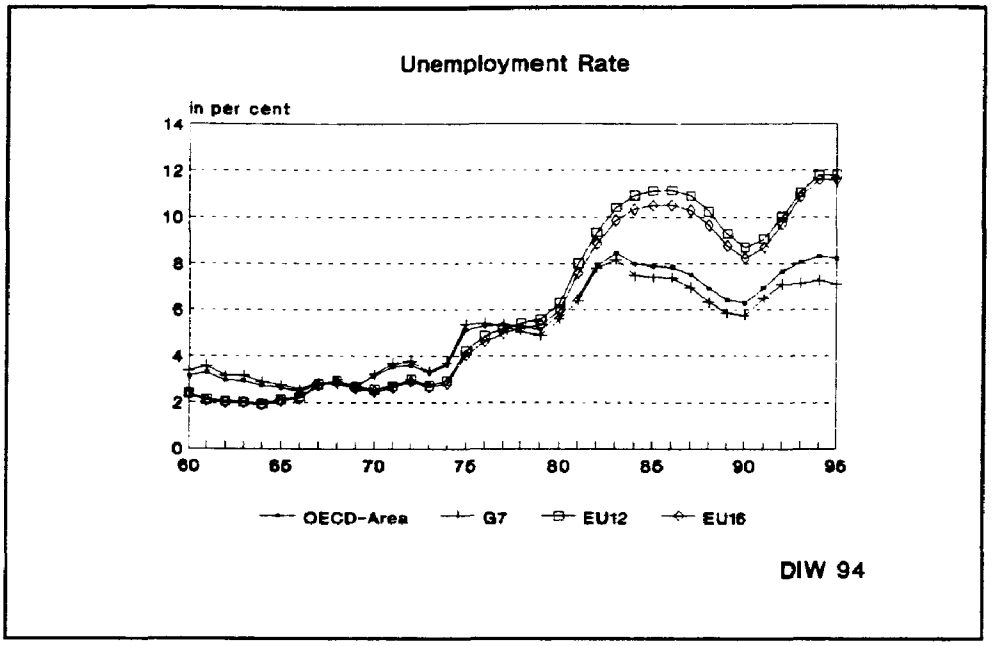
The present debate on strategies to overcome high unemployment is also closely linked to current debates on international competitiveness of nations (see e.g. EU, 1993) which attributes the increase in unemployment in OECD countries to a relative decline of OECD competitiveness to Newly Industrializing Countries (NICs). This view was recently challenged by Paul Krugman (1994b) as grossly misleading because it over emphasizes impacts of international economic relations and diminishes the importance of domestic factors leading to high unemployment in OECD countries. Is higher productivity growth in OECD countries needed to stay internationally competitive or is it necessary to reduce the rate of productivity growth to increase employment growth and reduce unemployment in this manner? Is an acceleration of economic growth feasible to substantially reduce unemployment? What are possible policy options to stimulate faster economic growth? These are questions setting an agenda for the current international debate on unemployment and were once again discussed at the employment summit in Detroit this year by policy leaders of the industrialized countries.

We hope, however, to elucidate some aspects of the present unemployment problem by studying past and current experiences in OECD countries using the theoretical framework of Verdoorn's and Okun's law.

Some Basic Facts on Growth, Employment and Unemployment

Our data base used in this study is the Economic Outlook Statistic of the OECD which cover the years from 1960 to 1993 (OECD, 1993). The published data from December 1993 also include a forecast for the years 1994 and 1995. In some of the following graphs and tables we included them to show recent expectations of the OECD for the near future. If no other source is mentioned explicitly, forecasts are always those of the OECD from December 1993.

Fig. 1 - Unemployment Rates in the OECD Area, 1960-1995.



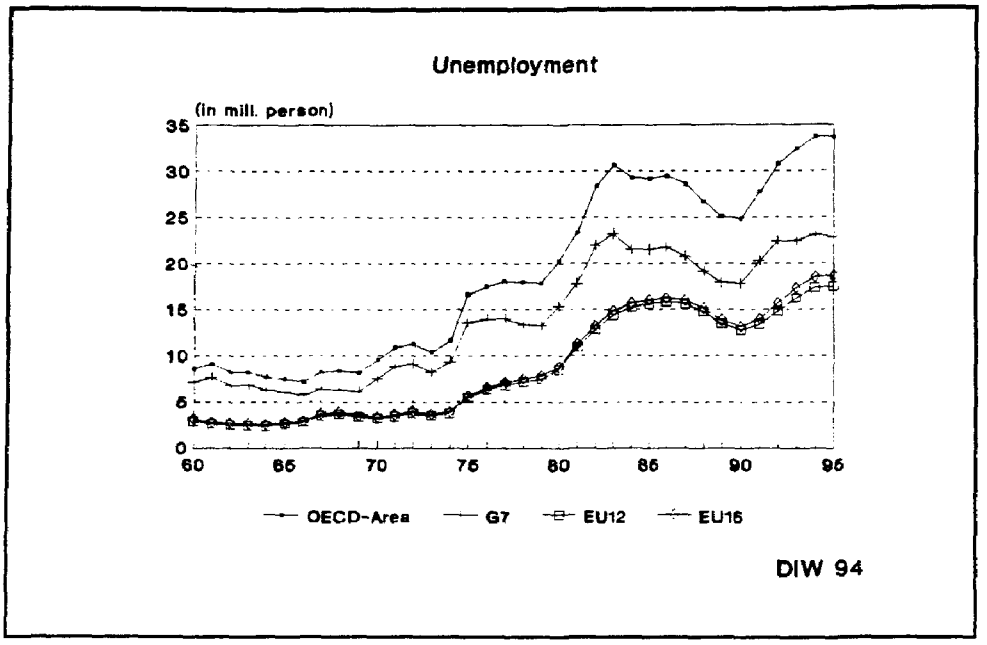
A first brief look at the development of unemployment rates and the number of unemployed shows: During the 1960s unemployment rates nearly always were below 3 per cent and little more than 8 mill. person in the OECD area were unemployed (see. Fig. 1 and Fig. 2). From the mid-1970s unemployment rates were around 5 per cent and this more than doubled the number of unemployed to 18 mill. persons by 1979 because of growing populations and labor participation rates. In the early 1980s unemployment rates peaked in 1983 at 8.5 per cent for the whole OECD area and only declined slowly in the second half of the 1980s to 6.3 per cent in 1990. With a slow recovery after a major recession at the end of the 1980s unemployment rates quickly went up again to over 8 per cent in 1993. This leaves currently about 35 million people in the OECD area without jobs. This development shows that the societies and economic policies in particular were unable to recover job losses or to create sufficiently new ones since the mid-1970s. Furthermore Western European countries showed an even worse performance. For the European Union area unemployment rates are above 11 per cent of the labor force. Therefore one can observe a global shift in the unemployment problem from the non-European areas of the OECD to the European OECD member countries.[1]

This brief aggregate survey of the development of unemployment does not reveal the country specific differences. A first attempt to show how much long-term differences in output and

[1] Note that the European countries had below OECD average unemployment rates in the 1960s and 1970s (see Fig. 1).

employment growth have contributed to this development is presented in table 1. As an output variable we used the gross domestic product at 1991 prices, GDP, and for employment the number of total employment which includes the self-employed.

Fig. 2 - Unemployment in the OECD-Area, 1960-1995.



The ratio of real GDP to employment is used as a measure of labor productivity.[2] For comparisons of labor productivity levels which need a common unit of output measurement, the 1991 purchasing power parities for the GDP or respectively GNP of the OECD (see OECD, 1993) were applied.

If we compare the different developments of the OECD countries in table 1, we notice:

Japan is the economy which managed to grow most rapidly by 5.3 per cent during the three and a half decades. More surprising is that a number of smaller economies like Turkey, Iceland, Portugal and Greece follow on the ranks 2 to 5 of all OECD countries. Canada grew at an average annual rate of 3.9 per cent which is the best result for the G7 countries after Japan. Italy and France

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[2] This definition is used to measure the productivity per employee which is more useful, if we want to see how labor productivity differs between countries as an opportunity to locate investments. If labor productivity per effective working hour is higher in one country than in another one, this is often compensated by a shorter annual work time per employee. The same labor productivity per employee might therefore correspond to quite different allocations of work time and productivity per working hour in different countries. Since these values are national averages it will not correspond to the microeconomic situation which will allow for much more flexibility in work time schedules. It gives, however, a general impression on the situation in different countries.

follow with 3.4 and 3.2 per cent GDP growth. From the other major economies the USA and Germany[3] grew at the same rate of 2.7 per cent. The United Kingdom showed the lowest growth rate of all G7 countries. Only Switzerland and New Zealand experienced a slower long-term GDP growth in the OECD area.

Table 1

Average Annual Growth Rates in % for all OECD Countries

(1960–1993)

Country	GDP	Employment	Labor Productivity	rank *) by GDP	rank *) by Employment	rank *) by productivity
1 United States	2.7	2.0	0.7	18	2	24
2 Canada	3.9	2.3	1.6	6	1	20
3 Japan	5.3	1.1	4.2	1	7	1
4 Germany (Western)	2.7	0.2	2.5	19	18	14
5 France	3.2	0.4	2.8	13	19	12
6 United Kingdom	2.2	0.1	2.1	22	10	22
7 Italy	3.4	0.3	3.1	11	18	7
8 Belgium	3.0	0.1	2.9	16	23	9
9 Netherlands	2.9	0.6	2.3	17	11	15
10 Luxembourg	3.0	1.3	1.7	15	5	18
11 Spain	3.6	−0.1	3.7	9	24	3
12 Portugal	4.1	1.1	3.0	4	8	8
13 Greece	4.0	0.5	3.5	5	14	6
14 Ireland	3.9	0.2	3.7	7	20	4
15 Denmark	2.5	0.5	2.0	20	15	16
16 Norway	3.7	1.1	2.6	8	9	13
17 Sweden	2.3	0.6	1.7	21	12	19
18 Finland	3.3	0.4	2.9	12	17	10
19 Austria	3.1	0.2	2.9	14	21	11
20 Switzerland	2.1	0.6	1.5	23	13	21
21 Iceland	4.4	0.2	4.2	3	22	2
22 Turkey	5.0	1.4	3.6	2	4	5
23 Australia	3.6	1.8	1.8	10	3	17
24 New Zealand	2.0	1.2	0.8	24	6	23

*) decending order.

Source: own computations.

[3] We only study the development of West Germany, because consistent time series for Germany including East Germany after unification in 1990 is not available for a study of long-term performance. Therefore we use always the term Germany as a short term for West Germany if not mentioning it explicitly, then we refer to the united Germany.

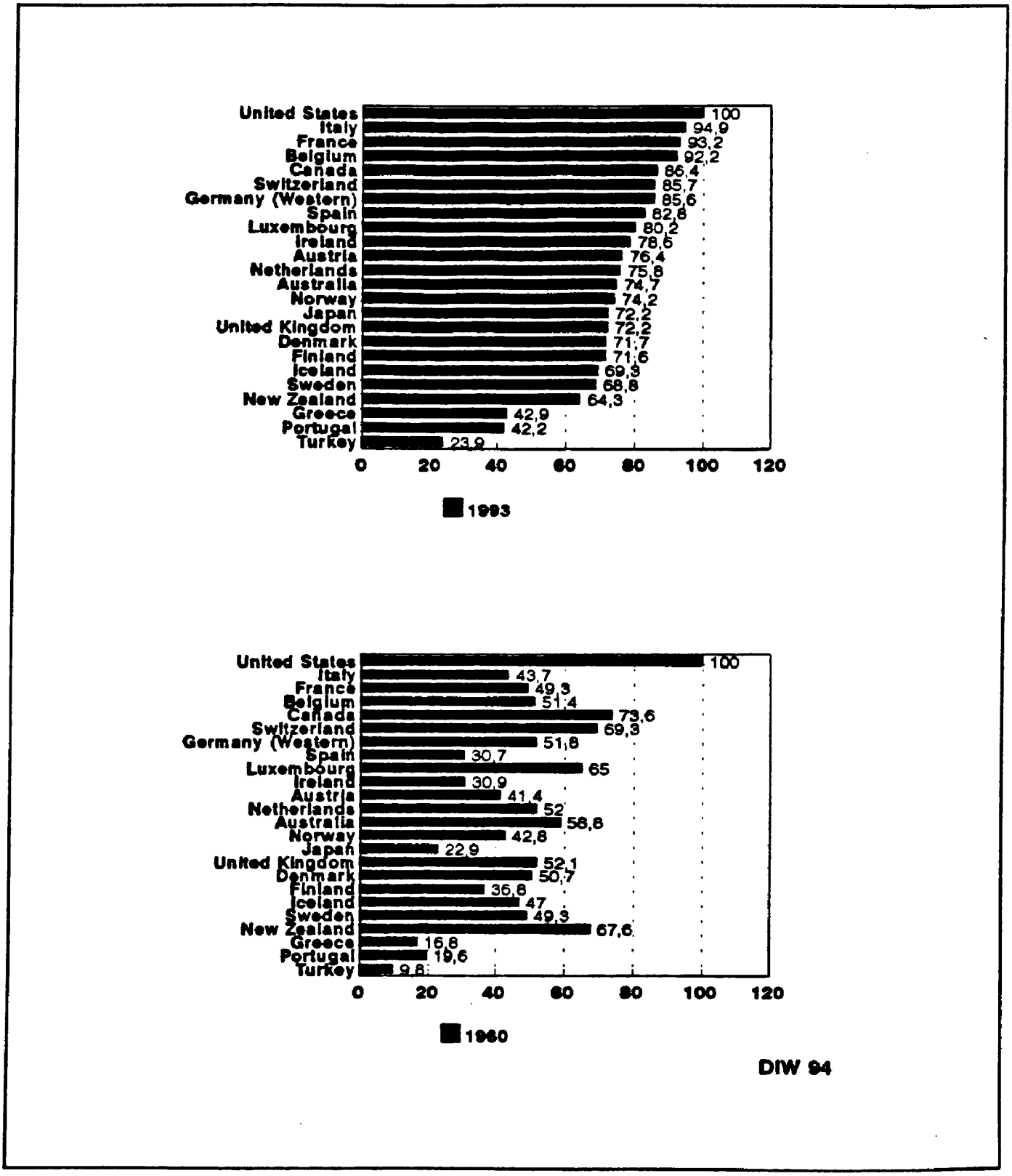
Looking at employment growth the situation looks quite different. Canada and the United States show the highest ability to create additional employment with 2.3 and 2 per cent annually. Japans GDP growth only created a moderate 1.1 per cent employment increase, which however was sufficient to keep unemployment rates significantly lower than in most other OECD countries. The four major European economies showed a much worse performance of generating new jobs as the growth rates of France with 0.4%, Italy with 0.3%, Germany with 0.2% and the United Kingdom with 0.1% signify. In Spain employment was even reduced by an average annual rate of -0.1%.

Since the growth rates of output, employment and labor productivity are linked by an identity so that the latter two add up to the first, high employment growth is compensated by low labor productivity growth if output growth is given. A good example for these differences are the United States and Germany. Both have the same average rate of GDP growth of 2.7% but while the U. S. expanded employment at 2 per cent annually its labor productivity only grew at the lowest rate of all OECD countries with 0.7 per cent. Germany had a fairly low capacity in job creation but on the other hand showed a 2.5 per cent increase in labor productivity. Similar experiences to that of Germany can be observed for most other European countries. Labor productivity growth always outperforms their employment growth significantly. The high rise in unemployment in Europe is therefore attributable to high productivity growth. Even if countries had higher GDP growth they did not utilize it for creating additional jobs. This poses the question: Why have these economies performed such a different strategy as the United States and Canada?

An answer might be that a comparison of growth rates merely tells us one part of the story. If we compare labor productivity levels the reason why most countries encouraged productivity growth more than employment growth is that they were significantly lagging behind the U.S. and Canada in productivity levels. Figure 3 shows the situation of relative labor productivity gaps to the United States for all OECD countries in 1960. In 1960 the United States and Canada were both leaders in labor productivity. With the exceptions of New Zealand, Australia, Switzerland and Luxembourg, all remaining OECD countries had productivity levels relative to the U.S.A. which were just about 50% or much less. Therefore in the following decades these countries undertook considerable efforts to catch up with the leading U.S. economy. If we look at the productivity levels in 1993 (see figure 3), we notice a dramatic closing of the productivity gap to the United States. Only Turkey has a productvity level which is 30% of the one for the United States. Italy, France and Belgium have labor productivity levels which are less than 10 per cent below that of the United States. This confirms that the priority in most European countries had been to adjust their productivity levels to that of the leading economy even if that had the undesired side-effect that employment growth was insufficient to employ the existing labor force and keep unemployment

levels in previously known bounds of 3 per cent. Fast GDP and labor productivity growth were accomplished by neglecting necessary employment growth to keep unemployment rates at lower levels.

Fig. 3 - Relative Labor Productivity Gaps of OECD Countries to the U.S.A.



In this context interesting questions to be studied are: Were the steep rise of unemployment in OECD countries lagging in productivity levels a necessary complement to catch up? What will happen in the future when the leading economies in productivity levels, the United States and Canada, cannot trade higher employment growth against lower productivity growth as they have done in the past decades? Will the successful U.S. job creation of the past decades falter if international competition which has caught up in productivity levels, is no longer at a disadvantage as they have been before?

In appendix A developments of catch up processes in relative labor productivity levels for all remaining OECD countries are summarized in figures 15 to 20.

An interesting feature of these catch up processes is that developments in different countries are quite uneven with respect to speed of adjustment and development paths. Some countries which were lagging much further behind than others - the most noteworthy example is Japan - caught up much more rapidly than others which were far closer to the U.S. level. Even one country, New Zealand, which had a fairly high productivity level, widened her labor productvity gap to the United States if we compare 1960 with 1993.

Higher labor productivity levels of Italy, France and Belgium in 1993 compared to Germany and the Nordic countries (Sweden, Norway, etc.) are somehow surprising because in the general public opinion they are not considered as outstanding success stories in their economic development during the last decades. One should however keep in mind that producitivity levels per effective working hour in other OECD countries, Germany for example, might be higher, but because of different lengths of effective working-time this is over compensated, if we base our comparison on labor productivity per employee. Furthermore, we use purchasing power parities (PPPs) and not exchange rates as conversion factors for GDPs here.

If exchange rates and purchasing power parities differ significantly, comparisons on productivity levels based on PPPs are not adequate measures to determine the competitiveness in international trade (see for an adequate type of analysis of this question e.g. Jorgenson; Kuroda, 1990). To conclude this section we would like to give some examples how the number of employees and unemployed shifted since 1960 in OECD country shares with respect to the whole OECD area for the GDP. In the text section we present the figures of only six countries. The remaining are included in appendix B.

Figure 4 shows that the United States successfully increased its share of OECD employment and reduced its share of unemployment. Its share of OECD GDP shrank quite steadily as well. Japan lowered its share in unemployment of all OECD countries and doubled its GDP share since 1960, but it is striking that this has not substantially increased its share in employment (see figure 5).

Fig. 4 - GDP, Employment and Unemployment Shares of the United States with respect to the OECD Area.

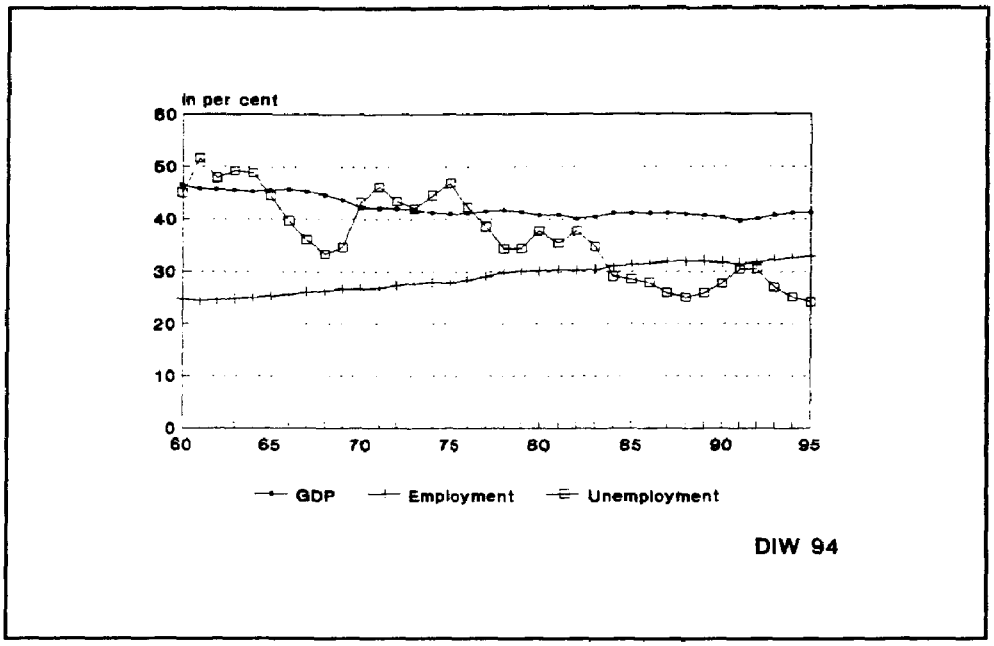


Fig. 5 - GDP, Employment and Unemployment Shares of Japan with respect to the OECD Area.

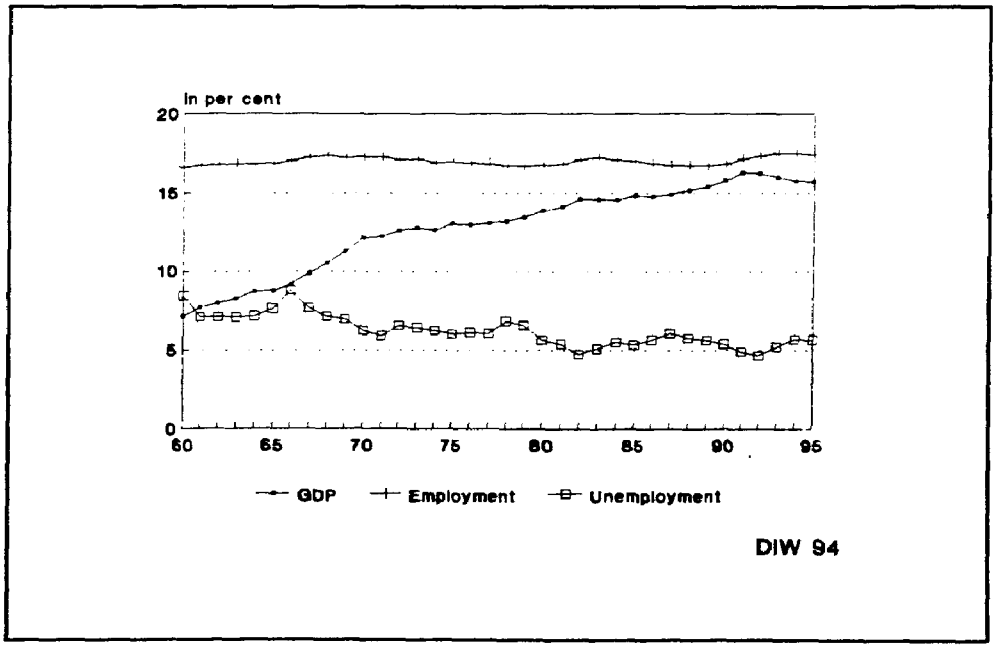


Fig. 6 - GDP, Employment and Unemployment Shares of Germany with respect to the OECD Area.

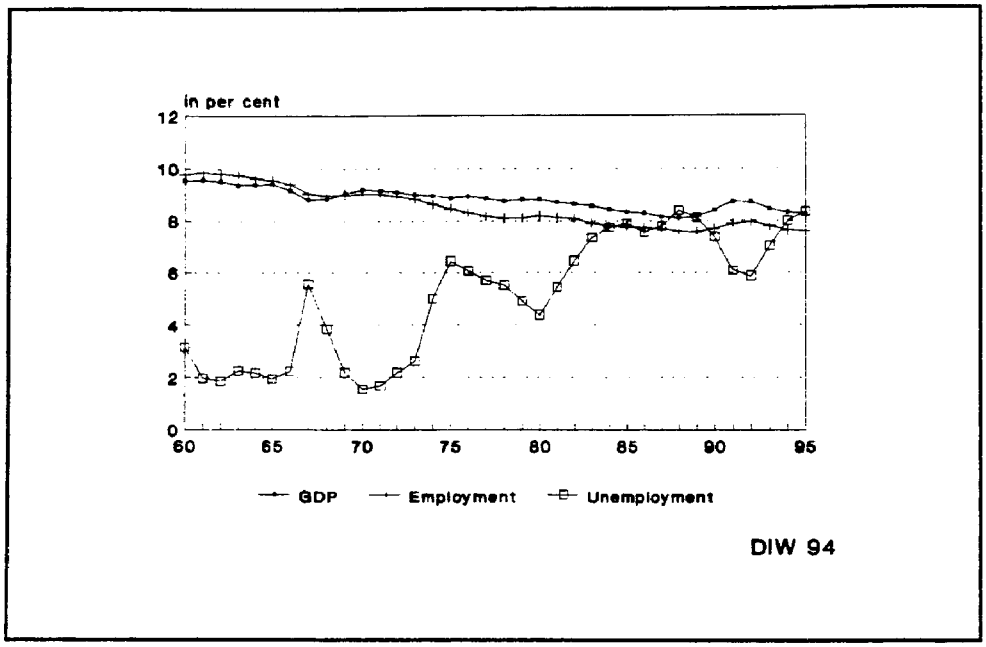


Fig. 7 - GDP, Employment and Unemployment Shares of France with respect to the OECD Area.

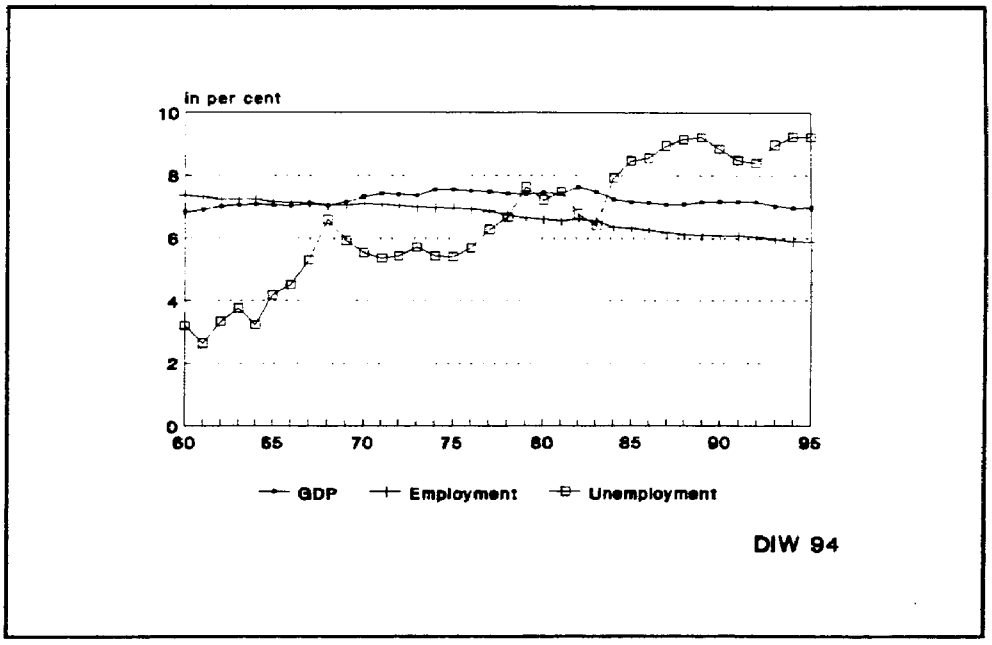


Fig. 8 - GDP, Employment and Unemployment Shares of the United Kingdom with respect to the OECD Area.

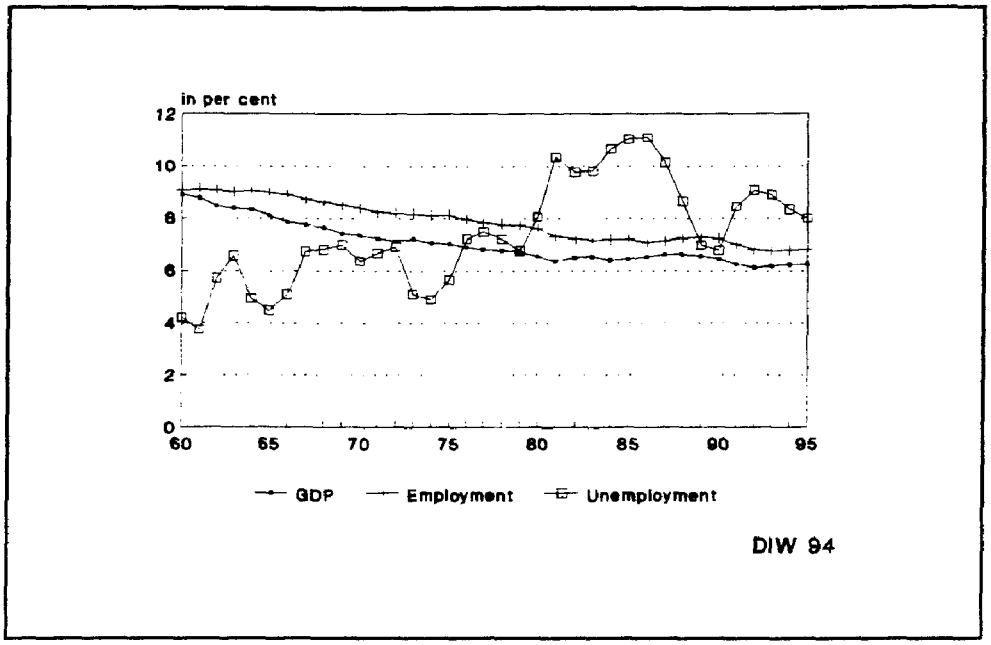
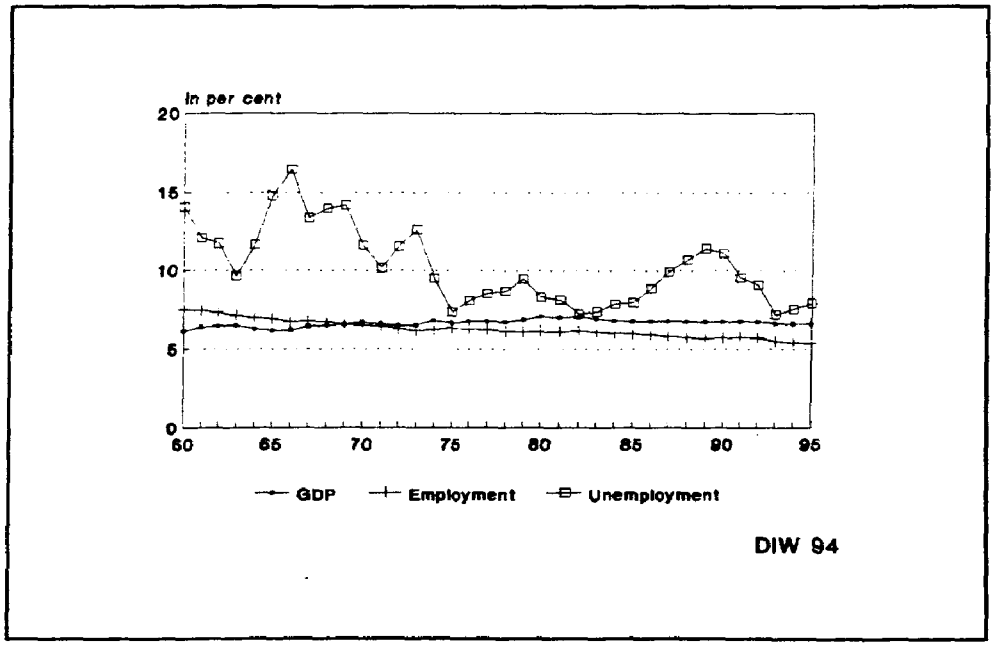


Fig. 9 - GDP, Employment and Unemployment Shares of Italy with respect to the OECD Area.



Taking total employment in the OECD area, Japan has not significantly gained jobs at the expense of other countries. The big redistribution of employment mainly took place between the United States and the European member states. This seems to be somewhat contrary to public perception since substantial higher output growth did not automatically shift jobs to Japan from the rest of the OECD countriesto the same extent. An interesting question for the future is, how Japans employment situation develops if high economic growth cannot be maintained in Japan as in previous decades. Will unemployment in Japan adjust to levels observed in other OECD countries?

The four major European economies Germany, France, Italy and the United Kingdom show an uneven development (see Fig. 6 to Fig. 9). In contrast to the other three countriesmost of the time Germany could keep its unemployment share lower than its GDP or employment share. Its GDP share of the OECD area was reduced, as well as that of the United Kingdom while France and Italy could maintain or even slightly improve their positions. The employment shares of all four countries decreased and contributed therefore to the increase in the U.S. employment share.

This shift does not mean that the U.S. managed to attract jobs from Europe by foreign trade, it just shows that the U.S. used its absolute productivity advantage to expand its employment and implicitly accepted a slower productivity growth thus steadily reducing steadily her previous advantage. The debate in America on strengthening U.S. competitiveness which started in the 1980s can be interpreted as a reflex to the growing awareness that low productivity growth would in the near future lead to an erosion of the U.S. economy's relative superior international position in productivity in comparison to other OECD countries. If that happens the living standards would then have to fall below that of other major OECD economies. The persistent huge deficits in the U.S. trade and current account balance during the 1980s and early 1990s are seen by many U.S. economists as a failure to adjust to these changing circumstances which puts a heavy burden on the future of the U.S. economy (cf. e.g. Thurow, 1992). Others like Paul Krugman just advise the American people to live with this situation and diminish their expectations of future growth of their living standards (Krugman, 1990).

Summarizing the major findings of this section we observe that the countries leading in productivity levels in the period 1960 to 1993, the United States and Canada, used this advantage for a significantly more rapid expansion of their employment and through this kept unemployment rates lower than most of the other OECD countries. The remaining major OECD countries prefered a higher rate in productivity growth to reduce the productivity gap to the leading countries. These catch-up processes which took place since the end of WWII have already at the mid-1990s led to a close convergence in productivity levels between most major OECD countries. Past experiences show that equality in economic growth rates does not translate into a similar growth of employment as the

example of the United States and Germany shows and higher economic growth in one country does not necessarily shift employment from one to another OECD country as Japan demonstrated.

Okun's Law Reconsidered

As already mentioned at the beginning of this study Okun stated that changes in unemployment rates, d ur / d t, and percentage rates of change in output, g_{GDP}, are closely linked with one another. This functional relation can be denoted by:

$$\frac{d\ ur}{d\ t} = f(g_{GDP}) \qquad (1)$$

If one wants to study this relation empirically one has to specify at the beginning how to measure both rates. Here we used the published OECD data on unemployment rates.[4] For rates of change in output we again took the national GDP data published by the OECD. The base year for price indices applied to calculate real output data is 1991.

Since data are on an annual basis the functional relation has to be transformed by a discrete approximation:

$$\Delta\ ur_t = f(g_{GDP,t}) \qquad (2)$$

with

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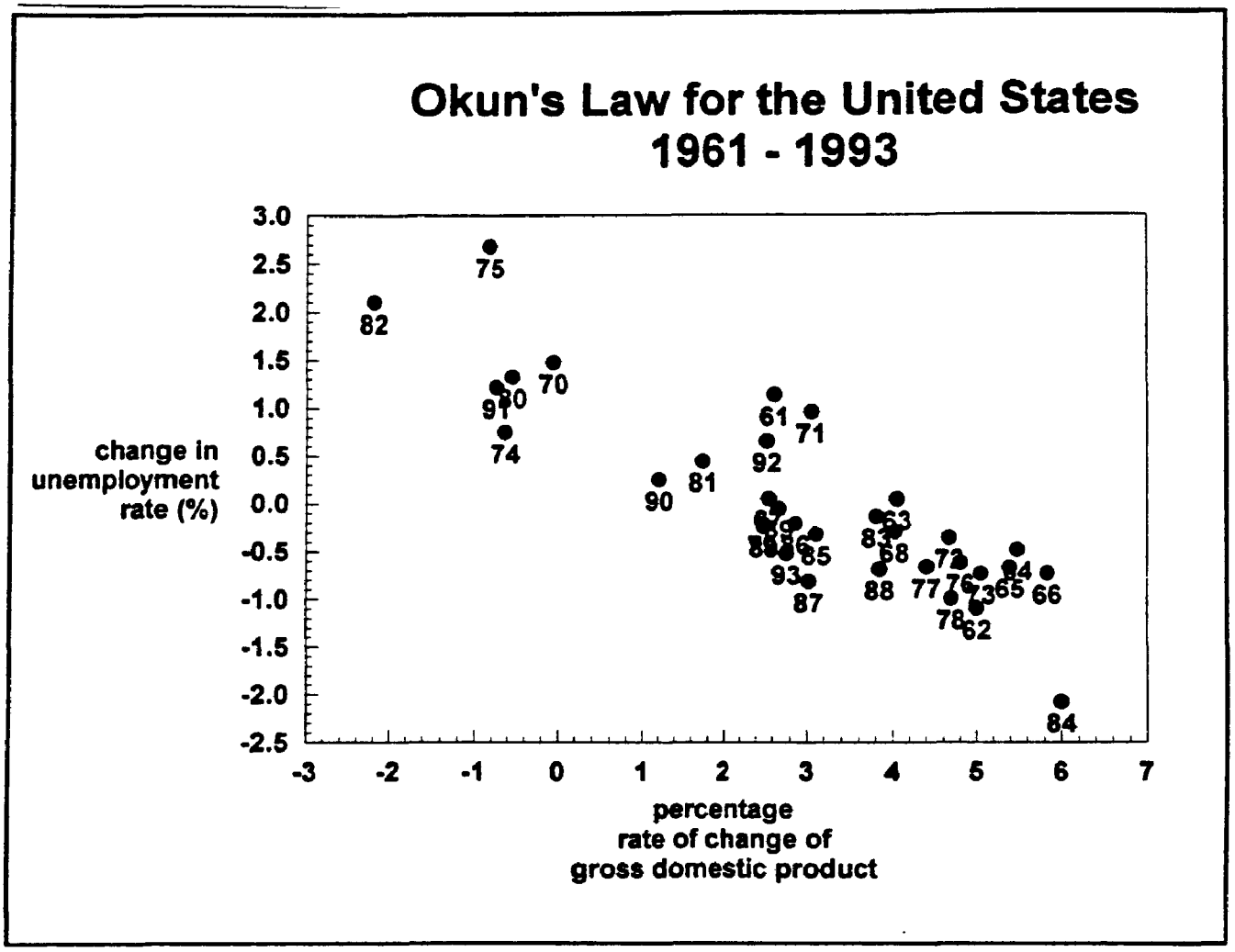
[4] These will to some extent not appropriately measure the effective unemployment rates. In the literature on labor markets it is a quite well established fact that these official data do not account for many types of unvoluntary unemployment as there are people that are discouraged to look for employment after a longer period of unemployment, unemployed are not accounted for in official unemployment statistics, because after a while they lose their entitlements to unemployment benefits or they vanish from the labor market because of early retirement schemes. Furthermore, national statistics in the different countries of the OECD area use different definitions and methods of calculating the unemployment rates, thus it is difficult to compare them without proper adjustments. Taking these problems as a permanent challenge which is still not solved satisfactorily we take here the OECD data merely as a currently best available source. It is not our intent in this study to present a more elaborate calculation of unemployment rates. Therefore we use them as they are. The obtained results will show that these data are at least sufficiently accurate to find strong empirical support for the existence of Okun's law.

$$\Delta\ ur_t := ur_t - ur_{t-1} \quad \wedge \quad g_{GDP,t} := \ln GDP_t - \ln GDP_{t-1} \tag{3}$$

In figure 10 we show the scattergram for the two variables for the United States covering the years from 1961 to 1993. One can see that there exists a fairly strong linear relation between both variables.

Fig. 10 - Scattergram of Okun's Law for the United States, 1961-1993.

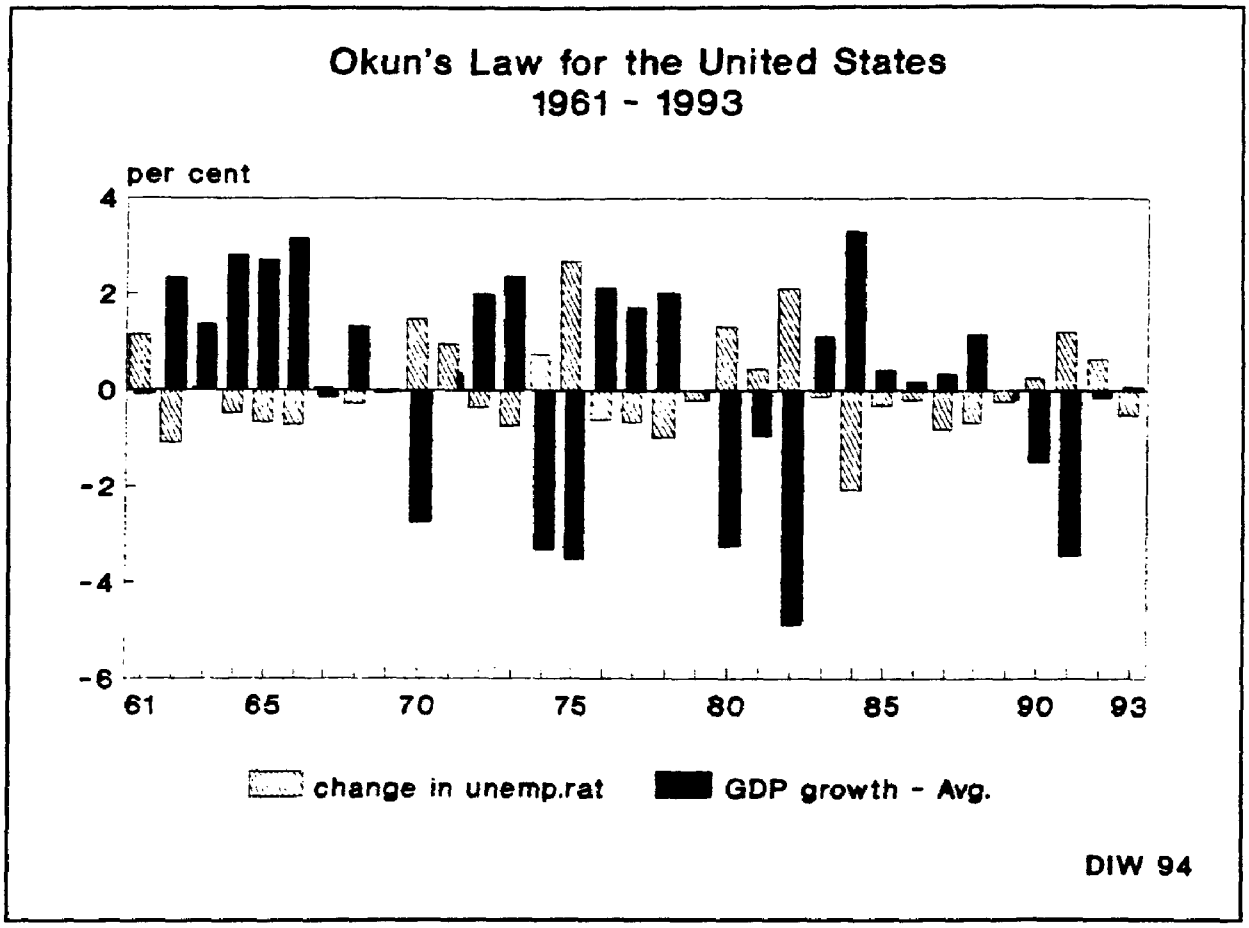


Therefore it seems appropriate to use a linear function to represent Okun's law.

$$\Delta\ ur_t \approx \alpha - \beta \cdot g_{GDP,t} \tag{4}$$

The two parameters α and β have the following economic interpretation. α is the autonomous change in the unemployment rate of a stagnant economy, i.e. $g_{GDP} = 0$. We expect therefore that $\alpha > 0$. A positive value for α may result from labor saving technological progress which makes employees redundant at a fixed rate α. The parameter β gives the elasticity of the unemployment rate with respect to GDP growth. If total GDP grows by 1 per cent the unemployment rate will decrease by β per cent. Output growth reduces the unemployment rate and vice versa with a constant elasticity if Okun's law is properly represented by (4).

Fig. 11 - Okun's Law for the United States, 1961-1993.



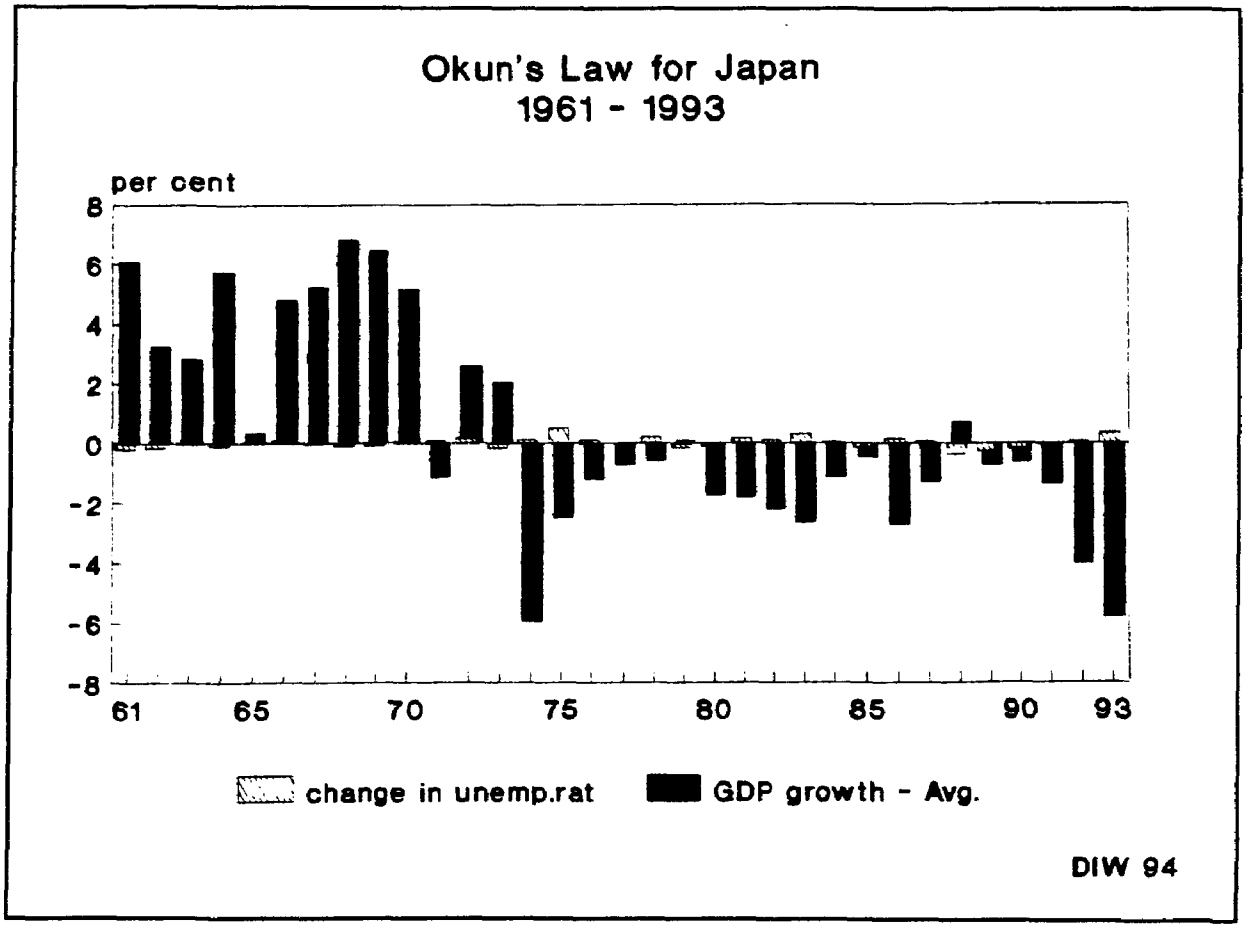
Using a scattergram to show the relation of Okun's law makes it difficult to analyze the time sequence of the empirical data. During a business cycle some regular pattern shows how unemployment and output growth rates fluctuate. To separate business cycle fluctuations from a long-term growth trend of an economy, we could rewrite the function by analyzing changes in unemployment rates depending on deviations from the long-term percentage growth rates of the GDP.

$$\Delta\, ur_t \approx \alpha - \beta \cdot (g_{GDP,t} - \overline{g_{GDP}}) \qquad (5)$$

As an estimate for the long-term GDP growth rate we use the values from table 1 which were obtained by logarithmic linear time trend regressions of the GDP data from 1960 to 1993. Plotting the U.S. data against the time axis we get the following graph (see fig. 11). One can observe that with very few exceptions - when deviations of GDP growth from the long-term trend are minor and the corresponding changes in unemployment rates are also close to zero - Okun's law describes the fluctuations in unemployment rates very well. When there is a significant deviation of GDP growth from its long-term trend, then unemployment rates always move in the opposite direction.

Looking at the graphs for other OECD countries one notices Japan as a striking exception (see fig. 12).

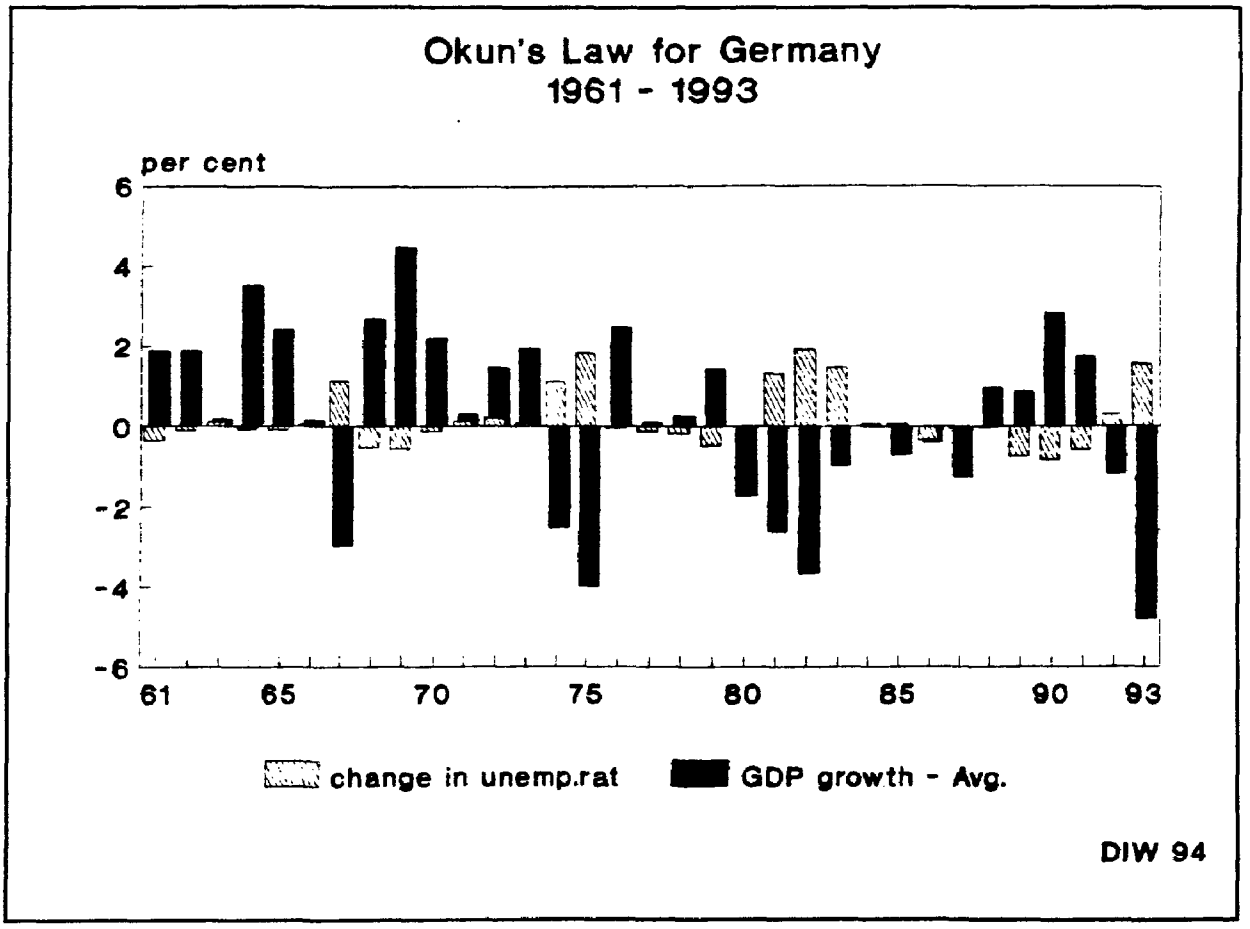
Fig. 12 - Okun's Law for Japan, 1961-1993.



Substantial fluctuations in the long-term GDP growth rate of Japan have had only a very minor impact on the level of unemployment rates. Up to the beginning of the first oil price shock in

1974 Japanese GDP growth rates exceeded her long-term rate calculated for the period 1961 to 1993. Since then they almost always fell below this level. This indicates that the Japanese economy experienced a significant reduction in its long-term growth. It would therefore be more appropriate to take a structural break of the long-term output growth rate for the Japanese economy into account. Summarizing the Japanese experiences over the past decades, it is obvious that Okun's law fails to contribute a significant part in explaining the extraordinary stable low rate of umemployment. A possible explanation for this outstanding performance might be that economic growth always was high enough to avoid any significant tension on the labor market. Okun's law might therefore be restricted by a ceiling of the GDP growth rate where unemployment rates are kept at persistent low levels. The difficult question still unanswered here is how to determine the ceiling by an economic theory.

Fig. 13 - Okun's Law for Germany (Western), 1961-1993.



The development of the variables of Okun's relation for Germany shows, likewise to the U.S., a quite similar pattern (see fig. 13). For Germany as well as the majoritiy of OECD countries

one can state that an increase in the unemployment rate takes place more rapidly than a decrease. If major recessions occur - especially when they last for more than one year - unemployment rates rise quickly. To reverse this process a longer time period of above the long-term average GDP growth rates are needed to reduce it by the same amount. This phenomenon has been named a hysteresis effect of unemployment changes. It implies an asymmetric reaction of unemployment rates around the long-term output growth path.

The respective figures for the remaining OECD countries are included in appendix C.

Summarizing these observations in our formulation of Okun's law in (5) we note that it should be modified by the following formulation:

$$\Delta\, ur_t \approx \begin{cases} 0 & \text{if} \quad \overline{g_{GDP}} \geq g^c_{GDP} \\ \alpha - \beta^+ \cdot (g_{GDP,t} - \overline{g_{GDP}}) & \text{if} \quad 0 \leq g_{GDP} \;\wedge\; \overline{g_{GDP}} < g^c_{GDP} \\ \alpha - \beta^- \cdot (g_{GDP,t} - \overline{g_{GDP}}) & \text{if} \quad g_{GDP} < 0 \;\wedge\; \overline{g_{GDP}} < g^c_{GDP} \end{cases} \tag{6}$$

If the long-run growth rate of output exceeds a certain ceiling - we may call it the long-term rate of full employment growth - the unemployment rate just stays at its permanent rate - we may call it the natural rate of unemployment - regardless if the actual output growth rate fluctuates around it. This is so because each fluctuation in output growth is perceived as transitory and therefore labor hoarding avoids labor shortages afterwards as long the long-term full employment growth rate is perceived to be sustainable. If the long-run growth rate of output is below this ceiling rate and the actual growth rate of GDP is positive the elasticity of unemployment rates is given by β^+. We expect β^+ to have an absolute value lower than β^- because an unexpected low output growth or even a shrinking output level has more severe effects for firms than a transitory unexpected high output growth. This might be due to a number of factors like scale economies, asymmetric adjustment costs, etc.

If the long-run rate of growth is below this ceiling and the actual rate of change for output is negative the elasticity of unemployment rates is given by β^-.

Note that the permanent rate of unemployment is assumed to be the same under all conditions for output growth. However, a gradual shift over time increasing or reducing the autonomous change in the unemployment rate might exist. To account for this possibility we include a time trend variable. If its parameter value is significantly different from zero it will indicate a gradual shift of the autonomous change in the unemployment rate to be increased/decreased. Possible factors might be a changing pattern of the social and institutional organization of the national labor market. The

flexibilty to hire and to dismiss workers might be slowly changing the autonomous rate of unemployment change. Taking this into account the final version of our model of Okun's law used in this study will then have the following form:

$$\Delta ur_t \approx \begin{cases} \gamma \cdot t & \text{if} \quad \overline{g_{GDP}} \geq g^c_{GDP} \\ \alpha - \beta^+ \cdot (g_{GDP,t} - \overline{g_{GDP}}) + \gamma \cdot t & \text{if} \quad 0 \leq g_{GDP} \wedge \overline{g_{GDP}} < g^c_{GDP} \\ \alpha - \beta^- \cdot (g_{GDP,t} - \overline{g_{GDP}}) + \gamma \cdot t & \text{if} \quad g_{GDP} < 0 \wedge \overline{g_{GDP}} < g^c_{GDP} \end{cases} \quad (7)$$

Testable hypothesis are:

- That only for economies with a long-term full employment growth rate (see e.g. Japan) Okun's law breaks down, i.e.

H_0: $\alpha = \beta^+ = \beta^- = 0$ against G: $\alpha \neq 0$ or $\beta^+ \neq 0$ or $\beta^- \neq 0$

- If a permanent natural rate of unemployment exists which is independent of a time trend.

H_0: $\gamma = 0$ against G: $\gamma \neq 0$

- If a hystheresis effect exists in changes in unemployment rates.

H_0: $\beta^+ \neq \beta^-$ against G: $\beta^+ = \beta^-$

- If unemployment rates increase more rapidly if actual output growth rates are below the long-term rate than vice versa given the same absolute deviation of the actual output growth rate.

H_0: $|\beta^+| < |\beta^-|$ against G: $|\beta^+| \geq |\beta^-|$

At first we tested a simple version of Okun's law to have a benchmark to see if the more elaborate formulation given by (7) significantly improves the results compared to those of the function given by (4). We just added a time trend to take gradual shifts of the autonomous change of unemployment rates into account, since as we will see, this effect is significant for a number of countries (see the following table 2).

Table 2

Parameter Estimates of Okun's Law using a SUR Estimator *)
Changes in the Unemployment Rate for all OECD Countries

(1961–1993)

i Country	alpha(i) (t-value)	beta(i) (t-value)	gamma(i) (t-value)	R^2 DW	rank **) by productivity elasticity
1 United States	1.8	−0.43	−0.03	0.83	21
	(11.4)	(−34.1)	(−4.0)	2.37	
2 Canada	2.1	−0.37	−0.03	0.66	24
	(8.3)	(−17.4)	(−2.9)	0.92	
3 Japan	0.4	−0.04	−0.01	0.32	6
	(4.5)	(−6.2)	(−2.4)	1.83	
4 Germany (Western)	1.3	−0.26	−0.02	0.73	19
	(7.7)	(−14.6)	(−2.3)	1.28	
5 France	2.0	−0.31	−0.03	0.62	16
	(11.9)	(−15.6)	(−5.5)	2.22	
6 United Kingdom	1.3	−0.37	−0.01	0.47	20
	(4.4)	(−19.0)	(−0.9)	1.16	
7 Italy	0.4	−0.06	−0.01	0.06	4
	(1.5)	(−1.8)	(−0.5)	1.51	
8 Belgium	1.2	−0.21	−0.01	0.39	9
	(3.7)	(−6.3)	(−1.0)	0.77	
9 Netherlands	1.3	−0.20	−0.03	0.34	12
	(4.4)	(−7.4)	(−2.0)	0.95	
10 Luxembourg					
11 Spain	3.5	−0.43	−0.06	0.57	22
	(9.0)	(−15.7)	(−3.6)	1.02	
12 Portugal	1.4	−0.13	−0.04	0.18	1
	(3.9)	(−5.6)	(−2.5)	1.08	
13 Greece	0.4	−0.10	0.01	0.26	2
	(1.2)	(−4.0)	(0.6)	1.24	
14 Ireland	0.9	−0.22	0.02	0.28	8
	(2.5)	(−8.3)	(1.2)	1.53	
15 Denmark	1.0	−0.22	−0.01	0.47	14
	(4.0)	(−10.0)	(−0.7)	1.47	
16 Norway	0.6	−0.14	0.00	0.38	15
	(3.3)	(−8.1)	(0.6)	1.80	
17 Sweden	0.8	−0.22	−0.01	0.52	11
	(4.3)	(−15.3)	(−0.7)	0.59	
18 Finland	1.7	−0.39	−0.00	0.69	17
	(4.8)	(−15.3)	(−0.2)	1.03	
19 Austria	0.4	−0.12	0.00	0.44	7
	(3.0)	(−7.2)	(0.5)	1.81	
20 Switzerland	0.0	−0.06	0.01	0.28	23
	(0.3)	(−8.4)	(1.9)	0.40	
21 Iceland	0.3	−0.06	0.01	0.40	10
	(1.5)	(−5.2)	(0.8)	1.86	
22 Turkey	−0.1	0.06	−0.01	0.09	3
	(−0.2)	(3.6)	(−0.6)	1.85	
23 Australia	1.8	−0.32	−0.02	0.60	18
	(6.7)	(−12.1)	(−1.5)	1.85	
24 New Zealand	0.1	−0.06	0.02	0.26	13
	(0.4)	(−4.9)	(1.7)	1.84	

*) *Regression model: d uer(i) = alpha(i) + beta(i) * d ln(GDP(i)) + gamma(i) * time.*
**) decending order.

Source: own computations.

Luxembourg was ommited because its time series for unemployment rates began after 1961. To estimate the model we added random variables, $u_{i,t}$ for each country. The index i runs from 1 to 24 denoting the respective country (see table 2).

$$\Delta\, ur_{i,t} = \alpha_i - \beta_i \cdot g^{i}_{GDP,t} + \gamma_i \cdot t + u_{i,t} \quad i = 1,\ldots,24 \tag{8}$$

To take present correlations between the different random variables of different countries into account and thus assure a more efficient estimate we pooled the equations to a seemingly unrelated regression (SUR) model of all countries and estimated it by Zellner's SUR estimator. The program system used for econometric estimations was TSP 4.2B.

Looking at the results in table 2 we notice that Spain has the highest autonomous rate of change in unemployment with 3.5 per cent. However, this high rate at the beginning of the 1960s was reduced over time by 0.06 per cent annually. The t-values of both parameter estimates are significantly different at a 5% significance level. Other countries with unusually high autonomous changes in unemployment rates are Canada (2.1%), France (2.0%), Australia and the United States both with (1.8%). For all four countries this high rate was reduced over time as the significant negative parameter values for γ show. Finland has a high persistent rate of autonomous unemployment changes with 1.7 per cent which remained unaltered over the estimation period. In a medium range position we find countries like Portugal (1,4%), Germany, the United Kingdom, the Netherlands (all with 1.3%), Belgium (1.2%) and Denmark (1.0%). Only Portugal and Germany show a signficant decline of their autonomous rates. Statistically significant autonomous rates are also found for Japan (0.4%), Ireland (0.9%), Norway (0.6%), Sweden (0.8%) and Austria (0.4%).

The country with the highest absolute values for output growth elasticities with respect to changes in unemployment rates are the United States and Spain with -0.43. Behind these countries follow Finland (-0.39), Canada (-0.37), the United Kingdom (-0.37), Australia (-0.32), France (-0.31) and Germany (-0.26). Japans elasticity is much lower with -0.04. However, even for this country the parameter estimate is statistically significant. One outlier of the whole country set is Turkey. Its coefficient estimates show inverse signs to those theoretically expected. The positive value for the parameter estimate of the output growth elasticity is even statistically significant. This result might be an outcome of quite untypical conditions there and influences of labor migration movements from and to Turkey in accordance to business cycle developments in other West European countries which

absorbs a substantial part of the Turkish labor force.[5]Our Study of Okun's law does not take into account labor migration movements between countries caused by differences in their growth development. Another reason for the strange results for the Turkish economy might be attributable to the fact that it is the only economy in our country set which is more or less a developing country. High output growth in the Turkish economy might therefore be a result of mechanization processes in the large agricultural sector and the creation of an industry with insufficient absorbtion capacity to employ dismissed workers from agriculture.

Summarizing the results from this first test of Okun's law we note that the results confirm that it is a useful relation to explain changes in unemployment rates. The variation of significant estimates of output growth elasticities between different countries during 1961 to 1993, however, is substantial, covering a range from -0.43 to -0.04. The importance of Okun's law to develop a strategy to reduce unemployment rates in different countries therefore varies dramatically from country to country. Accelerating output growth as an engine to create additional employment and by this lowering the unemployment rate has been proven to be an attractive strategy for those countries who show fairly high output growth elasticities. For other countries it might be more important to generate structural adjustments which might later on indirectly induce an increase of the long-term output growth elasticities. A pure growth strategy for the latter countries to lower unemployment rates sufficiently would need output growth rates which are not feasable to them.

Let us now turn to the analysis of the empirical results of the modified version of Okun's law. Before discussing them we have to explain briefly the way the empirical specification of the model and the statistical methods applied for estimating the model parameters and testing procedures applied for the previously outlined hypothesis.

Estimating the modified version of Okun's law given by equation (8) makes it necessary to add random variables, $u_{i,t}$, for each country with the usual assumptions concerning its expectation values and variances. Again we pooled the single equations for each country to a set of seeming unrelated regression equations and applied Zellner's SUR estimator. To take the conditions of (7) into account, we split our data set for the GDP growth rates with the help of properly defined dummy variables.

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[5] In Germany for example, about 2 million Turkish people live. They returned to Turkey in larger numbers when a recession occured in Germany and migration rates to Germany increased during the boom periods of the German economy.

$$d_{i,t}^{+} = \begin{cases} 0 & \text{if} \quad 0 \le g_{GDP,t}^{i} - \overline{g_{GDP,i}} \\ 1 & \text{if} \quad g_{GDP,t}^{i} - \overline{g_{GDP,i}} < 0 \end{cases} \tag{9}$$

$$d_{i,t}^{-} = \begin{cases} 1 & \text{if} \quad 0 \le g_{GDP,t}^{i} - \overline{g_{GDP,i}} \\ 0 & \text{if} \quad g_{GDP,t}^{i} - \overline{g_{GDP,i}} < 0 \end{cases} \tag{10}$$

Using these dummy variables we obtain the following equation system:

$$\Delta\, ur_{i,t} = \alpha_i - \beta_i^{+} \cdot d_{i,t}^{+} \cdot \left(g_{GDP,t}^{i} - \overline{g_{GDP,i}} \right) - \beta_i^{-} \cdot d_{i,t}^{-} \cdot \left(g_{GDP,t}^{i} - \overline{g_{GDP,i}} \right) + \gamma_i \cdot t + u_{i,t} \tag{11}$$

$$i = 1,\ldots,24$$

Note that the α_i is not the same as in equation (8). Because we introduce the deviation of annual ouput growth rates from their respective long-term rate as an explanatory variable both α_i's are different. Therefore the results for α_i of both estimations (see table 2 and 3) are not comparable.

To test the different hypothesis concerning the break down of Okun's law, the time dependent shifting of the autonomous change in unemployment rates, and the asymmetric behaviour of unemployment rate changes with respect to deviations of GDP growth from its long-term trend, we used t-statistics for tests concerning just a single parameter and Wald's test for combined hypothesis concerning more than a single parameter. As significance levels for tests we applied 5%.

$$\Delta\, ur_{i,t} = \alpha_i - \beta_i^{+} \cdot d_{i,t}^{+} \cdot \left(g_{GDP,t}^{i} - \overline{g_{GDP,i}} \right) - \beta_i^{-} \cdot d_{i,t}^{-} \cdot \left(g_{GDP,t}^{i} - \overline{g_{GDP,i}} \right) + \gamma_i \cdot t + u_{i,t} \tag{12}$$

$$i = 1,\ldots,24$$

The results obtained from estimating parameters of the equation system are summarized in table 3.

Table 3

Parameter Estimates of the Modified Okun's Law using a SUR Estimator *)
Changes in the Unemployment Rate for all OECD Countries

(1961–1993)

Country	alpha(i) (t-value)	beta_+(i) (t-value)	beta_–(i) (t-value)	gamma(i) (t-value)	R^2 DW
1 United States	0.7	−0.43	−0.42	−0.03	0.83
	(4.0)	(−12.2)	(−15.1)	(−3.9)	2.35
2 Canada	0.4	−0.24	−0.43	−0.03	0.67
	(2.0)	(−5.2)	(−16.2)	(−2.7)	0.86
3 Japan	0.1	−0.03	−0.06	−0.01	0.39
	(2.3)	(−3.9)	(−6.7)	(−2.6)	1.98
4 Germany (Western)	0.2	−0.09	−0.43	−0.01	0.79
	(1.4)	(−2.9)	(−16.1)	(−2.3)	1.19
5 France	0.8	−0.23	−0.30	−0.03	0.62
	(5.5)	(−6.2)	(−9.7)	(−4.2)	2.11
6 United Kingdom	0.4	−0.28	−0.44	−0.02	0.48
	(1.5)	(−6.6)	(−11.5)	(−1.1)	1.08
7 Italy	0.6	−0.20	0.07	−0.01	0.11
	(2.3)	(−3.1)	(−1.2)	(−1.0)	1.77
8 Belgium	0.1	0.00	−0.37	−0.01	0.46
	(0.4)	(−0.0)	(−6.5)	(−0.7)	0.83
9 Netherlands	0.2	0.02	−0.43	−0.02	0.48
	(0.6)	(0.3)	(−8.2)	(−1.4)	0.98
10 Luxembourg					
11 Spain	0.7	−0.12	−0.87	−0.04	0.78
	(2.7)	(−3.3)	(−16.7)	(−3.4)	1.97
12 Portugal	0.7	−0.07	−0.13	−0.04	0.19
	(1.9)	(−1.2)	(−2.7)	(−2.2)	1.04
13 Greece	−0.2	−0.05	−0.10	0.02	0.27
	(−0.7)	(−0.9)	(−2.3)	(1.1)	1.09
14 Ireland	0.1	−0.33	−0.18	0.02	0.28
	(0.4)	(−6.6)	(−3.2)	(1.2)	1.56
15 Denmark	0.1	−0.09	−0.38	−0.02	0.52
	(0.4)	(−2.1)	(−7.2)	(−0.2)	1.41
16 Norway	−0.1	−0.04	−0.19	0.00	0.39
	(−0.4)	(−1.7)	(−8.4)	(0.5)	1.91
17 Sweden	−0.0	−0.04	−0.38	0.00	0.70
	(−0.3)	(−1.2)	(−15.8)	(−0.3)	1.15
18 Finland	0.1	−0.11	−0.58	−0.01	0.77
	(0.2)	(−2.4)	(−17.2)	(−0.8)	1.18
19 Austria	0.0	−0.10	−0.11	0.00	0.44
	(0.1)	(−2.6)	(−3.5)	(0.7)	1.79
20 Switzerland	−0.3	0.03	−0.08	0.02	0.33
	(−2.2)	(1.3)	(−5.0)	(2.9)	0.49
21 Iceland	−0.1	−0.05	−0.07	0.01	0.41
	(−0.3)	(−1.5)	(−3.6)	(0.8)	1.91
22 Turkey	0.6	−0.09	0.22	−0.01	0.24
	(2.9)	(−2.1)	(5.7)	(−0.6)	2.04
23 Australia	−0.1	−0.11	−0.46	−0.01	0.64
	(−2.1)	(−2.1)	(−11.4)	(−0.8)	2.00
24 New Zealand	0.0	−0.09	−0.08	0.02	0.26
	(0.1)	(−3.2)	(−2.9)	(1.5)	1.86

*) Regression model: d uer(i) = alpha(i) + beta_+(i) * d_+(i) * d ln(GDP(i)) + beta_–(i) * d_–(i) * d ln(GDP(i)) + gamma(i) * time.

**) decending order.

Source: own computations.

One notices that in a large number of countries we obtain results supporting the hypothesis of an asymmetric reaction of changes in unemployment rates. With few exceptions the coefficient, β^-, gets the higher t-values and its absolute value is larger than that of β^+. Outstanding high values are found for Spain (-0.87) and Finland (-0.58). Countries with high values for β^- are also the United States (-0.42), Canada (-0.43), Germany (-0.43), the United Kingdom (0.44), the Netherlands (0.43), and Australia (-0.46). Countries which have a very low output elasticity are Japan (-0.06), Switzerland (-0.08), Iceland (-0.07), and New Zealand (-0.08). Only for Italy and Turkey do we obtain strange results with 0.0 for Italy and even 0.22 for Turkey. The rest of the countries have elasticities in the medium range of -0.38 to -0.10.

The estimates for β^+ are on average much lower. Only for the United States and Ireland higher absolute values for β^+ with respect to β^- occurred with 0.43 and 0.33. The most striking feature of the estimates for β^- is that for a number of countries like Belgium, the Netherlands, Portugal, Greece, Norway, Sweden, Finland, Switzerland and Iceland they are not significantly different from zero. Output growth above the long-term trend of these countries seem to have no significant impact to decrease the unemployment rate.

Figure 14 visualizes the asymmetric reaction of unemployment rates with respect to deviations from long-term output growth.[6]

Results for the coefficients of determination, R^2, and Durbin-Watson statistics for testing for first order autocorrelation, DW, show that the ability of Okun's law to explain the actual variations in unemployment rates in the OECD countries differs significantly. The best result found for a country to explain variations in changes of unemployment rates is that for the United States (R^2 = 0.83). The worst result to fit these data is obtained for Italy (R^2 = 0.11). In a couple of countries like Canada, France and Italy positive autocorrelation is still present in the residuals. Others easily pass the Durbin-Watson test like the United States, Japan or the United Kingdom.

The introduction of an asymmetric reaction of unemployment rates to deviations from long-term output growth improves sometimes the equation fit signficantly. For Sweden from R^2 = 0.52 for the symmetric model to R^2 = 0.70 - but in many other cases the effect is close to zero or very moderate.

Finally we tested the hypothesis if Okun's law breaks for some countries down because the long-term growth rate of a country exceeds her full employment rate. As we can see (cf. table 4), the hypothesis is rejected for all OECD countries, even for Japan, which seemed to be a candidate to support the hypothesis at the first visual inspection of the data.

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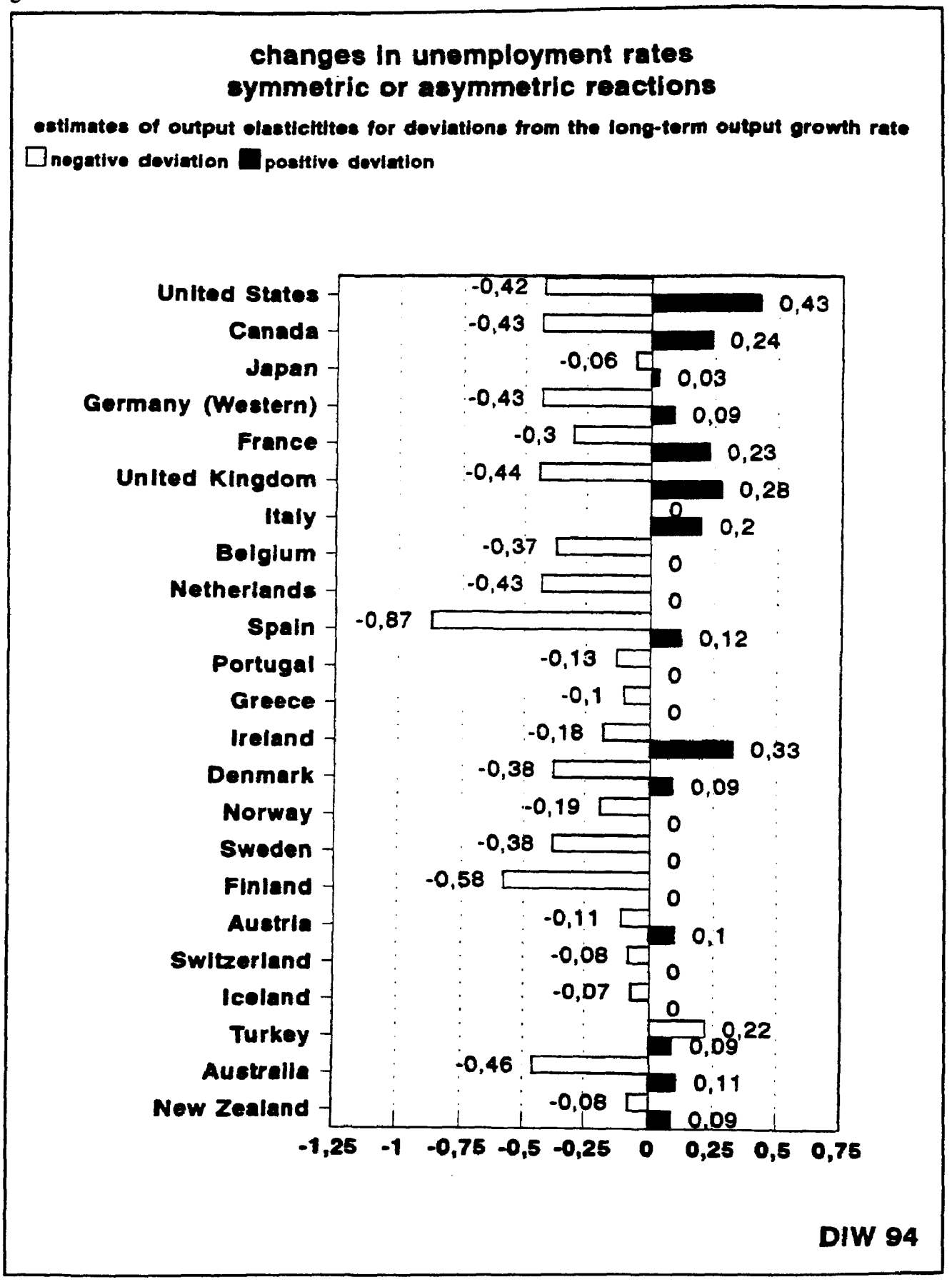
[6] Note that the graph uses a positive sign for the elasticities which relate to positive deviations from the long-term output growth trend.

Fig. 14 - Asymmetric reaction of unemployment rates to deviation from the long-term output growth rate.



Testing for time dependent shifts in autonomous changes in unemployment rates gives mixed results for the OECD countries. Some countries like the United States, Canada, Japan, Germany or France support the hypothesis. Other countries, like the United Kingdom, Italy or Belgium, reject it.

Similarly the test for symmetric or asymmetric behavior show mixed results. For the G7 countries only the United States and France reject the hypothesis of asymmetric reactions. The other G7 countries also pass the test that elasticities for negative deviations have an absolute value larger than that for positive deviations. The latter hypothesis only is rejected for Turkey.

Our results give substantial evidence for asymmetric behavior for a great number of OECD countries. However, the unsolved question is: Why do some countries show symmetric and some asymmetric behavior?

Table 4

Testing*) for Asymmetric Adjustments of Unemployment Rates based on Okun's Law, for Time Dependent Shifts in Autonomous Changes of Unemployment Rates and for Economies where Okun's Law breaks down covering all Countries of the OECD Area

(1960–1993)

Country	Okun's law breaks down	Significant time dependent shifts	Significant asymmetric adjustments	$\lvert \beta(+) \rvert < \lvert \beta(-) \rvert$ is statistically significant
1 United States	rejected	accepted	rejected	–
2 Canada	rejected	accepted	accepted	accepted
3 Japan	rejected	accepted	accepted	accepted
4 Germany (Western)	rejected	accepted	accepted	accepted
5 France	rejected	accepted	rejected	–
6 United Kingdom	rejected	rejected	accepted	accepted
7 Italy	rejected	rejected	accepted	rejected
8 Belgium	rejected	rejected	accepted	accepted
9 Netherlands	rejected	rejected	accepted	accepted
10 Luxembourg				
11 Spain	rejected	accepted	accepted	accepted
12 Portugal	rejected	accepted	rejected	–
13 Greece	rejected	rejected	rejected	–
14 Ireland	rejected	rejected	rejected	–
15 Denmark	rejected	rejected	accepted	accepted
16 Norway	rejected	rejected	accepted	accepted
17 Sweden	rejected	rejected	accepted	accepted
18 Finland	rejected	rejected	accepted	accepted
19 Austria	rejected	accepted	rejected	–
20 Switzerland	rejected	accepted	accepted	accepted
21 Iceland	rejected	rejected	rejected	–
22 Turkey	rejected	rejected	accepted	rejected
23 Australia	rejected	rejected	accepted	accepted
24 New Zealand	rejected	rejected	rejected	–

*) all tests use a 5% significance level.

Source: own computations.

Assessing Verdoorn's Law

Verdoorn's law states that growth rates of labor productivity, g_{lp}, are functionally related to growth rates of output, g_{GDP}.

$$g_{lp} = h(g_{GDP}) \tag{13}$$

with

$$g_{lp} = \frac{1}{lp} \cdot \frac{d\ lp}{d\ t} \quad \wedge \quad g_{GDP} = \frac{1}{GDP} \cdot \frac{d\ GDP}{d\ t} \tag{14}$$

for continous and with

$$g_{lp_t} = \ln lp_t - \ln lp_{t-1} \quad \wedge \quad g_{GDP_t} = \ln GDP_t - \ln GDP_{t-1} \tag{15}$$

for discrete variables.

Labor productivity, lp_t, will be measured as before by GDP_t per employee, EMP_t, i.e.[7]

$$lp_t = \frac{GDP_t}{EMP_t} \tag{16}$$

Between the growth rates of output and labor productivity the following identity exists:

$$g_{lp_t} = g_{GDP_t} - g_{EMP_t} \tag{17}$$

Therefore it follows from (13) and (17) that if (13) holds, it implies an inverse functional relation between output growth and employment growth. We will denote this relation as the inverse Verdoorn's law.

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[7] Other versions of Verdoorn's law are reasonable as well which are based on different definitions of productivity like labor productivity per working hour or on total factor productivity.

$$g_{EMP_t} = z(g_{GDP_t}) = g_{GDP_t} - f(g_{GDP_t}) \tag{18}$$

Relation (18) states that employment growth is also related to output growth.

For Verdoorn's as well as for the inverse Verdoorn's law we expect that its first derivative with respect to the output growth rate will always be positive.

$$\frac{d\, g_{lp_t}}{d\, g_{GDP_t}} > 0 \quad \wedge \quad \frac{d\, g_{EMP_t}}{d\, g_{GDP_t}} > 0 \tag{19}$$

As well we expect that

$$g_{lp_t} = h(0) > 0 \quad for \quad g_{GDP_t} = 0 \tag{20}$$

and

$$g_{EMP_t} = z(0) < 0 \quad for \quad g_{GDP_t} = 0 \quad . \tag{21}$$

Drawing a scattergram for the variables of Verdoorn's law with the data for the United States we will notice that a linear approximation of this relationship will fit the data quite well. The function then has the following form:

$$g_{lp_t} = \kappa + \lambda \cdot g_{GDP_t} \tag{22}$$

The parameter κ can be interpreted as the autonomous growth rate of labor productivity while λ measures the elasticity of output growth induced labor productivity growth. Combining (18) and (22) the relation given by (23) states that $-\kappa$ measures the autonomous labor shake out which might be due to labor saving technological progress while $(1 - \lambda)$ determines the output growth induced increase in the employment growth rate.

$$g_{EMP_t} = -\kappa + (1 - \lambda) \cdot g_{GDP_t} \tag{23}$$

To establish the conditions (19) to (21) the parameters are restricted to:

$$0 < \lambda < 1 \quad \wedge \quad \kappa > 0 \tag{24}$$

To estimate the parameters with the data for all countries of the OECD area, we will similarly allow, as in the case of Okun's law, that the autonomous growth rate of labour productivity might shift over time due to factors like structural change causing a slowdown in the overall rate of technological progress measured at the aggregate level of a national economy. The well known three sector hypothesis of Fourastié and Clark for example would explain a slowdown of autonomous productivity growth at an aggregate level of an economy. Of course there might be other causes which are taken into account by the time trend variable as a catch-all variable.[8] Equation (22) and (23) will change to the following versions:

$$g_{lp_t} = \kappa + \lambda \cdot g_{GDP_t} + \delta \cdot t \tag{25}$$

and

$$g_{EMP_t} = -\kappa + (1 - \lambda) \cdot g_{GDP_t} - \delta \cdot t \tag{26}$$

Pooling the equations (25) to an equation system of seemingly unrelated equations and adding the usual stochastic terms, we estimated the parameters of Verdoorn's law for all OECD countries. The results are summarized in table 4. Since the inverse of Verdoorn's law can be also used to determine the model parameters, we estimated the equation system for the inverse of Verdoorn's law as well (see table 5). As one already knows from theory, the parameter estimates are the same in their absolute values. Even the Durbin-Watson statistics are the same.

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[8] We refrain from outlining the close connections of Verdoorn's law to more recent work on productivity growth accounting here. However, one should keep in mind that Verdoorn's law is linked to economies of scale, especially non-constant returns to scale which attracted so much attention recently in the new growth theories of Romer (1986), Grossman, Helpman (1991) and others.

Table 5

Parameter Estimates of Verdoorn's Law using a SUR Estimator *) for all OECD countries

(1961–1993)

I Country	kappa(i) (t-value)	lambda(i) (t-value)	delta(i) (t-value)	R^2 DW	rank **) by productivity elasticity
1 United States	0.001	0.45	−0.0002	0.62	21
	(0.4)	(14.8)	(−1.2)	1.29	
2 Canada	0.004	0.35	−0.0001	0.48	24
	(1.1)	(15.9)	(−0.6)	1.16	
3 Japan	0.005	0.84	−0.0004	0.97	6
	(1.6)	(33.3)	(−3.5)	1.93	
4 Germany (Western)	0.024	0.50	−0.0007	0.77	19
	(7.5)	(24.0)	(−4.6)	1.28	
5 France	0.018	0.58	−0.0004	0.92	16
	(7.6)	(20.7)	(−4.6)	1.68	
6 United Kingdom	0.013	0.47	−0.0001	0.44	20
	(2.8)	(10.8)	(−0.5)	1.31	
7 Italy	0.009	0.87	−0.0003	0.80	4
	(1.8)	(19.1)	(−1.5)	1.37	
8 Belgium	0.010	0.69	−0.0002	0.83	9
	(3.4)	(23.6)	(−1.3)	1.56	
9 Netherlands	0.013	0.64	−0.0006	0.75	12
	(3.0)	(18.0)	(−2.8)	0.85	
10 Luxembourg	0.005	0.85	−0.0008	0.76	5
	(0.9)	(21.1)	(−2.8)	1.07	
11 Spain	0.040	0.44	−0.0001	0.71	22
	(6.5)	(9.3)	(−3.7)	0.92	
12 Portugal	−0.015	1.15	0.0001	0.73	1
	(−1.8)	(25.7)	(0.2)	1.60	
13 Greece	0.008	0.98	−0.0006	0.92	2
	(1.6)	(32.3)	(−2.5)	1.96	
14 Ireland	0.011	0.71	−0.0001	0.66	8
	(2.5)	(21.5)	(−0.3)	1.44	
15 Denmark	0.006	0.63	−0.0001	0.76	14
	(1.7)	(26.0)	(−0.5)	1.56	
16 Norway	0.006	0.62	−0.0001	0.48	15
	(1.4)	(14.6)	(−0.3)	1.11	
17 Sweden	0.004	0.65	0.0001	0.40	11
	(0.6)	(10.2)	(0.4)	0.79	
18 Finland	0.011	0.55	0.0002	0.45	17
	(1.6)	(9.8)	(0.5)	1.01	
19 Austria	0.018	0.80	−0.0001	0.86	7
	(5.4)	(26.8)	(−5.2)	1.37	
20 Switzerland	0.012	0.38	−0.0002	0.57	23
	(3.0)	(9.9)	(−1.2)	1.13	
21 Iceland	−0.001	0.68	0.0001	0.63	10
	(−0.3)	(12.4)	(0.3)	2.30	
22 Turkey	−0.005	0.92	−0.0002	0.93	3
	(−1.5)	(36.4)	(−1.8)	1.31	
23 Australia	−0.003	0.54	−0.0001	0.55	18
	(−0.1)	(11.2)	(−0.3)	1.50	
24 New Zealand	0.013	0.64	−0.0001	0.75	13
	(3.0)	(18.0)	(−2.8)	0.85	

*) Regression model: d ln(lp(i)) = kappa(i) + lambda(i) * d ln(GDP(i)) + delta(i) * time.
**) decending order.

Source: own computations.

Table 6

Parameter Estimates of Inverse Verdoorn's Law using a SUR Estimator *) for all OECD countries

(1961–1993)

Country	–kappa(i) (t–value)	(1–lambda(i)) (t–value)	delta(i) (t–value)	R^2 DW	rank **) by employment elasticity
1 United States	–0.001	0.55	0.0002	0.58	4
	(–0.4)	(18.0)	(1.2)	1.29	
2 Canada	–0.004	0.65	0.0001	0.69	1
	(–1.1)	(29.6)	(0.6)	1.16	
3 Japan	–0.005	0.16	0.0004	0.30	19
	(–1.6)	(6.4)	(3.5)	1.93	
4 Germany (Western)	–0.024	0.50	0.0007	0.64	6
	(–7.5)	(23.6)	(4.6)	1.28	
5 France	–0.018	0.42	0.0004	0.63	9
	(–7.6)	(14.8)	(4.6)	1.68	
6 United Kingdom	–0.013	0.53	0.0001	0.44	5
	(–2.8)	(12.4)	(0.5)	1.31	
7 Italy	–0.009	0.13	0.0003	0.09	21
	(–1.8)	(2.4)	(1.5)	1.37	
8 Belgium	–0.010	0.31	0.0002	0.49	16
	(–3.4)	(10.5)	(1.3)	1.56	
9 Netherlands	–0.013	0.36	0.0006	0.29	13
	(–3.0)	(10.1)	(2.8)	0.85	
10 Luxembourg	–0.005	0.15	0.0008	0.21	20
	(–0.9)	(3.8)	(2.8)	1.07	
11 Spain	–0.040	0.56	0.0001	0.51	3
	(–6.5)	(12.0)	(3.7)	0.92	
12 Portugal	0.015	–0.15	–0.0001	0.04	24
	(1.8)	(–3.3)	(–0.2)	1.60	
13 Greece	–0.008	0.02	0.0006	0.15	23
	(–1.6)	(0.6)	(2.5)	1.96	
14 Ireland	–0.011	0.29	0.0001	0.23	17
	(–2.5)	(9.0)	(0.3)	1.44	
15 Denmark	–0.006	0.37	0.0001	0.46	11
	(–1.7)	(15.3)	(0.5)	1.59	
16 Norway	–0.006	0.38	0.0001	0.28	10
	(–1.4)	(9.0)	(0.3)	1.11	
17 Sweden	–0.004	0.35	–0.0001	0.33	14
	(–0.6)	(5.5)	(–0.4)	0.79	
18 Finland	–0.011	0.45	–0.0002	0.53	8
	(–1.6)	(8.0)	(–0.5)	1.01	
19 Austria	–0.018	0.20	0.0001	0.41	18
	(–5.4)	(6.7)	(5.2)	1.37	
20 Switzerland	–0.012	0.62	0.0002	0.70	2
	(–3.0)	(16.0)	(1.2)	1.26	
21 Iceland	0.001	0.32	–0.0001	0.32	15
	(0.3)	(5.7)	(–0.3)	2.31	
22 Turkey	0.005	0.08	0.0002	0.12	22
	(1.5)	(3.0)	(1.8)	1.31	
23 Australia	0.003	0.46	0.0001	0.44	7
	(0.1)	(9.5)	(0.3)	1.50	
24 New Zealand	–0.013	0.36	0.0001	0.29	12
	(3.0)	(8.7)	(–2.8)	0.85	

*) Regression model: d ln(emp(i)) = –kappa(i) + (1–lambda(i)) * d ln(GDP(i)) + delta(i) * time .
**) decending order.

Source: own computations.

On the other hand the t-statistics for output elasticities of labor productivity and of employment growth differ as well as the coefficients of determination. Assessing the goodness of fit for the data will therefore sometimes differ significantly because some economies are more productivity driven than others which are employment driven. A good example for a productivity driven economy is Japan. The R^2 statistic of Japan for Verdoorn's law is 0.97 while the value for the inverse of Verdoorn's law is just 0.3. As an example for an employment driven economy one might look at Canada whose R^2 statistic for Verdoorn's law is 0.48 and for the inverse of Verdoorn's law 0.69. Only Switzerland could also be classified as employment driven. The coefficients of determination for the United Kingdom are the only case where both are equal. The remaining economies are productivity driven.

Comparing the results for the autonomous labor productivity growth rate, one notices that even if it is sometimes statistically significant from zero, it is so tiny that it hardly matters in the determination of labor productivity growth. The same observation holds for the time shift parameter.

Therefore the central relation is the output induced labor productivity growth. Without output growth, labor productivity would not grow. Of course the unexplained variance in the residuals leave further options to introduce other factors in order to obtain a more complete explanation of labor productivity growth by reducing the residual variances. However, the degree of goodness of fit already accomplished by the single output growth variable is striking for many OECD countries.

The estimates of nearly all output elasticities - the only exception is the output elasticity of employment for Greece - are statistically significant at a 5% level.

The higherst output elasticity for labor productivity growth is obtained for Portugal with 1.15. This is the only result were the parameter restrictions given by (24) are violated. Behind Portugal follow Greece with 0.98 and Turkey with 0.92 output elasticities for labor productivity growth. How may one explain these results? Probably it shows that these fairly backward economies are in a structural transition process where employees from the agricultural sector are dismissed by mechanization and the ability to absorb these workers in other sectors like industry or services is insufficient. That this might be the causation process already became visible when we studied the outcomes of the respective parameter estimates of Okun's law in the previous section. The growth process is completely productivity driven and at the same time employment growth is very moderate, while unemployment rates went up.

After this group of less developed economies follow Luxembourg with 0.85, Japan and Italy with 0.84, Austria with 0.80, and Ireland with 0.71. This group of countries is far more heterogenous than the previous one. One reason for high output elasticities of labor productivity growth might therefore be attributable to the situation on the different national labor markets. Economies like Japan

or Luxembourg have experienced no significant labor market problems during the past decades. Therefore it seems natural for them that if the labor market is more or less cleared, output growth can only have mainly an impact on labor productivity. It is more difficult to explain why countries like Italy which have a substantial unemployment problem show such high output elasticities for labor productivity growth. One reason might be a very unequal regional development where the Northern parts of Italy have low unemployment rates and the Southern parts especially experienced very high unemployment. If the internal labor mobility in Italy is insufficient, this leads to structural unemployment because of unequal regional economic developments. To verify such a hypothesis however, one would need more disaggregated data on the basis of regions. Most of the remaining countries have output elasticities of labor productivity growth which fall into the range of 0.45 to 0.70 - for example France with 0.58, Germany with 0.5, the United Kingdom with 0.47, the Untied States with 0.45. Very low elasticities are found - as was already mentioned above - for Canada and Switzerland.

Summarizing the findings of this test of Verdoorn's law one may conclude that it proves to be a useful relation to explain labor productivity or employment growth rates for most countries of the OECD area. Extremely high output elasticities of labor productivity growth might have quite different causes, as the heterogenous mix of very different OECD countries indicate. Two major reasons for economies to be extremely labor productivity oriented is on the one hand that they are lagging behind in economic development (cases like Portugal, Turkey or Greece), or on the other hand it might be due to an outcome of labor shortage or regional disparities in labor market conditions (an example for the first case might be Japan and for the latter case might be Italy). Verdoorn's law applied without explicit reference to other conditions characterizing the particular economy cannot identify the origins of this high output elastcities. Only a more detailed analysis which is not the aim of the present study would help to obtain further insights.

An interesting extension of the previous version of Verdoorn's law is to take into account the catch-up hypothesis (for an extensive discussion of this topic, see Abramovitz, 1986). Neoclassical growth theories predict that productivity growth rates of less developed economies are significantly higher than those of advanced economies because they have the comparative advantage that they have the potential to introduce best practice technologies at once for a greater fraction or a whole industry because the previously existing capital stock is very small or nonexistent. The implication of the catch-up hypothesis is therefore that as the productivity gap to the leading economy is reduced the productivity growth rates will fall to the level of the leading economy as well. Therefore finally a convergence process will lead to an equalization of productivity levels as well as in productivity growth rates. This view was challenged recently by authors like Lucas (1988), Krugman (1991a,

1991b, 1991c), Barro and Sala-I-Martin (1992), David (1985) or Arthur (1989). They argue that under certain conditions - i.e. increasing returns to scale, a historical lock-in, positive externalities of human capital, public infrastructure, production-distribution-research networks - a general convergence in productivity growth rates and levels might not occur. Leading economies might further forge ahead, leaders might be overtaken, and lagging economies might fell back even further. The relevance of this hypothesis came to the fore because economists began to look for explanations as to why a large number of developing countries in the post WWII era failed to close the huge gap between their productivity and that of the industrialized countries. Furthermore, the fear that the Japanese economy might overtake the U.S. economy or the other leading Western European economies started research to explain why a leading economy might fall behind and lagging economies might forge ahead of the leader.

Our contribution to this debate will be quite simple. We will test the hypothesis if there is a significant relationship between the labor productivity growth rates of the lagging economies and their respective productivity gap to the leading U.S. economy. Taking the convergence hypothesis for granted one would expect that a closing of the productivity gap to the U.S. should reduce the growth rates of labor productivity. The corresponding parameter of the variable measuring the relative difference in the productivity level of the respective economy to the leading economy should have a negative sign to indicate that productivity growth rates shrink when the existing gap is reduced. Therefore the catch-up version of Verdoorn's law would lead to the following specification of our equation:

$$g_{lp_t} = \kappa + \lambda \cdot g_{GDP_t} + \delta \cdot t + \theta \cdot lp_{gap_t} \qquad (27)$$

As we have seen in the first section of this article the United States has been and still is the leading economy whose productivity level (see e.g. fig. 3) is superior to that of all other OECD countries.

If the parameter estimate of θ which we obtain is non-negative, one can conclude that the convergence hypothesis is inconsistent with the data and has to be rejected. The parameters of the catch-up version of Verdoorn's law were estimated by a SUR estimation as the previous one. In table 7 we summarize the results of our estimation of this modified version of Verdoorn's law.

Looking at the sign of our parameter estimates for θ one notices that for ten countries - Germany, France, Italy, Luxembourg, Greece, Denmark, Sweden, Finland, Austria, and Turkey - we obtain statistically significant negative signs so that for these countries the convergence hypothesis cannot be rejected. For ten other countries - Canada, the United Kingdom, Spain, Portugal, Ireland,

Table 7

Parameter Estimates of a Modified Verdoorns Law using a SUR Estimator *)
for all OECD countries

(1961–1993)

i Country	kappa(i) (t–value)	lambda(i) (t–value)	delta(i) (t–value)	theta(i) (t–value)	R^2 DW
1 United States	−0.002	0.52	−0.0002		0.62
	(−0.4)	(13.6)	(−0.9)		1.26
2 Canada	−0.026	0.36	−0.0003	0.00042	0.47
	(−1.2)	(13.2)	(−1.3)	(1.4)	1.12
3 Japan	−0.007	0.83	−0.0014	0.00057	0.97
	(−1.1)	(34.9)	(−3.3)	(2.4)	1.98
4 Germany (Western)	0.053	0.52	0.0001	−0.00061	0.78
	(3.6)	(22.5)	(0.2)	(−2.1)	1.27
5 France	0.042	0.56	0.0003	−0.00047	0.93
	(4.1)	(18.7)	(0.8)	(−2.3)	1.92
6 United Kingdom	0.077	0.53	0.0011	−0.00142	0.46
	(2.1)	(9.6)	(1.5)	(−1.8)	1.33
7 Italy	0.071	0.89	0.0020	−0.00140	0.84
	(3.9)	(19.5)	(2.8)	(−3.4)	1.71
8 Belgium	−0.024	0.69	−0.0013	0.00074	0.84
	(−2.3)	(26.4)	(−3.5)	(3.3)	1.53
9 Netherlands	−0.032	0.69	−0.0014	0.00084	0.77
	(−2.6)	(19.4)	(−4.7)	(3.8)	0.87
10 Luxembourg	0.093	0.92	0.0002	−0.00143	0.77
	(2.1)	(16.8)	(0.4)	(−2.1)	0.99
11 Spain	0.012	0.43	−0.0025	0.00093	0.71
	(0.6)	(8.2)	(−2.4)	(1.5)	0.90
12 Portugal	0.009	1.19	0.0010	−0.00129	0.74
	(0.5)	(20.2)	(1.5)	(−1.6)	1.71
13 Greece	0.033	0.98	0.0005	−0.00124	0.93
	(3.8)	(27.3)	(1.2)	(−3.3)	2.54
14 Ireland	0.001	0.69	−0.0009	0.00049	0.66
	(0.1)	(20.6)	(−1.3)	(1.3)	1.42
15 Denmark	0.073	0.68	0.0010	−0.00141	0.77
	(2.1)	(22.6)	(1.8)	(−2.0)	1.64
16 Norway	0.037	0.66	0.0009	−0.00083	0.49
	(1.2)	(12.3)	(0.9)	(−1.0)	1.13
17 Sweden	0.131	0.68	0.0016	−0.00254	0.47
	(3.0)	(9.0)	(2.7)	(−2.9)	0.99
18 Finland	0.128	0.67	0.0045	−0.00366	0.51
	(3.0)	(8.9)	(2.8)	(−2.8)	1.15
19 Austria	0.036	0.79	−0.0002	−0.00046	0.87
	(3.9)	(25.7)	(−0.5)	(−2.1)	1.42
20 Switzerland	0.053	0.38	0.0001	−0.00059	0.59
	(1.7)	(9.5)	(0.4)	(−1.4)	1.24
21 Iceland	−0.022	0.72	−0.0001	0.00029	0.63
	(−0.7)	(12.7)	(−0.1)	(0.4)	2.27
22 Turkey	0.029	0.95	0.0016	−0.00423	0.93
	(2.4)	(30.9)	(2.5)	(−2.9)	1.48
23 Australia	−0.015	0.56	−0.0002	0.00025	0.55
	(−0.4)	(10.8)	(−0.4)	(0.4)	1.45
24 New Zealand	−0.031	0.80	0.0008	0.00015	0.83
	(−0.9)	(24.4)	(3.1)	(0.3)	1.79

Regression model: d ln(lp(i)) = kappa(i) + lambda(i) * d ln(GDP(i)) + delta(i) * time + theta(i) * lpgap(i) .

Source: own computations.

Norway, Switzerland, Iceland, Australia, and New Zealand - the parameter estimate θ is statistically insignificant from zero. Only three economies - Japan, Belgium, and the Netherlands - have statistically significant positive θ values. For the United States the parameter θ was excluded because it is the productivity leader. The results of our estimates therefore confirm that convergence might be a fairly general pattern which holds true for many countries of the OECD area but there are exceptions which challenge its generality and makes it necessary to find reasonable economic explanations. However, this is not the aim and scope of the present paper. Future work will hopefully find out more of the underlying processes to explain why economies which contradict the rule of convergence exists.

Conclusions

If we finally sum up the results of this paper, we notice that Verdoorn's and Okun's law are useful relations to explain changes in unemployment rates, labor productivity growth or employment growth of the countries in the OECD area. It is noteworthy that all three relations performed quite differently in their ability to fit the data of different countries. This led to our attempt to classify countries as productivity or employment driven.

As we outlined in the first section, the unemployment problem emerged in the OECD over a long time beginning after the first oil price shock. The development since then led to a shift of the unemployment problem from the non-European countries to the European countries of the OECD. The results in the second section challenge the perception that a pure high economic growth strategy might be sufficient to overcome the unemployment problem in the near future. Especially if one takes the asymmetric reaction of changes in unemployment rates into account, it seems even more doubtful that a longer period of above the long-term average growth performance in countries with a substantial unemployment problem will improve the situation sufficiently. Contrary to this result, asymmetric reactions would urge policy makers and social partners in the OECD countries to avoid everything which would reduce output growth - even for a short period - below its long-term average. The respective policy rule - to at least maintain and slowly improve employment and reduce unemployment rates - is a policy supporting steady long-term growth. To stabilize unemployment with high volatility in ouput growth will not pay off in the long-run.

For many countries especially in Western Europe the hope for alleviating their unemployment problem in the future, which over the last decades were driven by the catch-up process in productivity to the United States, is that they might change from a productivity driven growth to a more employment driven growth like that of the United States. The debate on the employment summit in Detroit and the concept of the European Commission for OECD countries facing a huge

unemployment problem to aim to become more employment driven, shows the awareness of policy makers to utilize this option. That governments and social partners should discuss these options seems to be important, especially for countries who have already above the OECD average long-term output growth and have caught up with the leader in productivity levels, but experience a substantial employment problem.

Finally, we note that Krugman's (1994a) observation that Okun's law - we confronted it here with Verdoorn's law - has a sound empirical basis is correct, but one should keep in mind that if we compare the diversity of country specific experiences of the past, both laws prove to be more a fairly successful rule than a law. Of course, if we widen the scope of our analysis to introduce other variables and relations we might be able to explain results which up to now refute the significance of both laws for some countries. Our present analysis was just a first attempt to follow this line of research. By introducing asymmetric reactions or a dependency of productivity growth rates on the catch-up hypothesis we found out that useful improvements in the analysis are possible.

The competitiveness debate of the past years has led to an unwareness that a convergence process in productivity levels and growth rates is a dominant pattern between the majority of countries in the OECD area. If policy-markers and the public opinion in countries which were substantially lagging behind the leading economies in the past would realize that they have more or less closed the gap which existed before, it can open up an employment policy debate which is not driven by the fear that international competitiveness is at stake. The agenda opened up recently by the publication of the White Book of the European Commission (EU, 1993) and the Employment Summit in Detroit give some hope that the perception is changing to the right direction. The warning of Paul Krugman (1994b) to correct past obsessions concerning international competitiveness to face the present challenge of high unemployment in the OECD area, came just in time to get the focus right for future policy debates.

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Appendix A

Fig. 15 - Relative Labor Productivity Gaps to the United States of Canada, Japan, Australia, and New Zealand.

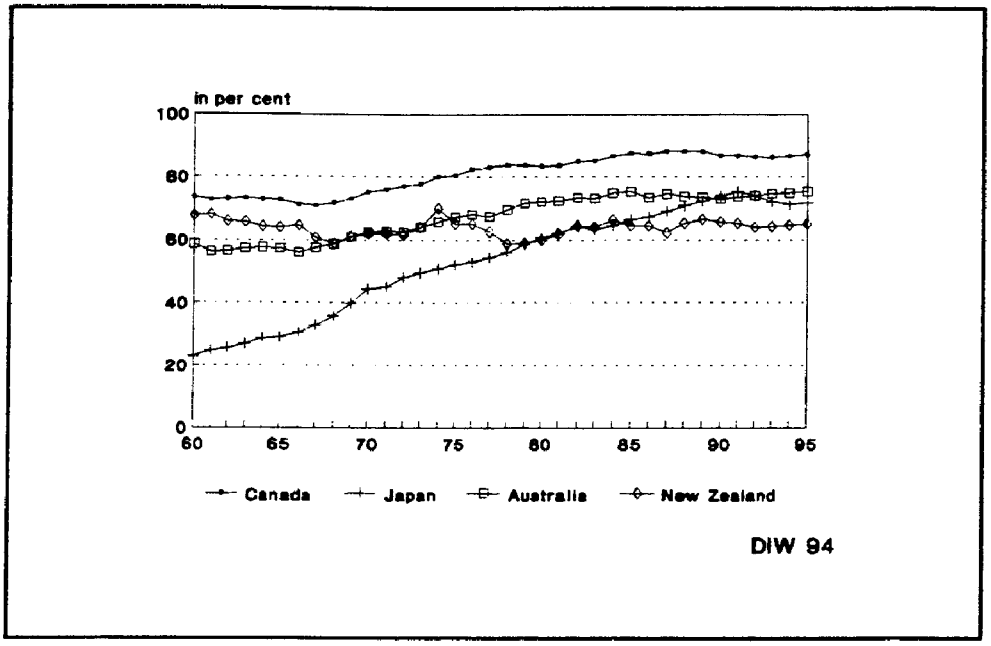


Fig. 16 - Relative Labor Productivity Gaps to the United States of Germany, France, the United Kingdom, and Italy.

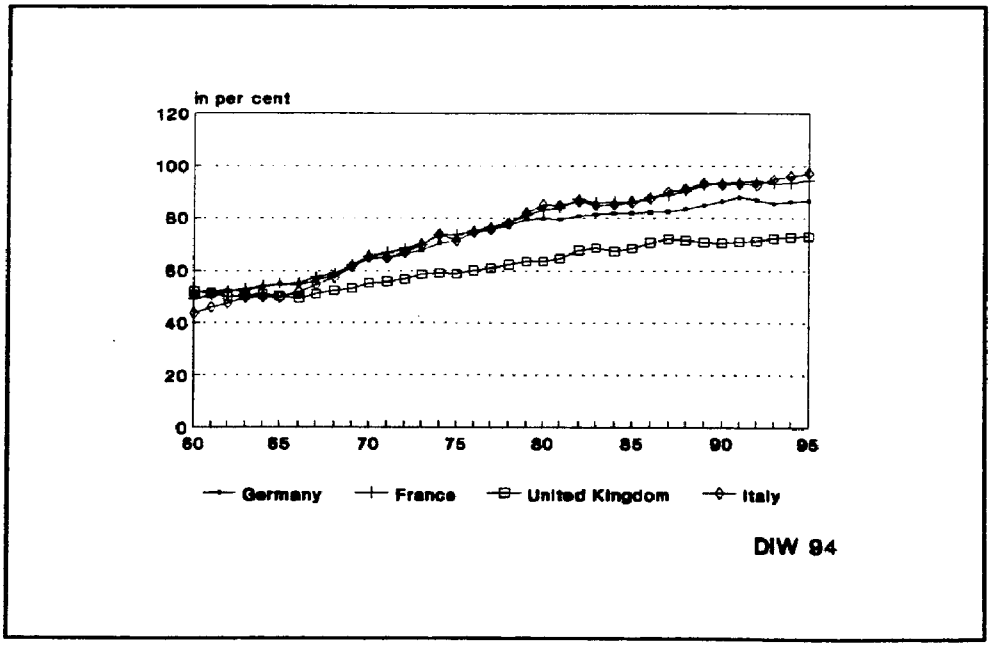


Fig. 17 - Relative Labor Productivity Gaps to the United States of Belgium, the Netherlands, Luxembourg, and Spain.

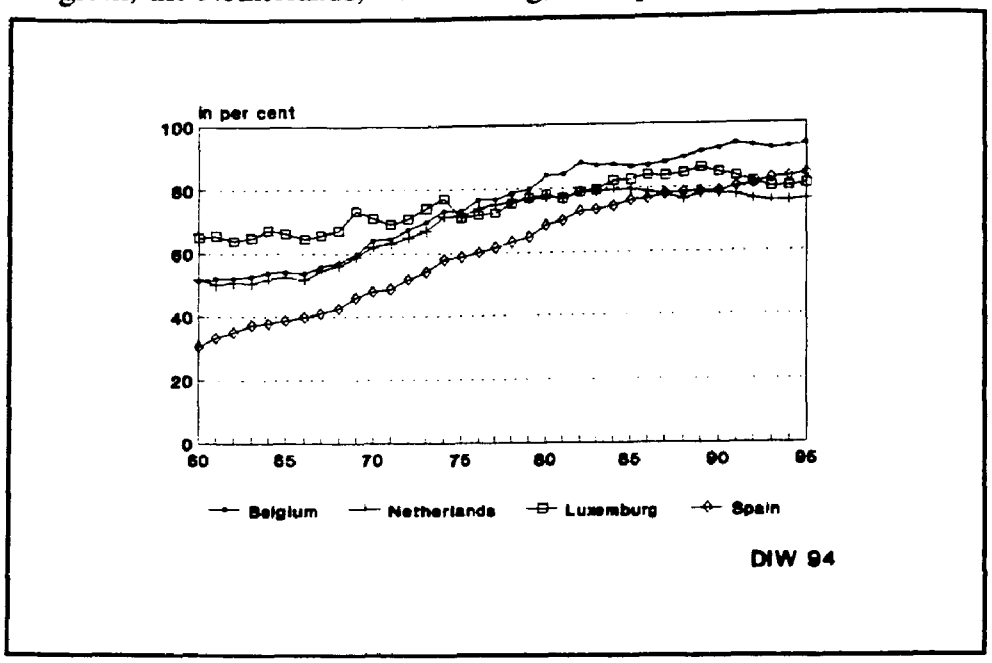


Fig. 18 - Relative Labor Productivity Gaps to the United States of Portugal, Greece, Ireland, and Denmark.

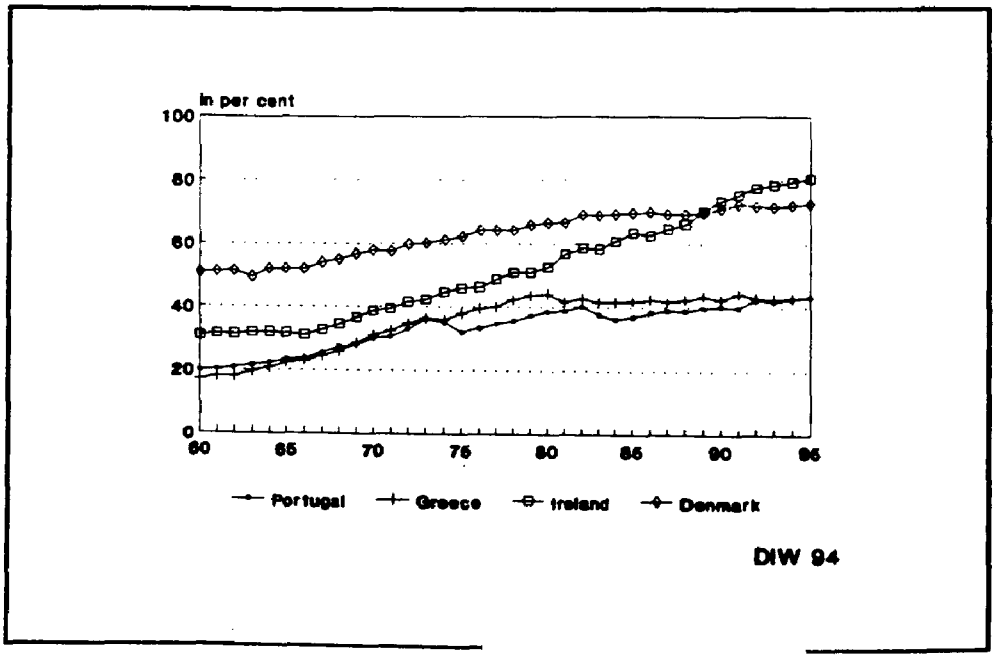


Fig. 19 - Relative Labor Productivity Gaps to the United States of Norway, Sweden, Finland, and Austria.

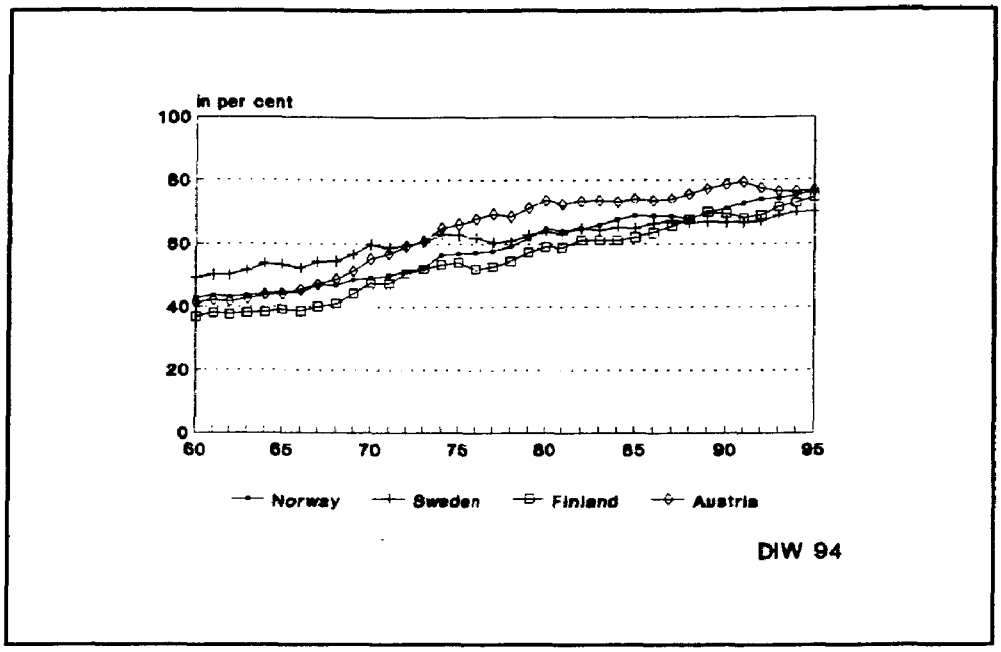
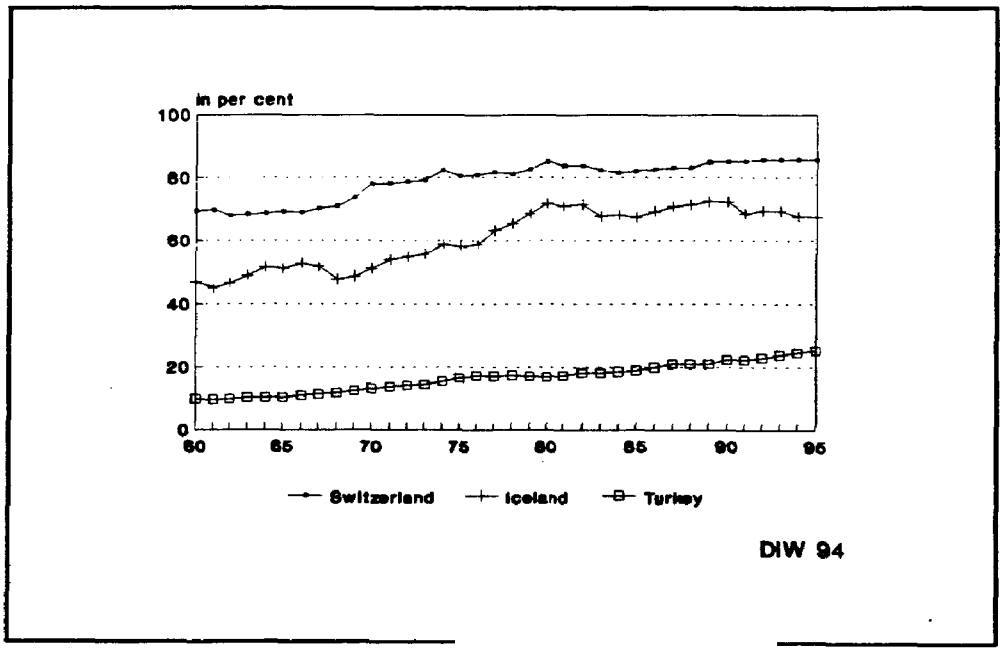


Fig. 20 - Relative Labor Productivity Gaps to the United States of Switzerland, Iceland, and Turkey.



Appendix B

Fig. 21 - GDP, Employment and Unemployment Shares of Canada with respect to the OECD Area.

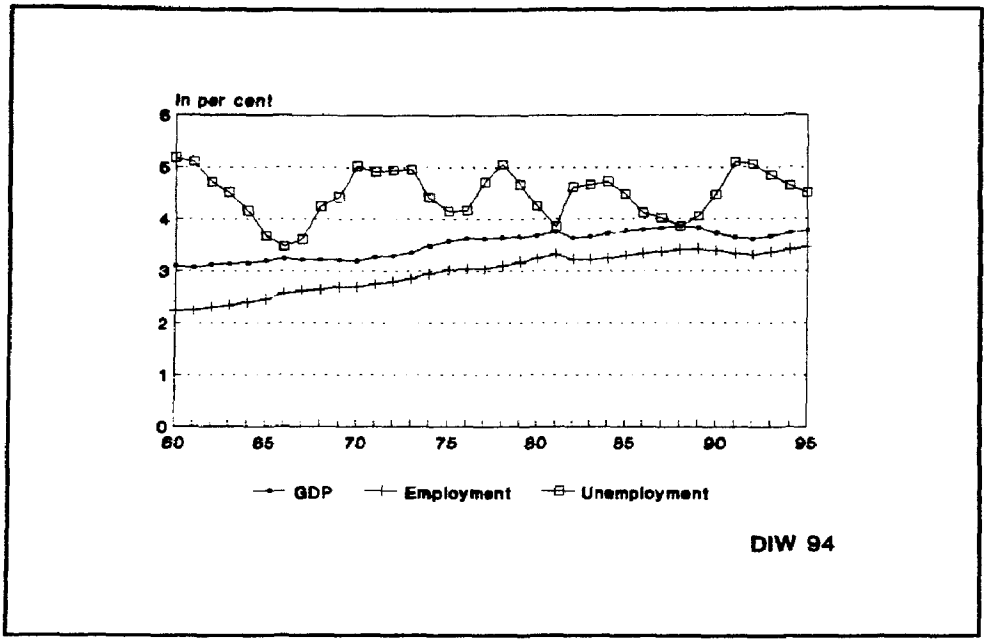


Fig. 22 - GDP, Employment and Unemployment Shares of Belgium with respect to the OECD Area.

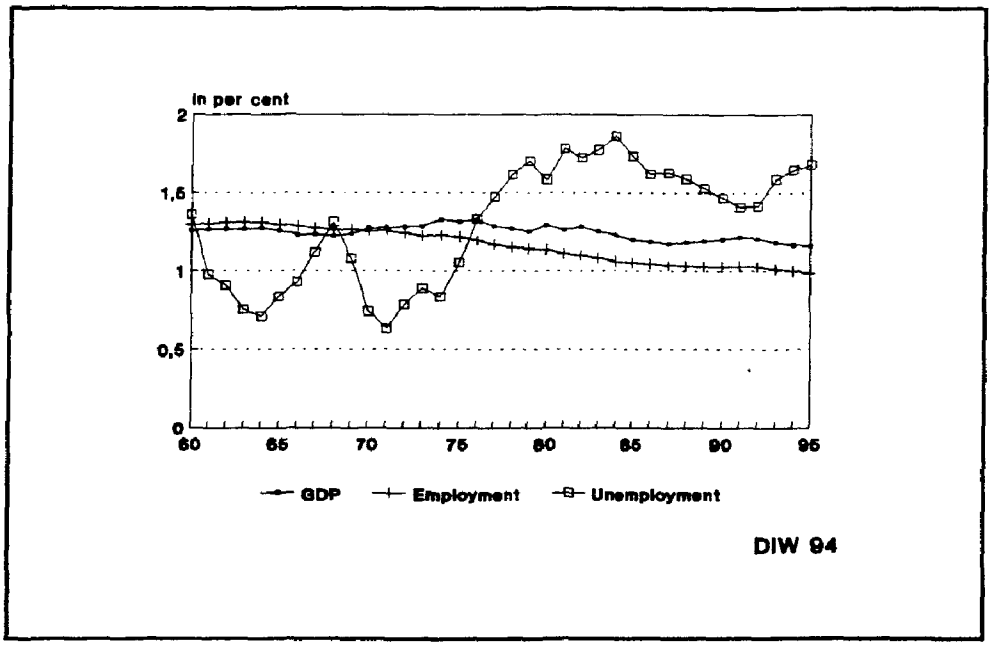


Fig. 23 - GDP, Employment and Unemployment Shares of the Netherlands with respect to the OECD Area.

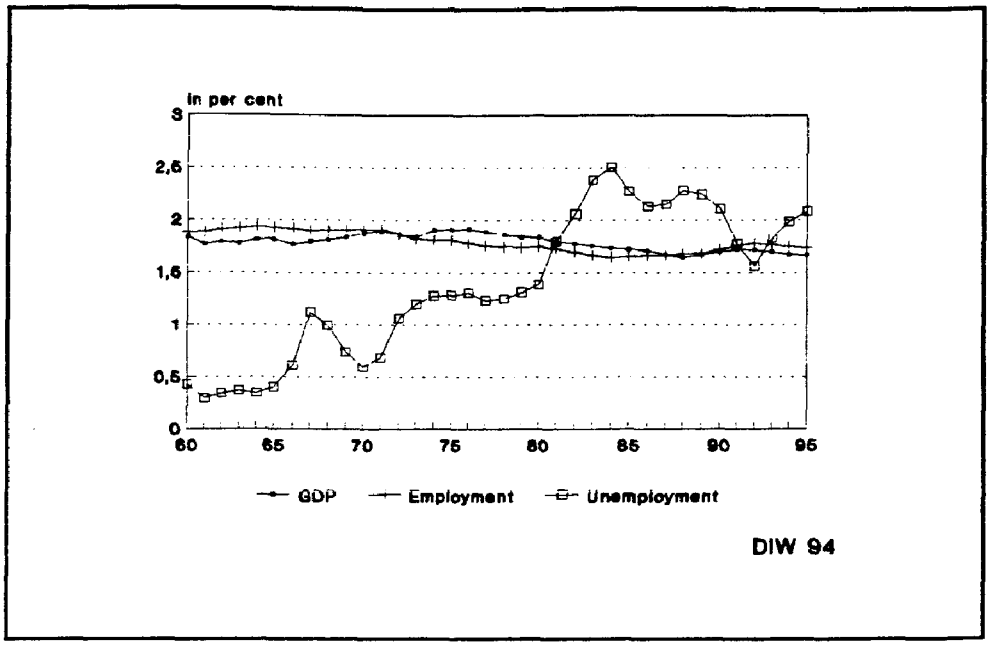


Fig. 24 - GDP, Employment and Unemployment Shares of Luxembourg with respect to the OECD Area.

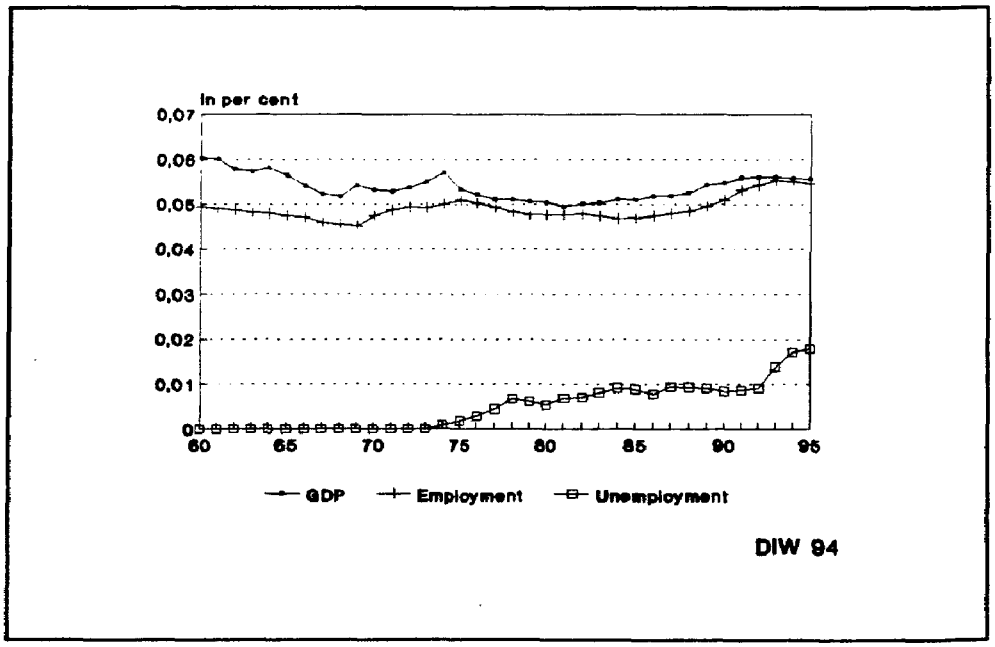


Fig. 25 - GDP, Employment and Unemployment Shares of Spain with respect to the OECD Area.

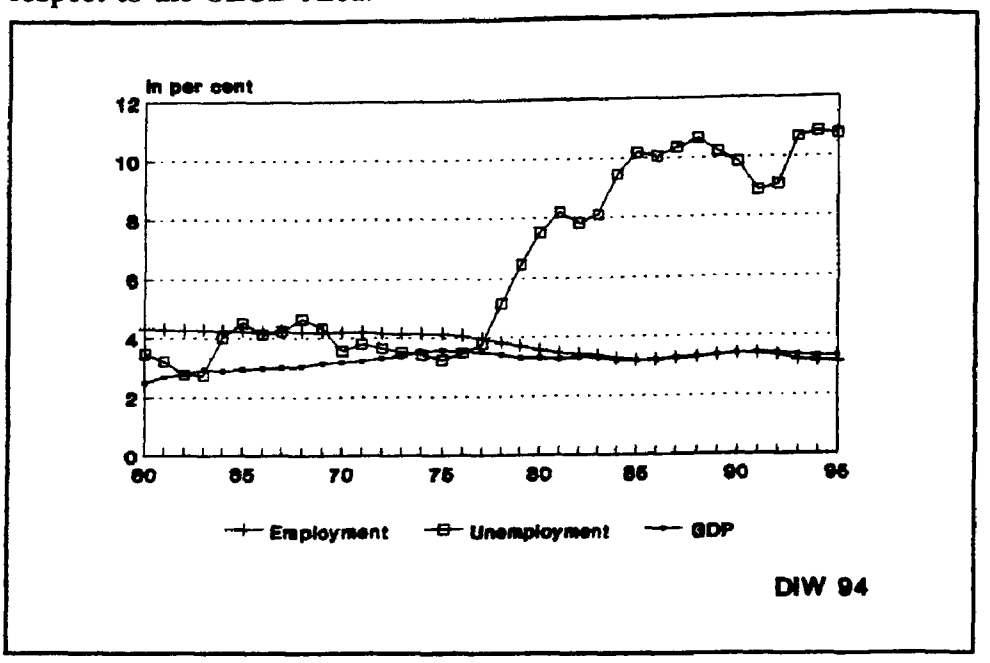


Fig. 26 - GDP, Employment and Unemployment Shares of Portugal with respect to the OECD Area.

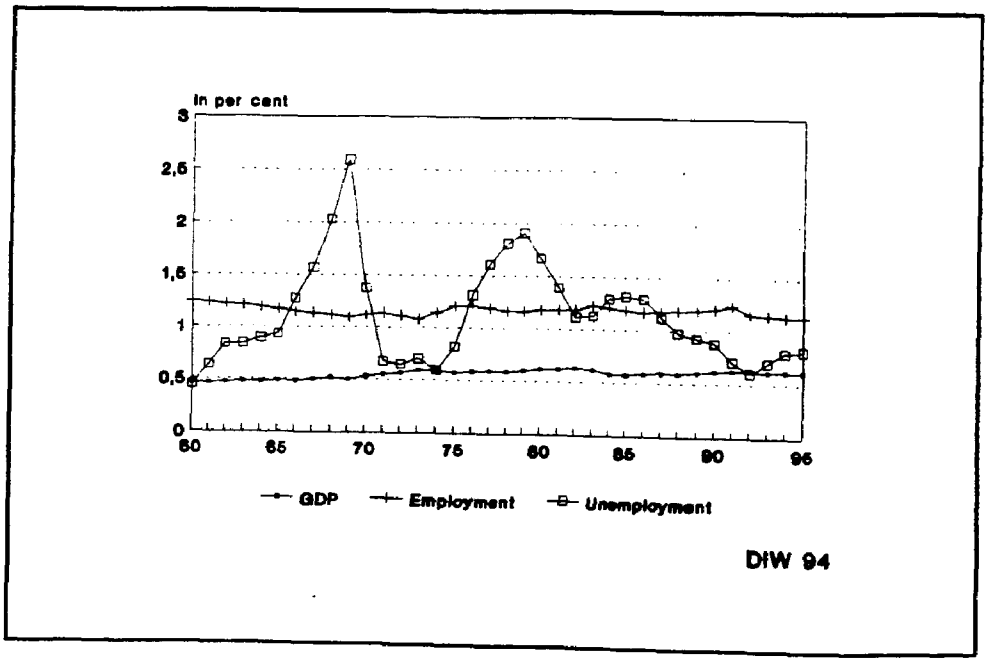


Fig. 27 - GDP, Employment and Unemployment Shares of Greece with respect to the OECD Area.

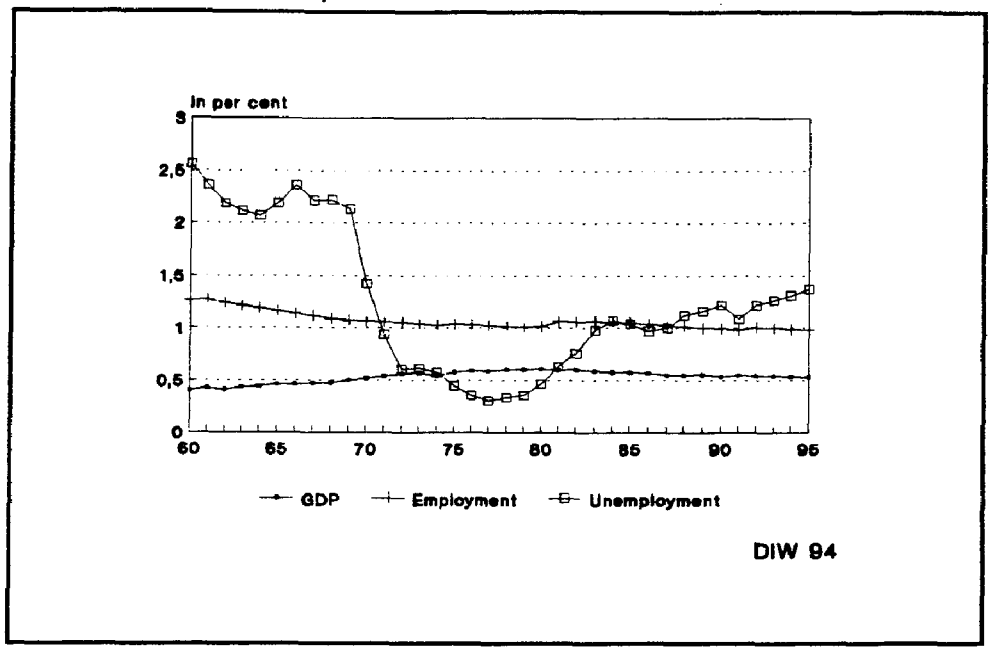


Fig. 28 - GDP, Employment and Unemployment Shares of Ireland with respect to the OECD Area.

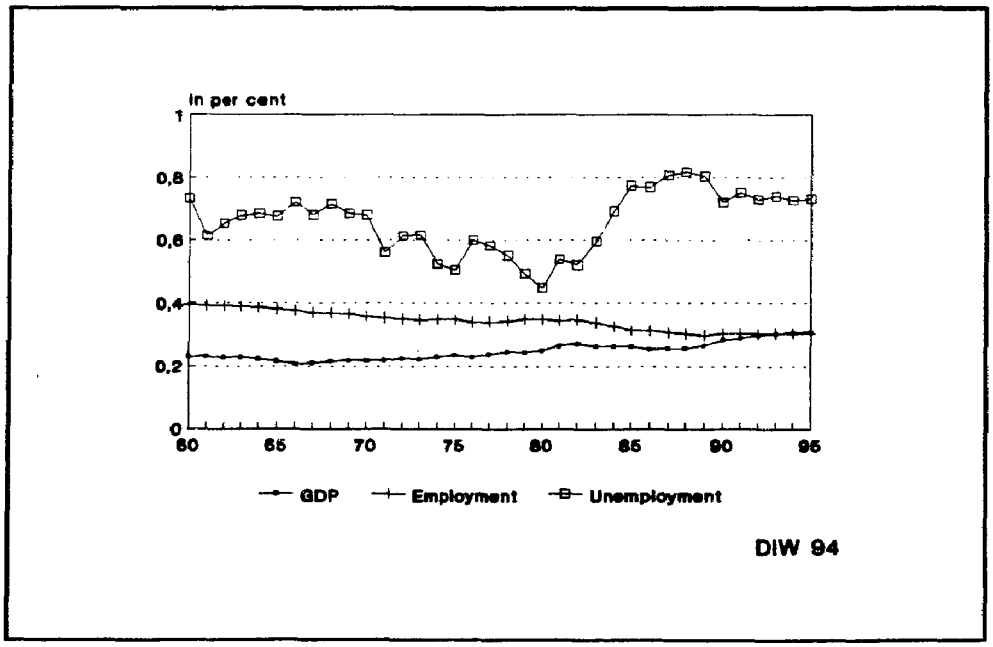


Fig. 29 - GDP, Employment and Unemployment Shares of Denmark with respect to the OECD Area.

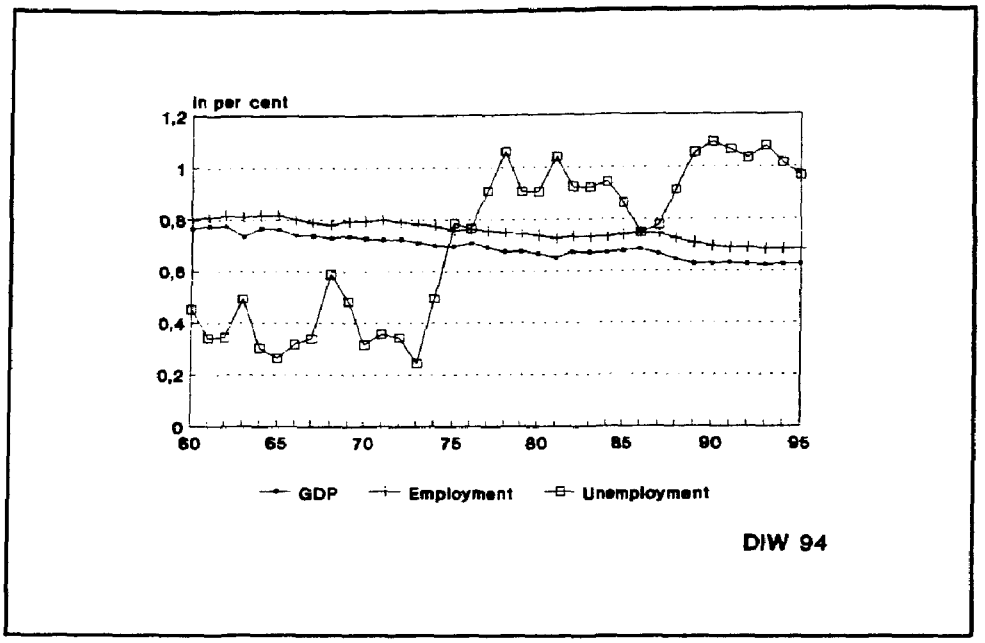


Fig. 30 - GDP, Employment and Unemployment Shares of Norway with respect to the OECD Area.

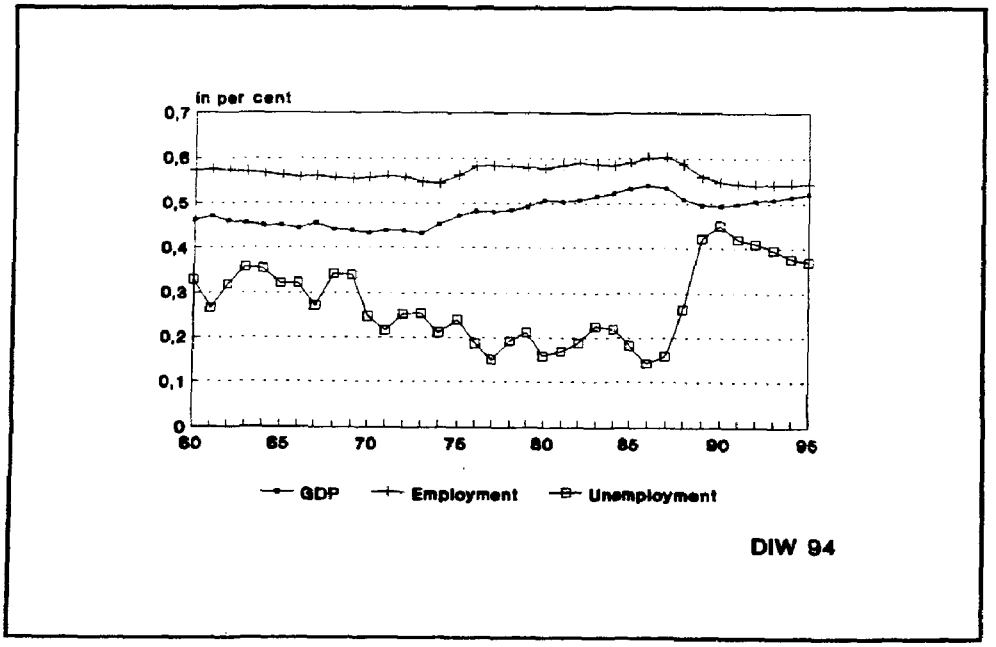


Fig. 31 - GDP, Employment and Unemployment Shares of Sweden with respect to the OECD Area.

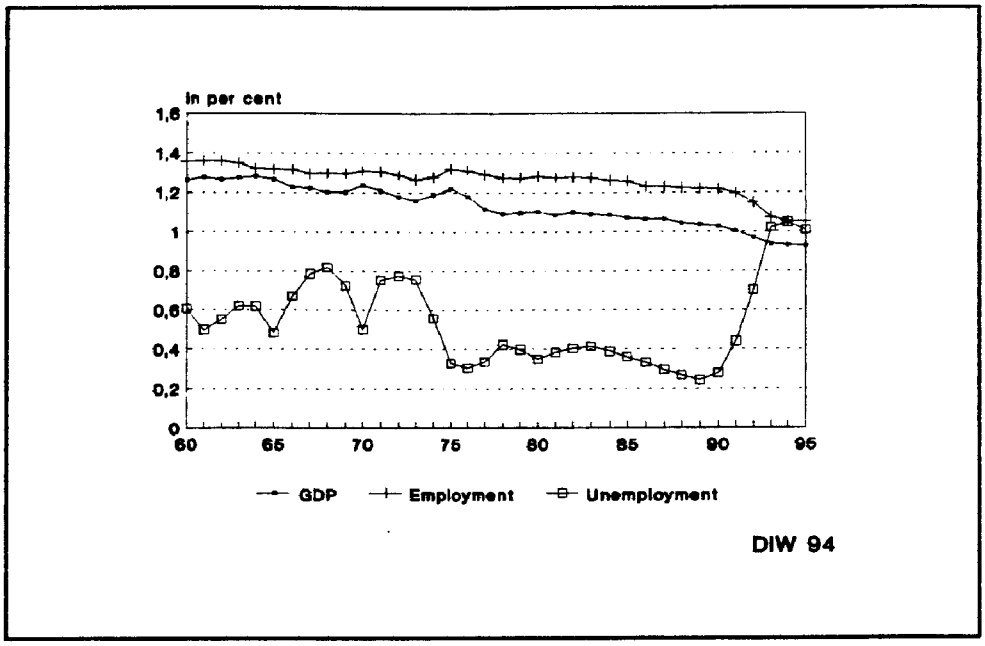


Fig. 32 - GDP, Employment and Unemployment Shares of Finland with respect to the OECD Area.

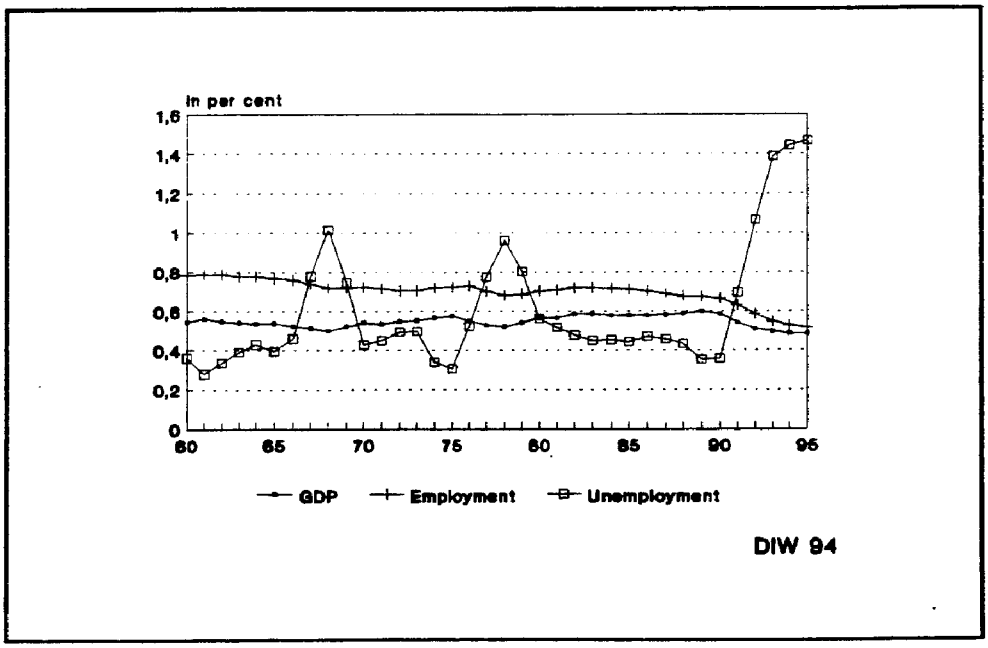


Fig. 33 - GDP, Employment and Unemployment Shares of Austria with respect to the OECD Area.

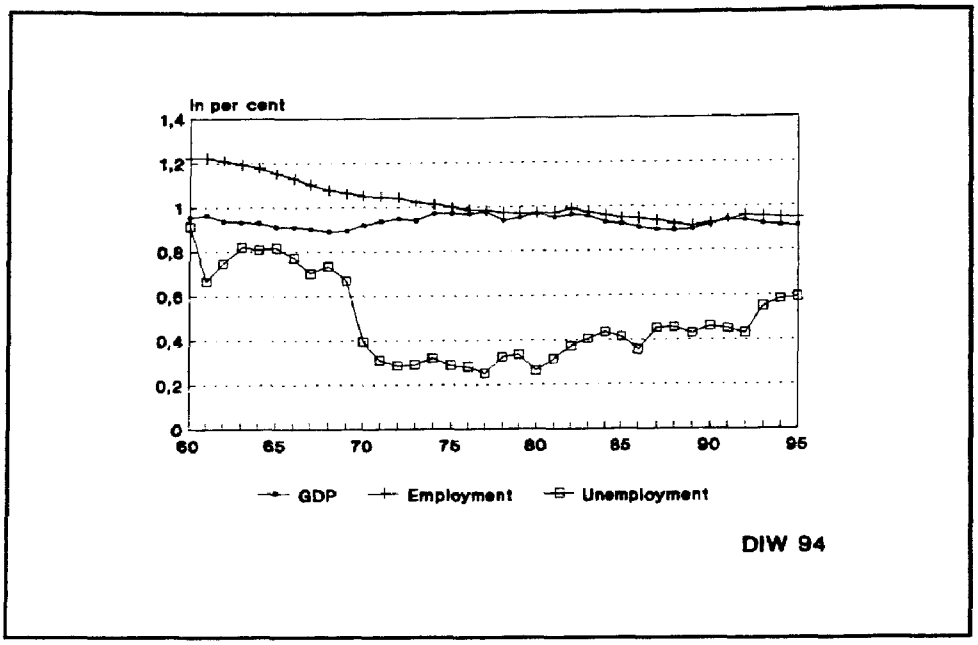


Fig. 34 - GDP, Employment and Unemployment Shares of Switzerland with respect to the OECD Area.

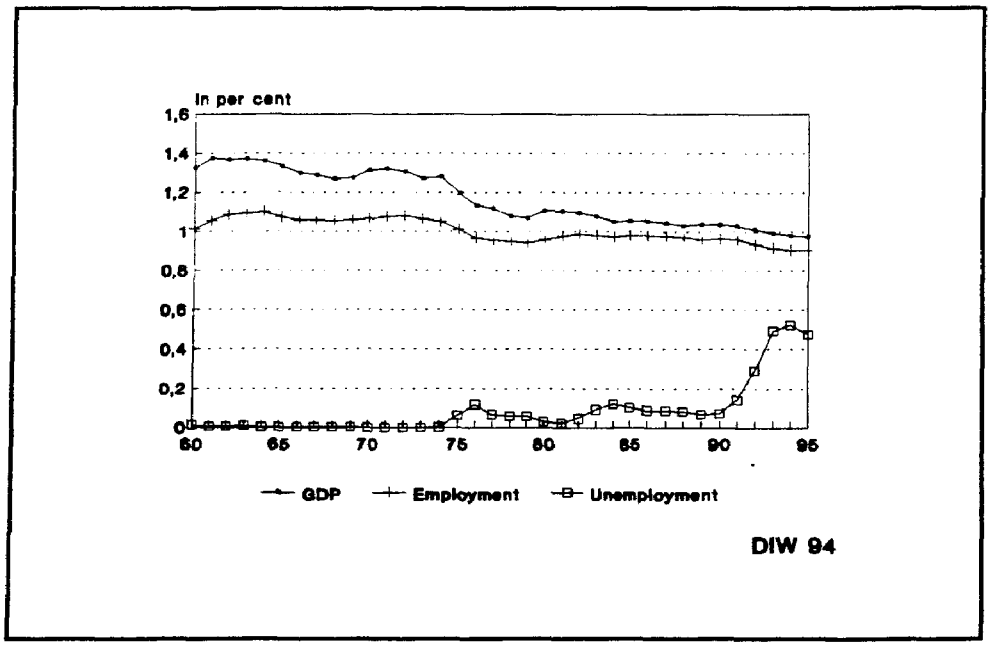


Fig. 35 - GDP, Employment and Unemployment Shares of Iceland with respect to the OECD Area.

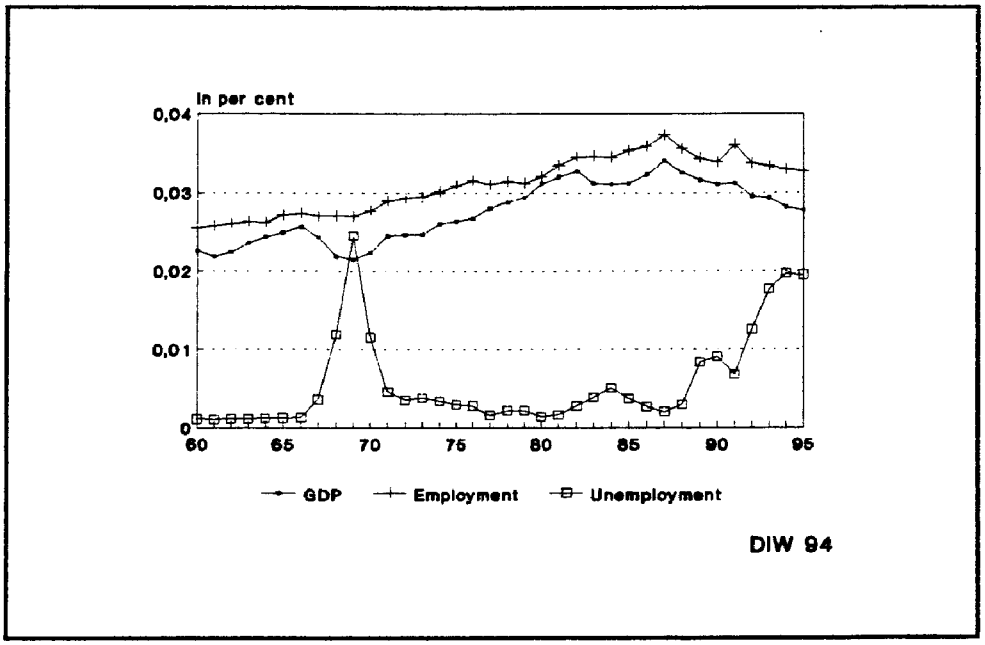


Fig. 36 - GDP, Employment and Unemployment Shares of Turkey with respect to the OECD Area.

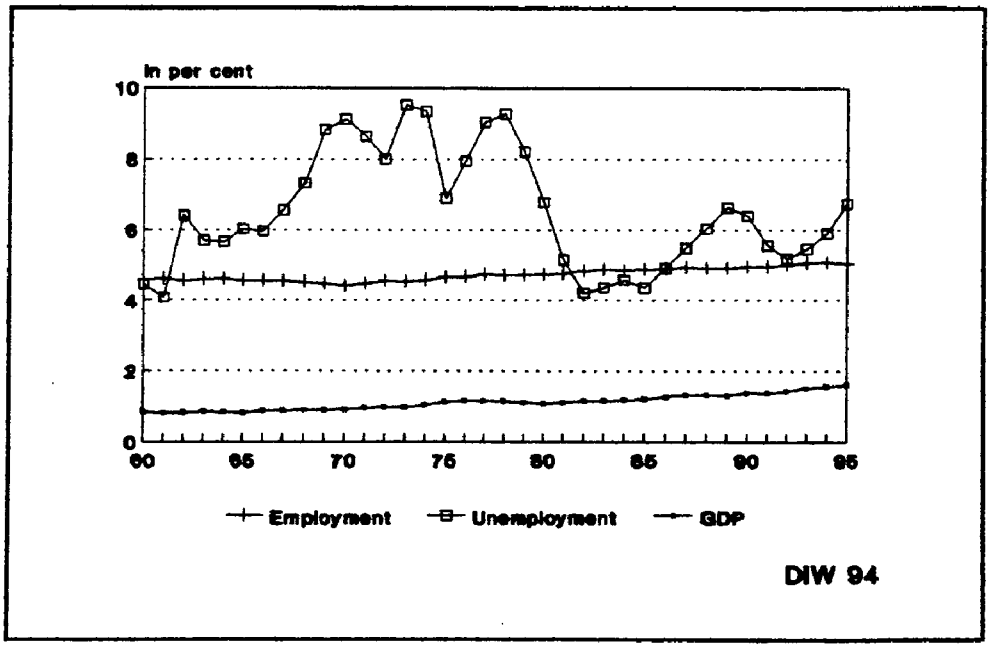


Fig. 37 - GDP, Employment and Unemployment Shares of Australia with respect to the OECD Area.

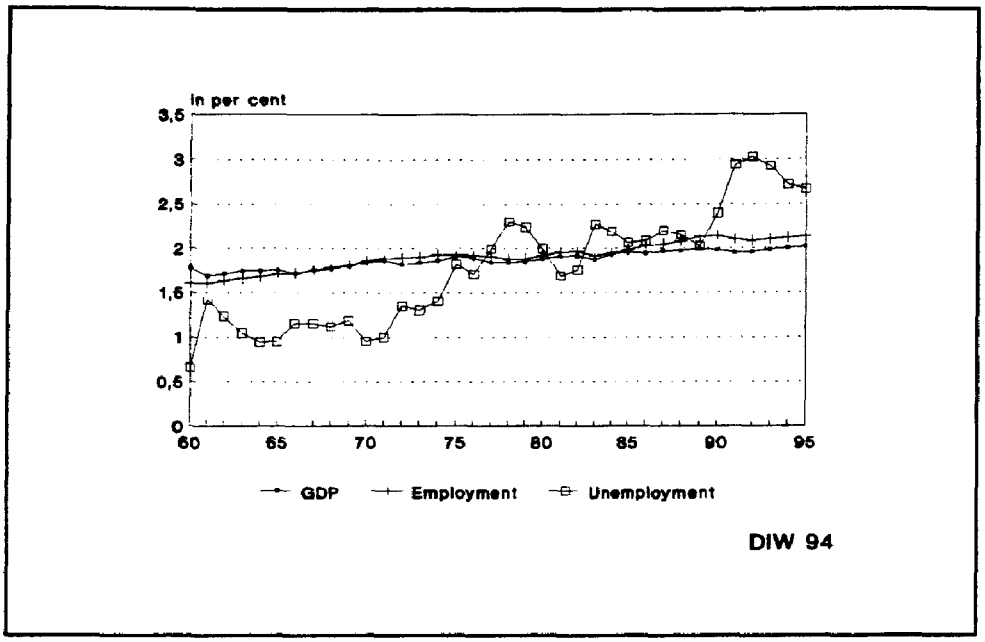
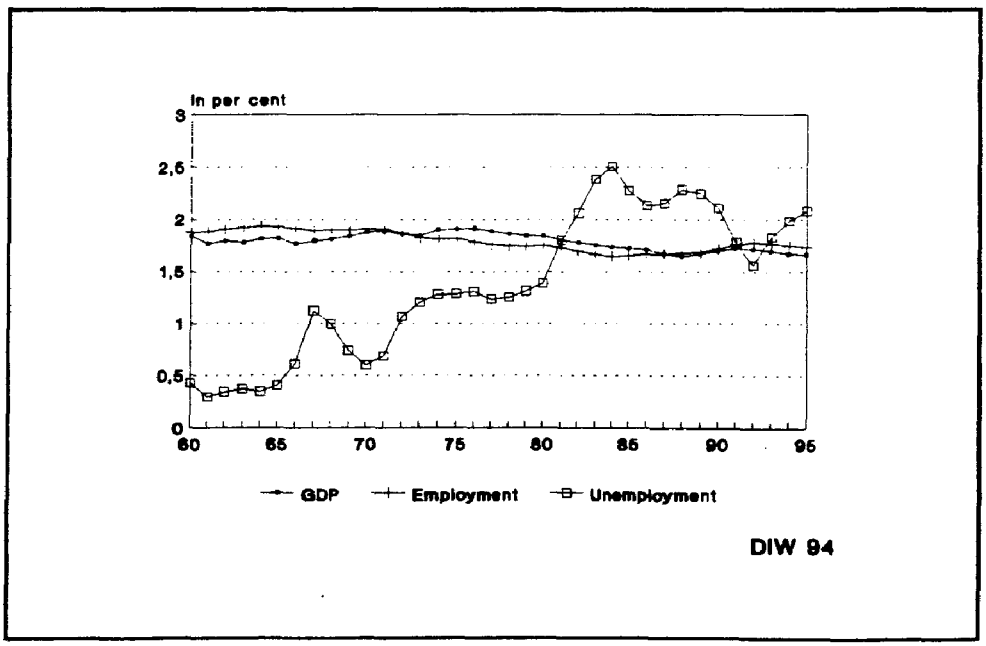


Fig. 38 - GDP, Employment and Unemployment Shares of New Zealand with respect to the OECD Area.



Appendix C

Fig. 39 - Okun's Law for Canada, 1961-1993.

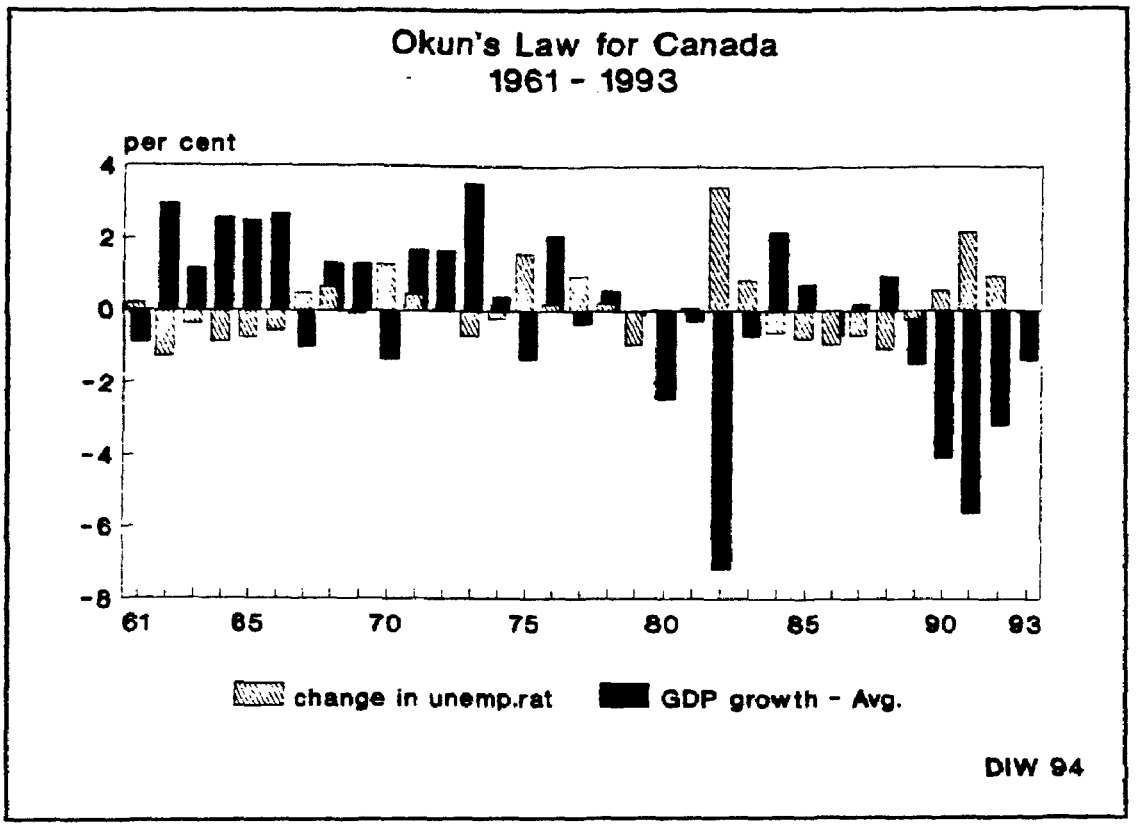


Fig. 40 - Okun's Law for France, 1961-1993.

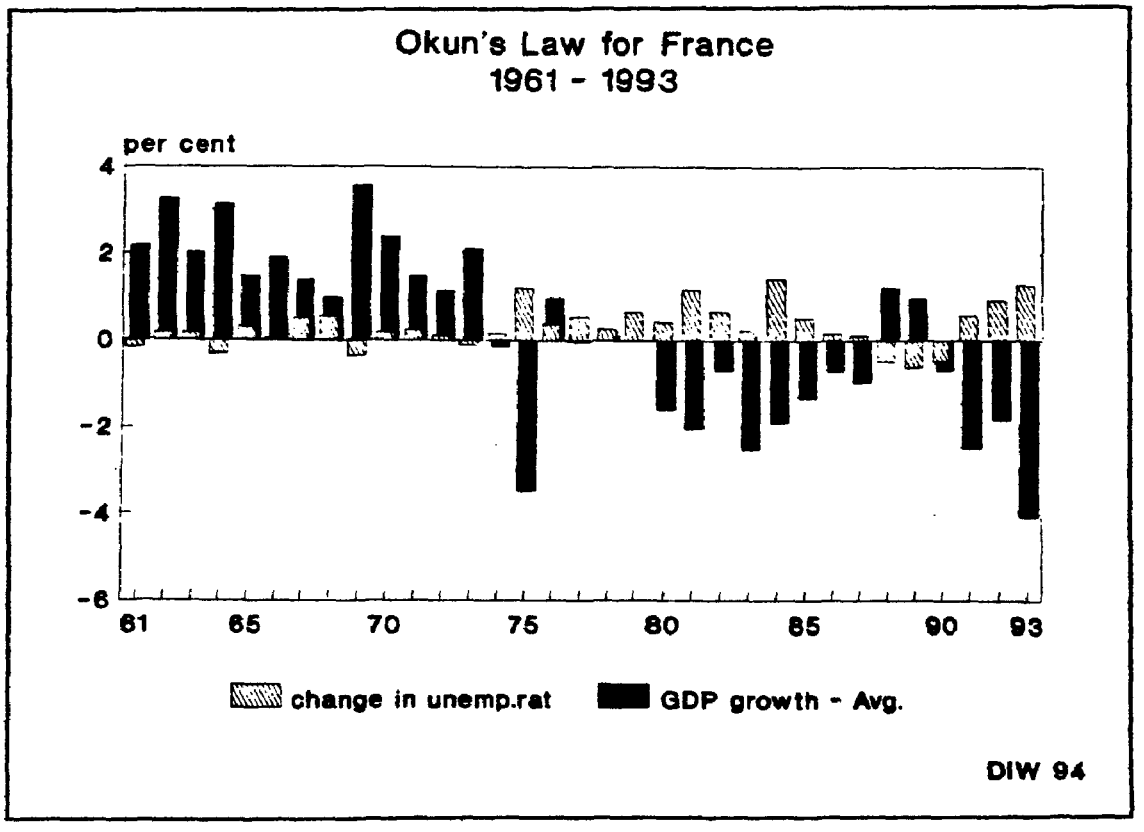


Fig. 41 - Okun's Law for the United Kingdom, 1961-1993.

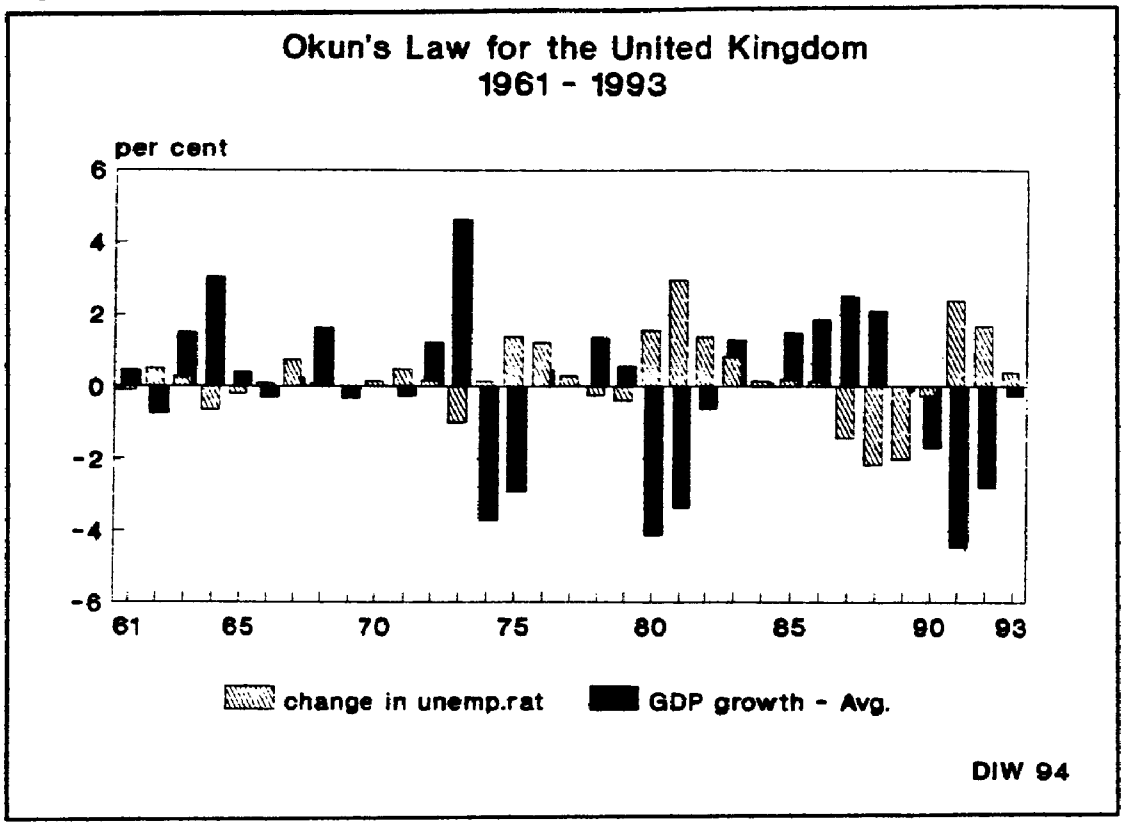


Fig. 42 - Okun's Law for Italy, 1961-1993.

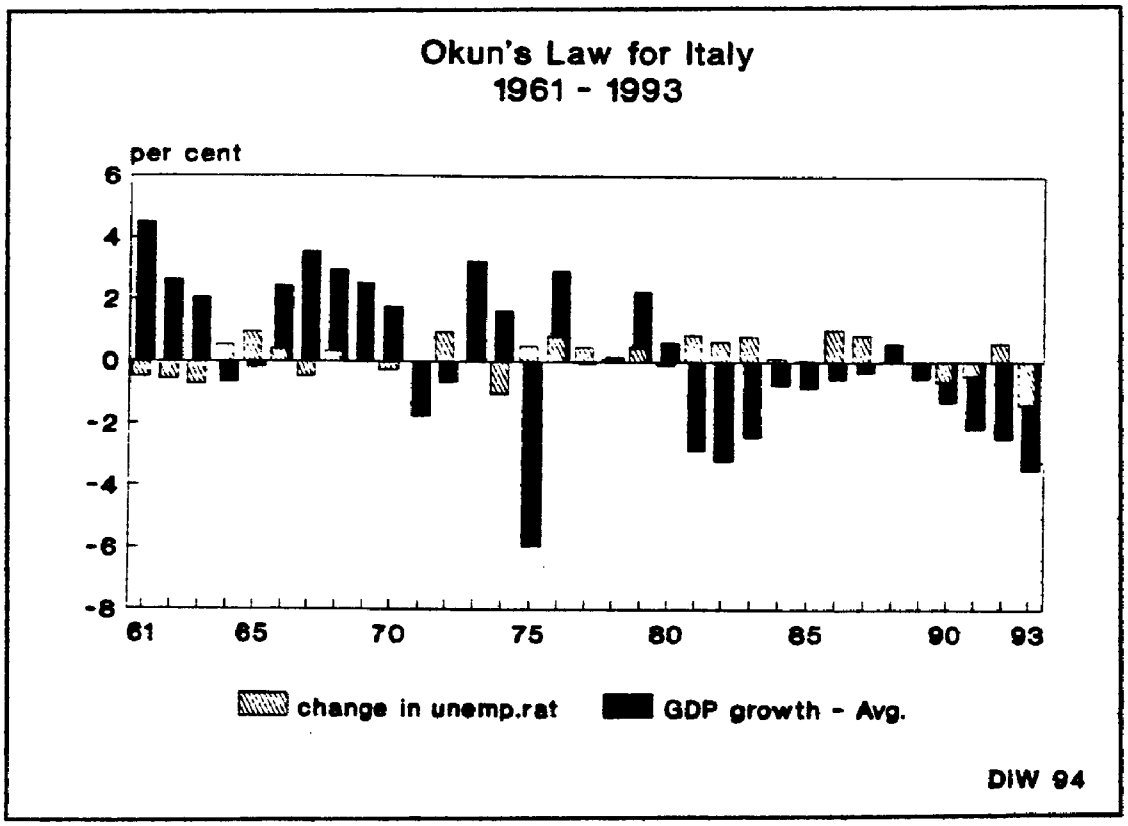


Fig. 43 - Okun's Law for Belgium, 1961-1993.

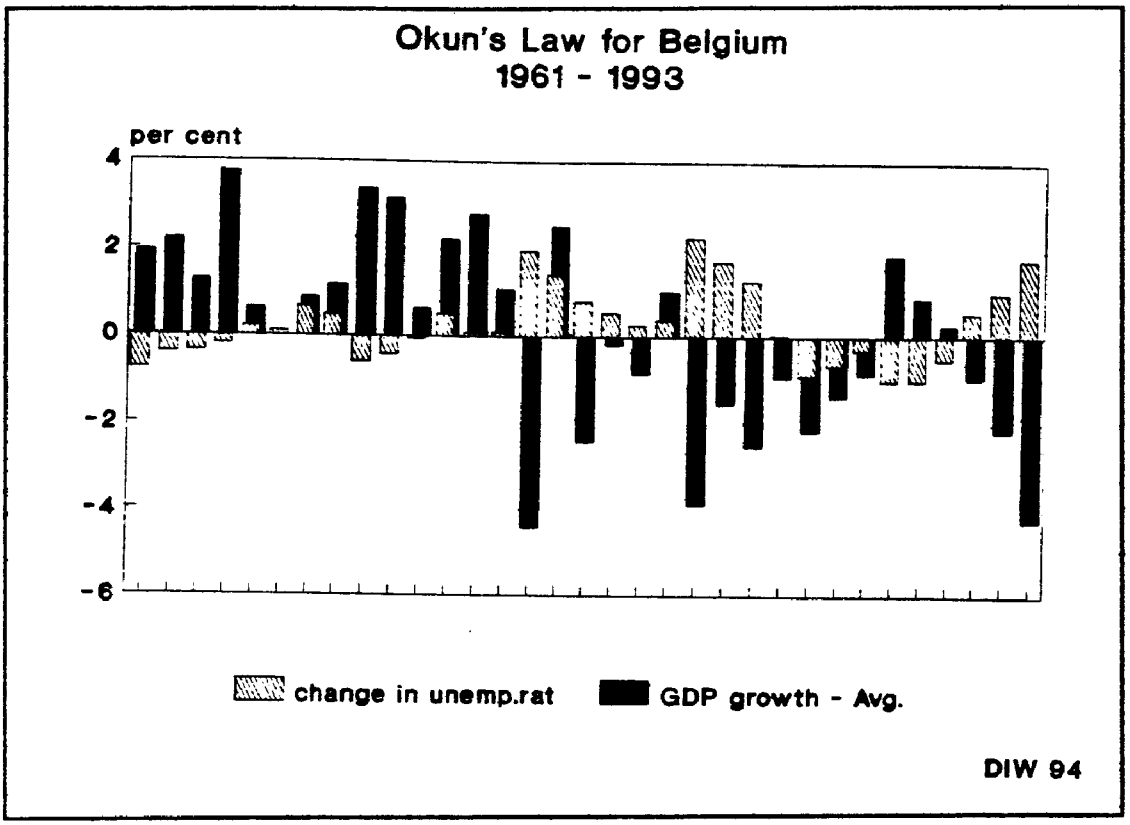


Fig. 44 - Okun's Law for the Netherlands, 1961-1993.

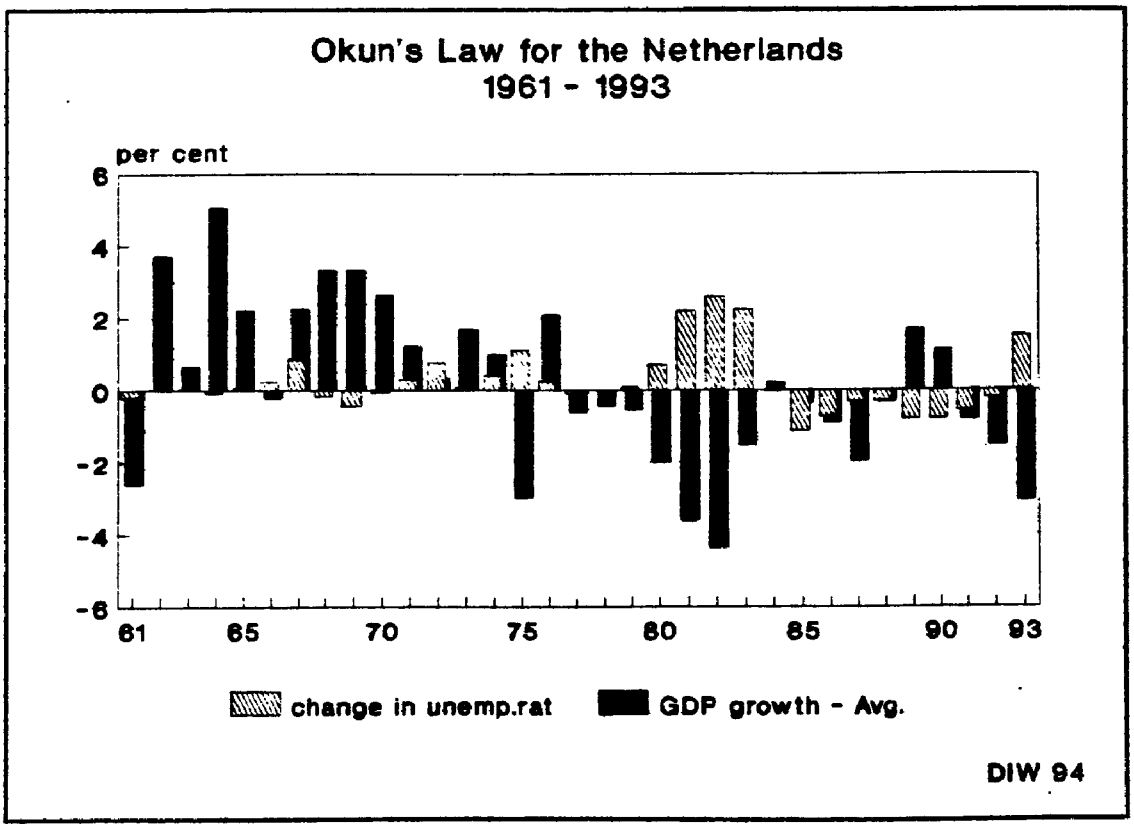


Fig. 45 - Okun's Law for Spain, 1961-1993.

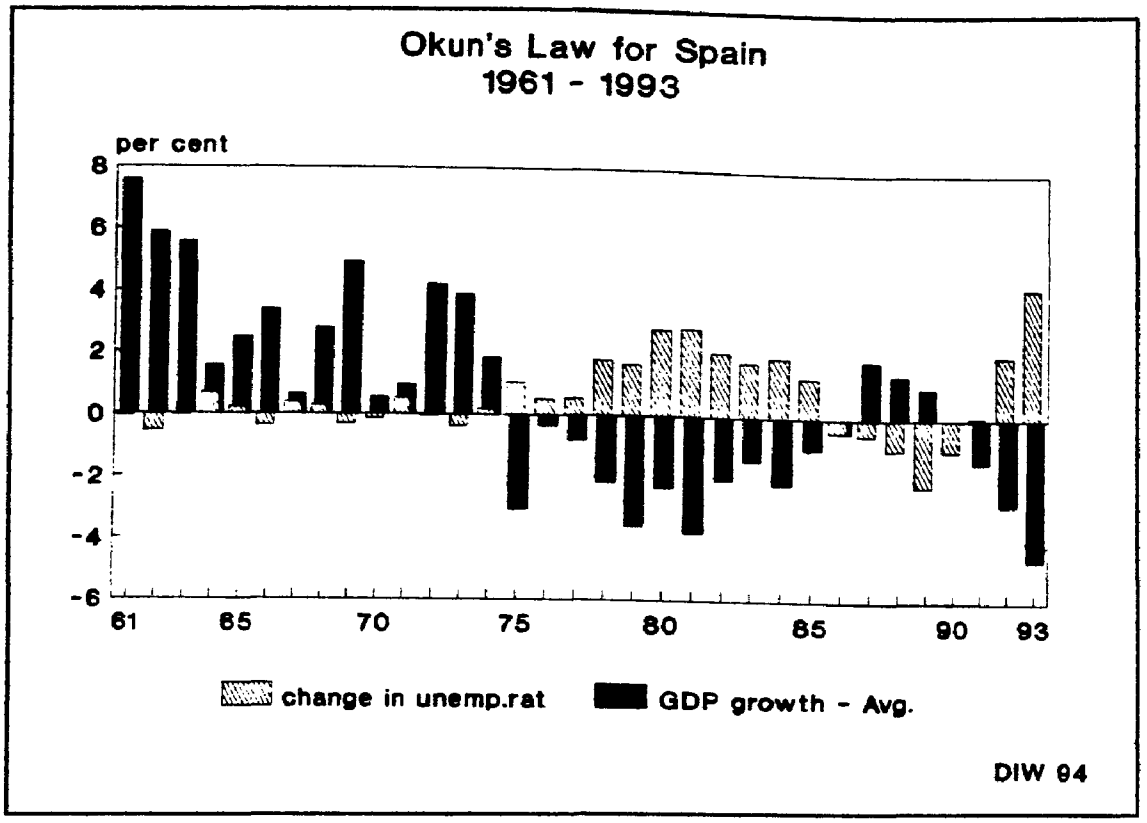


Fig. 46 - Okun's Law for Portugal, 1961-1993.

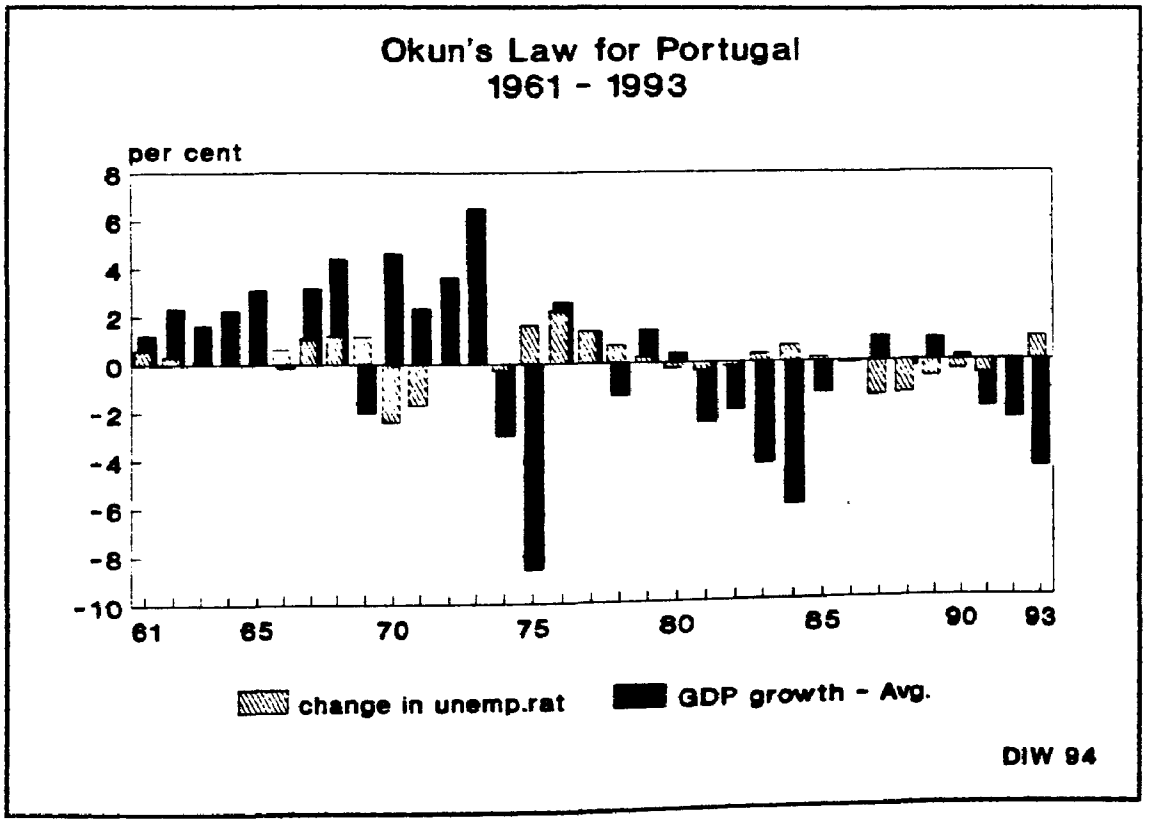


Fig. 47 - Okun's Law for Greece, 1961-1993.

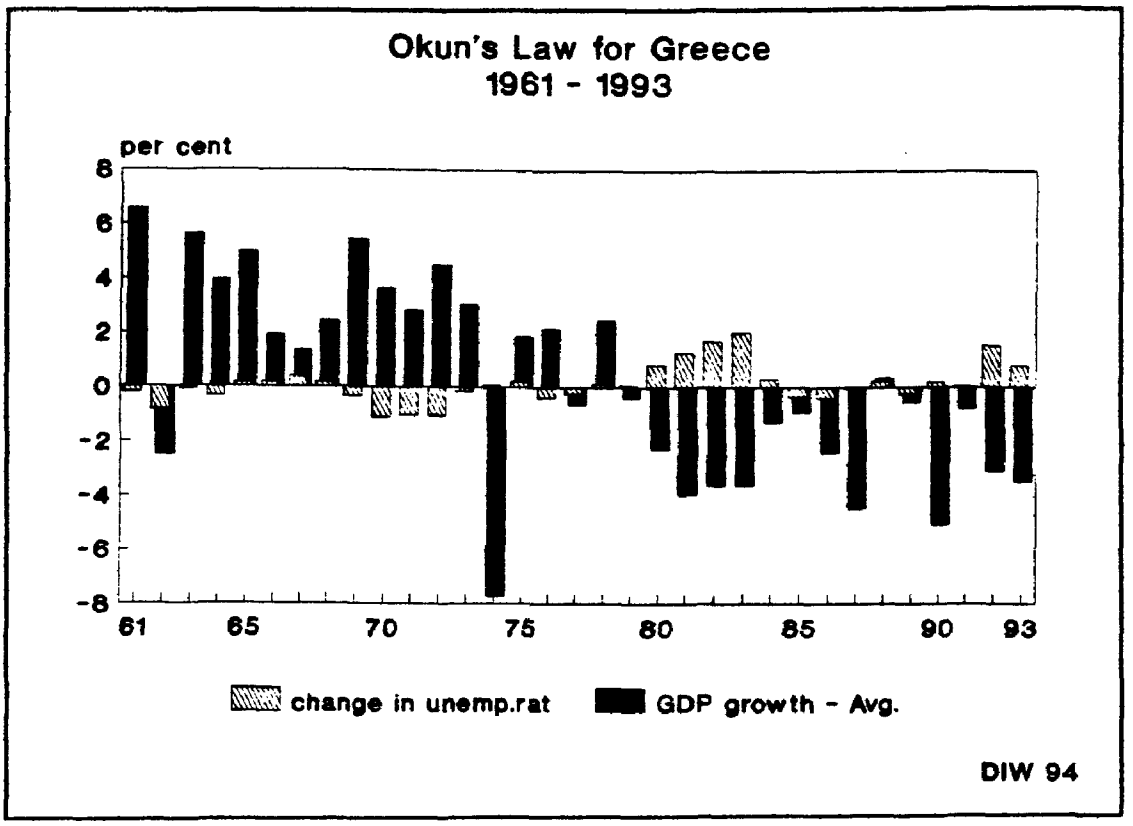


Fig. 48 - Okun's Law for Ireland, 1961-1993.

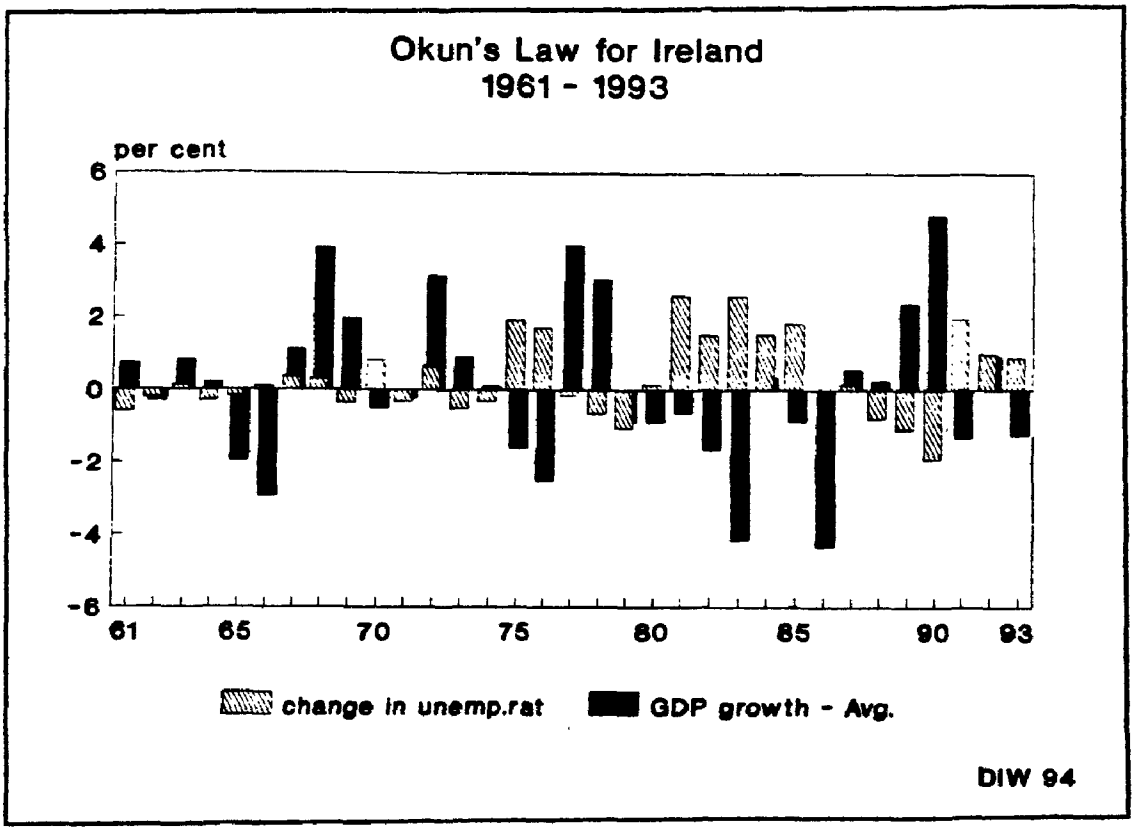


Fig. 49 - Okun's Law for Denmark, 1961-1993.

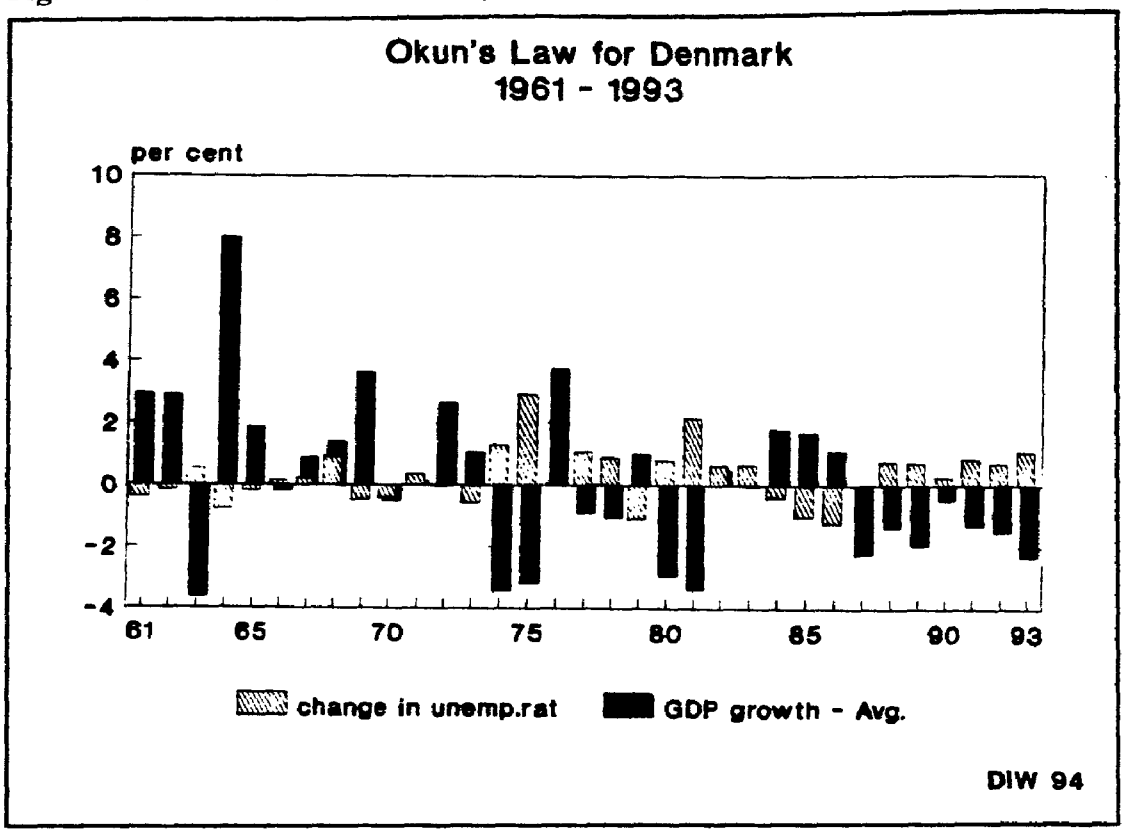


Fig. 50 - Okun's Law for Norway, 1961-1993.

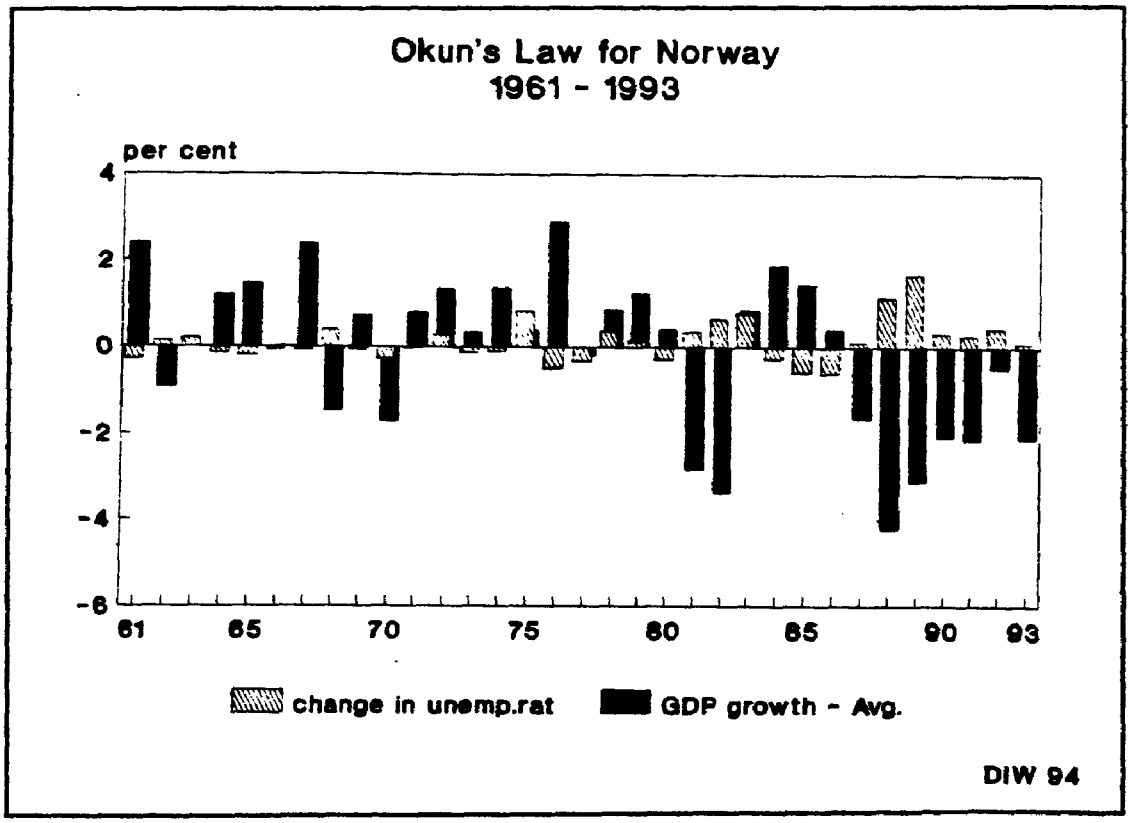


Fig. 51 - Okun's Law for Sweden, 1961-1993.

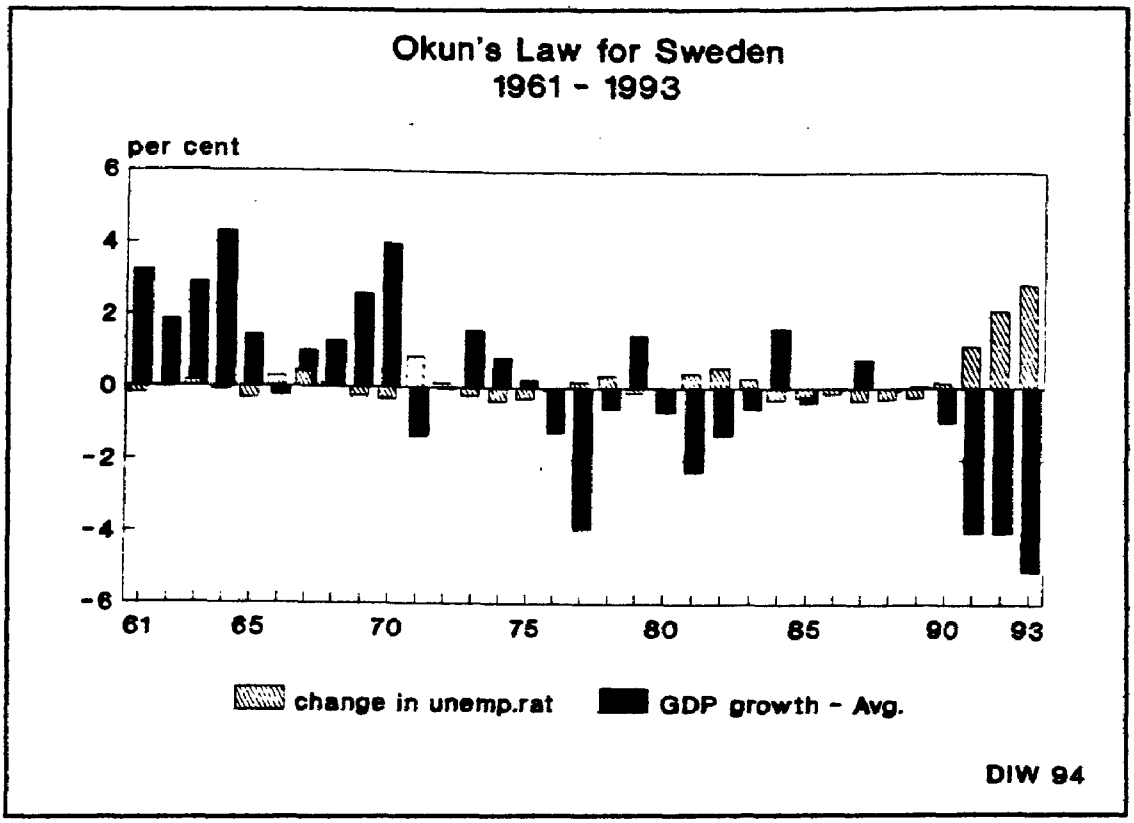


Fig. 52 - Okun's Law for Finland, 1961-1993.

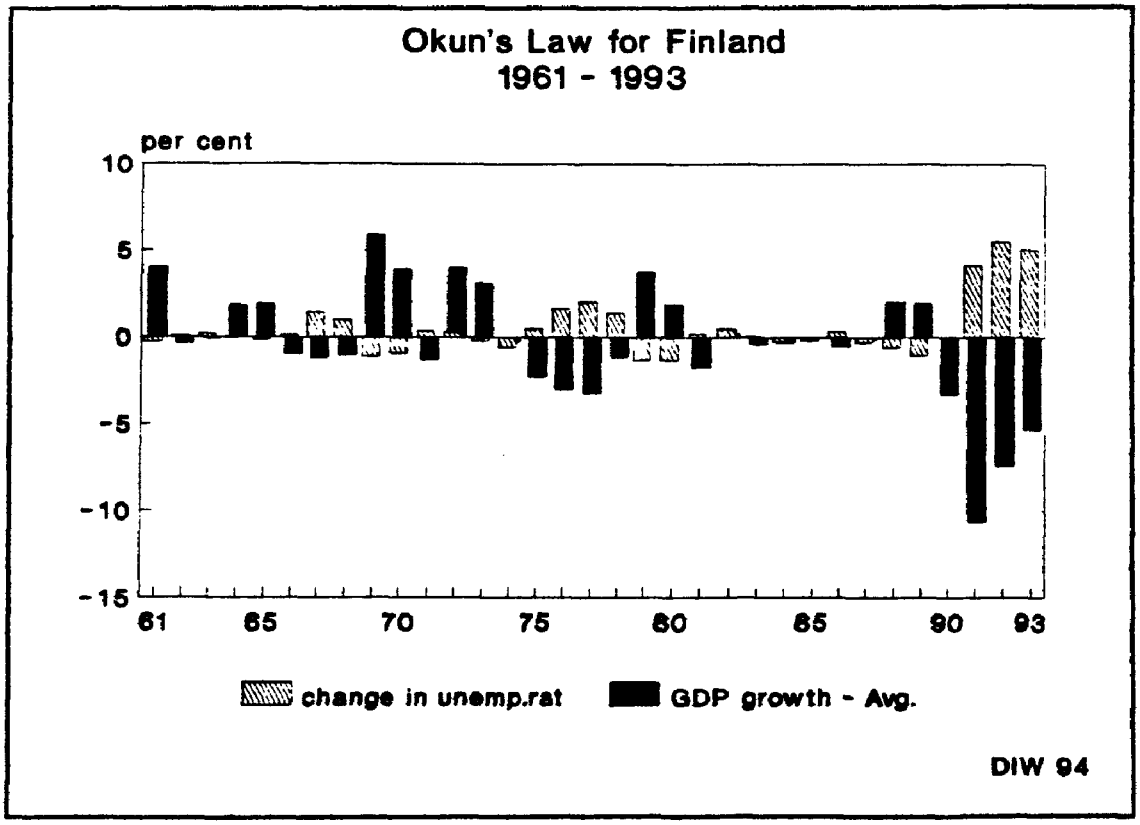


Fig. 53 - Okun's Law for Austria, 1961-1993.

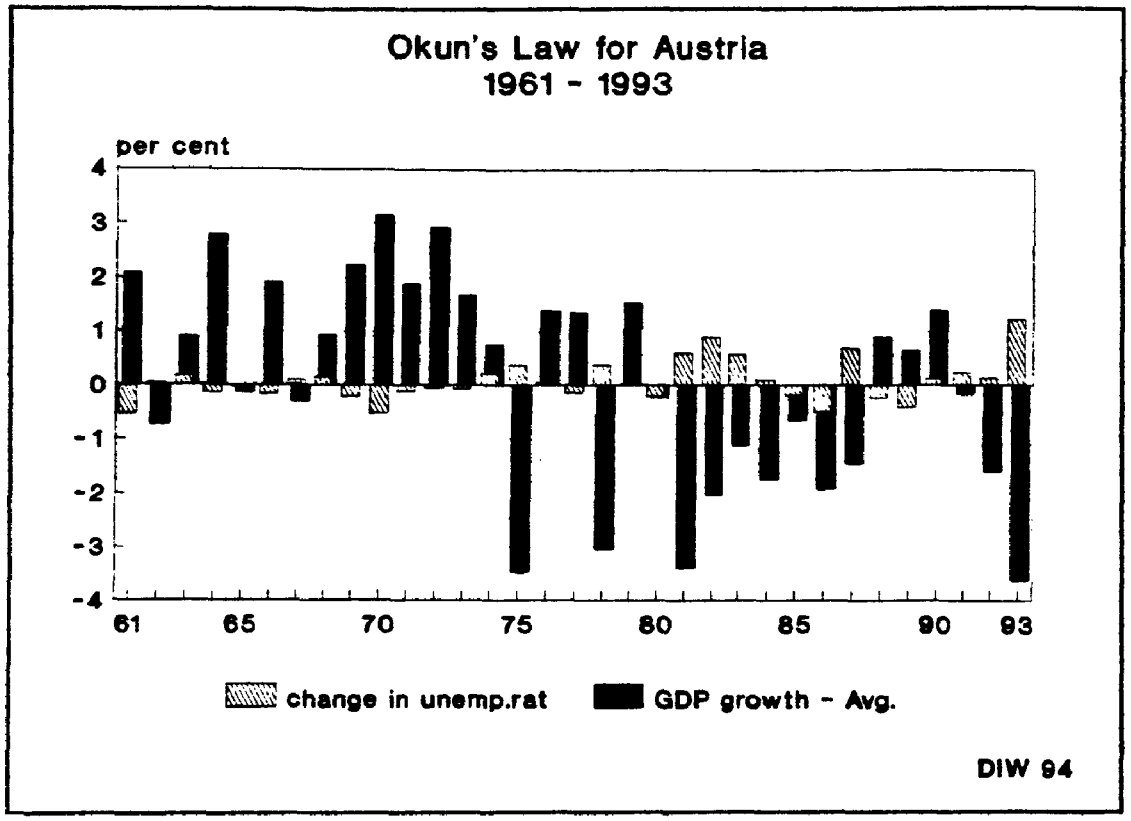


Fig. 54 - Okun's Law for Switzerland, 1961-1993.

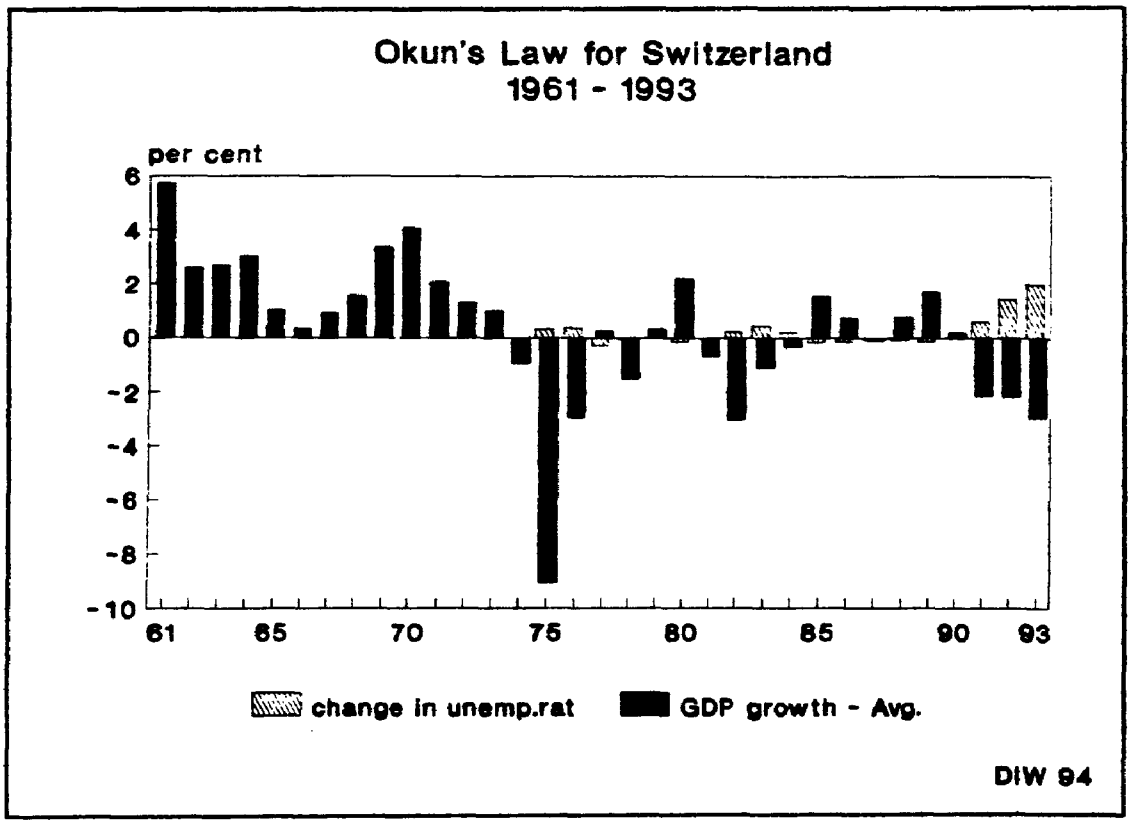


Fig. 55 - Okun's Law for Iceland, 1961-1993.

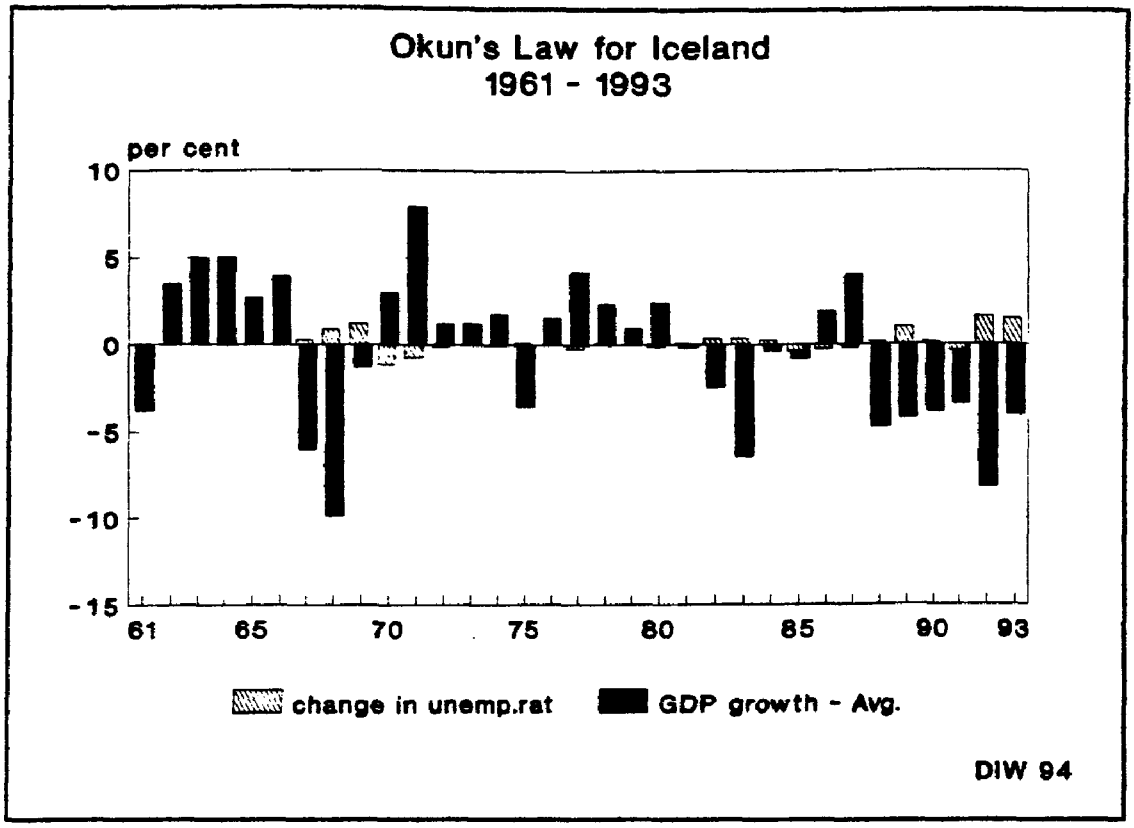


Fig. 56 - Okun's Law for Turkey, 1961-1993.