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PREFACE

Input-output analysis has found widespread empirical application, in studies of how certain industrial sectors react to changes in national and international economic conditions and in static and dynamic investigations of the interrelationships between industries. Since 1979 IIASA has been consistently active in this field, primarily through extensive collaboration with the Inter-Industry Forecasting Program (INFORUM) coordinated at the University of Maryland by Clopper Almon and Douglas Nyhus. IIASA's new aims have been to further the development of econometric input-output models, to assist in the linkage of national models, and to participate in and extend the international network of collaborating scientists.

To date, eighteen national models have been installed at IIASA, the software package SLIMFORP has been distributed widely, and linked runs of some of the national models have been carried out. Furthermore, annual task force meetings on input-output modeling have served to bring together present and prospective members of the INFORUM-IIASA "family" to review progress and to exchange ideas for further work.

In this paper Peter Mitter (Institute for Advanced Studies, Vienna) and Jiri Skolka (Austrian Institute for Economic Research, Vienna, and also a participant in several recent task force and advisory meetings at IIASA) present the results of an analysis of labor productivity in Austria between 1964 and 1980. The study was carried out as part of continuing work on an Austrian dynamic input-output model within the INFORUM framework, and the results will form the basis for the determination of the model's productivity functions.

Anatoli Smyshlyaev
Patterns of Economic Structural
Change and Industrial Adjustment

Labour Productivity in Austria between 1964 and 1980[1)]

The Austrian Institute for Economic Research and the Institute for Advanced Studies in Vienna are developing jointly an Austrian dynamic input-output model. The work is carried out in the framework of the INFORUM international project (see Almon et al. (1974), or Almon (1979)). The model is prepared in two versions, one is using the 1964, the other one the 1976 input-output table for Austria, both aggregated into 19 industries (definitions of the 19 industries are given in Appendix III). Both models include a number of econometric equations, calculated from time series valued at 1964 or 1976 constant prices. One equation set deals with output, productivity and employment. The interrelationship between their development in time was analysed by the authors first in 1980 on the basis of production data at 1964 constant prices (Mitter, Skolka (1981)), and was repeated after the publication of new time series at 1976 constant prices[2)]. The new results are presented below and partly compared with those of the first study.

The organisation of the study is as follows. Some statistical problems are dealt with first. These are followed by a general overview of productivity development in Austria during the second half of the sixties and in the seventies. The next topic concerns the effects of structural change, followed by an extensive investigation of the interrelation between the output and productivity increases.

Development of Labour Productivity in Austria

The study focuses on labour productivity only; capital[3)] or total factor productivity are not investigated. Labour productivity is understood as the ratio of output of an economic activity to its labour input. Output is measured by value added for the 19 industries (more detailed specifications are given later on), labour input is measured in man-years (on the basis of total working persons, i.e. of employed and self-employed) or in hours. Data on output were taken from the National Accounts of Austria[4)], data on employment were compiled by the two research institutes[5)] participating in the construction of the input-output model.

Basic information on productivity development in Austria between 1964 and 1980 is given in Tables 1 and 2. In both tables time series on output at 1976 constant prices are used, but results of the previous study which relied on the 1964 constant prices are partly reproduced (always in brackets). The period 1964-1980 is divided into three sub-periods: from 1964 to 1968, from 1968 to 1973 and from 1973 to 1980

Table 1

Labour Productivity in Austria between 1964 and 1980
(Value added per man-year, at 1976 and 1964 constant prices)

	Agriculture	Chemicals	Transport and Communications	Non-Metallic Minerals	Food	Textile, Apparel	Electricity, Gas and Water	Mining	Metal Products	Wood, Wood Products	Paper, Publishing	Construction	Trade	Personal Services	Basic Metals	Financing and Business Services	Petroleum	Restaurants and Hotels	Public Administration
	Annual Rates of Increase in Percent																		
1964	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
1965	– 5.9	3.8	4.6	3.6	3.3	3.6	7.1	2.1	5.6	5.8	4.6	2.3	3.2	1.4	– 1.0	3.9	17.8	– 1.2	0.9
1966	10.1	7.2	5.5	9.6	11.8	3.0	9.6	0.9	5.9	8.4	4.7	7.8	3.8	2.2	9.2	3.7	5.1	4.7	1.9
1967	20.6	7.1	0.3	6.6	4.4	5.7	– 0.5	– 0.2	5.1	2.5	1.1	5.9	1.9	2.1	– 2.0	3.5	11.9	– 1.5	1.2
1968	3.3	11.7	5.1	7.5	3.7	8.7	3.7	13.9	8.2	11.4	6.3	8.0	4.6	2.9	17.7	3.0	7.6	– 1.0	0.9
1969	5.6	4.7	11.1	8.1	7.6	12.4	4.3	12.3	11.5	10.5	3.7	4.0	3.5	3.2	14.0	4.0	5.2	2.3	0.3
1970	8.2	7.1	11.1	8.8	7.2	4.7	11.1	6.8	5.0	5.0	2.8	5.5	7.4	4.6	2.6	6.0	9.4	5.7	0.1
1971	– 1.8	3.2	3.8	10.1	6.8	2.7	– 3.5	5.4	1.0	6.4	3.0	8.9	5.0	5.2	– 2.6	0.3	3.6	2.7	0.3
1972	7.9	11.0	7.0	4.0	3.2	8.1	7.6	1.0	8.1	8.3	7.6	2.3	6.2	3.2	6.6	– 0.1	– 3.0	2.1	– 0.4
1973	11.4	6.5	7.5	– 0.7	9.4	5.3	8.8	12.6	– 1.2	– 3.2	7.3	1.1	3.6	6.1	2.7	1.0	9.2	– 1.5	2.9
1974	7.1	6.9	5.2	7.8	1.4	3.2	4.5	6.6	5.5	2.4	3.8	4.6	2.5	5.3	1.4	0.4	– 8.0	0.4	– 0.4
1975	8.5	0.8	– 1.3	– 1.0	0.9	– 1.4	2.0	– 5.0	– 1.7	– 0.7	– 7.3	1.7	– 0.0	2.7	– 18.2	1.0	– 6.0	0.8	– 1.6
1976	6.3	9.5	9.4	6.2	4.8	6.1	4.9	3.8	5.0	10.5	8.1	1.0	3.7	– 1.7	16.2	3.7	1.0	– 4.0	1.4
1977	2.0	4.8	4.3	3.9	2.7	2.0	6.5	– 7.7	8.4	4.6	3.2	1.5	3.8	2.6	– 3.8	5.4	– 4.7	– 3.8	1.2
1978	10.5	5.9	4.5	0.1	2.7	0.6	2.2	4.3	– 0.4	– 5.1	2.4	– 0.9	– 5.0	0.9	9.0	– 0.0	9.2	– 0.7	0.4
1979	5.5	8.5	6.3	10.0	7.2	7.9	9.1	19.4	7.5	7.3	10.2	3.5	4.8	1.5	5.6	2.1	0.6	2.7	1.8
1980	6.8	6.0	4.4	4.9	4.9	4.7	3.3	2.4	7.2	2.2	4.3	0.6	1.4	1.7	– 5.1	2.0	– 9.5	3.3	1.4
	Average Annual Rates of Increase in Percent																		
1964/1980 (prices 1976)	6.6	6.7	5.5	6.2	5.1	5.3	4.3	5.2	5.0	5.0	4.1	4.6	3.9	3.1	3.8	3.0	3.6	0.8	0.3
1964/1977 (prices 1964)	6.8	6.5	5.8	5.4	5.0	4.8	4.8	4.8	4.6	4.6	3.8	3.7	3.4	3.1	2.8	2.3	2.3	0.6	0.1
1964/1968	8.3	7.3	3.7	7.1	6.2	5.1	4.8	3.3	6.0	6.7	3.9	6.1	3.3	2.2	5.2	3.6	9.8	0.5	1.3
1968/1973	5.5	6.5	7.7	6.5	6.5	6.1	5.1	6.6	4.7	5.7	4.7	4.8	5.4	4.5	3.5	2.1	4.3	2.5	– 0.4
1964/1973	6.7	7.0	6.4	7.2	6.3	6.4	4.7	6.4	6.0	6.8	4.2	5.6	4.5	3.4	5.8	3.0	6.7	1.7	0.3
1973/1980	6.5	6.0	4.8	4.2	3.5	3.1	4.7	2.4	4.3	3.0	3.4	1.5	1.4	1.5	1.1	2.3	– 1.5	– 0.8	0.7
	Relative Productivity Levels in Percent (Productivity Level in the Economy = 100)																		
1976 prices: 1964	36.2	84.6	72.0	92.8	106.4	53.2	283.8	96.3	81.6	63.2	100.2	96.1	115.1	142.1	119.7	219.4	596.2	98.2	126.2
1980	53.8	126.2	92.4	119.5	127.9	61.2	336.3	109.0	96.7	71.3	102.6	91.7	102.2	119.1	101.5	177.0	502.1	59.3	73.0
1964 prices: 1964	49.4	169.7	99.4	139.0	133.9	71.4	321.2	110.6	89.8	79.6	114.3	103.7	138.1	106.5	132.0	172.0	500.1	74.4	86.3
1977	60.8	220.7	107.0	168.9	143.7	75.6	323.1	107.4	95.1	86.1	108.7	102.3	125.8	86.6	114.6	149.3	462.4	43.5	61.1

Table 2

Output, Output per Man-Year and Economically Active Persons in Austria between 1964 and 1980

	Agri-culture	Chemi-cals	Transport and Communi-cations	Non-Metallic Mine-rals	Food	Textile, Apparel	Elec-tricity, Gas and Water	Mining	Metal Products	Wood, Wood Products	Paper, Publi-shing	Con-struction	Trade	Perso-nal Services	Basic Metals	Finan-cing and Business Services	Petro-leum	Restau-rants and Hotels	Public Admini-stration
								Percentage Shares of the Gross Domestic Product1)											
1976 prices: 1964	7.43	1.59	4.73	1.77	4.77	3.75	2.62	0.99	8.00	2.11	2.36	8.48	13.62	5.49	2.59	8.75	1.92	3.93	15.08
1980	5.03	2.93	6.32	1.87	4.85	2.63	3.38	0.52	11.01	2.29	2.11	7.78	13.93	3.88	2.17	11.72	1.39	3.00	13.22
1964 prices: 1964	9.57	3.00	6.05	2.50	5.66	4.75	2.79	1.07	8.31	2.50	2.54	8.64	15.42	3.81	2.70	6.39	1.54	2.81	9.95
1977	6.15	5.05	7.02	2.60	5.59	3.47	3.23	0.55	10.54	2.66	2.26	8.78	16.30	2.60	2.37	8.75	1.28	2.08	8.74
								Average Annual Rates of Increase in Percent (Output at 1976 Prices)											
Output (Value added)	2.01	8.49	6.40	4.44	4.24	1.95	5.92	0.13	6.31	4.86	3.36	3.90	4.60	2.05	3.25	6.17	2.14	2.43	3.38
Labour Productivity	6.79	6.54	5.75	5.40	4.96	4.83	4.83	4.77	4.62	4.60	3.81	3.70	3.37	3.11	2.82	2.31	2.28	0.57	0.08
Economically Active Persons	– 4.48	1.83	0.61	– 0.91	– 0.69	– 2.75	1.04	– 4.43	1.61	0.24	– 0.43	0.19	1.19	– 1.03	0.42	3.77	– 0.14	1.85	3.30
								Percentage Shares of Total Economically Active Persons											
1964	19.22	1.76	6.14	1.79	4.20	6.61	0.87	0.96	9.18	3.12	2.21	8.26	11.07	3.62	2.02	3.73	0.30	3.75	11.19
1980	9.00	2.23	6.59	1.50	3.65	4.14	0.97	0.46	10.96	3.10	1.98	8.15	13.13	3.13	2.06	6.37	0.27	4.88	17.43

1) Gross domestic product less value added tax plus imputed bank service charges.

(the first two subperiods were used also in the earlier investigation). Table 1 gives yearly productivity increases and productivity levels (per capita output) in the starting and closing years of the investigation periods, Table 2 depicts the elementary relationships between output, productivity and employment. In both tables, industries are ranked by the average rate[6] of labour productivity increase between 1964 and 1980.

Some general features of the productivity development in Austria between 1964–1980 do not confirm certain ex ante expectations. The high ranking of agriculture and chemicals on the one hand and the low ranking of public administration and of hotels and restaurants on the other hand could be expected. Unusual, however, are the rankings of transport (third from the top) and of crude petroleum and oil refining (third from the bottom) which both contradict the broadly accepted view that productivity grows rapidly in production of goods and slowly in services[7]. Changes in the structure of employment by industries were (see Table 2) shaped by differences in productivity growth rates more strongly than by differences in output growth rates (which reflect the differences in the rates of increase in domestic and foreign demand). A similar causation was also found in a cross-country study on Western European economies (ECE, 1982).

The shift from the 1964 to the 1976 price base had a strong, but foreseable impact on the measures of the output structure: it raised the shares of industries with slow productivity and fast price growth (i.e. in public administration, restaurants and hotels, petroleum, financing and business services and personal services) and lowered the shares of industries with fast productivity and slow price increases at the top and in the middle of the scale.

Tables 1 and 2 contain no data on average productivity growth rates in the whole economy. The new UN System of National Accounts (1968) allows three slightly different measures, which are shown for Austria in Table 3. Productivity in the whole economy is most frequently measured as a ratio of gross domestic product to total number of economically active persons. Productivity growth rates according to this definition (they are given in the first two columns of Table 3) are, however not equal to the weighted arithmetic average of productivity growth rates by industries (as given in Table 1). The summed value added by industries is equal to the gross domestic product only if indirect taxes (in Austria value added tax levied both on domestic output and imports) is added and total banking services charges are subtracted. In table 3 value added tax is subtracted from the GDP in the first adjustment step. Since the tax cannot be attributed to the work of any economi-

Table 3

Labour Productivity Growth in the Austrian Economy between 1964 and 1980

Year	Total Output Measured by:							
	Gross Domestic Product at 1976 Prices		Gross Domestic Product less Value Added Tax at 1976 Prices		Gross Domestic Product less Value Added1) Tax plus Imputed Bank Service Charges at 1976 Prices		1964 Prices	
	Index 1964=100	Annual Growth Rate in Per Cent	Index 1964=100	Annual Growth Rate in Per Cent	Index 1964=100	Annual Growth Rate in Per Cent	Index 1964=100	Annual Growth Rate in Per Cent
1964	100.00		100.00		100.00		100.00	.
1965	103.55	3.55	103.36	2.72	103.64	3.64	103.46	3.46
1966	110.03	6.25	109.80	5.18	110.22	6.35	110.27	6.58
1967	115.15	4.65	115.03	2.97	115.67	4.95	115.84	5.06
1968	121.37	5.41	121.27	4.09	122.13	5.59	122.57	5.80
1969	128.08	5.53	128.17	5.62	129.22	5.81	130.38	6.37
1970	135.91	6.11	135.85	6.37	137.26	6.22	139.03	6.63
1971	141.19	3.89	140.60	4.71	142.38	3.73	144.47	3.92
1972	148.87	5.44	147.82	5.90	149.71	5.15	152.08	5.27
1973	153.56	3.14	152.65	5.01	154.75	3.37	157.32	3.44
1974	158.13	2.98	157.56	4.18	159.94	3.35	163.02	3.63
1975	158.26	0.08	157.28	– 0.62	160.05	0.07	161.93	– 0.67
1976	164.59	4.00	163.72	4.67	166.88	4.26	169.91	4.93
1977	170.17	3.39	169.15	4.29	172.80	3.55	174.43	2.66
1978	170.60	0.25	170.03	0.78	174.29	0.86	–	–
1979	178.58	4.68	178.23	5.03	183.29	5.16	–	–
1980	183.69	2.86	183.50	3.22	188.93	3.08	–	–
ϕ 1964/1980		3.87		3.86		4.03	–	–
ϕ 1964/1968[2)]		5.06		5.05		5.23		–
		(5.32)		(5.16)		–		(5.34)
ϕ 1968/1973[2)]		4.87		4.72		4.86	–	–
		(5.26)		(4.94)		–		(5.13)
ϕ 1964/1973		5.09		5.03		5.19		–
ϕ 1973/1980		2.56		2.62		2.86		–

1) In the time series at 1964 constant prices only import duties and import taxes were subtracted.
2) Average growth rates calculated from data valued at 1964 constant prices are in brackets.

cally active person the resulting figures in the third and fourth columns reflect the best measure of productivity development in the whole economy. Figures in the last four columns of table 3 include the banking service charges and thus are averages of productivity across industries.

A comparison of the growth rates which are in brackets with those which are not (i.e. a comparisons of results at the 1964 and 1976 constant prices) shows, that an introduction of a more recent pricing base has generally lowered rates of productivity growth. The extraordinarily long use of an outdated price base of 1964 in Austria has in the seventies caused an overestimation of output and productivity growth rates and, consequently, an underestimation of the rate of inflation. Such differences of output growth rates in different systems of constant prices are consistent with index number theory under the assumption that increases in output and in prices are inversely correlated. (See, inter alia, Brody (1980), who refers to the classical paper by Bortkiewicz (1923)).

In table 3 one can see that the three measures of productivity growth for the whole economy are not identical. The figures in the middle of the table (i.e. in the third and fourth columns), which are the best measure of productivity development, are however seldom used in economic analysis. In the 1976 pricing system, they are relatively close to productivity growth rates measured by GDP. Total value added by industries overestimates the productivity growth (both in the whole economy and in individual industries). Bank service charges (included in value added by industries) grew evidently faster than output. In the 1964 pricing system both GDP and total value added by industries overestimate the output and productivity growth. The increase in output per man-year in Austria slowed down after 1973. Similar retardation in productivity growth was observed earlier in the United States (Nordhaus (1972), Denison (1979), Norsworthy, Harper, Kunze (1979)), and occured in the seventies to other industrial countries[8]. This productivity slowdown is usually explained by the following four causes:

1. Technological gap of Western Europe and Japan behind the United States has narrowed, it is now less easy to raise productivity by copying American technology. Japan and Europe will have to share with the United States their contribution to future technical progress.

2. The economic structure in developed countries has changed. Easy productivity gains by shifting labour from agriculture to manufacturing are no longer possible.

3. Some administrative measures adopted in the seventies created obstacles for productivity growth.

4. The recession in the seventies has reduced capital formation and the simultaneous inflation has weakened price competition. A period of negative real interest rates had a negative effect on the efficiency of resource allocation (Giersch, Wolter (1982)). All that had a negative impact on productivity growth.

In this paper, only the following three potential causes of the retardation the growth of output per man-year in Austria in the seventies will be investigated:

1. Structural changes.

2. Reduction of the duration of the working time.

3. Retardation in output growth.

Other tentative causes of slower productivity growth will not be considered. The measurement of some of them is difficult, or (for example for the interrelation between investment and productivity increases) econometric analysis of available data gave no usable or convincing results.

Structural change and productivity growth

Productivity development in the whole economy has a structural component, which is caused by changes in the composition of output and employment by industries[9]. It will be assumed here that "primary" structural shifts are shifts in the composition of output, caused by changes in domestic and foreign demand[10]. They influence productivity performance in the whole economy because of (i) different productivity growth rates and (ii) different productivity levels (i.e. different values of output per man-year) in particular industries.

The magnitude of the impact of those structural effects on productivity growth rates will be calculated with an index formula (described exactly in Appendix I), which at first assumes constant (instead of the actual changing) industrial output shares on the GDP in time. The difference between the resulting hypothetical productivity development and the actual one is the magnitude of the structural effect. It is further decomposed into the effect of changes in the allocation of labour among industries with different productivity growth rates on the one hand

and into a weighted effect of different productivity levels by industries on the other. The calculations were carried out for productivity data for 19 industries given in table 1. Structural effect is investigated for their average productivity, i.e. for productivity growth measured by gross domestic product less indirect taxes plus imputed bank service charges.

In table 4 one finds first the actual productivity development in the Austrian economy, in the first column at the 1976, in the second column at the 1964 constant prices (see also the fifth and the sixth column of Table 3). The next three columns (i.e. third, fourth and fifth one) give the hypothetical productivity development under the assumption of constant output shares. Columns three and four contain calculations at the 1976, column five at the 1964 constant prices. 1976 constant output shares are used in column three, 1964 output shares in the other two columns. Data in column three are interesting only from theoretical point of view (they show effects of the projection of the standard output structure in 1976 both back to 1964 and forward to 1980). Columns four and five use the structure of 1964, differences in results are caused by the use of 1964 and 1976 prices, respectively.

The two hypothetical productivity developments at the 1976 prices and at the 1964 prices are compared with the actual productivity development. Their difference gives the magnitude of the total structural effect (columns six, seven and eight). Data in column six are again interesting only from a theoretical point of view. The other two columns do not differ much. Both show a slightly positive total effect of the structural change on the productivity development in the Austrian economy between 1964 and 1980, which raised the average annual productivity growth rate by 0.36 percentage points. The positive effect, however, declined in time, from 0.85 percentage points between 1964 and 1968, over 0.52 percentage points between 1968 and 1973 to 0.06 percentage points between 1973 and 1980 (see column seven). This means that the decline in the overall productivity growth rate in the Austrian economy between the 1964/1968 and 1968/1973 periods from 5.23 to 4.86 percent, i.e. by 0.37 percentage points (see column one of table 4) is almost fully accounted for by the decline in the positive structural effect from 0.85 to 0.52 i.e. by 0.33 percentage points. On the contrary, the strong decline in productivity growth in the whole economy between the 1968/1973 and 1973/1980 periods by 2 percentage points can be only partly explained by the decline in the positive structural effect by 0.46 percentage points. Data for individual years show, that the structural effect started to be very low or negative in 1973 (its rather high value in 1977 is probably due to the sudden reduction of the number of

Table 4

Structural Effects in the Productivity Development of the Austrian Economy 1964-1976
(Productivity and output at constant 1964 and 1976 prices)

	Productivity growth in the whole economy (Annual rates of increase in percent)					Effect of Structural changes								
						Total			Effect of employment structure			Effect of productivity levels		
	Actual1)		Weighted with output shares of			Weighted with output shares of			Weighted with output shares of			Weighted with output shares of		
Constant prices	1976	1964	1976	1964	1964	1976	1964	1964	1976	1964	1964	1976	1964	1964
			1976	1976	1964	1976	1976	1964	1976	1976	1964	1976	1976	1964
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1965	3.64	3.48	2.75	2.54	2.56	0.89	1.10	0.90	+ 0.08	+ 0.10	+ 0.10	0.81	1.00	0.80
1966	6.35	6.58	5.00	5.40	5.89	1.35	0.95	0.69	+ 1.04	− 0.02	− 0.01	0.31	0.97	0.70
1967	4.95	5.06	3.36	4.13	4.72	1.59	0.82	0.34	+ 1.52	− 0.64	− 0.53	0.07	1.36	0.89
1968	5.59	5.80	4.76	5.09	5.62	0.83	0.50	0.18	+ 0.56	− 0.17	− 0.16	0.27	0.67	0.34
1969	5.81	6.37	5.10	5.54	6.17	0.71	0.27	0.20	+ 0.57	− 0.23	− 0.23	0.14	0.50	0.43
1970	6.22	6.63	5.45	5.77	6.40	0.77	0.45	0.23	+ 0.58	− 0.27	− 0.26	0.19	0.72	0.49
1971	3.73	3.92	2.74	2.91	3.20	0.99	0.82	0.72	+ 0.30	+ 0.04	+ 0.10	0.69	0.78	0.82
1972	5.15	5.27	3.97	4.39	4.80	1.18	0.76	0.47	+ 0.59	− 0.41	− 0.47	0.59	1.17	0.94
1973	3.37	3.44	2.57	3.39	3.53	0.80	− 0.02	− 0.09	+ 0.46	− 1.13	− 0.88	0.34	1.11	0.79
1974	3.35	3.63	2.76	3.14	3.66	0.59	0.21	− 0.03	+ 0.23	− 0.75	− 0.63	0.36	0.96	0.60
1975	0.07	− 0.67	− 0.38	− 0.05	− 0.21	0.45	0.12	− 0.46	+ 0.09	− 1.39	− 1.31	0.36	1.51	0.65
1976	4.26	4.93	4.03	4.24	5.22	0.23	0.02	− 0.29	+ 0.05	− 0.72	− 0.65	0.18	0.74	0.36
1977	3.55	2.66	3.15	2.93	2.45	0.40	0.62	0.21	+ 0.01	− 0.11	− 0.41	0.39	0.73	0.62
1978	0.86		0.70	1.31		0.16	− 0.45		− 0.13	− 1.69		0.29	1.24	
1979	5.16		4.95	5.27		0.21	− 0.11		− 0.12	− 0.67		0.33	0.56	
1980	3.08		2.89	3.10		0.19	− 0.02		− 0.13	− 0.72		0.32	0.70	
ϕ 1964/1980	4.03		3.31	3.67		0.72	0.36		0.38	− 0.68		0.34	0.94	
ϕ 1964/1968	5.23	5.34	4.01	4.38	4.81	1.22	0.85	0.53	0.90	− 0.18	− 0.17	0.32	1.03	0.70
ϕ 1968/1973	4.86	5.13	3.95	4.34	4.76	0.91	0.52	0.37	0.49	− 0.33	− 0.29	0.42	0.85	0.68
ϕ 1964/1973	5.19		4.19	4.58		1.00	0.61		0.67	− 0.26		0.33	0.87	
ϕ 1973/1980	2.86		2.55	2.80		0.31	0.06		0.01	− 0.87		0.30	0.93	

1) See Table 3, Columns 6 and 8.

economically active persons in agriculture after the introduction of a pension scheme for farmers).

The decomposition of the total structural effect into the productivity growth and productivity level effects helps to understand its changes between 1964 and 1980 (the results are again similar in the 1976 and 1964 pricing systems). The productivity level effect of the shifts towards industries with higher per capita value added was positive and stable in time. It amounted to 0.94 percentage points annually for the whole period from 1964 to 1980: the average annual values for three subperiods were: 1964/1968: 1.03; 1968/1973: 0.85 and 1973/1980: 0.93 (see column 13 in Table 4). That means that shifts towards industries with higher productivity levels (one can see these shifts clearly in tables 1 and 2) have contributed almost one percentage point to average productivity growth rate in the Austrian economy. But productivity levels in these industries are high because their productivity growth rates were and are permanently low and cause high relative prices of their output. Permanent differences in productivity growth emerge at any, i.e. also the 1964 and 1976 relative prices, used as the yardstick in national accounts (see Baumol (1967) or Skolka (1977)). On the other hand one can see from data given in column 10 (in column 11 at the 1964 prices), that except for 1964 and 1971 (low positive effects) the structure of employment in Austria steadily moved towards industries with lower productivity growth rates. The contribution of this structural shift to the overall productivity growth rate in whole period from 1964 to 1980 was equal to -0.58 percentage points annually. The average annual value was -0.18 between 1964 and 1968, it declined to -0.33 between 1968 and 1974, and to -0.87 between 1973 and 1980. The negative effects of shifts towards industries with slow productivity growth after 1973 are remarkable (in particular the large negative effects in 1975 and 1978), but not large enough to explain the strong decline in the productivity growth rates in the whole economy after 1973.

How far was the structural effect responsible for the decline in productivity growth rates in Austria during the period 1964 and 1980? Between 1964 and 1973 the decline in the overall productivity growth rate in Austria was rather small, and can be to a large degree attributed to the decline of the positive structural effect. But after 1973 a further reduction of the positive structural effect was much smaller than the decline in the overall productivity growth.

The development of the per-hour productivity

Measurement of productivity development by value added per man-year establishes

a direct link between output, productivity and employment but ignores the effect of changes in the duration of the working time on the output volume. Productivity measured by value added per man-hour takes into account both prolongation of the normal working time by overtime, as well as reductions in working time by law, strikes, sickness or part-time work.

Normal working time in Austria was reduced in 1970 (a reduction of the working week from 45 to 43 hours), in 1972 and in 1975 (step-wise reductions to 42 and 40 hours, respectively). In 1977 the minimum annual leave was prolonged from three to four weeks. Between 1964 and 1980 there were no significant changes in the duration of the average sick-leave per man, and strikes were negligible.

Table 5 contains data on gross domestic product per hour worked in Austria between 1964 and 1980, both at 1976 and 1964 constant prices. The time profiles of both series and their differences to the per-man productivity development are of interest. The average annual rate of increase in the per-hour productivity in Austria between 1964 and 1980 (at 1976 prices) was 5.0 percent, i.e. 1.1 percentage points higher than the annual rate of increase in the per-man productivity (see column 2 in table 3): 22 percent of the per-hour productivity increase were consumed by working time reduction. The three subperiods between 1964 and 1980 are very different. Between 1964 and 1968, the per-hour productivity grew by 5.9 percent and the per-man productivity by 5.1 percent annually. The difference is 0.8 points, i.e. 16 percent of the per-hour productivity increase was consumed by the reduction of working hours. In the following period 1968/1973 the per-hour productivity grew faster than during the preceding one, i.e. by 6.4 percent a year. The increase of the per-man productivity by 4.9 percent annually was slower than in the preceding period. The difference, i.e. 1.5 points or 24 percent of the annual rate of increase in the man-hour productivity, was consumed as shorter working time. In the last period from 1973 to 1980, the per-hour productivity rose by 3.8 percent, and the per-man productivity by 2.6 percent a year only. The difference of 1.2 points or 32 percent of the former rate of increase was due to the reduction of the working hours.

These data complement partly those in the preceding paragraph. The period between 1964 and 1980 can be divided into two halves with 1973 as the dividing point. In the first half the increase in the per-hour productivity was fast with a slight tendency to accelerate. The average annual rate of increase of the per-man productivity, however, declined, partly due to changes in the structure of output and partly due to larger reductions in the duration of the working time. After 1973

Table 5

Labour productivity in Austria between 1964 and 1980
(Annual rates of increase of value added per hour in per cent)

Year	at constant prices of 1976	at constant prices of 1964
1965	5.8	5.8
1966	6.6	7.1
1967	6.0	6.2
1968	4.8	5.2
1969	6.1	6.9
1970	8.2	8.9
1971	5.9	6.1
1972	6.6	6.7
1973	4.1	4.5
1974	2.6	2.9
1975	3.4	2.2
1976	5.8	7.4
1977	3.6	3.1
1978	1.5	
1979	5.1	
1980	3.9	
ϕ 1964/1980	5.0	–
ϕ 1964/1968	5.9	6.2
ϕ 1968/1973	6.4	6.8
ϕ 1964/1973	6.2	–
ϕ 1973/1980	3.8	–

the rate of growth in the per-man productivity fell sharply from 5.1 percent (1964-1973) to 2.6 percent (1973-1980), i.e. by 2.5 percentage points. The decline in the per-hour productivity growth rate was parallel, from 6.2 to 3.8 percent, i.e. by 2.4 percentage points. One third of the increase in the per-hour productivity was consumed by working time reductions.

Retardation of Output Growth and Productivity Slowdown.

Even after consideration of working hours reduction since 1973 the slowdown of labour productivity growth is not yet fully explained. There was also a retardation of output growth in this period (see table 3). A synchronism of that kind is not restricted to a unique situation in the seventies, and also not to periods of decreasing economic activity. Growth models for the explanation of such a relation go back to Tinbergen (1942) and Verdoorn (1949,1951) who deduced that in the steady-state of an expanding economy there is a constant elasticity of labour productivity with respect to output ("Verdoorn's law"). Verdoorn checked his finding in inter-country, inter-industrial, and inter-temporal regressions arriving at an elasticity value of about 0.5. In the sequel there was some vagueness whether the correct relation between the two growth rates should rather be a linear one, and even Verdoorn himself used both a linear and a constant ratio model. As the latter can be seen as a special case (intercept zero), and as the former can be derived from the Tinbergen-Verdoorn growth model (see Appendix II), the more general version of a linear model is used here (this is in accordance with most empirical studies).

Verdoorn's law was re-discovered (and subsequently made well-known) by Kaldor (1966,1967) who added new arguments. According to him, the "macro-phenomenon" of increasing returns is the fundamental explanation of the empirical relationship investigated by Verdoorn. As technological progress and learning by doing enters into it, it should be regarded as a dynamic relationship concerned with the rates of change of productivity and output (rather than being a static one relating the levels). It is a phenomenon particularly associated with the so-called secondary activities (manufacturing, public utilities, construction), due to Kaldor's view that these activities are subject to economies of scale while the activities of the other sectors are not. Empirical studies based on Verdoorn's (or Kaldor's) law consequently concentrate on manufacturing industries. Methods chosen are usually cross-country or cross-industry regressions of average growth rates (see e.g. ECE (1977) or Giersch and Wolter (1982) for advanced economies, UNIDO (1979) for developing countries), but time series are also investigated (see e.g. Wenban-Smith (1981) or

Felli (1981)). Carlsson (1980) found out similar effects in a micro-level study on Swedish enterprises.

In the non-manufacturing activities one can also expect to find a relation between the growth rates of output and productivity. Productivity gains in the primary sector are to a large extent induced by the growth in industrial production either directly (by increased mechanisation) or indirectly (by absorption of surplus labour). A positive correlation between industrial and agricultural production will result in a Verdoorn-like relation also in the primary sector and even in the case of diminishing returns. Moreover, there are effects of learning by doing, spread of knowledge and large scale production methods also in the primary and, even stronger, in the tertiary sector. In the latter case the problem lies in the inadequacies in measuring output, which makes productivity at least partially an artificial notion. While some authors claim that in many service industries productivity grew faster than in the whole economy (Fabricant (1972)), it may happen that Verdoorn estimates in the tertiary sector are heavily biased by measurement errors (McCombie (1981)).

Table 6 shows Verdoorn estimates for the Austrian economy. At first sight the relation is considerably stable, both with 1964 and 1976 prices. The stability was tested by means of a Chow test, confirming the no change hypothesis. Moreover, the differences between the parameter estimates based on 1964 prices and those based on 1976 prices are small and correspond to different values of output growth rates. One can conclude that the effects of a slowdown in output growth on employment are not as bad as could be expected on the basis of a naive extrapolation of productivity growth. Without a reduction of the (annual) working time, a loss in output growth of 1 percentage point results in a loss in employment growth of 1/3 percentage point approximately. Recent long-term forecasts of labour demand in Austria are based on similar assumptions (see e.g. Beirat für Wirtschafts- und Sozialfragen (1980), Clement et. al. (1980), Mitter (1982)). On the other hand, activities to reinforce output growth might be insufficient to absorb a large expansion of labour supply resulting from demographic shifts, as will be the case in Austria till the middle of the eighties. Moreover, productivity losses in the slowdown period cannot be compensated for solely by return to the growth path of the sixties and early seventies, but only by a period of extraordinary fast output growth.

There is one clear difference between the estimates based on 1976 prices and those on 1964 prices: the goodness-of-fit when using 1976 prices is much worse than when

Table 6

Verdoorn Relation

	1964 prices	1976 prices
1964/1973	p = 0.544 y + 3.308 (0.237) (1.256)	p = 0.436 y + 3.929 (0.296) (1.465)
	R^2 = 0.43 DW = 1.80	R^2 = 0.24 DW = 1.62
1964/1977	p = 0.614 y + 2.629 (0.143) (0.720)	
	R^2 = 0.65 DW = 1.75	
1964/1980		p = 0.635 y + 2.457 (0.177) (0.781)
		R^2 = 0.48 DW = 1.37

p = percentage change in real GDP per hour worked
y = percentage change in real GDP
Standard errors in parentheses.

using 1964 prices. For the period 1964/73 only one quarter of the variation in productivity growth is explained by variations in output growth. For the total period 1964/80 still only about 50 % of the variation is explained.

It is difficult to give an interpretation of this result. The relation between industry-level Verdoorn effects and any total economy Verdoorn effect - if there exists such a one - is extremely complex. Even in the case of strong and identical effects on the industry level there is no guarantee of finding a similar relation for the whole economy. The inclusion of tertiary branches where the validity of the Verdoorn effect is not as clear as in manufacturing adds further perturbations.

The worse goodness-of-fit when using 1976 prices however vanishes on the industry level. To be more precise: for nearly all primary and secondary industries the goodness-of-fit when using 1976 prices is better than or at least as good as when using 1964 prices, for nearly all tertiary industries it is exactly the other way round. This does not necessarily mean that there is no significant relation between output and productivity growth in the tertiary industries, but the relation may be of another kind. One should remember that in the tertiary sector output frequently more or less equals input, and assumptions on productivity growth directly enter the computation of output growth at constant prices.

Table 7 contains the Verdoorn estimates at the industry level for the whole period 1964/80 as well as for the three sub-periods. All regressions are of the following type: productivity growth = a + b.output growth. The estimates for agriculture reflect the steady decrease of its employment share to a present value of 9 % which still is relatively high. The a estimate accounts for most of the decrease in employment, in the first line because of inter-generational mobility out of agriculture. As more than 80 % of all economically active persons in agriculture are self-employed farmers or family helpers, the decline in employment corresponds to a decline in the number of firms. Of course, mobile persons do more easily to find an appropriate job in boom periods than in recessions, and this fact also accounts for the relatively high b estimate.

Shifts in the firm structure also account for the (measured) productivity increase (employment decrease) in mining. Activity losses in branches with small rentability (salt and coal mining) increase total productivity levels. The strong role of state enterprises in mining may also account for the high b estimate, because there is a tendency not to reduce employment in recessions.

Table 7

Verdoorn Relation at the Industry Level
Per-hour Productivity (growth rates in Percent)

Industry	1964/1980				1964/1968				1968/1973				1973/1980			
	a	b	R^2	DW	a	b	R^2	DW	a	b	R^2	DW	a	b	R^2	DW
Agriculture and Forestry	5.44+	0.96+	0.85	2.20	6.57*	1.02*	0.97	1.31	5.97+	0.96+	0.96	2.27	4.60*	0.89	0.52	1.43
Mining and Quarrying	5.65+	0.84+	0.50	2.60	7.82	0.96	0.67	0.70	5.04*	1.13+	0.95	1.72	4.43	0.78	0.38	2.18
Manufacture of Food, Beverages and Tobacco	3.94+	0.47+	0.43	1.67	2.27	0.85*	0.95	2.42	4.51	0.42	0.56	1.45	5.03+	−0.05	0.01	1.03
Textile, Wearing Apparel and Leather Industries	4.59+	0.57+	0.84	2.38	5.42	0.29	0.13	2.28	4.03+	0.66+	0.97	3.03	4.31+	0.54+	0.90	1.18
Manufacture of Wood and Wood Products	1.68	0.81+	0.72	1.26	3.98*	0.71*	0.95	2.23	−0.24	1.12*	0.80	1.08	1.17	0.72*	0.75	1.95
Manufacture of Paper and Paper Products Printing and Publishing	1.67*	0.95+	0.85	2.70	3.14*	0.52	0.87	1.77	1.89	0.72	0.44	2.72	1.82*	1.09+	0.95	2.48
Manufacture of Chemicals	5.43+	0.23	0.15	2.95	1.62	0.73	0.45	1.09	−1.10	0.72	0.21	2.15	5.76+	0.20	0.33	2.46
Crude Petroleum, Natural Gas and Petroleum Refineries	1.18	1.14+	0.83	1.20	3.50	1.33	0.87	0.77	−2.89	1.58*	0.88	1.46	−0.20	0.82+	0.89	3.03
Manufacture of Non-Metallic Mineral Products	4.13+	0.55+	0.53	1.39	3.84*	0.75*	0.92	2.36	1.85	0.81	0.54	1.19	4.57+	0.42*	0.63	1.31
Basic Metal Industries	0.84	0.92+	0.89	1.83	2.59	0.90*	0.95	1.94	−0.08	1.03*	0.90	2.21	0.09	0.89+	0.89	1.51
Manufacture of Fabricated Metal Products, Machinery and Equipment	2.77*	0.49+	0.50	2.17	5.02	0.30	0.52	2.53	−5.35*	1.17+	0.98	1.85	3.59*	0.41*	0.59	2.94
Electricity, Gas and Water	0.69	0.89+	0.77	2.56	−1.92	1.27*	0.98	1.96	−0.38	1.06+	0.97	2.50	4.20*	0.23	0.17	1.29
Construction	3.12+	0.38	0.22	1.57	5.34	0.21	0.17	0.88	1.49	0.63	0.30	1.17	3.19*	−0.49	0.25	1.58
Trade	−0.34	1.03+	0.83	1.66	1.54	0.53	0.71	2.69	−0.64	1.12	0.54	0.89	−0.32	1.01+	0.88	2.05
Restaurants and Hotels	−0.81	1.00+	0.77	2.98	−0.59	0.84	0.83	2.01	0.04	0.84*	0.77	3.28	−1.87	1.41+	0.79	3.08
Transport, Storage and Communication	0.98	0.86+	0.65	1.66	1.35	0.73*	0.91	2.16	−0.84	1.14	0.57	1.83	1.73	0.65	0.44	1.56
Financing, Insurance, Real Estate and Business Services	−0.86	0.65	0.21	2.67	−5.22	1.43	0.65	2.62	−2.02	0.74	0.17	1.30	−0.59	0.61	0.17	2.75
Social and Personal Services	2.17*	0.67	0.23	0.85	2.88	−0.40	0.39	2.89	3.05	1.25	0.37	0.93	−0.98	1.30*	0.73	1.49
Public Administration and Defence	−1.58	0.83*	0.31	1.12	1.57	0.04	0.01	1.49	−4.24	1.67*	0.88	1.83	−0.72	0.56	0.14	1.48
Total (GDP)	2.46+	0.64+	0.48	1.37	5.15	0.18	0.07	1.42	−4.69	1.93*	0.81	1.32	2.44*	0.42	0.38	1.91

* significant at the 95 per cent confidence level
\+ significant at the 99 per cent confidence level

With only few exceptions there is a strong and significant Verdoorn relation in the secondary sector. It is rather weak in the chemical and construction industries, and it is not very strong in food production, with generally no improvement if one considers sub-periods only. This might be caused by product-mix effects, and in the case of construction additionally by the fact that variations in seasonal employment patterns are not reproduced accurately by the employment statistics. Although there is a good fit in the petroleum industry, the high b estimate (greater than 1, though not significantly) indicates that the relation is not of a Verdoorn type there. In all other secondary industries the b estimates are grouped around the value for the whole economy (0.64) or Verdoorn's 1949 estimate (0.57, referred to per-man productivity in manufacturing industries), ranging from 0.49 (metal products) to 0.95 (paper and publishing). Once more it turns out that the a and b estimates are negatively correlated ($r=-0.86$), indicating that there might be an overall Verdoorn relation in the secondary sector. On the other hand there are good reasons for industry-specific relations, above all because of wage level differences. In industries with low wage level one could expect that an expansion of production is accompanied by an employment increase mainly, thus giving a low estimate of b. In high wage industries, on the other hand, one could expect that production expansions rather induce the implementation of productivity-increasing investment plans, thus resulting in a high estimate of b. Such a correlation exists in some cases (e.g. petroleum industry or basic metals with high b estimates, food or textile with low b estimates), but it is not of a uniform kind.

Even in the tertiary sector one should expect to find a Verdoorn-type relation, reflecting the customs of the statisticians at least. The goodness-of-fit is considerably good in trade, restaurants/hotels, and transport/communications. It is rather bad in real estate, personal and public services. Because of measurement practices this is rather surprising, but it may be caused by the heterogenous composition of those industries. The negative values of the a estimates in four out of six tertiary industries (though not significantly negative) clearly indicate that in the tertiary sector the relation is not of the same kind as in manufacturing.

As measured productivity is highly artificial in the public sector, and disturbed by surplus labour in agriculture, the aggregate "non-farm business sector" is frequently used instead of the whole economy. The output of this aggregate equals GDP minus GDP originating in agriculture and the public sector, and minus housing rents. Table 8 contains a review of Verdoorn regressions for the non-farm business sector in 13 OECD countries. To enable comparisons, the regressions were calculated on the basis of per-man productivity, and the covered period ends in

Table 8

Verdoorn Relation: Non-Farm Business Sector
Output per worker (percentage change)

	a	b	R^2	DW	a	b	R^2	DW	Chow Statistic
		1964/1978				1964/1973			
Austria	0.53	0.78	0.82	0.95	2.05	0.55	0.43	1.07	0.5
1964 prices	(0.9)	(7.4)			(1.4)	(2.3)			
Austria	0.66	0.73	0.78	0.87	2.29	0.46	0.35	1.38	0.6
1976 prices	(1.2)	(6.5)			(1.7)	(2.0)			
		1960/1978				1960/1973			
Belgium	1.00	0.64	0.77	2.03	1.10	0.59	0.66	2.04	2.9
	(2.3)	(7.6)							
Canada	− 1.70	0.67	0.53	1.17	− 0.80	0.52	0.26	1.34	0.7
	(2.0)	(4.4)			(0.6)	(2.3)			
Finland	1.50	0.30	0.23	2.27	1.40	0.31	0.10	2.30	0.2
	(2.2)	(2.5)			(1.1)	(1.5)			
France	0.90	0.55	0.78	2.07	1.10	0.53	0.49	2.10	0.3
	(2.3)	(7.8)			(1.1)	(3.6)			
Germany	1.90	0.52	0.72	1.57	1.60	0.56	0.77	1.90	2.2
	(5.1)	(6.8)			(3.5)	(6.5)			
Italy	− 0.30	0.86	0.82	1.83	1.50	0.61	0.53	2.20	1.0
	(0.5)	(8.8)			(1.4)	(3.8)			
Japan	− 0.90	0.81	0.83	1.72	− 3.00	0.97	0.74	1.38	0.3
	(1.0)	(9.1)			(1.5)	(6.0)			
Netherlands	0.60	0.71	0.62	0.54	− 0.30	0.83	0.53	0.57	0.5
	(0.8)	(5.4)			(0.3)	(3.8)			
Norway	− 0.70	0.89	0.91	2.68	− 0.80	0.92	0.91	1.98	1.2
	(2.2)	(13.2)			(1.8)	(11.4)			
Sweden	0.40	0.76	0.83	1.91	1.10	0.63	0.84	2.10	4.6
	(1.2)	(9.3)			(2.8)	(7.9)			
United Kingdom	0.80	0.77	0.62	1.22	1.00	0.67	0.13	1.10	0.7
	(1.4)	(5.3)			(1.2)	(3.1)			
USA	− 0.40	0.51	0.61	1.40	− 0.00	0.50	0.59	1.38	2.9
	(0.8)	(5.3)			(0.0)	(4.3)			

t-Statistics in parentheses.

Source: Austria: own computations, other countries: OECD.

1978. The fitness problems mentioned above obviously vanish in this aggregate, the low value of the Durbin-Watson statistic may be caused by a rather slow adaptation of employment to output fluctuations. In many cases it seems that the estimates for a fall and those for b rise when the longer period is compared with the shorter one, indicating a stronger influence of output on productivity after 1973 at the expense of autonomous elements in productivity growth, but the Chow test does not allow the conclusion that there may have been a break after 1973 (only for Sweden the 95 %-critical value is exceeded). In the ECE Survey 1981 essentially the same conclusion of a stable Verdoorn effect is reached.

Conclusions

The study presents data on the development of labour productivity in Austria between 1964 and 1980, based on new national account statistics at 1976 constant prices, classified by 19 industries. The average annual rate of productivity growth during that period in Austria, measured by GDP per man, was 3,9 percent. Differences in growth rates among industries were large, the highest average annual values being those for agriculture (6.8 percent) chemical industry (6.5 percent) and transport and communication (5.8 percent), the lowest ones being for the petroleum industry (2.3 percent), restaurants and hotels (0.6 percent) and for public administration (0.1 percent). Differential productivity growth rates were an important reason for changes in the allocation of labour among industries.

In the seventies, the rate of productivity growth slowed down: the average annual rate of growth declined to one half i.e. from 5.1 percent between 1964 and 1973 to 2.6 percent between 1974 and 1980. The slowdown had many reasons, among which the following three were investigated: (i) Changes in the structure of the economy; (ii) reduction of the duration of working time; and (iii) retardation of ouput growth in the recession after 1974.

We can conclude, that all three factors contributed to the slowdown in the growth of output per man-year in Austria. The per-hour productivity rose between 1964 and 1973 by 6.2 percent annually, between 1973 and 1980 by 3.8 percent annualy. Compared with per-man productivity growth there is a difference, in the first subperiod, of 1.1 percent and, during the second period, of 1.2 percent. This part of the per-hour productivity increase was consumed by reductions of the working hours.

The average rate of growth of output per man was also influenced by structural

shifts. Over the whole period 1964–1980 the contribution of structural shifts to the average rate of productivity growth in the Austrian economy was positive, but can be divided into two different components. The structure of the Austrian economy shifted in favour of industries, which have over-average productivity levels but at the same time low productivity growth rates. The effect of the level differences over the whole period was almost constant, positive and close to one percentage point annually. The growth rate effect was negative, its magnitude increased over time and this shift has contributed to the steady decline of the productivity growth rate in the whole economy.

Even after consideration of working hours reduction and of structural shifts there remains a slowdown in productivity growth which can be explained by a retardation of output growth. A linear relationship between these two growth rates is known as "Verdoorn's law". On the total economy level this relation is significant irrespective of the price base, and there is no breakdown after 1973. When using 1976 prices, however, the fit is much worse than with 1964 prices. This is caused by different effects on the industry level. For nearly all primary and secondary activities the fit becomes better when switching to the more recent price base. Here - as well as on total economy level - a one percent drop in output growth results in some 2/3 percent drop in productivity growth. For nearly all tertiary industries, on the other hand, the switch to 1976 prices deteriorates the goodness-of-fit. This result is in line with Kaldor's view that "Verdoorn's law" concerns a phenomenon particularly associated with the secondary sector.

Causal interpretation of each of the three shifts towards slower productivity growth in the Austrian economy is different. It is easy for the structural effect. For the existing differences of productivity levels and productivity growth rates among industries it can be expected, that on the one hand shifts in the structure of output and employment towards industries with higher productivity levels will contribute positively and more or less equally to the average productivity growth rate in the whole economy, and that on the other hand shifts toward industries with lower productivity growth rates will result in an expanding negative effect. Since productivity growth rates and price increases are negatively correlated, a shift to new constant prices must renew such a constellation of productivity levels and productivity growth rates and slightly reduce the average rate of growth in the whole economy.

Reductions of working hours are an economic and political question. The average difference between per-hour and per-man productivity growth in the Austrian

economy before and after 1973 was almost equal (1.1 percent and 1.2 percent respectively), thus independent of the rate of the per-hour productivity growth, which was reduced to a half during the latter period. It is, however, difficult to predict if this tendency will or can be continued.

The interpretation of the Kaldor-Verdoorn relation is the most difficult issue. Reduced economies of scale are no doubt among its causes. A part of the stock of employees behaves like fixed capital, their number cannot be flexibly adjusted to changes in the production level for economic, technological and institutional reasons. Slow growth after 1973 has also led to a reduction in the investment activity in the Austrian economy and probably slowed down the rate of technical progress. We could not find an econometric confirmation of this hypothesis, but this does not mean that it must be necessarily wrong.

References

C.Almon: An International Network of Input-Output Models, IIASA, Laxenburg 1979.

C.Almon, M.Buckler, L.M.Horwitz, T.C.Reimbold: 1985, Interindustry Forecasts of the American Economy, Lexington 1974.

W.J.Baumol: Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis, The American Economic Review, May 1967.

Beirat für Wirtschafts- und Sozialfragen: Längerfristige Arbeitsmarktentwicklung, Wien 1980.

L.Bortkiewicz: Zweck und Struktur einer Preisindexzahl. Nordisk Statistik Tidskrift, 1923.

A.Brody: On measuring growth, Acta Oeconomica, No. 1-2, 1980, pp.47-56.

B. Carlsson: Technical Change and Productivity in Swedish Industry in the Post-War Period, Research Report No. 8, The Industrial Institute for Economic and Social Research Stockholm, 1980.

W. Clement, P.F. Ahammer, A. Kaluza: Bildungsexpansion und Arbeitsmarkt, Wien 1980.

J.S.L. McCombie: What still remains of Kaldor's Laws? Economic Journal, March 1981.

E.F.Denison: Accounting for Slower Growth, the United States in the 70s, Brookings Institution, 1979.

ECE: Structure and Change in European Industry, Geneva, 1977.

ECE: Economic Survey of Europe in 1981, New York, 1982.

ECE: Structural Changes and Analysis of Labour Productivity in the ECE Market Economies and Some Implications for Future Economic Growth, Note by the Secretariat, Geneva, 1982.

S. Fabricant: Productivity in the Tertiary Sector, Acta Oeconomica Vol. 8 (2-3), 1972, pp.207-219.

E. Felli: Labour Productivity, Returns to Scale and Capital Accumulation in Italian Manufacturing Industry (1954-1978), Rivista di Politica Economica, Year LXXI -3rd Series, December 1981, pp.61-107.

H. Giersch, F. Wolter: On the Recent Slowdown in Productivity Growth in Advanced Economies, Kiel Working Paper No. 148, Institut für Weltwirtschaft an der Universität Kiel, 1982.

F.Hahn, L.Schmoranz: Schätzung des österreichischen Kapitalstocks nach Wirtschaftsbereichen, WIFO Monatsberichte 1, 1983, pp.40-52.

M.J.Harper, K.Kunze, J.R.Norsworthy: The Slowdown in Productivity Growth: Analysis of Some Contributing Factors, Brooking Papers on Economic Activity, No. 2/1979.

N. Kaldor: Causes of the Slow Rate of Growth of the United Kingdom, An Inaugural Lecture, Cambridge 1966.

N. Kaldor: Strategic Factors in Economic Development, New York 1967.

E.Lundberg: Productivity and Structural Change - A Policy Issue in Sweden, The Economic Journal, March 1972 (Supplement).

F.Machlup: Structure and Structural Change: Weaselwords and Jargon, Zeitschrift für Nationalökonomie, 1958, pp.280-298.

A.Maddison: Long Run Dynamics of Productivity Growth, Banca Nationale del Lavoro Quarterly Review, No.128, March 1979.

P. Mitter: Arbeitsmarkt, in Ch. Mandl (Hrsg.): Österreich-Prognosen bis zum Jahr 2000, Wien 1982.

P.Mitter, J.Skolka: Entwicklung der Arbeitsproduktivität in Österreich 1964 bis 1977, WIFO Monatsberichte 1, 1981, pp.19-31.

L.Nadiri: Sectoral Productivity Slowdown, National Bureau for Economic Research, Working Paper No.423, Cambridge (MA) 1980.

W.Nordhaus: The Recent Productivity Slowdown, Brookings Papers on Economic Activity, No.3/1972.

OeSZA: Österreichs Volkseinkommen 1964-1977, Neuberechnung, Wien 1979.

OeSZA: Österreichs Volkseinkommen 1970-1980, Wien, 1982.

J.Skolka: Unterschiedliches Produktivitätswachstum und Veränderungen der Wirtschaftsstruktur in Österreich, WIFO Monatsbericht No.8/1977.

J. Tinbergen: Zur Theorie der langfristigen Wirtschaftsentwicklung, Weltwirtschaftliches Archiv 55, 1942, pp.511-549.

UNIDO: World Industry since 1960: Progress and Prospects, New York, 1979.

P.J. Verdoorn: Fattori che regolano lo sviluppo della produttivita del lavoro, L'Industria 1, 1949, pp.3-10.

P.J. Verdoorn: On an Empirical Law Governing the Productivity of Labor, Econometrica vol.19 no.2, 1951, pp.209-210.

G.C.Wenban-Smith: A Study of the Movements of Productivity in Individual Industries in the United Kingdom 1968-1979, National Institute Economic Review, No.97, August 1981.

L.Wohlin: Skogindustrins strukturomvandling och expansionsmöjliheter, Stockholm 1970.

Notes

1) The authors would like to thank Iain Paterson for the help in English language editing.

2) Minor additional revisions of the productions statistics were made recently. It was not possible to consider them in the article.

3) Time series on fixed capital assets disaggregated by 19 industries of the Austrian input-output model were compiled in the autumn of 1982. Capital productivity was not yet analysed, see Hahn, Schmoranz (1983).

4) Time series at 1964 prices were taken from OeSZA (1979), at 1976 prices from OeSZA (1982) or directly supplied by the Central Statistical Office.

5) Data on self-employed were compiled by G.Biffl from the Austrian Institute for Economic Research, data on employed by P.Mitter from the Institute for Advanced Studies.

6) The continous rate of growth rc, derived by semilogarithmic interpolation of the time series, is recalculated into an annual discountinuous rate rd according to the following formula:

$$rd = \exp(rc) - 1$$

7) The difficult and controversial problem of output and productivity measurement in services will be not discussed here.

8) From a long-run point of view, however, the rate of productivity increase remained high. In sixteen industrial countries the average annual increase in labour productivity was equal to 1.4 percent between 1879 and 1913, 1.1 percent between 1913 and 1950, 3.9 percent between 1950 and 1970, and 2.1 percent between 1970 and 1976 (Maddison (1979)).

9) This concept of structural change corresponds to the "clearer meanings of structure in economics" as summarized by Machlup (1958): "Structure of production

is distribution of outputs and inputs among industries, structural change are permanent alterations of this composition".

10) Demand, however, may be influenced by the price of the output while the price depends on productivity performance. Such a feed-back effect between productivity, prices, demand, and productivity will not be analyzed here.

APPENDIX I

Decomposition of productivity growth rates

We use the following denotations:

Q_i^t = output in industry i, year t

E_i^t = employment in industry i, year t

$p_i^t = Q_i^t/E_i^t$ productivity in industry i, year t

$q_i^t = Q_i^t/Q^t$ output share

$e_i^t = E_i^t/E^t$ employment share

$\bar{p}^t = \Sigma p_i^t e_i^t$ productivity in the whole economy.

Consider now percentage changes between year t=0 and t=1.

The hypothetical change in productivity in the whole economy, given the assumption that there are no employment shifts between industries is

$$\frac{\Sigma p_i^1 e_i^o - \Sigma p_i^o e_i^o}{\Sigma p_i^o e_i^o} = \Sigma \frac{p_i^1 - p_i^o}{p_i^o} q_i^o = \Sigma dp_i^1 q_i^o \qquad (1)$$

The difference between the actual change $(\bar{p}^1 - \bar{p}^o)/\bar{p}^o$ and the hypothetical change (1) - the structural component - can be split up into two parts

$$\frac{\Sigma p_i^1 e_i^1 - \Sigma p_i^1 e_i^o}{\Sigma p_i^o e_i^o} = \Sigma dp_i^1 (e_i^1 - e_i^o) +$$

$$+ \Sigma \frac{p_i^1}{p_i^o} \left(\frac{p_i^o}{\bar{p}^o} - 1\right)(e_i^1 - e_i^o) \qquad (2)$$

where the first part measures the influence of employment shifts towards industries with high productivity growth rates. The second term corresponds to an interaction effect measuring the influence of employment shifts towards industries with high (i.e. more than the average $\bar{p}^o$) productivity levels, weighted with sectoral productivity indexes p_i^1/p_i^o . The interaction term vanishes, if there are no productivity level differences in the base period t=0.

This is not the only possible decomposition of productivity growth rates. In ECE (1982) the structural component (2) is split up into one part measuring shifts towards industries with high productivity levels (thus corresponding to the second term above) and to a residual interaction effect (corresponding to the first term above). As sectoral productivity level differences heavily depend on the price base chosen (while sectoral growth rates do not), our method seems to be more adequate, but in practice both methods yield similar results. Further decompositions as e.g. the five-factor-formula in Nordhaus (1972) go short of interpretability and mutual independence of the isolated effects.

APPENDIX II

Verdoorn's Law

In its most general version, Verdoorn's (or Tinbergen's) model consists of five equations

Output	$x = a^{\alpha} b^{\beta} e^{\nu t}$	(1)
Labour demand	$v = \alpha(x/a)$	(2)
Labour supply	$v = \alpha(a/p)^{\rho} e^{\lambda t}$	(3)
Investment	$b = \gamma x$	(4)
Population growth	$p = e^{\pi t}$	(5)

where a, b, x, v, p, t denote employment, capital, output, real wage rate, population, and time, respectively, and the rest are constants. To avoid unnecessary complications, assume α and β between 0 and 1 and the growth rates ν, λ and π to be nonnegative. For the wage flexibility ρ (or, inversely, the elasticity of labour participation) Tinbergen definitely admitted even negative values except between 0 and -1. Assume further that the parameters θ and η defined by

$$\theta = \beta\frac{1+\rho}{1+\rho-\alpha} \qquad \eta = \frac{\rho(\alpha\pi+\nu)+\nu-\alpha\lambda}{1+\rho-\alpha} \tag{6}$$

satisfy $\theta<1$ and $\eta>0$ (which does not seem to be restrictive, but is necessary for further analysis). Then the growth rate form of the solution of the system (1)-(5) is

$$\frac{\dot{a}}{a} = \frac{\eta(\theta-\beta)}{\alpha(1-\theta)} \cdot u(t) + \frac{\eta-\nu}{\alpha} \tag{7}$$

$$\frac{\dot{b}}{b} = \frac{\eta}{1-\theta} \cdot u(t) \tag{8}$$

$$\frac{\dot{x}}{x} = \frac{\theta\eta}{1-\theta} \cdot u(t) + \eta \qquad (9)$$

where $u(t) = 1/\left[1 + \left(\frac{\eta}{(1-\theta)\gamma} - 1\right) e^{-\eta t}\right]$, i.e. $\lim_{t\to\infty} u(t) = 1$.

In the steady-state this solution reduces to

$$\frac{\dot{a}}{a} = \frac{\eta(1-\beta)}{\alpha(1-\theta)} - \frac{\nu}{\alpha} \qquad (10)$$

$$\frac{\dot{b}}{b} = \frac{\dot{x}}{x} = \frac{\eta}{1-\theta} \qquad (11)$$

As a consequence Verdoorn's law in its original version

$$V = \frac{(\dot{x}/a)}{x/a} \Big/ \frac{\dot{x}}{x} = \frac{\alpha+\beta-1}{\alpha} + \frac{\nu}{\alpha}\frac{(1-\theta)}{\eta} \qquad (12)$$

is valid. This is not very surprising, because constant steady-state growth rates of output, employment, and productivity imply the constancy of V.

The critical issue is: why can we expect to observe - as Verdoorn did - across countries, industries, and periods <u>different</u> growth rates of output (and productivity, resp.), but a <u>uniform</u> ratio or a uniform linear relationship between these two rates? Variations in $\dot{x}/x$ or $\dot{a}/a$ must be attributed to variations in the parameters α, β, ν, θ, η which hardly will leave unchanged the value of V.

Within the Tinbergen - Verdoorn framework there are two explanations. Firstly, a reformulation of (12) using (11) yields the linear relationship

$$\frac{(\dot{x}/a)}{x/a} = \frac{\alpha+\beta-1}{\alpha}\frac{\dot{x}}{x} + \frac{\nu}{\alpha} \quad . \qquad (13)$$

If - across countries, periods, or industries - there are variations in labour supply parameters only, then the relation (13) will be uniform, because its coefficients depend on the parameters of the production function only. The Verdoorn elasticity V, on the other hand, will not be uniform in this case.

Secondly, the steady-state assumption may not be fulfilled. There are good reasons that adaptation towards steady state is quite slow (fixation of the parameters in plausible ranges yield half-lifes of several decades), so growth rates may differ with respect to the actual position of the adaptation phase. Although V is not constant in the non-steady state case, the following linear relationship holds:

$$\frac{(\dot{x/a})}{x/a} = \frac{\rho}{\rho+1}\,\frac{\dot{x}}{x} + \frac{\alpha-\rho\,\pi}{\rho+1} \qquad (14)$$

where the effect of output growth depends on the elasticity of labour participation only. The relation is uniform, if there are similar conditions of labour supply.

In both situations one can expect to have a uniform linear relationship between the growth rates of output and productivity (rather than a constant elasticity V). Because of the ambiguity of the actual causes, however, a clear interpretation of the coefficients in terms of the underlying system parameters is not possible.

Appendix III

Classification of industries in the dynamic input-output model

	ISIC groups[1)]
1. Agriculture and Forestry	1
2. Mining and Quarying	2 minus 22, 2901
3. Manufacture of Food, Beverages and Tobacco	31
4. Textile, Wearing Apparel and Leather Industries	32
5. Manufacture of Wood and Wood Products	33, 3902, 3903
6. Manufacture of Paper and Paper Products, Printing and Publishing	34, 9592
7. Manufacture of Chemicals	35 minus 353
8. Crude Petroleum, Natural Gas and Petroleum Refineries	22, 353
9. Manufacture of non-Metallic Mineral Products	36, 2901
10. Basic Metal Industries	37
11. Manufacture of Fabricated Metal Products, Machinery and Equipment	38
12. Electricity, Gas and Water	4
13. Construction	5
14. Trade	61, 62
15. Restaurants and Hotels	63
16. Transport, Storage and Communication	7
17. Financing, Insurance, Real Estate and Business Services	8 minus 833
18. Social and Personal Services	9 minus 91, 9592, 96
19. Public Administration and Defence	91

1) International Standard Industrial Classification of All Economic Activities, Rev. 2, United Nations, New York, 1968.