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GRADUATE COLLEGE

THE INDUSTRIAL SECTORS OF EAST GERMANY AND WEST GERMANY: A COMPARATIVE STUDY

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

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degree of

DOCTOR OF PHILOSOPHY

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ANDREW JOHN DANE

Norman, Oklahoma

1975

THE INDUSTRIAL SECTORS OF EAST GERMANY AND WEST GERMANY:

A COMPARATIVE STUDY

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CHAPTER I

THE SCOPE AND METHOD OF THE STUDY

The two countries, East and West Germany, were created out of the Third Reich following World War II. At that time Germany was an advanced and industrialized country. Historically, East Germany was the first advanced, industrialized country to implement a socialist, centrally planned economy.

Up to the time of the creation of East Germany one of the major problems of comparing the economic performance of socialist and capitalist economies--especially the United States and the Soviet Union--was that the Soviet Union began central planning as a relatively backward, agrarian country. By 1928, when central planning on an economy-wide scale began in the Soviet Union, the United States was already a major advanced, industrial nation. The problem was essentially comparing economies at different stages of economic development.

In looking at post-war East Germany all of the preconditions for success of a socialist country existed, e.g., a high percentage of the labor force in industry, a low illiteracy rate, and relatively diversified industries. As a result East Germany's economic performance should be comparable to that of advanced, industrialized capitalist nations.[1]

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[1]Wolfgang F. Stolper, The Structure of the East German Economy (Cambridge, Massachusetts: Harvard University Press, 1960), pp.1-2.

The best comparison would be with West Germany because prior to 1945 Germany was a single cultural and economic unit.

The study of the two Germanies provides almost a laboratory case for comparing economic performance. Factor endowments were similar for both countries. Both countries have abundant supplies of lignite and potash. Neither country has high quality iron ore. One major difference in resource endowments, however, is that soft coal used for coke in the production of steel is concentrated in West Germany. Another difference is the fact that West Germany has the Rhine River which allows cheap transportation by water compared to the almost exclusive reliance of East Germany on rail transportation with its higher costs. Both countries had highly skilled labor forces, although the distribution of skilled labor reflected the distribution of types of coal. Lignite-based industries tended to be concentrated in what is now East Germany. These industries were electric power oriented and included aluminum and magnesium industries, the heavy chemicals, synthetic rubber, and sythetic gasoline industries. In addition light industries such as textiles, clothing, and precision instruments and optical equipment were concentrated in East Germany. Most heavy industry was concentrated in West Germany, particularly in the Ruhr River Valley, where abundant quantities of cokeable coal are found.[2]

The basic hypothesis of this study is that there should be little or no difference in the industrial performance in the two countries. Any observed differences can be accounted for by differences in the political-economic systems. The study will focus on industrial performance of

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[2]Ibid., pp. 3-4.

seventeen industries in each country from 1958 to 1967. One reason for confining the study to this time period is that the pre-1958 data for West German industry are not comparable to post-1958 data due to the repatriation of the Saarland to West Germany by the French in 1957. After 1958 production and factor statistics for the Saarland are included in the output and factor series for West German industry. In East Germany a major recrganization of industry occurred in 1968 in which industrial boundaries were extensively redefined.[3] The series of industrial statistics from 1968 to the present are thus not comparable to earlier industrial statistics.

The study first concentrates on the general development of industry in the two countries from the end of World War II through 1967 with an emphasis on the 1958-1967 time period. East Germany is a centrally planned economy which underwent extensive reforms in its industrial planning system over the ten-year period. The purpose of these reforms was to increase the efficiency of the system. The result of the reforms was to considerably decentralize the planning system. The role of profits was emphasized as well as the allowance of a greater degree of enterprise autonomy. West German industry operates in a mixed economic system in which the state has considerable influence, but the predominant method of allocating resources remains in the hands of the private sector.

Comparison of industrial performance centers around estimates of the contributions of capital and labor to the growth of output, the rate

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[3]Deutsches Institut für Wirtschaftsforschung, DDR Wirtschaft, (Frankfurt am Main: Fischer Bucherei, GmbH, 1971), pp.62-63.

of growth of output, technical change, and the elasticity of substitution of capital for labor. Analysis takes place within the context of the theory of production. The basic assumptions underlying the production model are that technical change is Hicks neutral, that the production function is homogeneous of degree one and is subject to constant returns to scale, and that capital and labor are paid their marginal products.

Subject to the above restrictions no particular form of the production function is assumed a priori. Instead three forms of the production function are estimated. Two of these forms, the CES and the Cobb-Douglas, require that the elasticity of substitution be constant. The third, the constant marginal shares (CMS) function, allows for a variable elasticity of substitution. The properties of these production functions are described in detail in Chapter III.

Except for estimates of the elasticity of substitution, the comparative performance of the industries in the two countries is expressed in terms of changes and rates of change. No attempt has been made to convert the value of output and capital in one country into those of the other.[4] The reason for not making the conversion stems from the fact that in this case very little seems to be gained from dynamic comparisons using output and capital valued in one country's prices given the availability of statistics in the two countries. In a major study prepared for the West German government the capital stock of East Germany was

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[4]See Herbert Wilkins, "Labor Productivity in East and West German Industry," Economic Bulletin, Vol. 7 (June 1970), pp. 53-56 and Federal Republic of Germany, Bundesministerium für innerdeutsche Beziehungen, Bericht der Bundesregierung und Materialien zur Lage der Nation 1971 (Kassel: A. G. Wenderoth, 1971), Chapter V, for a discussion of this method.

simply multiplied by 0.8 to convert it into West German prices while East German output was converted for only one year and then assumed to change at the same rate as gross production.[5] One problem stems from the fact that no index of net production or value added is available from the East German authorities, and no index of gross output or value added is available from the West German authorities. The conclusion is that while such procedures might be useful for static comparisons, they make little difference in dynamic comparisons. This study is concerned more with the direction of change over time than with comparisons at any given time. Some static concepts such as the capital-output ratios are used, but again the principal concern is with the direction in which they are moving since rising or falling capital-output ratios are one indicator of the trend of capital productivity.

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[5]Federal Republic of Germany, Bundesministerium für innerdeutsche Beziehungen, Bericht und Materialien, pp. 106-107. See also Appendix B for a detailed discussion of the method of converting the East German output series.

CHAPTER II

EAST AND WEST GERMAN INDUSTRY

Introduction

The purpose of this chapter is to set out the industries to be compared and to examine the organization of industry in the two Germanies. East Germany has a socialist, centrally planned economy. East Germany altered its industrial planning system in 1963 from a version of the Stalinist model to what Campbell has called a cartelized planning system, i.e., one in which much of the planning is done by intermediate agencies between the firm and the higher level of bureaucratic authorities.[1] The West German economy cannot be said to be a pure market economy because of the large economic role played by government which includes either full or partial government ownership of the major firms in the economy.

All definitions of industrial boundaries are made according to East German classifications because of the higher degree of aggregation compared to those of West Germany.[2] One major industry in both countries, vehicle manufacturing, has been omitted because of a significant change

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[1]Robert Campbell, "Economic Reform in the U. S. S. R.," American Economic Review 58 (May 1968), pp. 556-557.

[2]The method of comparing East and West German industries is given in Appendix A.

in the definition of this industry in 1964 by the East German authorities. In 1964 about one-fourth of the workers in this industry were transferred to the state railways.[3] Pre-1964 series on this industry are thus not comparable to post-1964 series. Seventeen industries are compared in this study; they are mining, metallurgy, chemicals, building materials, electrotechnical, shipbuilding, machinery, metal goods, precision instruments and optical equipment, woodworking, textiles, clothing, leather goods, pulp and paper, polygraphic, glass and ceramics, and food industries.

East German Industry

The command economy in Germany dates from World War I. It became a permanent feature of the economy in Germany under the Nazis in the 1930's and continued practically unaltered after 1945 in the Soviet Occupation Zone. The importance of this fact needs to be stressed for an understanding of the East German economy. Managers and workers were quite familiar with a command system at the end of World War II. There was no need, therefore, to impose a centrally planned system on the Germans in the Eastern Zone with the attendant disruptions of production. The Soviet authorities of course expropriated most of the private owners of industry and eliminated the top management of firms who had been closely associated with the former Nazi regime, but the major planning apparatus remained intact. The major features of the central planning system of the Nazi regime--central control of resources and allocation of these resources

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[3]German Democratic Republic, Staatlichen Zentralverwaltung für Statistik, Statistisches Jahrbuch der Deutschen Demokratischen Republik 1965, (East Berlin: Staatsverlag der Deutschen Demokratischen Republik, 1965), p. 97 (hereafter cited as SJBDDR followed by date).

according to political rather than economic considerations, rationing, and centrally controlled prices--remained in force. The reasons for this retention of the command economy with the underlying reliance on pre-war managers and technicians were that the ideology of the Soviet Union favored central planning and that not enough reliable German communists existed to replace the existing managers. Indeed the German people as a whole were considered ideologically unreliable by the Soviets.[4]

Until 1950 the basic Nazi command system was retained with few alterations. In 1950 the State Planning Commission was created. From 1953 to 1963 the East German planning system was closely patterned after that of the U. S. S. R.[5] The planning system both before and after the introduction of the State Planning Commission was geared to war reparations to the Soviet Union. The rapid recovery of the East German economy was necessary from the Soviet point of view for war reparations. Estimates of the degree of exploitation of the East German economy from 1945 to 1953 by the Soviet Occupation authorities amount to about 25 percent of GNP in each year.[6] This should be compared with the high levels of recovery aid given to West Germany under the Marshall Plan. After the uprisings in 1953 the Soviets ended their war reparations policy, and East Germany slowly began to become just another of the Soviet satellite countries

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[4]Radoslav Selucky, Economic Reforms in Eastern Europe (New York: Praeger Publishers, 1972), pp. 57-58.

[5]Gustav Stolper, Karl Hauser, and Knut Borchart, The German Economy: 1870 to the Present (New York: Harcourt, Brace and World, Inc., 1967), p. 310.

[6]Wolfgang Stolper, The Structure of the East German Economy (Cambridge, Mass.: Harvard University Press, 1960), p. 5.

rather than an occupied zone. By 1957 the burden of Soviet occupation costs paid by East Germany was sharply reduced, and an emphasis was laid on expanding the economy, especially consumer goods production. With the enormous war burdens eliminated and occupation costs reduced, the East German economy was ready to begin operation primarily for domestic needs. Finally by 1957 the reconstruction of the economy had been largely completed.[7]

During the period 1958 to 1967 the East German planning system underwent a major reorganization beginning in 1963. Figure 1 shows the planning apparatus which existed from 1958 to 1963. Not shown in the formal planning organization chart is the place of the East German Socialist Unity Party or SED (Socialist Einheitspartei Deutschland). Planning objectives were set out by the Politbureau and Central Committee of the SED. These objectives were passed to the Council of Ministers (Ministerrat) and then to the State Planning Commission[8] which coordinated these directives with the Economic Council.[9] The State Planning Commission initially prepared what are called prospective plans for several years as well as the annual plan. The National Economic Council (VWR or Volkswirtschaftsräte) coordinated the annual plans of the State Planning Commission and the directives of the Council of Ministers into directives for industry. In the VWR there were specialized industrial

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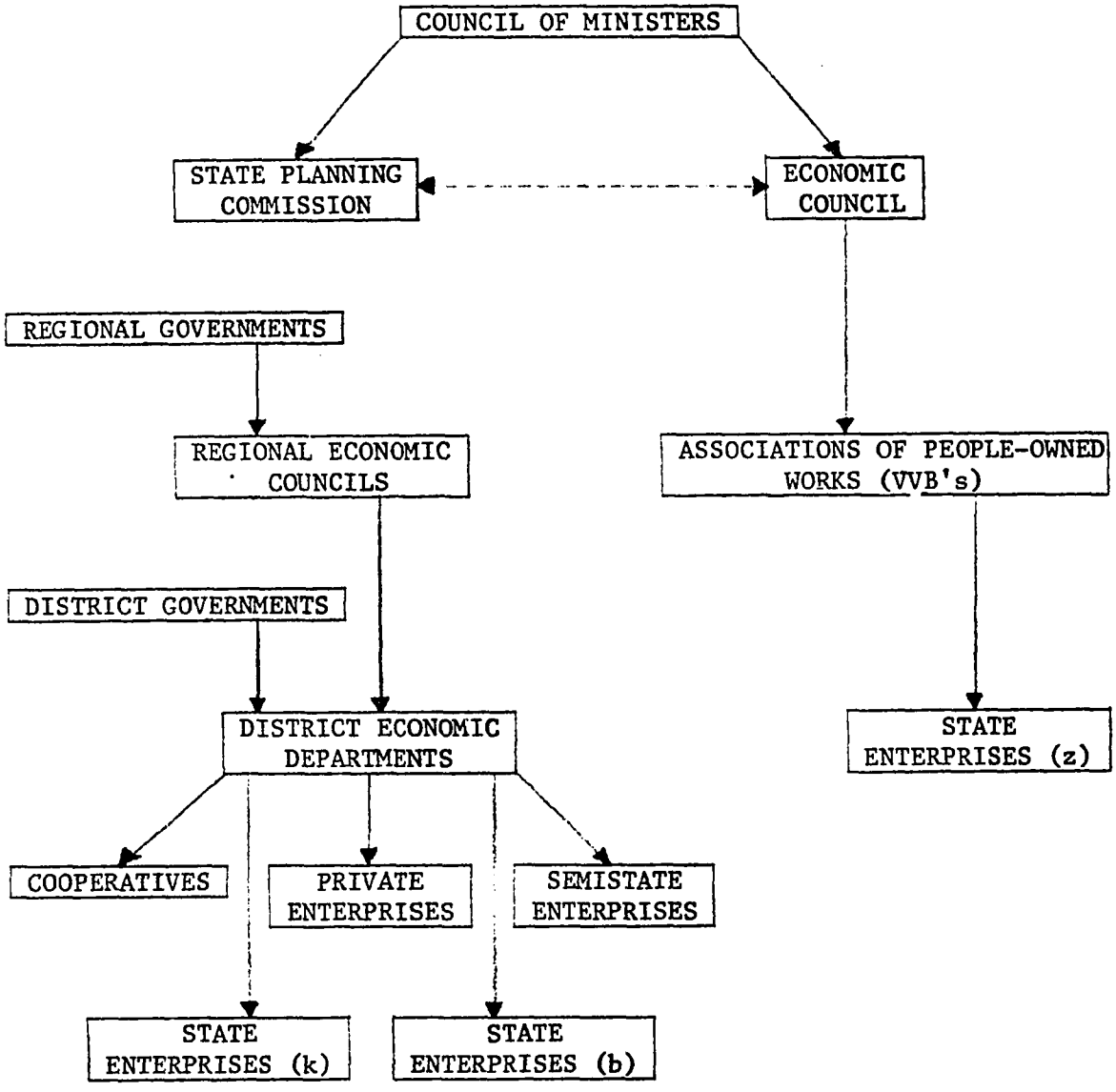
[7]Selucky, Economic Reforms in Eastern Europe, pp. 69-70.

[8]Stolper, et al., The German Economy, p. 313.

[9]Klaus Wagenknecht, "Zusammenstellung der Reformen im Plannungs- und Leitungssystem der DDR: 1950-1969," paper presented at Free University, Berlin, 1972. (Mimeographed) p. 3.



k: Combines

b: Regionally controlled

z: Centrally controlled

——→ : Direction of Authority

- - - - → : Cooperation

SOURCE: Klaus Wagenknecht, "Zusammenstellung der Reformen im Plannungs- und Leitungssystem der DDR: 1950-1969," paper presented at Free University, Berlin, 1972, (Mimeographed) p. 5; and Martin Schnitzer, East and West Germany: A Comparative Economic Analysis, p. 294.

FIGURE 1. Industrial planning system in East Germany from 1958 to 1963.

ministries prior to 1958.[10]

The planning process now passed downward to the Regional Economic Councils (Bezirkswirtschaftsräte or BWR's) and to the Associations of People Owned Works (Volkseignigung Volkseigener Betrieben or VVB's). The BWR's along with the respective regional governments then passed the plan targets to the District Economic Departments (Wirtschafts Abteilungen des Kreise). Finally the enterprises under their control received their plans. The other line of command went from the VVB's to the enterprises under them.[11] The enterprises now had to indicate what they needed to fulfill their plans to the appropriate authorities, and the planning procedure went into reverse. Clearly it was in the best interest of each enterprise to get as low a plan as possible. The same held true for each District Economic Council, BWR, and VVB. There apparently therefore was the problem of the overordering of materials and the hiding of capacity. The top planning agencies found it necessary to implement strict controls which were not always too effective. In 1958 a reform of the system was begun which ultimately led to the so-called New Economic System (NES) in 1963.[12] In 1961 the VWR and State Planning Commission were merged.[13] This merger would appear to be little more than a reorganization at the top. The really significant changes were to be found at the enterprise level. A great deal of the detailed planning was abandoned, and the enterprises were allowed more freedom to

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[10]Ibid., p. 3.

[11]Ibid., pp. 3-4

[12]Stolper, et al., The German Economy, pp. 312-313.

[13]Wagenknecht, "Zusammenstellung der Reformen," p. 3.

determine their own share of the plan. More importantly, enterprises were allowed to establish contracts with each other directly rather than through planning apparatus and could sue one another for non-payment of bills, non-delivery of ordered materials, or delivery of the wrong type of materials.[14] While planning was largely done in terms of physical units by the method of material balances, the economy was a monetary one. It was thus not only necessary for the State Planning Commission to balance the inputs needed after the enterprises made known their input needs, but also to plan financial flows. The financial plan was used as a method of controlling the physical material plan.[15]

In 1963 the NES was instituted. There were eight major points in the reform. The number of plan targets was reduced. The VVB's were given considerable authority in the planning process. Profit became the major success criterion. Enterprises were given greater authority in sales and input procurement. Certain enterprises were allowed to conduct their own export transactions. A price reform was begun in 1964. Capital charges were introduced. Finally formulation of the plan was decentralized with a leading role being played by the VVB's.[16]

The East German VVB is similar to a trust or cartel. They were first established in 1958 after the abolition of the industrial ministries. Prior to 1963 the VVB's were simply an administrative unit. After 1963 they became economic units entrusted with investment, sales, and export goals. In 1965 the industrial ministries were re-established

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[14]Stolper, et al., The German Economy, p. 313.

[15]Ibid.

[16]Selucky, Economic Reforms in Eastern Europe, pp.61-62.

and the VVB's were subordinated to them.[17] The VVB's however retained much of the ministries' functions after 1965. They are empowered to develop plans for their member enterprises; to determine prices subject to the control authorities' approval; to conduct research and development; to sell the output of subordinate enterprises under them; to manage the enterprises under them; to make production responsive to consumer demand within limits; and to determine most investments. The VVB's are however subject to control by the central authorities when certain major investments are made.[18]

Clearly the degree of decentralization had been significant. VVB's are semiautonomous nonstate organs for economic management. There was a significant transfer of authority from state organs (ministries) to non-state organs (VVB's). Obviously however the nature of the centrally planned economy has not been significantly changed because the enterprises did not gain autonomy. They are still subordinated to the VVB's which are themselves subordinated to the industrial ministries. The VVB's however are based on financial principles rather than on physical output principles. They are also largely responsible for the entrepreneurial functions, e.g., control of enterprise profits for investments and innovation. Since profits became the major success criterion, the economic decisions are based on price-cost considerations. Although in principle all decisions are based on optimizing the central plan, there is evidence that VVB's respond at least to a degree to demand, since

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[17]Martin Schnitzer, East and West Germany: A Comparative Economic Analysis (New York: Praeger Publishers, 1972), p. 230.

[18]Selucky, Economic Reforms in Eastern Europe, pp. 61-62.

TABLE 2-1

CAPITAL-OUTPUT RATIOS IN EAST GERMAN INDUSTRY: 1958, 1963, 1968

Industry	1958	1963	1967
Mining	5.55	7.70	9.60
Metallurgy	3.35	2.97	3.26
Chemicals	3.15	2.62	2.48
Building materials	3.86	4.28	3.81
Electrotechnical	1.06	0.87	0.85
Shipbuilding	2.06	1.71	1.42
Machinery	2.00	1.51	1.48
Metal goods	1.72	1.38	1.24
Precision instruments and optical equipment	1.45	1.14	1.01
Woodworking	1.79	1.50	1.46
Textiles	2.28	2.20	2.06
Clothing	0.42	0.45	0.46
Leather goods	1.89	1.61	1.42
Pulp and paper	4.50	4.72	4.36
Polygraphic	1.68	1.77	1.71
Glass and ceramics	2.72	2.53	2.62
Food industries	1.99	1.86	1.71

SOURCE: Appendix Tables B-6 and C-4.

profits are made on actual sales. In addition the reforms tied premium funds for bonuses to economic performance (i.e., profits). In theory at least this should encourage both enterprises and VVB's to operate at optimum levels rather than to conceal reserve capacity.[19]

The introduction of capital charges was clearly designed to eliminate overordering of capital goods. The introduction of largely self-financed investment was also designed for the same purpose. The central authorities hoped that such measures would increase the effectiveness of investments that were made and help overcome the rising capital-output ratio.[20] In Table 2-1 the capital-output ratios for 1958, 1963, and 1967 are shown for each of the seventeen industries. The reforms began in 1958 culminating in the introduction of the NES in 1963. The NES was then modified and extended over the next four years. In the cases of mining, building materials, pulp and paper, polygraphic, and clothing, the capital-output ratio rose between 1958 and 1963. After 1963 the capital-output ratio began falling in all but the mining, polygraphic, and clothing industries. A relationship of more interest however is the incremental capital-output ratio which measures the effect on output of new capital formation. Table 2-2 shows the incremental capital-output ratios from 1958 to 1963 and from 1963 to 1967 for the seventeen industries. These are based on changes in gross capital stock and changes in gross output. They show a somewhat different picture of the effectiveness of investment when compared to the simple capital-output ratios. As a general statement heavy

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[19]Ibid., pp. 62-63.

[20]Ibid., pp. 63-64.

TABLE 2-2

INCREMENTAL CAPITAL-OUTPUT RATIOS IN EAST GERMAN INDUSTRY: 1958-1963, 1963-1967

Industry	1958-1963	1963-1967
Mining	22.82	32.73
Metallurgy	1.91	4.55
Chemicals	1.88	2.12
Building materials	5.30	2.37
Electrotechnical	0.60	0.80
Shipbuilding	0.89	0.61
Machinery	0.83	1.40
Metal goods	1.24	0.87
Precision instruments and optical equipment	0.58	0.77
Woodworking	0.90	1.29
Textiles	1.82	1.43
Clothing	0.60	0.55
Leather goods	0.82	0.54
Pulp and paper	3.97	3.03
Polygraphic	2.13	1.39
Glass and ceramics	2.06	2.91
Food industries	1.30	0.90

SOURCE: Appendix Tables B-6 and C-4.

industry shows a rise in the incremental capital-output ratios while light industry shows declining incremental capital-output ratios. Apparently the reforms only partially accomplished one goal which was to increase the effectiveness of investment. A probable explanation of the poorer performance of heavy industry is that East Germany is a relatively resource poor country. In pre-war Germany heavy industry based largely on soft coal was located in the Ruhr and in the Upper Silesian Basin now a part of Poland. Traditionally East Germany was a major producer of precision instruments, optical equipment, textiles, clothing, printed materials, and office machinery. Heavy industry was largely confined to industrial chemicals.[21]

The problem faced by East Germany was that it has only two major types of natural resources, lignite or brown coal and potash. East Germany is the world's largest lignite producer. Lignite as an energy base is a relatively inferior material compared to hard coal, oil, or natural gas because of low caloric content. It also has a high moisture content making it expensive to transport. Lignite is however a good raw material for the chemical industry. The incremental capital-output ratio for mining shows the increasing difficulty of producing additional lignite. While 92 percent of East Germany's lignite is mined by open pit methods, increasingly large amounts of overburden must be removed per ton of lignite mined. In an economy based on lignite this fact must affect the development of heavy industry as evidenced by the metallurgical industry which must use lignite brickettes specially prepared for coking or

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[21]Wolfgang Stolper, Structure of East German Economy, p. 4.

imported coal of coking quality.[22]

The structure of the planning system by 1967 is set out in Figure 2. This system embodies the major changes made in the planning system from 1963 to 1967. As can be seen, the system was more decentralized than the 1958-1963 system. The State Planning Commission and industrial ministries were now more concerned with the longer term or so-called prospective plans. The intermediate agencies--especially the VVB's--were more concerned with the annual plan. In fact the VVB's were even given responsibility for balancing, subject to approval from the higher agencies.[23]

There remains to be discussed the various types of enterprises. These are the combine (Kombinat), the private enterprises, semistate enterprises (Halbstaatliche Betrieben), the production cooperatives (PGH's or Produktionsgenossenschaften des Handels), and the state enterprises (VEB's or Volkseigene Betrieben). Ideologically there is a strange mixture of ownership forms, but all are subordinated to the central planning structure. Table 2-3 indicates the relative importance of state-owned enterprises including the combines, PGH's, private firms, and semistate enterprises in East German industry. As can be seen, state-owned enterprises or VEB's produced the bulk of industrial output. In particular the state-owned enterprises under central direction, i.e., state-owned (z), which are subordinated to the VVB's, dominate industrial production. Since the reforms of 1963 the VVB's have

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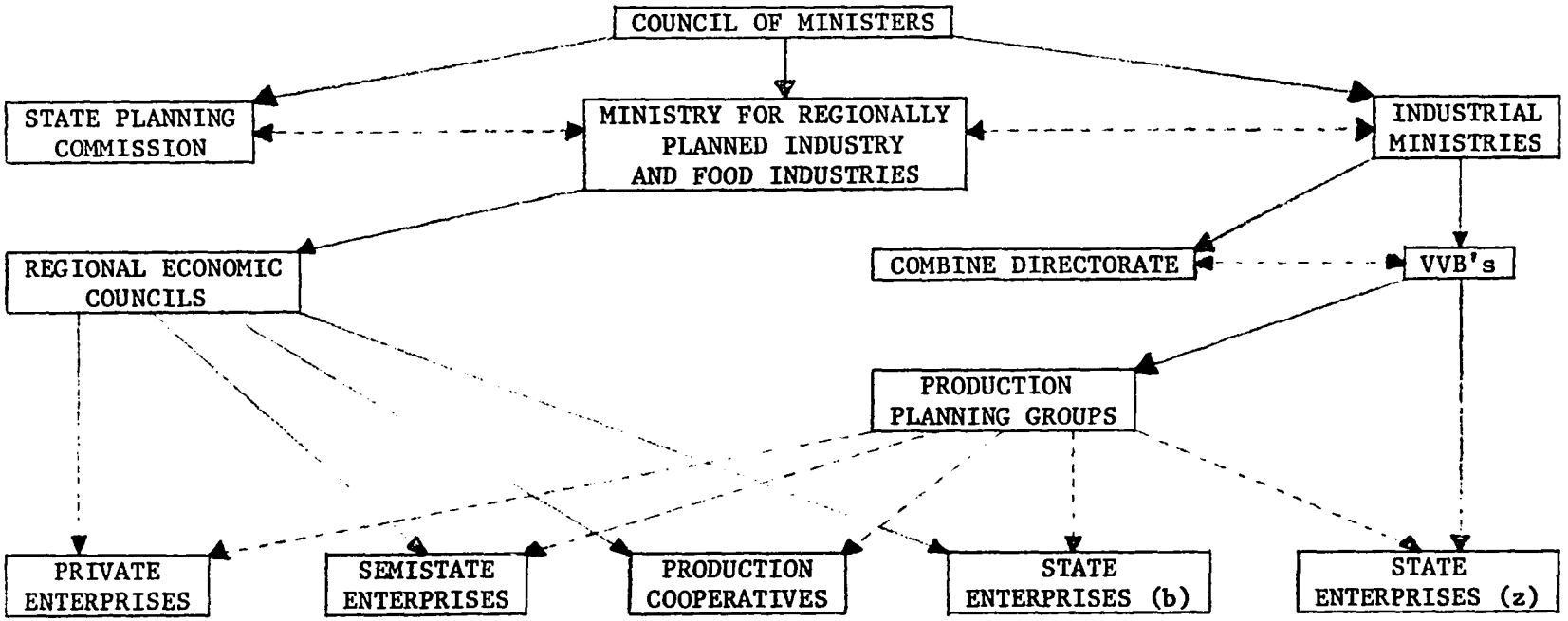
[22] Eugene Keefe, et al., Area Handbook for East Germany (Washington, D. C.: Government Printing Office, 1972), pp. 240-241.

[23] Wagenknecht, "Zusammenstellung der Reformen," p. 10.



b: Regionally controlled

z: Centrally controlled

——▶ : Direction of Authority

- - - ▶ : Cooperation

SOURCE: Adapted from Klaus Wagenknecht, "Zusammenstellung der Reformen," p. 15; and Deutsches Institut für Wirtschaftsforschung Berlin, DDR Wirtschaft (Frankfurt am Main: Fischer Bucherei, GmbH, 1971, p. 61.

FIGURE 2. Industrial planning system in East Germany in 1967.

TABLE 2-3

RELATIVE SHARES OF INDUSTRIAL OUTPUT OF TYPES OF ENTERPRISES IN EAST GERMANY IN 1958, 1963, AND 1967

Type of Enterprise	Share of Gross Industrial Output		
	1958	1963	1967
State-owned (z)	86.1	68.2	71.5
State-owned (b)		17.2	13.0
PGH	2.6	2.3	2.3
Privately-owned	8.1	2.7	2.3
Semistate-owned	3.2	9.6	10.9

SOURCE: Staatlichen Zentralverwaltung für Statistik, Statistisches Jahrbuch der Deutschen Demokratischen Republik, 1968 (East Berlin: Staatsverlag der Deutschen Demokratischen Republic, 1968), p. 117; Statistisches Jahrbuch der Deutschen Demokratischen Republik, 1962, pp. 282-283; Statistisches Jahrbuch der Deutschen Demokratischen Republik, 1964, p. 93.

had an advisory role in planning for the other types of enterprises through the production planning groups as shown in Figure 2. The degree of control of the VVB's over enterprises not directly under them is not very clear. It is known, however, that the VVB's were responsible for translating the general production directives of the State Planning Commission and ministries into enterprise plans for those enterprises directly subordinate to them.[24]

The combine is a major type of state-owned enterprise which may be

[24]Schnitzer, East and West Germany, p. 230.

subordinate to either a VVB or a Regional Economic Council. It is similar to a vertically integrated corporation in the West in that enterprises which join a combine lose their status as legally independent entities. The basic reason for the formation of combines was economies of scale. The East German authorities believed that substantial increases in efficiency could be attained by the merger of certain types of enterprises. Each enterprise in a combine is evaluated on the basis of its plan fulfillment whether its output is to be sold to the combine or to outside enterprises.[25]

Production cooperatives (PGH's) are post-1958 creations. They are for craftsmen and artisans. Starting in 1958 considerable pressure was put on private craftsmen and artisans to join PGH's. The ostensible reason was economies of scale of larger operations when individual craftsmen and artisans' activities are combined in large workshops. In addition the state provides financial, marketing, and technical services for PGH's. The ultimate goal appears to be to eliminate the private artisan and craftsman. To accomplish this goal the state uses tax discrimination against private artisans and craftsmen and raises their production targets each year. Cooperatives are concentrated in eight occupations: Carpentry, plumbing, painting, electricians, shoemaking, watchmaking, auto mechanics, and television repairing. A craftsman must contribute his tools and about 1000 Ost Marks to join a cooperative. While net profits are divided up at the end of each year, a member is also liable for losses of his PGH. The management of a PGH is elected by secret ballot, and all major decisions affecting the PGH must be

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[25]Ibid., p. 234.

approved by two-thirds of the members.[26] To what extent the management is freely elected without SED interference is not known.

The state enterprise (VEB) is a legal entity engaged in production. This definition would include combines. Unlike its Soviet counterpart the VEB's major objective is its profit target which is the major criterion for evaluating an enterprise's economic performance.[27] Other objectives or targets relate to investment, the assortment of output, quality, and physical output. These are usually planned by the enterprise and its VVB or Regional Economic Council. Unlike the Soviet system, the exact plan for an enterprise is based partly on market research and a definite market strategy.[28] The reason for the development of a market strategy is simple. The VEB's must arrange to buy and sell from each other. They do not go through the planning apparatus. Indeed VEB's have the authority to sue each other for violation of contracts.[29]

Profits are important to the VEB because profits and incentive payments are closely linked. It is clearly in the interest of the VEB and by implication the VVB to maximize profits. Before continuing, care must be taken to emphasize that planning is the motivating force in production. The general targets set out by the top planning authorities must be met. Generally 20 percent of profits after deductions

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[26]Ibid., p. 234.

[27]Ibid., pp. 234-235.

[28]Deutsches Institut für Wirtschaftsforschung Berlin, DDR Wirtschaft (Frankfurt am Main: Fischer Bucherei, 1971), p. 67 (hereafter author cited as DIW).

[29]Stolper, et al., The German Economy, pp. 313-314.

(i.e., profits taxes) are paid to the state and go into the incentive fund.[30]

For profits and profit targets to be meaningful, prices had to be reformed. Prior to 1964 prices were based on 1945 prices which were unrealistically low in many cases. Many raw materials were subsidized out of the state budget.[31] Obviously for the period 1958-1963 prices bore little relationship to true cost or scarcity conditions. Profits during this period would clearly be accidental. In 1964 a major price reform was begun in which prices were generally raised. First, capital asset prices were increased to achieve realistic depreciation costs. In addition prices for industries producing coal, ores, potash, non-ferrous metals, pig iron, and rolling mill products were raised an average of 70 percent. In 1965 prices for wood, pulp and paper, leather and hides, and chemicals were raised by an average of 40 percent. In 1967 machinery, some chemicals, and consumer goods were raised by an average of 4 percent. This price reform enabled the state to cut subsidies by over 50 percent. Prices were based largely on labor cost plus depreciation. Obviously a major problem arose later in that the labor intensive industries' prices were too high and the capital intensive industries' prices were too low. Reforms of the pricing system were continued after 1967.[32]

The agency responsible for prices in East Germany is the Office of Prices. It has the final say over prices set by a VEB or a VVB. There

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[30]Schnitzer, East and West Germany, p. 236.

[31]Ibid., p. 222.

[32]Ibid., pp. 223-224.

are three forms of prices. First, there is the maximum price. A VEB or VVB may lower this price subject to approval by the Office of Prices if the VVB or VEB is not claiming a state subsidy. Second, buyers and sellers are bound by so-called established prices. These may not be changed once in force. Indeed these prices tend to remain stable over long periods of time and appear to be centrally determined for basic materials. Finally, there are contract prices which are negotiated. Generally these prices which are worked out between VEB's apply to construction materials, repair work, machinery, and virtually all subcontracting work.[33]

One problem which one might foresee is that the director of either the enterprise or the VVB could act to raise profits in a manner which would not be in the best interests of the state. If VVB's are similar to cartels, why should they not attempt to restrict output if such a restriction would result in higher profits? The top East German planning authorities set profitability norms. If a profitability norm is exceeded, the enterprise or VVB is supposed to lower prices. If it does not have the authority to lower prices, then the VVB or VEB should recommend to the Office of Prices that a reduction of the prices is needed.[34] Prior to 1967 it is not clear whether the Office of Prices had the authority to force the VVB or VEB to lower prices. After 1967 this power is more clearly defined.[35] In any case there is little incentive to behave

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[33]Ibid., p. 237.

[34]Ibid., p. 238.

[35]The best discussion of the mechanics of the price reform particularly after 1967 is found in Manfred Meltzer, "Preispolitik und Preisbildung in der DDR," Vierteljahrshefte zur Wirtschaftsforschung, (Drittes Heft, January 1969), pp. 313-353. See especially pp. 338-348 for the post-1967 methods used in lowering prices.

monopolistically since any "excess" profits will be wiped out in the next planning period by lower prices.

The semistate-owned enterprise involves a mixture of private and state ownership with the state owning over 50 percent. As with the cooperatives, the state has put a great deal of pressure on private enterprises to permit partial state ownership through tax discrimination and limits on the number of employees a private enterprise can employ.[36] The share of total industrial output of the semistate enterprises rose rapidly between 1958 and 1963 from 3.2 percent in 1958 to 9.6 percent in 1963. Since 1963 the share has been slowly increasing as shown in Table 2-3. This relatively small share however does not reflect the true importance of the semistate enterprise. In 1963 this type of enterprise produced 19.7 percent of the gross output of light industry,[37] and 21.9 percent in 1967.[38] The semistate enterprises are subordinated to the Regional Economic Councils, and they are responsible for plans passed through the planning apparatus. The state as a part owner supplies capital and receives a share of the profits. The manager who has control of the enterprise is usually the owner who receives a salary and part of the profits. He is usually not interfered with by the authorities as long as he meets planned targets and makes a profit. The authorities frequently use the unit costs of the semistate enterprises as a measure to compare unit costs in state-owned enterprises

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[36]Schnitzer, East and West Germany, p. 233.

[37]SJBDDR 1964, p. 3. (Light industry is made up of the woodworking, textiles, clothing, leather goods, pulp and paper, polygraphic, and glass and ceramics industries.)

[38]SJBDDR 1968, p. 119.

in similar lines of activity.[39]

East Germany is the only Soviet Bloc country permitting the operation of private firms. Private enterprises in industry are concentrated in light industry and in the food industry.[40] In 1967 65.3 percent of the output of all private firms was concentrated in these industries.[41] The state does tolerate this type of enterprise where real needs of the population exist for certain types of goods which can be produced best by enterprises having considerable skills as e.g., fur and leather goods, or which can be produced in small quantities. The tax system is designed to keep private firms small. For private entrepreneurs the tax schedules are highly progressive, and there is a tax on capital assets which are usually overvalued by the authorities for tax purposes. Expansion of the size of the private firm is possible but extremely difficult.[42]

One problem faced by East Germany is a chronic labor shortage. Between 1958 and 1967 the population declined by about 2.4 percent compared to a rise in West Germany of 12.1 percent.[43] This decline in population can be partially attributed to immigration prior to the erection of the Berlin Wall in 1961 and partially to low birth rates. Even more striking is the 10.2 percent decline in the 15-65 year age

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[39]Schnitzer, East and West Germany, p. 233.

[40]Ibid., p. 238.

[41]SJBDDR 1968, p. 117.

[42]Schnitzer, East and West Germany, pp. 238-239.

[43]Bundesministerium für innerdeutsche Beziehungen, Bericht der Bundesregierung und Materialien zur Lage der Nation, 1971 (Kassel: A. G. Wendroth, 1971), p. 255.

group.[44] As a result of this problem there are legal provisions designed to bring women into the labor force. Women with families must accept available part-time employment. Widows who are able to work may not draw pensions unless their husbands died in industrial accidents or as a result of work-related illnesses. As a result, female labor force participation rates are among the highest in the world. The official explanation is that this high rate of female labor force participation reflects the high degree of equal rights of women under socialism.[45]

West German Industry

The National Socialist central planning system was applied in the Western Occupation Zone in 1945 to prevent total economic collapse as was the case in the Soviet Occupation Zone.[46] The system was maintained roughly until 1948 when major reconstruction of the Western Zone began. The Western Allies engaged in dismantling factories along with the Soviets but never on the same scale. Dismantling of factories ended in 1951. The major loss to West Germany was the Saarland, an important iron and coal producing region, to France. The Saarland was not returned to West Germany until 1957.[47]

Deconcentration of industry was not a major objective of the Western Allies. The only real long term successes in this area were the breaking up of the I. G. Farben concern which totally dominated the

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[44] SJBDDR 1968, p. 516.

[45] Keefe, et al., Area Handbook for East Germany, pp. 250-251.

[46] Stolper, et al., The German Economy, p. 204.

[47] Ibid., pp. 190-191.

pre-war chemical industry, the breakup of the Vereinigte Stahlwerke steel complex, and the partial breakup of the coal and steel industries' relationship. Before the war the twelve largest steel and coal firms controlled 90 percent of the steel output and 50 percent of the coal output. These firms were broken up into 28 separate companies.[48]

In 1948 the reconstruction of the German economy began in earnest. There are five identifiable factors which aided the rapid recovery of the West German economy. First was the enormous flood of refugees. In a severely damaged economy this flood of refugees would at first appear to be a handicap since they needed food and shelter. They increased the labor force, however, and were able and willing to work, and their existence helped hold down wages.[49] Indeed they constituted a highly mobile manpower reserve, and the increase in supply was largely responsible for the fact that productivity increased more rapidly than wages. To get an idea of the impact of the refugees on the West German labor force, it has been estimated that prior to 1950 eight million refugees entered West Germany. Between 1950 and 1962 another 3.6 million left East Germany and settled in West Germany.[50] Second, there was a small defense burden. The defense burden including occupation costs fell from 5 percent of the GNP in 1950 to 2.7 percent in 1958. Third, the extent of damage to industry was not as great as is usually believed. Estimates of industrial capacity suggest that it was actually greater

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[48]Ibid., pp. 194-196.

[49]Malcolm MacLennan, Murray Forsyth, and Geoffory Denton, Economic Planning and Policies in Britain, France, and Germany (New York: Frederick A. Praeger, Publishers, 1968), p. 51.

[50]Stolper, et al., The German Economy, pp. 279-280.

in 1946 than in 1936 as a result of the very high rates of investment during the war. The West German economy thus began the post-war period with a substantial industrial base. Fourth, much of investment in the post-war years was channeled into the vehicles, chemicals, electrical engineering, and machinery industries which were all major growth sectors in the world economy. The output of these industries therefore helped earn a great deal of foreign exchange for needed imports. Finally, the volume of American aid both through the Marshall Plan and from other sources, $1.28 billion and $2.27 billion respectively, helped offset reparations and occupation costs.[51]

After 1948 the West German government created what has been called the social market economy (Sociale Marktwirtschaft) which meant a free private enterprise system modified by aggregate target goals with tax and subsidy manipulation to achieve desired results.[52] The policy, instituted by Ludwig Erhard, Minister of Economics and later Chancellor, was designed to reduce the role of government interference in the economy. The approach was to have as much free play of market forces as possible.[53] The German government's approach to the economy was based on the views of the so-called Freiburg School of economics founded in 1932-1933. This school stressed what has come to be called the competitive order or neo-liberalism.[54] It is necessary to emphasize that the

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[51]MacLennan, et al., Economic Planning and Policies, pp. 52-53.

[52]Hans-Joachim Arndt, West Germany: Politics of Non-Planning, (Syracuse, N. Y.: Syracuse University Press, 1966), p. 17.

[53]Andrew Schonfield, Modern Capitalism (New York: Oxford University Press, 1965), pp. 239-240.

[54]MacLennan, et al., Economic Planning and Policies, p. 35.

views of the Freiburg School were not those of laissez faire. Government intervention in the economy was not viewed as undesirable provided that it did not seriously disrupt the market process. The overall guiding principle was that of the use of monetary policy to insure a stable monetary system and stable prices. Other legitimate types of government intervention included anti-monopoly laws, minimum wage legislation, and the correction of the undesirable effects of social costs.[55]

The Freiburg School dealt with the areas of aggregate anti-cyclical policy and the political-ethical aspects of the competitive order.[56] These are not of interest here because they affect industrial structure only indirectly. The thrust of the Freiburg School's recommendations for the competitive order was that government intervention in the economy should ideally make use of the market mechanism to achieve the desired goal, or should be of such a nature that the intervention would make the economy more competitive.[57] A special subsidy to industry in depressed regions, for example, would tend to direct firms into the desired areas. Eventually, of course, the regions would no longer be depressed if the policy worked. Such a policy would be more desirable than prohibiting industrial expansion in given areas to force firms to carry out expansion plans in the depressed areas.

The neo-liberal policies which directly affected the development of West German industry were free trade, anti-monopoly policy, the middle estate policy, denationalization of state-owned enterprises, and company law reform in the 1965 Company Law. Prior to the founding of the EEC in 1958, West Germany was one of the lowest tariff countries in

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[55]Ibid., pp. 39-41. [56]Ibid., pp. 44-45. [57]Ibid., pp. 43-44.

the OECC. In addition, by the end of the 1950's capital movements were almost entirely freed and exchange controls were eliminated. Such a policy was designed to increase competition in Germany and force German industry to be more efficient.[58]

The development of an anti-monopoly law was not achieved until 1957 with the passage of the Law against Restraints of Competition. The most significant feature of the law is that it does not allow cartel agreements to be enforced by the courts. This portion of the act was a sharp break with Germany's past. In any case exceptions were made. Cartels were not completely prohibited since many types of cartels were allowed. It was possible for example to form a cartel to arrange types of delivery and payment terms and for export and import agreements. In addition the Minister of Economics could license any cartel if he believed such a cartel were in the national interest.[59]

The law set up the Cartel Office (Kartelamt) with which all cartels were required to register. The Cartel Office was not given the power to stop the formation of legal cartels except in the case where an agreement unfairly restricted competition in the relevant market. A legal cartel can also be moved against if it abuses its power. Of course, the law did prohibit certain types of vertical and horizontal agreements.[60] It appears, however, that the law has been used primarily against smaller firms which have tried to form cartel-like agreements as a competi-

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[58]Ibid., pp. 54-55.

[59]Stolper, et al., The German Economy, p. 258.

[60]MacLennan, et al., Economic Planning and Policies, p. 59.

tive effort against their larger rivals.[61] The law does not prohibit mergers. It only requires that a merger in which the resulting firm would control 20 percent of the market be registered with the Cartel Office.[62]

Probably more important to maintenance of competition and the softness of the anti-cartel law was Germany's entry into the EEC in 1957. Economic concentration in Germany could not be viewed seriously if there existed a number of competitors in the EEC. Clearly if other governments were encouraging larger scale firms, it would not be to Germany's advantage to unilaterally restrict the growth of the size of its firms.[63] In any case the power of domestic cartels would only be effective if foreign competitors could be excluded from the market. With a fall in barriers to trade within the EEC the effectiveness of German cartels would be severely diminished as would the market power of big domestic business firms.

Even though a very weak anti-monopoly law was passed, central and state (Länder) governments have had a very active policy of encouraging small to medium-size firms. This policy is called the middle estate policy (Mittelstandpolitik). Such a policy is designed to help foster a competitive environment. Rather substantial amounts of funds have been made available to small and medium-sized firms; for example, about one billion marks in 1966 were made available to finance research and development, economic advisory services, vocational training, and loan

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[61]Arndt, West Germany, p. 37.

[62]MacLennan, et al., Economic Planning and Policies, p. 59.

[63]Ibid., p. 61.

guarantees, and direct loans for the establishment of new firms. Finally, financial aid has been provided to small and medium-sized firms which face strong international competition. In this latter case the firms in question are subsidized so that they may survive long enough to move into other lines of production. Apart from direct financial aid the various governments have had a policy of placing contracts with small to medium-sized firms where possible. In the area of defense spending, for example, the central government has normally placed about 45 percent of its contracts which do not require high technological capability with small and medium-sized firms.[64]

In the area of public ownership of industrial firms, the government has engaged in a policy of selling off its shares. One company which does not enter in the scope of this study, Volkswagen, was partially sold to the public in the early 1960's. Other firms such as Preussag, the large mining and smelting company, and VEBA, a large mining and power company, were partially denationalized in 1959 and 1965 respectively.[65]

The Company Law of 1965 was aimed at three important practices in West German industry. The first had to do with accounting practices and need not be discussed here. The second practice was that of controlling proxy voting of a company's shares by banks. Since the law was not in effect for most of the period under study, i.e., 1958-1967, it is of some importance to look at the question of how banks controlled voting shares in industry prior to 1965. Basically, the 1965 law provided that shareholders be advised of how a bank plans to vote their shares at com-

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[64] Ibid., pp. 62-64.

[65] Ibid., pp. 65-66.

pany meetings. The shareholder can now give the bank permission to go ahead with its plans, or the shareholder is allowed the right to place his proxy with someone else or vote the shares himself. The final provision of significance is the prohibition of interlocking directorates between competitors.[66] These last two provisions are of importance because of the nature of corporate law in West Germany. A group of shareholders or an institution which owns or controls 25.1 percent of the shares in a corporation can be said to have effective veto power over any major corporate decision since most major decisions must be approved by 75 percent of the voting shares. This situation has allowed many institutions to control many more companies than would be possible if they had to have 50.1 percent of the voting shares. The major German banks own an estimated 10 percent of the shares of all public West German corporations. They also are usually allowed to vote the shares of their clients who keep their shares in the banks. This right to vote shares on deposit (Depotstimmrecht) is of major significance because banks are the only stockbrokers in West Germany.[67] To gain an insight into the power of the banks in 1960, 70 percent of the shares in companies whose nominal share of capital represented 75 percent of all quoted shares was controlled by banks either by outright ownership or by proxy. Prior to the 1965 Company Law these proxies given to the banks by shareholders were not for voting on specific issues but were a blanket authorization for the bank to vote the shares as it wished. In addition the banks

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[66]Ibid., p. 65.

[67]Frank Vogel, German Business After the Economic Miracle (New York: John Wiley and Sons, 1973), pp. 56-57.

could loan voting rights to one another or to some other third party (Stimmenleihe).[68]

Quite clearly the majority of public corporations were controlled by a relatively few institutions. Schonfield points out that it would be incorrect to view this concentration of control as a modern version of the traditional industrial cartel. Even prior to the 1965 Company Law a bank officer or board member would not serve on the board of directors of two competing firms. Of course different officers of a bank would sit on the boards of competing firms. In any case one major side benefit to German industry was that new techniques spread rapidly from one company to another. Again bank officers apparently did not divulge trade secrets between firms but did pass on new ideas about management and other business practices. There is some evidence, however, that bankers have directed their lending policies in such a way as to affect the development of the steel industry in a fashion that assured an orderly, coordinated transition in rationalization and expansion beginning in 1962-1963. An uncoordinated market solution to overcapacity would result in the destruction of weaker firms. Instead the industry worked out joint long-term plans in which one firm would engage in one type of investment while another would invest in other types of facilities.[69]

What appears to be an overwhelming case for a highly concentrated industrial market structure has certain flaws. Schonfield himself points out that German businessmen are very responsive to market forces

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[68]Schonfield, Modern Capitalism, pp. 251-252.

[69]Ibid., pp. 253-256.

and competition does indeed exist.[70] Other observers also argue that at least "workable competition" exists[71] or that in the context of the EEC the degree of concentration in industry is not great.[72] One form of indirect evidence of the lack of coordination of enterprises is the method of forecasting market trends. There is strong evidence that no standard time frames are used by different firms for forecasting and, indeed, there seems to be no attempt to standardize forecasting methods so that firms can easily compare their estimates and procedures with those of other firms. There is, for example, much more standardization of firm planning techniques in U. S. industry.[73] Indeed, even with the power of the banks in terms of voting power, there seems to be no real effort to coordinate West German industry.[74] The steel industry appears to be a rare case of direct intervention. Apparently the banks act as owners of corporations do elsewhere. As long as management does a good job of running the company, the banks seem to be content to leave the managers alone.

Although concentration ratios could not be found for each industry, the number of firms for each industry in 1967 is given in Table 2-4. In only two cases were there less than 1000 firms in each industry in 1967 considering all firms, and only three industries with less than

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[70]Schonfield, Modern Capitalism, p. 246.

[71]Graham Hallett, The Social Economy of West Germany (New York: St. Martin's Press, 1973), p. 36.

[72]Arndt, West Germany, pp. 24-25.

[73]Schonfield, Modern Capitalism, pp. 258-259.

[74]Ibid., p. 261.

TABLE 2-4

NUMBERS OF FIRMS IN WEST GERMAN INDUSTRY BY EAST GERMAN INDUSTRIAL CLASSIFICATION METHOD: 1967

Industry	1967[a]	1967[b]
Mining	235	171
Metallurgy	1705	1253
Chemicals	7544	3492
Building materials	7358	3786
Electrotechnical	3176	2040
Shipbuilding	134	118
Machinery	7725	5689
Metal goods	4717	3399
Precision instruments and optical equipment	1517	870
Woodworking	8066	4962
Textiles	5539	3123
Clothing	6786	3957
Leather goods	2303	1394
Pulp and paper	7707	4282
Polygraphic	5879	3113
Glass and ceramics	1361	690
Food industries	9832	4905

SOURCE: Statistiches Bundesamt, "Industrie und Handwerk, Fachwerie D," Zensus im Produzierenden Gewerbe 1967, (Stuttgart und Mainz: Verlag W. Kohlhammer, 1971), pp. 4-5.

[a]All firms [b]Firms with 10 or more employees

1000 firms considering firms employing ten or more employees. Although such large numbers of firms are not conclusive evidence of competitive market structure, it is at least an indication of the plausibility of relatively competitive market structures. It is of course obvious that the use of the East German industrial classification method would tend to reduce the concentration and increase the number of firms in most industries because of the broader classification scheme. Finally, as was argued above, the gradual reduction of barriers to trade within the EEC is indicative of a relatively competitive environment. Clearly, it would be wrong to view each industry in West Germany in isolation from competition from similar industries in other Common Market countries.

CHAPTER III

THEORETICAL BASIS FOR COMPARING EAST AND WEST GERMAN INDUSTRY

Introduction

Comparison of East German and West German industries is made by use of the theory of production. Since time series are used, an attempt must be made to estimate technical change or changes in total factor productivity. The basic model for estimating technical change is based on Solow's pioneering work.[1] Following the model for technical change, the assumptions underlying the specification of output, capital, and labor are set out. These assumptions are then discussed in terms of the work of Jorgenson and Griliches[2] and the work of Denison.[3] Finally the specific forms of the production functions to be tested are specified.

The Model for Estimating Technical Change

If Q is a measure of real output and K and L are measures of real capital and labor inputs, then the production function can be expressed

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[1]Robert M. Solow, "Technical Change and the Aggregate Production Function," The Review of Economics and Statistics, Vol. 39 (August 1957), pp. 312-320.

[2]Dale W. Jorgenson and Zvi Griliches, "The Explanation of Productivity Change," The Review of Economic Studies, Vol. 34 (July 1967), pp. 249-283.

[3]E. F. Denison, The Sources of Economic Growth in the United States and the Alternatives Before Us, (New York: Committee for Economic Development, 1962).

as

$$Q = f(K, L; t) \tag{3-1}$$

where t is a time variable allowing for technical progress. If the case of Hicks neutral technical progress is assumed, and the production function is homogeneous of degree one, then (3-1) can be rewritten as

$$Q = A(t)\, f(K, L) \tag{3-2}$$

where $A(t)$ measures the effects of shifts in f over time.[4]

Differentiating (3-2) totally with respect to time and dividing by Q,

$$\dot{Q}/Q = \dot{A}/A + E_K \dot{K}/K + E_L \dot{L}/L \tag{3-3}$$

is obtained where dots denote time derivatives and

$$E_K = \partial Q/\partial K \; (K/Q) \tag{3-4a}$$

$$E_L = \partial Q/\partial L \; (L/Q) \tag{3-4b}$$

The terms E_K and E_L represent the competitive factor shares of capital and labor respectively in the value of total output. If all income is defined as labor or non-labor income and assuming labor and capital are paid their marginal products, then

$$Q = rK + wL \tag{3-5}$$

where r is the real rate of return on capital and w is the real wage rate, and time subscripts are implied. The use of (3-5) implies the assumption of constant returns to scale. This assumption allows E_K and E_L to be estimated as

$$S_K = \frac{Q - wL}{Q} \tag{3-6a}$$

$$S_L = 1 - S_K \tag{3-6b}$$

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[4]Solow, "Technical Change," p. 312.

where $\underline{S}_K$ and $\underline{S}_L$ are estimates of $\underline{E}_K$ and $\underline{E}_L$ respectively. Rearranging (3-3) and substituting $\underline{S}_K$ and $\underline{S}_L$ for $\underline{E}_K$ and $\underline{E}_L$ gives

$$\dot{A}/A = \dot{Q}/Q - S_K \dot{K}/K - S_L \dot{L}/L \tag{3-7}$$

which when written in discrete form

$$\Delta A/A = \Delta Q/Q - S_K \Delta K/K - S_L \Delta L/L \tag{3-8}$$

allows the computation of technical change or shifts in the production function for each year. Up to now nothing has been said about the form of the production function, since the analysis holds true for any production function in two variables which is homogeneous of degree one, is subject to neutral technical change, and exhibits constant returns to scale. To estimate the exact form of the production function, it is necessary to calculate the A(t) series. The computation is made as follows: Let

$$A(t + 1) = A(t) \{1 + \Delta A(t)/A(t)\} \tag{3-9}$$

where $A(t_1) = 1$. The A(t) series represents the shift factor in the production function. Recalling that

$$Q = A(t) f (K, L), \tag{3-2}$$

divide both sides by A(t) and (3-2) becomes

$$Q/A(t) = f (K, L). \tag{3-10}$$

Output can now be computed net of technical change and the production function reduced to a single curve.[5]

Measures of Outputs and Inputs and the Effect of Technical Change

Output series for each industry in West Germany are net output and

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[5]Ibid., p. 317.

are estimates of net output in East German industry.[6] These series are in 1962 prices in West Germany and are in "unchanged plan prices" for East Germany. Presumably these "unchanged plan prices" are actually constant. They are based on 1955 prices.[7] Since no complete price indexes by industry exist, the value of output is assumed to be expressed in real terms.

Labor input is measured in manhours unadjusted for quality change or labor intensity. In East Germany the assumption of full employment of labor seems reasonable, given a centrally planned, communist system. Adjustments for labor quality changes were not possible since the East German authorities do not provide a detailed breakdown of e.g., educational attainment by industry. As for changes in labor intensity the effect of a changed work week on output per manhour was unknown, and it seemed unwise to make a priori estimates given that the East German manhours series themselves are estimates.[8] Since comparability was desired, no quality or intensity adjustments were made on the West German manhours series. The use of manhours therefore assumes that labor services can be measured by manhour inputs.[9] The use of manhours under-

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[6]For the derivation of East German net output series, see Appendix B.

[7]German Democratic Republic. Staatlichen Zentralverwaltung für Statistik, Statistisches Jahrbuch der Deutschen Demokratischen Republik 1965, (East Berlin: Staatsverlag der Deutschen Demokratischen Republik, 1965), p. 99 (hereafter cited as SJBDDR followed by date).

[8]See Appendix D for the method of estimating manhours.

[9]John W. Knowles, The Potential Economic Growth in the United States, Study Paper No. 20, Joint Economic Committee (Washington, D. C.: Government Printing Office, January 30, 1960), p. 20. See also John W. Kendrick, Productivity Trends in the United States, (Princeton, N. J.: Princeton University Press, 1961), pp. 32-33.

states the contribution of labor input to the growth of output and is discussed below. In the case of West Germany one encounters the problem of the business cycle. There were two recessions between 1958 and 1967. The first occurred in 1961-1962 and the second in 1966-1967. Clearly there was unemployed labor in these years. This fact is not so important for labor but becomes quite serious for capital estimates. Unfortunately the degree of unemployment in each of the seventeen West German industries could not be estimated due to a lack of unemployment statistics on a per industry basis.

Ideally what one would wish to have is a measure of capital services. What is, in fact, available is a measure of the capital stock in both countries. The assumption is made that the flow of capital services is proportional to the capital stock. This assumption leaves much to be desired but is useful at least as a first approximation.[10] This assumption by analogy with using the labor force (i.e., employment) has the effect of possibly overstating the contribution of capital input to the growth of output. This point will be discussed below.

In East Germany there is no reason to expect less than full employment of capital, at least conceptually. While some capital hoarding by firms may be expected, the extent of this practice is unknown. In the case of West Germany capital utilization cannot possibly be at full employment levels in the four recession years. As Solow points out, it is not the capital stock that is important but the capital stock in use.[11] The method of adjusting the West German capital stock involved the use

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[10]Jorgenson and Griliches, "Productivity Change," p. 264.

[11]Solow, "Technical Change," p. 314.

of available potential output figures. The ratio of actual to potential output was computed and multiplied by the actual capital stock. Such a measure should give a measure of capital stock in use.[12]

The question raised here is what does the preceding discussion mean in terms of technical change? Clearly "technical change" will include improvements in the quality of inputs and particularly labor inputs.[13] To the extent also that labor input is measured in actual manhours, technical change will tend to be overstated as will be discussed below. It is to the problems raised by the use of the above definitions of output, labor, and capital to measured technical change that the discussion now turns.

Jorgenson and Griliches (J-G) have argued that the growth of total factor productivity or technical change is negligible if output and factor inputs are correctly specified.[14] Their model shows that with the standard measure of technical change, i.e., (3-8), for the United States economy for the years 1945 to 1965 that technical change accounted for 47.6 percent of the increase in total output.[15] By correcting for measurement of capital, labor, and output, technical change is shown to explain only 3.3 percent of the increase in total output.[16]

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[12]Barry N. Siegel, "Technical Change and Employment in the United States, 1890-1965," Western Economic Journal, Vol. 6 (March 1968), p. 133. See Appendix C for a discussion of the capital stock of East and West Germany.

[13]Micha Gisser and Paul Jonas, "Soviet Growth in the Absence of Centralized Planning," Journal of Political Economy, Vol. 82 (March April 1974), pp. 340-341.

[14]Jorgenson and Griliches, "Productivity Change," pp. 249-250.

[15]Ibid., pp. 260-261.

[16]Ibid., P. 271.

J-G begin by assuming the accounting identity

$$\Sigma q_i\, y_i = \Sigma p_j\, x_j \qquad i = 1, \ldots, n \quad j = 1, \ldots, m \tag{3-11}$$

where y_i is the quantity of the ith output; q_i, the price of the ith output; p_j, the price of the jth input; and x_j, the quantity of the jth input. The current market value is therefore equal to the current market value of all inputs. In defining technical change J-G begin by differentiating (3-11) totally with respect to time and dividing the right hand side by total output and the left by total factor input resulting in

$$\Sigma w_i \left[\frac{\dot{q}_i}{q_i} + \frac{\dot{y}_i}{y_i}\right] = \Sigma v_j \left[\frac{\dot{p}_j}{p_j} + \frac{\dot{x}_j}{x_j}\right] \tag{3-12}$$

where

$$w_i = \frac{q_i\, y_i}{\Sigma q_i\, y_i} \tag{3-13a}$$

$$v_j = \frac{p_j\, x_j}{\Sigma p_j\, x_j}\,. \tag{3-13b}$$

The weight w_i is the share of the current value of output i in the total current value of output. Similarly v_j represents the share of the current value of input j in the total current value of all inputs. In addition the condition

$$\Sigma w_i = \Sigma v_j = 1 \tag{3-14}$$

must be met.[17]

J-G then construct Divisa output and input indexes which are the weighted average of the rates of growth of output and input or

$$\dot{y}/y = \Sigma w_i\, \dot{y}_i/y_i \tag{3-15}$$

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[17]Ibid., pp. 251-252.

(3-16) $$\dot{x}/x = \Sigma v_i \dot{x}_j/x_j .$$

The definition of technical change is

(3-17) $$p = y/x$$

and the rate of growth of technical change is defined as

(3-18) $$\dot{p}/p = \dot{y}/y - \dot{x}/x = \Sigma w_i \dot{y}_i/y_i - \Sigma v_j \dot{x}_j/x_j .$$[18]

To this point the only real difference between the J-G model and the Solow model is the introduction of Divisa indexes and disaggregation of output. The disaggregation of output by economic sector is obviously desirable for aggregate studies. In terms of this dissertation disaggregation has been made as fine as possible and thus (3-13a) becomes

(3-19) $$w = q\,y\,/\Sigma q_i y_i = 1$$

since

(3-20) $$q\,y = \Sigma q_i y_i .$$

The use of the $\underline{v}_j$ share indices requires input prices. These are not available for capital for East Germany. In any case the use of Divisa share indices in the J-G model as well as Divisa output indices reduces the contribution of technical change to total output growth from 0.476 to 0.457 or about two percent.[19] The loss in explanatory power of using the $\underline{S}_K$ measurement appears to be slight.

J-G argue that a major measurement error involves the assumption that output is homogeneous. In fact they argue that output must be broken down into at least two components--consumption goods ($\underline{C}$) and investment goods ($\underline{I}$). Let $\underline{Q}^*$ be the relative measurement error in the price of investment goods prices; $\underline{I}^*$, the output of investment goods

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[18]Ibid., p. 252.

[19]Ibid., p. 261.

computed with the incorrect price of investment goods; and $\underline{I}$, the real amount of investment goods. Then the rate of growth of investment goods will be biased by the amount

$$\dot{I}^*/I^* - \dot{I}/I = - \dot{Q}^*/Q^* \quad (3\text{-}21)$$

.[20]

It is clear that the rate of growth of Q^*/Q is positive (negative) if the measurement error of investment goods is negative (positive). Then if $\underline{K}^*$ is the amount of capital computed by use of the incorrect price of investment goods, the rate of growth of capital services will be

$$\dot{K}^*/K^* - \dot{K}/K = I/Q^*K^* - I/K \quad (3\text{-}22)$$

.

This bias will be negative (positive) if the rate of growth of the measurement error in investment goods is positive (negative).[21]

Finally, to compute measurement error in technical change, set up the relation

$$\dot{P}/P = w_I \dot{I}/I + w_C \dot{C}/C - v_K \dot{K}/K - v_L \dot{L}/L \quad (3\text{-}23)$$

where $\underline{w}_I$ and $\underline{w}_C$ are the relative share of investment and consumption goods respectively. If P^* is the index of technical change computed by use of incorrect investment goods prices, then

$$\dot{P}^*/P^* = w_I \dot{I}^*/I^* + w_C \dot{C}/C - v_K \dot{K}/K - v_L \dot{L}/L \quad (3\text{-}24)$$

.

Subtracting (3-23) from (3-24) gives

$$\dot{P}^*/P^* - \dot{P}/P = w_I (\dot{I}^*/I^* - \dot{I}/I) - v_K (\dot{K}^*/K^* - \dot{K}/K) \quad (3\text{-}25)$$

which is the bias in the rate of growth of technical change. This expression can be reduced to

$$\dot{P}^*/P^* - \dot{P}/P = - w_I \dot{Q}^*/Q^* - v_K (I/Q^*K^* - I/K) \quad (3\text{-}26)$$

by substituting (3-21) and (3-22) into (3-25).[22]

The above analysis by J-G allows for the elimination of signifi-

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[20] Ibid., p. 258. [21] Ibid. [22] Ibid.

cant error in estimating technical change. In J-G this adjustment reduces the contribution of technical change to the growth of output from 47.6 percent to 39.0 percent.[23] The problem with using this method is that no price indexes for East German investment goods are available. There is thus no way to correct for possible biases in investment goods' prices. In addition, series on consumption and investment output for each industry are not available in either country.

J-G initially assumed that labor and capital services were proportional to the stocks of capital and labor.[24] Such an assumption is not strictly correct. What is needed is a measure of utilization of capital and labor. Solow simply assumed that labor and capital were unemployed by the same percentage as the unemployment rate with no allowance for a shorter work week.[25] J-G point out that this assumes that the relative utilization of capital and labor is dependent on the unemployment rate for labor alone.[26] Their argument is that a better measure of capital and labor utilization can be made separately. For capital J-G estimate capacity use on the basis of power utilization of electric motors.[27] In this dissertation neither J-G's nor Solow's method of adjusting the capital stock for utilization is possible. Solow's method requires an unemployment rate for labor which is not available on an industry basis in either country, and J-G's method requires power utilization of electric motors which is also not

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[23] Ibid., p. 264.

[24] Ibid., pp. 255-256.

[25] Solow, "Technical Change," p. 314.

[26] Jorgenson and Griliches, "Productivity Change," p. 265.

[27] Ibid., pp. 278-279.

available on an industry basis. The assumption that capital services are proportional to the capital stock is therefore retained in this study. The final adjustment for capital stock is to disaggregate it into five classes: land, residential and non-residential structures, equipment, and inventories.[28] Capital stock figures for East German industry are as finely disaggregated as possible and thus this adjustment cannot be made.

J-G make several adjustments for labor. They first make Denison's adjustment for labor intensity. The reason is that the stock of labor represents an upper boundary for labor services while actual manhours worked represent a lower boundary.[29] Denison argued that while employment increased 44.1 percent in the U. S. economy from 1929 to 1957, manhours worked increased by only 17.5 percent. The average annual growth rates of real output, employment, and manhours were 2.93 percent, 1.31 percent, and 0.58 percent respectively with labor comprising 73 percent of total input. If labor input is measured by employment alone, with the assumption that a shorter work week has no influence on output per man, then the conclusion could be made that only the quantity of labor had changed. The contribution of labor to the growth of output would therefore have been 73 percent of the rate of growth of employment or a rate of growth of 0.96 percent per year (i.e., 0.73 times 1.31). The increase in employment would thus explain 33 percent of the rate of growth of output from 1929 to 1957 (i.e.,

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[28] Ibid., p. 267. See also E. F. Denison, Sources of Economic Growth, pp. 94-105.

[29] Jorgenson and Griliches, "Productivity Change," p. 266.

0.96/2.93). On the other hand, if the assumption were made that labor was measured by manhours with a shortened work week having no influence on output per manhour, then 15 percent of the growth rate of output (i.e., 0.73 times 0.58/2.93) could be attributed to the increase of labor.[30]

Denison concludes that an adjustment must be made. He argues that as hours worked decline, output per manhour declines by less than the total decrease in hours worked. A one percent decline in manhours in 1929 is assumed to be fully offset by an increase in output per manhour. By proportional interpolation he argues that intermediate points may be found; for example at the mid-point between 1929 and 1957 a one percent decline in manhours caused output per manhour to decrease by only 0.3 percent.[31]

While Denison applies this adjustment to potential manhours per man, J-G apply it to actual manhours per man. Their manhour series thus reflects short-run changes in labor intensity due to business fluctuations.[32] While this adjustment would be desirable, the author has no a priori knowledge of the rate of change in output per manhour as manhours change. In addition, as Denison points out, his final series is most useful in making long-run comparisons where effects of the business cycle are to be eliminated.[33] While this would be desirable in the present study, one of the major theoretical points

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[30] Denison, Sources of Economic Growth, pp. 37-38.

[31] Ibid., p. 40.

[32] Jorgenson and Griliches, "Productivity Change," p. 266.

[33] Denison, Sources of Economic Growth, p. 41.

in evaluating the performance of a capitalist vis a vis a socialist economy is that under socialism, business cycles do not occur. This absence of business cycles is an alleged superior feature of a socialist economy.[34] In this study, therefore, the effects of the business cycles, actually minor recessions in 1961-1962 and 1967, will not be abstracted out of the West German industrial data except for capital stock adjustments.

The last adjustments J-G make in measuring labor services involve quality adjustments and elimination of errors of aggregation. Quality adjustments are made only on male members of the labor force by years of schooling and by industry.[35] Second, errors of aggregation are eliminated, first by calculating the price of labor services by type of labor service and then computing a Divisa index of the types of labor services. For Divisa index of labor, weighted rates of growth of the various types of labor services are added together, i.e., by the relationship

$$\dot{L}/L = \Sigma v_s \dot{L}_s/L_s. \qquad (3\text{-}27)$$

In this relationship v_s is the relative share of the sth type of labor in the value of total labor. The next step is to create a weighted index of manhour input (h) and employment input (n) in the form

$$\dot{L}/L = \Sigma v_s \dot{n}_s/n_s + \Sigma v_s \dot{h}_s/h_s. \qquad (3\text{-}28)$$[36]

Since labor input for German industry is as finely disaggregated as

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[34] Oskar Lange, "On the Economic Theory of Socialism," On the Economic Theory of Socialism, ed. Benjamin E. Lippencott, (New York: McGraw-Hill Book Company, 1964), pp. 105-106.

[35] Jorgenson and Griliches, "Productivity Change," pp. 269-270.

[36] Ibid., p. 269.

possible, such a weighted average would be meaningless because

$$v_s = \Sigma v_s = 1 \tag{3-29}$$

and

$$\dot{L}/L = v_s \dot{L}_s/L_s \tag{3-30}$$

and therefore

$$\dot{L}/L = \dot{n}/n + \dot{h}/h. \tag{3-31}$$

As noted above, employment measures an upper boundary to the rate of growth of labor services and manhours measure a lower boundary to the rate of growth of labor services. The use of (3-31) would certainly overstate the rate of growth of labor services by the amount of $\dot{h}/h$. This study of German industry will use manhours unadjusted for changes in quality and intensity. The consequence of using this measure of labor input is to understate the contribution of labor to the growth of output and thus to overstate the growth of technical change or total factor productivity. Finally, the assumption is made that capital services are proportional to the capital stock.

Forms of the Production Function

There are no a priori reasons to choose one specification of the production function over any others. Consequently, three forms are proposed. The first and most obvious form is the Cobb-Douglas production function in the form

$$Q = Ae^{ct} K^a L^b \tag{3-32}$$

where $b = 1 - a$. Equation (3-32) is assumed to exhibit constant returns to scale and can be rewritten as

$$Q/L = Ae^{ct} (K/L)^a. \tag{3-33}$$

This form of the Cobb-Douglas production function is estimated in Chapter IV as well as the form

(3-34) $$\{Q/A(t)\}/L = B\ (K/L)^{a}$$

where B is a pure scale parameter.

Another obvious choice is the CES production function in the form

(3-35) $$Q = A(t)\ \{dK^{-p} + (1 - d)L^{-p}\}^{-v/p}.$$ [37]

In this form v is the returns to scale parameter, d and (1 - d) are the distribution parameters, and p is the substitution parameter because of its relation to the elasticity of substitution, s by the relation

(3-36) $$s = \frac{1}{1 + p}.$$ [38]

Kmenta has suggested a method of approximating (3-35) for direct estimation purposes. He does not assume any particular form of technical change. Kmenta approximates the CES production function by means of a Taylor's series expansion around p = 0 which yields

(3-37) $$\log Q = \log A + vd \log K + v(1 - d) \log L - \tfrac{1}{2} pvd\ (1 - d)\ (\log K - \log L)^2$$

This approximation to the CES production function can be divided into two parts. If p were zero, then the whole term $-\frac{1}{2} pvd(1 - d)\ (\log K - \log L)^2$ would disappear.[39] Equation (3-37) is estimated along with a variant of it which is deflated for technical change in the form

(3-38) $$\log \{Q/A(t)\} = \log B + d \log K + (1 - d) \log L - \tfrac{1}{2} pd\ (1 - d)\ (\log K - \log L)^2$$

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[37] Kenneth J. Arrow, H. B. Chenery, B. S. Minhas, and R. M. Solow, "Capital-Labor Substitution and Economic Efficiency," Review of Economics and Statistics, Vol 43 (August 1961), p. 230. Referred to hereafter as Arrow et al., "Capital-Labor Substitution."

[38] Ibid.

[39] J. Kmenta, "On Estimation of the CES Production Function," International Economic Review, Vol. 8 (June 1967), pp. 180-181.

where B is a pure scale parameter. Because of the assumptions behind the computation of the A(t) series, i.e., constant returns to scale, $v = 1$. Equation (3-37) and (3-38) will provide a test of not only the CES production function but also the Cobb-Douglas case.

Other methods of estimating a CES production function rest on the assumption of constant returns to scale. Ferguson defined the CES production function as

$$Q = Ae^{ct} \{dK^{-p} + (1 - d) L^{-p}\}^{-1/p} \tag{3-39}$$

In this form Hicks neutral technical change is explicitly assumed. The following relationships were defined:

$$\log y = b_0 + b_1 t + b_2 \log w \tag{3-40}$$

where y is the output-labor ratio and w is the wage rate. Then the relationships

$$s = b_2 = \frac{1}{1 + p} \tag{3-41a}$$

$$c = b_1/(1 - b_2) \tag{3-41b}$$

hold. In this case p and technical change can be directly computed from the regression coefficients.[40]

Since estimates of Hicks neutral technical change can be computed from (3-8), equation (3-40) can be rewritten as

$$\log \left[\frac{Q/A(t)}{L}\right] = b_0 + b_2 \log w. \tag{3-42}$$

In (3-42) output is first computed net of technical change. The estimate b_2 is still equal to the elasticity of substitution, s, and is now no different conceptually from the original formulation

$$\log Q/L = \log a + b \log w \tag{3-43}$$

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[40] C. E. Ferguson, "Substitution, Technical Progress, and Returns to Scale," American Economic Review, Vol. 55 (May 1965), pp. 298-299.

for cross-section studies.[41] As was pointed out in the model for estimating technical change, the operation described in equation (3-10) eliminates the effect of technical change on output and allows the estimation of production relationships on a single production surface.

The third choice of the production function is the constant marginal shares (CMS) production function. The CMS production function is useful in estimating production relationships where marginal factor shares are constant but where the average share of capital or labor can be rising, falling, or constant. In Bruno's model the empirical relation between output per unit of labor and the real wage rate is linear and of the form

$$Q/L = cw + d \tag{3-44}$$

where $c>0$ and represents labor's marginal share of output. The symbol d may be positive, negative, or zero implying a rising, falling, or constant average labor share respectively. The CMS model implies that the marginal product of labor, $\partial Q/\partial L$, is linearly related to the real wage rate in the form

$$\partial Q/\partial L = pw + q \tag{3-45}$$

where p and q are institutional parameters. If $p = 1$ and $q = 0$, then there is competitive equilibrium in both product and factor markets.[42]

If p, q, c, and d are related to two other technical constants, a and m, in the following way

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[41] Arrow et al., "Capital-Labor Substitution," p. 228.

[42] Michael Bruno, "Estimation of Factor Contribution to Growth Under Structural Equilibrium," International Economic Review, Vol. 9 (February 1968), p. 50.

(3-46a) $$c = p\ (1 - a)$$

(3-46b) $$d = \frac{q + ma}{1 - a}$$

where $a \neq 1$, then the following differential equation can be derived from (3-44), (3-45), 3-46a), and (3-46b):

(3-47) $$\partial Q/\partial L = (1 - a)\ Q/L - ma.$$

Integrating (3-47) results in

(3-48) $$Q = c\ (K,\ t)\ L^{1-a} - mL$$

where c is a constant of integration. If the production function is assumed to be subject to constant returns to scale and Hicks neutral technical progress, it can be written in the form

(3-49) $$Q = Ae^{ct}\ K^{a}\ L^{1-a} - mL$$

or in the constant returns to scale form

(3-50) $$Q/L = Ae^{ct}\ (K/L)^{a} - m$$

It is obvious that if $m = 0$, the CMS production function is the simple Cobb-Douglas case and the elasticity of substitution, s, is one since

(3-51) $$s = 1 - \frac{am}{1 - a}\ L/Q.$$

If $m > 0$, then $s < 1$ and if $m < 0$, then $s > 1$. The interpretation of $m > 0$ is that the ratio of the marginal productivities of labor and capital increases over time. Such a conclusion suggests that strict Hicks neutrality does not hold, since technical change is capital saving. If $m < 0$, then the conclusion is that technical change is labor saving.[43]

The case of $p = 1$, $q = 0$ represents perfect competition. If $p = 1$ and $q < 0$, there would be a constant positive difference between the real wage rate and the marginal productivity of labor. As w and the

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[43]Ibid., pp. 52-53.

marginal product of labor grow larger, the relative importance of the difference becomes smaller because $(w + q)/w$ grows smaller as $\underline{w}$ becomes larger. If $\underline{q} = 0$ and $\underline{p} \neq 0$, then there is imperfect competition in the labor market since

$$p = 1 + 1/E_s \tag{3-52}$$

where E_s is the elasticity of supply of labor.[44]

Conclusion

In conclusion then the basic theoretical approach is to estimate technical change from a linear homogeneous production function exhibiting constant returns to scale. At least three specifications of such a production function are used. These are the Cobb-Douglas, CES, and CMS functions. Attempts are made to estimate technical change both directly and indirectly from these specifications. In addition these forms of the production function imply differing elasticities of substitution. Of particular interest is whether or not the elasticity of substitution diverges significantly from one. Finally, by use of the theory of production, it will be possible to show the contributions of labor, capital, and technical change to the growth of net output by industry from 1958 to 1967.

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[44] Ibid., p. 54.

CHAPTER IV

EMPIRICAL RESULTS

In this chapter estimates of technical change, the contribution of capital and labor to the growth of output, and the elasticity of substitution are presented. The first approach is to try to obtain these estimates directly using single equation estimation of three forms of the production function. Next, using the theory of production, estimates of the contribution of labor and capital to the growth of output and technical change are made. Finally, estimates of the elasticity of substitution are made using output deflated for technical change.

Direct Estimation

The three forms of the production function to be estimated are given by equations

(3-33) $$Q/L = Ae^{ct} (K/L)^{a}$$

(3-35) $$Q = A_t \{dK^{-p} + (1 - d) L^{-p}\}^{v/p}$$

and

(3-50) $$Q/L = Ae^{ct} (K/L)^{a} - m$$

These equations are specifications of the Cobb-Douglas production function in constant returns to scale form, the CES production function, and the constant marginal shares (CMS) production function in constant returns to scale form.

For estimation purposes (3-33) is transformed to

(4-1) $$\log (Q/L) = \log A + ct + a \log (K/L) + e$$

where e is a disturbance term with zero mean and constant variance. For the East German industries (4-1) gave uniformly unsatisfactory results. In all cases there were high standard errors or the wrong signs or both for the parameters. The explanation appears to be the high degree of correlation between time trend and the logarithm of the capital-labor ratio. Except for the chemicals, shipbuilding, and textiles industries in West Germany, the same problem prevented direct estimation of the parameters of (4-1). In all cases except the three West German industries cited, the correlation coefficient between time trend and the logarithm of the capital-labor ratio was 0.9 or greater. Comparisons of the parameters using the specification of the production function (4-1) proved impossible.

Direct estimation of (3-35) was attempted by the use of Kmenta's procedure summarized in (3-37). For least squares estimation the addition of the disturbance term e yielded

$$\log Q = \log A + vd \log K + v(1 - d) \log L - \tfrac{1}{2} pvd (\log K - \log L)^2 + e. \tag{4-2}$$

In all cases (4-2) yielded unsatisfactory results with high standard errors and/or wrong signs. The reason again was multicollinearity. This problem was however to be expected as Kmenta himself pointed out. Kmenta suggested using an estimate of d to avoid the problem.[1] A reasonable alternative seemed to be the use of an outside estimate of p. Accordingly an attempt was made to secure estimates of p.

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[1] J. Kmenta, "On Estimation of the CES Production Function," International Economic Review, Vol. 8 (June 1967), p. 181.

The method chosen was to assume constant returns to scale for the CES production function. Then following the example of Arrow, Chenery, Minhas, and Solow, p could be estimated from

$$(4\text{-}3) \qquad \log (Q/L) = \log b_0 + b_1 \log w + e.$$ [2]

The estimate of p can be derived from (4-3) since

$$(4\text{-}4) \qquad b_1 = \frac{1}{1 + p},$$

$$(4\text{-}5) \qquad p = 1/b_1 - 1.$$

Equation (4-3) was estimated across industry boundaries for each year. In no case for either East or West German industry was b_1 significantly different from one.[3]

Another attempt to eliminate the effects of the multicollinearity involved estimation of the Cobb-Douglas specification in the form

$$(4\text{-}6) \qquad \log (Q/L) = \log A + a \log (K/L) + e$$

across industry boundaries for each year. Results of the estimation of a were statistically reasonable for each year for West German industry. The estimates of a, however, showed little uniformity ranging from 0.336 to 0.502 in 1958 and 1967 respectively. The value of a rose consistantly over the ten-year period. For East German industry, estimation of (4-6) provided a statistically significant estimate of a in only two years--1958 and 1959. For the years 1960 through 1967 the Cobb-Douglas specification yielded values of a not significantly different from zero. The year 1959 yielded a value

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[2] K. J. Arrow, H. B. Chenery, B. S. Minhas, and R. M. Solow, "Capital-Labor substitution and Economic Efficiency," Review of Economics and Statistics, Vol. 43 (August 1961), p. 228.

[3] See Appendix E.

for $\underline{a}$ significantly different from zero but the F ratio testing the significance of the regression was below the critical F value. There appears to be no common factor for the value of $\underline{a}$ in East German industry over the time period under investigation.[4]

The next specification of the CES production function involved an attempt to estimate technical change and the elasticity of substitution from (3-40), the Ferguson model, in the form

$$\log (Q/L) = b_o + b_1 t + b_2 \log w + e. \qquad (4\text{-}7)$$

For West German industry only building materials yielded $\underline{b_2}$, the elasticity of substitution, significantly different from zero. All other cases yielded high standard errors and/or wrong signs. The reason apparently was the high degree of correlation between time trend and the logarithm of the real wage rate which, except for building materials, was consistently 0.90 or greater.

The results for East German industry were satisfactory statistically for nine of the seventeen industries including building materials. Except for building materials, however, no basis for a reasonable comparison of industries in the two countries existed. For building materials alone the elasticity of substitution in East Germany was 0.693 and in West Germany, 0.477.

The final functional form is the CMS production function given as

$$Q/L = Ae^{ct} (K/L)^a - m. \qquad (3\text{-}50)$$

Equation (3-50) can be rewritten as

$$Q/L + m = Ae^{ct} (K/L)^a. \qquad (4\text{-}8)$$

In the form (4-8) it is nonlinear. Further the application of least

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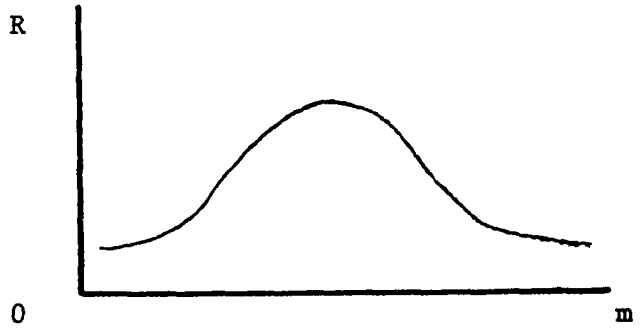
[4]See Appendix E.

squares cannot be used to estimate the parameters A, m, c, or a. Conger argued that (4-8) can be linearized by means of a logarithmic transformation of the form

$$\log (Q/L + m) = \log A + ct + a \log (K/L) + e. \quad (4\text{-}9)$$

Obviously m is not known and must be estimated by a trial and error method. Using Conger's approach, an adaptation of Mayor's scanning technique,[6] values of m from zero to one were placed in (4-9). The coefficient of multiple determination, R^2, was plotted against values of m as shown in Figure 3. If $m > 0$, then R^2 would rise to a maximum. The value of m could then be narrowed down to two decimal places.[7] If R^2 reached a peak at m = 1, then larger integer values for m were inserted, and the scanning technique was performed until a peak range was found.



SOURCE: Darius J. Conger, "Structural Disequilibrium, Factor Productivity and Soviet Economic Growth," (Ph. D. Dissertation, University of Oklahoma, 1974), p. 58.

FIGURE 3. Conger scanning technique for estimating m

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[5]Darius J. Conger, "Structural Disequilibrium, Factor Productivity and Soviet Economic Growth," (Ph. D. dissertation, University of Oklahoma, 1974), pp. 56-57.

[6]Thomas H. Mayor, "Equipment Expenditures by Input-Output Industries," Review of Economics and Statistics, LIII (February 1971), p. 27.

[7]Conger, "Structural Disequilibrium," p. 58.

Values of $\underline{m}$ found in this way cannot be subjected to tests of significance. A method for testing the hypothesis $\underline{m} > 0$ was developed by Weitzman.[8] Let $m = 0$ and therefore the elasticity of substitution be one. Equation (4-9) then becomes the Cobb-Douglas case. To construct a test statistic, estimate the CMS function for $\underline{m} = 0$ and $\underline{m} > 0$. Let the computed error sum of squares for the CMS function with $\underline{m} = 0$ be SER_{cd} and the error sum of squares for the CMS function with $\underline{m} > 0$ be SER_{cms}. The test statistic $g = (n-k)\ (SER_{cd} - SER_{cms}\ \ SER_{cms})$ is an F statistic with (1, n-k) degrees of freedom.[9] The CMS function is therefore tested indirectly against the more restrictive Cobb-Douglas hypothesis rather than by computing the level of significance of $\underline{m}$. The Cobb-Douglas case is accepted if $\underline{g}$ is less than the upper confidence level of $F_{1,\ n-k}$.[10]

Attempts to estimate the CMS function in the form (4-9) for East German industry resulted in high standard errors and/or the wrong signs on $\underline{a}$. The problem again was the high degree of correlation between time trend and the logarithm of the capital-labor ratio. In the case of West German industry the chemical, metal goods, textiles, clothing, and pulp and paper industries gave an $\underline{m} > 0$ using the Conger scanning technique. The test statistic, $\underline{g}$, however was less than the critical F value in all cases so that the CMS hypothesis was rejected in favor of the Cobb-Douglas hypothesis.

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[8]Martin L. Weitzman, "Soviet Postwar Economic Growth and Capital-Labor Substitution," American Economic Review, LX (September 1970), p. 682.

[9]Ibid., p. 683.

[10]Conger, "Structural Disequilibrium," pp. 59-60.

All attempts to directly estimate technical change, the contribution of capital and labor to the rate of growth of output and the elasticity of substitution directly failed for comparison purposes. The next step therefore was to approach the problem indirectly.

Estimation of Hicks Neutral Disembodied Technical Change

Using

$$\Delta A/A = \Delta Q/Q - S_K \Delta K/K - S_L \Delta L/L, \tag{3-8}$$

the contribution of capital and labor to growth of output and technical change can be computed. The results of using (3-8) for each industry are summarized in Tables 4-1 and 4-2. All rates of expansion were multiplied by 100 to present them in percentage form.

In East Germany in all industries the majority of factor expansion came from capital. In no case was the percentage rate of expansion of capital inputs ($S_K \Delta K/K \times 100$) less than 10.03. By way of contrast, the percentage rate of expansion of labor ($S_L \Delta L/L \times 100$) was greater than 10.03 in only four industries--metallurgy (21.26), electrotechnical (10.43), machinery (13.32), and precision instruments and optical equipment (11.83). In nine industries the percentage rate of expansion of labor was actually negative. The same pattern held true for West German industry, but to an even greater degree. The percentage rate of expansion of capital in all industries except shipbuilding and mining, two declining industries, far exceeded the percentage rate of expansion of labor where in fourteen of the seventeen industries, the percentage rate of expansion of labor was negative. In West Germany a large decline in manhours worked occurred between 1966 and 1967,

TABLE 4-1

MEASUREMENT OF HICKS NEUTRAL DISEMBODIED TECHNICAL CHANGE IN EAST GERMANY

Industry	Expansion of Production[a]	Expansion of Factors[a]		Technical Change
		Capital	Labor	
Mining	23.26	12.06	-10.49	21.69
Metallurgy	66.10	28.61	21.26	16.13
Chemicals	103.34	40.66	3.52	59.16
Building materials	87.36	29.75	-0.07	57.86
Electrotechnical	156.25	53.77	10.47	92.05
Shipbuilding	93.77	14.40	1.40	77.97
Machinery	122.61	26.32	13.32	82.97
Metal goods	133.29	31.30	3.50	98.49
Precision instruments and optical equipment	138.08	23.56	11.83	102.69
Woodworking	89.02	18.57	-3.30	73.75
Textiles	48.21	13.77	-12.89	47.33
Clothing	42.86	23.78	-1.36	20.44
Leather goods	64.31	10.03	-1.30	55.58
Pulp and paper	53.64	12.35	-7.09	48.38
Polygraphic	46.15	20.50	-4.41	30.06
Glass and ceramics	85.12	22.50	1.10	61.52
Food industries	47.26	18.51	-1.42	30.17

SOURCE: Appendix Tables B-6, C-4, and D-2, and equation (3-8).

[a]All rates of expansion are in percentage form.

TABLE 4-2

MEASUREMENT OF HICKS NEUTRAL DISEMBODIED TECHNICAL CHANGE IN WEST GERMANY

Industry	Expansion of Production[a]	Expansion of Factors[a]		Technical Change
		Capital	Labor	
Mining	-10.05	-0.70	-23.76	14.41
Metallurgy	34.00	31.02	-5.83	8.81
Chemicals	159.80	60.33	5.11	94.36
Building materials	61.29	93.91	-3.27	-28.63
Electrotechnical	78.00	48.94	3.29	25.77
Shipbuilding	-1.74	-9.93	-22.57	30.76
Machinery	31.61	41.18	-0.16	-9.41
Metal goods	46.75	57.03	-2.85	-7.43
Precision instruments and optical equipment	43.69	36.58	-4.53	11.64
Woodworking	50.94	45.40	-7.33	12.87
Textiles	30.88	28.36	-12.43	14.95
Clothing	42.21	45.57	-2.70	-0.66
Leather goods	3.16	19.34	-13.30	-2.88
Pulp and paper	56.19	53.34	-1.64	4.49
Polygraphic	57.53	50.16	0.60	6.77
Glass and ceramics	44.30	58.38	-8.30	-5.78
Food industries	51.68	60.71	-1.10	-7.75

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (3-8).

[a]All rates of expansion are in percentage form.

since 1967 represented a recession year.[11]

In East Germany technical change is the largest component explaining the rate of growth of output with the exception of metallurgy where both the percentage rate of growth of capital and labor exceeded the percentage rate of growth of technical change. In most of the West German industries, however, the major contribution to the rate of growth of output came from the expansion of capital. The exceptions were mining and shipbuilding, both of which are declining industries, and chemicals which showed the largest percentage rate of growth of output, 159.8 percent, of all West German industries. One major difference in the industrial performances of the two countries is that in all cases in East Germany the percentage rate of technical change was positive. In seven West German industries--building materials, machinery, metal goods, clothing, leather goods, glass and ceramics, and food industries --it was negative. In these seven industries the percentage rate of growth of capital exceeded that of output while labor input declined. Negative technical change under these circumstances suggests diminishing returns to capital, a decline in the quality of capital or a decline in the quality of labor. Since a decline in the quality of capital is unlikely, the probable explanation is a combination of diminishing returns to capital and a lowering of the quality of the labor force. A lower quality of labor force for all West German industry is not improbable given the influx of Southern European and North African workers in the 1960's. In only two of the industries with negative

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[11]See Appendix D, Table D-1 for manhours in the seventeen West German industries. In all industries there were large declines in manhours worked.

technical change, machinery and metal goods, would the use of unskilled and semi-skilled workers be unlikely. The very large percentage rate of growth of capital in such a short time span in all cases suggests that the effects of diminishing returns could not be ignored as a significant factor.

Estimation of Production Functions Net of Technical Change

While Tables 4-1 and 4-2 show the shift in the production function due to Hicks neutral technical change, they do not show technical change in a form suitable for use in estimating a production function. The production function is written in the form

$$Q = A(t)\ f\ (K,L) \tag{3-2}$$

showing that what is needed is an A(t) series. The A(t) series is computed by means of

$$A(t + 1) = A(t)\ \{1 + \Delta A(t) / A(t)\} \tag{3-9}$$

where $A(t_1) = 1$, and all forms of the production function to be estimated have output deflated for technical change.[12] The production function is now written as

$$Q/A(t) = f\ (K,L). \tag{3-10}$$

In Chapter III it was argued that deflating output for technical change would reduce the production function to a single curve which could be estimated by statistical methods.

The Cobb-Douglas production function is written as

$$\frac{Q/A(t)}{L} = B(K/L)^a. \tag{3-34}$$

For estimation purposes (3-34) is transformed to

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[12]See Appendix F, Tables F-1 and F-2 for the A(t) series.

TABLE 4-3

COBB-DOUGLAS ESTIMATES FOR WEST GERMAN INDUSTRY
FOR OUTPUT NET OF TECHNICAL CHANGE[a]

Industry	B	a^b	R^2	SER	F
Mining	1.54	0.571 (0.004)	0.99937	0.0035	12690.41
Metallurgy	1.98	0.567 (0.007)	0.99875	0.0035	6394.04
Chemicals	1.41	0.677 (0.027)	0.98583	0.0119	556.59
Building materials	1.89	0.703 (0.022)	0.99994	0.0017	133325.33
Electrotechnical	2.94	0.476 (0.026)	0.97374	0.0148	296.65
Shipbuilding	2.31	0.335 (0.001)	0.99225	0.0052	1024.31
Machinery	2.75	0.586 (0.022)	0.98782	0.0131	648.81
Metal goods	2.75	0.607 (0.002)	0.99989	0.0017	12984.67
Precision instruments and optical equipment	2.62	0.519 (0.005)	0.99915	0.0034	9408.19
Woodworking	2.20	0.612 (0.005)	0.99941	0.0038	13551.32
Textiles	1.74	0.566 (0.066)	0.88818	0.0484	63.54
Clothing	3.03	0.583 (0.007)	0.99865	0.0047	5917.93
Leather goods	2.57	0.569 (0.007)	0.99852	0.0050	5397.41

TABLE 4-3--Continued

Industry	B	a[b]	R^2	SER	F
Pulp and paper	1.46	0.704 (0.023)	0.99077	0.0171	858.74
Polygraphic	2.30	0.614 (0.005)	0.99929	0.0033	11259.61
Glass and ceramics	2.44	0.576 (0.004)	0.99947	0.0041	15086.34
Food industries	1.47	0.824 (0.005)	0.9972	0.0030	28563.43

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (4-10).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

$$(4\text{-}10) \qquad \log \left\{\frac{Q/A(t)}{L}\right\} = \log B + a \log (K/L) + e.$$

This form of the Cobb-Douglas production function yields uniformly good results for both East and West German industry. The results of the Cobb-Douglas estimates are summarized in Tables 4-3 and 4-4. The only East German industries that might be questioned on theoretical grounds are mining which has a low capital share in output (0.102) and chemicals and food industries which have high capital shares in output (0.665 and 0.715 respectively). These three industries show large departures from the "usual" Cobb-Douglas factor shares. The West German industries which show unusual capital shares are chemicals (0.614), and food industries (0.824).

One notable feature of the Cobb-Douglas estimates is the uniformly

TABLE 4-4

COBB-DOUGLAS ESTIMATES FOR EAST GERMAN INDUSTRY
FOR OUTPUT NET OF TECHNICAL CHANGE[a]

Industry	B	a^b	R^2	SER	F
Mining	2.99	0.102 (0.006)	0.97209	0.0049	278.64
Metallurgy	1.67	0.456 (0.004)	0.99999	0.0001	833324.99
Chemicals	0.99	0.665 (0.008)	0.99878	0.0033	6549.38
Building materials	1.69	0.311 (0.011)	0.98874	0.0079	702.48
Electrotechnical	2.09	0.541 (0.010)	0.99705	0.0051	2703.86
Shipbuilding	1.79	0.439 (0.001)	0.99991	0.0004	88880.88
Machinery	1.92	0.402 (0.011)	0.99318	0.0035	1165.02
Metal goods	1.62	0.482 (0.017)	0.98924	0.0089	735.49
Precision instruments and optical equipment	2.21	0.342 (0.010)	0.99193	0.0040	983.33
Woodworking	2.05	0.299 (0.034)	0.89515	0.0179	68.30
Textiles	1.87	0.329 (0.015)	0.98210	0.0082	483.93
Clothing	5.36	0.373 (0.008)	0.99646	0.0044	2251.89
Leather goods	1.87	0.397 (0.006)	0.99772	0.0018	3500.78

TABLE 4-4--Continued

Industry	B	a[b]	R^2	SER	F
Pulp and paper	1.59	0.303 (0.005)	0.99789	0.0022	3783.47
Polygraphic	1.58	0.402 (0.010)	0.99464	0.0051	1484.54
Glass and ceramics	1.62	0.356 (0.014)	0.98715	0.0084	614.59
Food industries	1.15	0.715 (0.006)	0.99938	0.0020	12895.22

SOURCE: Appendix Tables B-6, C-4, and D-2; and equation (4-10).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

higher estimates of the capital share of output for each West German industry compared to those for the East German industries. In only one case, shipbuilding, is the capital share higher in East Germany (0.439) than in West Germany (0.335).

Attempts to estimate the Kmenta form of the CES production function (3-38) in the form

$$\log \{Q/A(t)\} = \log B + d \log K + (1 - d) \log L - \tfrac{1}{2} pd (\log K - \log L)^2 + e \tag{4-11}$$

yielded parameters with high standard errors or the wrong sign or both for East and West German industry. The problem is the high degree of correlation, 0.90 or greater, of the final term in (4-11) with log $\underline{K}$.

Estimations of the elasticity of substitution by use of the CES

TABLE 4-5

CES ESTIMATES FOR EAST GERMAN INDUSTRY
FOR OUTPUT NET OF TECHNICAL CHANGE[a]

Industry	b_0	$b_2=s^b$	R^2	F	T value for b_2 different from one
Mining	0.927	0.365 (0.027)	0.95388	165.46	-22.567
Metallurgy	1.709	0.174 (0.229)	0.06814	0.58	-3.609
Chemicals	1.281	0.752[c] (0.168)	0.67983	16.99	-1.478
Building materials	0.412	0.823[c] (0.130)	0.81244	34.65	-1.355
Electrotechnical	0.359	1.099[c] (0.125)	0.89511	68.27	0.799
Shipbuilding	0.785	0.618 (0.158)	0.61418	12.74	-2.407
Machinery	0.853	0.543 (0.783)	0.83897	41.68	-5.820
Metal goods	0.578	0.771[c] (0.109)	0.84585	43.90	-2.101
Precision instruments and optical equipment	0.901	0.418 (0.046)	0.90179	73.46	-12.703
Woodworking	0.731	0.499 (0.137)	0.57876	10.99	-3.670
Textiles	0.811	0.541 (0.082)	0.82626	38.05	-5.603
Clothing	0.837	0.562[c] (0.224)	0.36981	4.70	-1.953

TABLE 4-5--Continued

Industry	b_0	$b_2=s$[b]	R^2	F	T value for b_2 different from one
Leather goods	1.040	0.391 (0.086)	0.68587	17.47	-7.064
Pulp and paper	0.944	0.380 (0.075)	0.73459	22.14	-8.321
Polygraphic	0.214	1.223[c] (0.282)	0.66433	15.83	0.790
Glass and ceramics	0.605	0.611 (0.136)	0.68051	17.04	-2.858
Food industries	1.546	0.648 (0.116)	0.77174	27.04	-3.059

SOURCE: Appendix Tables B-6, C-4, and D-2; and equation (4-12)

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

[c]The elasticity of substitution is not significantly different from one

production function (3-42) in the least squares form

$$\log \left\{\frac{Q/A(t)}{L}\right\} = b_0 + b_2 \log w + e \qquad (4\text{-}12)$$

yielded statistically acceptable results in all but six East German industries. The results for industries in both countries are summarized in Table 4-5 and 4-6. The six East German industries--chemicals, building materials, electrotechnical, metal goods, clothing, and polygraphic--had estimates of b_2, the elasticity of substitution, which were significantly different from one. In these cases the Cobb-Douglas model (4-10) is accepted, i.e., the elasticity of substitution is one.

TABLE 4-6

CES ESTIMATES FOR WEST GERMAN INDUSTRY
FOR OUTPUT NET OF TECHNICAL CHANGE[a]

Industry	b_0	$b_2 = s^b$	R^2	F	T value for b_2 different from one
Mining	0.962	0.829 (0.044)	0.97453	306.10	-3.851
Metallurgy	1.478	0.554 (0.052)	0.92705	101.67	-8.676
Chemicals	1.857	0.453 (0.030)	0.96199	202.47	-18.524
Building materials	1.050	1.117 (0.042)	0.98725	619.47	2.795
Electrotechnical	1.472	0.413 (0.290)	0.95762	180.77	-20.384
Shipbuilding	1.385	0.186 (0.069)	0.40902	5.54	-11.740
Machinery	1.465	0.522 (0.032)	0.96726	236.35	-15.029
Metal goods	1.208	0.736 (0.040)	0.97436	304.01	-6.652
Precision instruments and optical equipment	0.240	0.532 (0.027)	0.97761	349.30	-17.666
Woodworking	1.308	0.616 (0.058)	0.92594	100.02	-6.641
Textiles	1.006	0.763 (0.048)	0.96583	226.12	-4.975
Clothing	1.305	0.570 (0.024)	0.98478	517.62	-18.374

TABLE 4-6--Continued

Industry	b_0	$b_2=s^b$	R^2	F	T value for b_2 different from one
Leather goods	1.244	0.581 (0.021)	0.98874	702.48	-20.799
Pulp and paper	1.384	0.672 (0.075)	0.95011	152.35	-6.403
Polygraphic	1.480	0.562 (0.018)	0.99090	871.12	-24.966
Glass and ceramics	1.105	0.769 (0.039)	0.97735	345.21	-5.961
Food industries	1.957	0.799 (0.026)	0.99031	817.63	-7.829

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (4-12).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

In all of the West German industries $\underline{b}_2$ was significantly different from one. The elasticity of substitution for the seven West German industries--chemicals, electrotechnical, shipbuilding, machinery, metal goods, clothing, and polygraphic--was lower than the elasticity of substitution for the same East German industries. Of these seven industries, five were the East German industries which could best be described as Cobb-Douglas cases. In only one instance, the building materials industry in West Germany, was the elasticity of substitution greater than one.

The CMS production function given as (3-50) is estimated as

$$(4\text{-}14) \qquad \log \left[\frac{Q/A(t)}{L} + m \right] = \log B + a \log (K/L) + e$$

Results for this form are provided in Tables 4-7, 4-8, and 4-9. Using the Conger scanning technique developed earlier in this chapter, nine East German industries--electrotechnical, machinery, precision instruments and optical equipment, woodworking, leather goods, pulp and paper, polygraphic, glass and ceramics, and the food industries--provided a rising $\underline{R}^2$ for $\underline{m} > 0$. Of these industries only three--leather goods, pulp and paper, and the food industries--passed the test that $\underline{m} > 0$ where the values of $\underline{m}$ were 1.00, 0.50, and 1.00 respectively. Five of twelve West German industries--precision instruments and optical equipment, leather goods, polygraphic, glass and ceramics, and the food industries--passed the test that $\underline{m} > 0$ where the values of $\underline{m}$ were 0.49, 0.50, 1.04, 1.07, and 0.49 respectively.

The elasticity of substitution for the CMS production function was defined in Chapter III as

$$(3\text{-}51) \qquad s = 1 - \left[\frac{am}{1 - a} \right] L/Q$$

The elasticity of substitution for the East and West German industries with $\underline{m} > 0$ is given in Table 4-10. Estimates of the elasticity of substitution in the range 0.839 to 0.959 are unlikely to be significantly different from one.

Conclusion

Attempts to estimate technical change, the contributions of labor and capital to the growth of output, and the elasticity of substitution directly from the Cobb-Douglas, CES, and CMS production functions failed to provide estimates which could form a basis of comparison of East and West German industries. The procedure adopted, therefore was to

TABLE 4-7

CMS ESTIMATION FOR EAST GERMAN INDUSTRY

Industry	B	a	m	R^2	SER	F
Metallurgy			0.00			
Chemicals			0.00			
Electro-technical	2.45	0.502 (0.009)	0.50	0.99741	0.0044	3081.279
Shipbuilding			0.00			
Machinery	2.10	0.384 (0.008)	0.24	0.99637	0.0024	2196.099
Precision instruments and optical equipment	1.12	0.278 (0.007)	0.99	0.99499	0.0026	1588.933
Woodworking	3.04	0.232 (0.026)	1.10	0.89828	0.0136	70.647
Clothing			0.00			
Leather goods	2.68	0.324 (0.001)	1.00	0.99994	0.0002	133325.33
Pulp and paper	1.98	0.279 (0.003)	0.50	0.99909	0.0013	8787.071
Polygraphic	2.44	0.310 (0.007)	1.00	0.99532	0.0036	1701.402
Glass and ceramics	2.22	0.300 (0.011)	1.00	0.98751	0.0066	632.533
Food industries	1.53	0.652 (0.002)	1.00	0.99992	0.0007	99992.000

SOURCE: Appendix Tables B-6, C-4, and D-2; and equation (4-14).

TABLE 4-8

CMS ESTIMATION FOR WEST GERMAN INDUSTRY

Industry	B	a	m	R^2	SER	F
Metallurgy	2.14	0.540 (0.004)	0.50	0.99947	0.0022	15086.339
Chemicals	1.79	0.628 (0.141)	0.99	0.98664	0.0108	590.802
Electro-technical	4.54	0.376 (0.020)	2.00	0.97520	0.0113	314.581
Shipbuilding	2.72	0.306 (0.009)	0.50	0.99280	0.0045	1103.111
Machinery	2.98	0.554 (0.020)	0.50	0.98791	0.0124	653.726
Precision instruments and optical equipment	3.00	0.483 (0.003)	0.49	0.99966	0.0020	23521.411
Woodworking	2.54	0.574 (0.004)	0.48	0.99928	0.0032	17383.304
Clothing	3.44	0.543 (0.005)	0.48	0.99928	0.0032	11103.111
Leather goods	2.95	0.529 (0.004)	0.50	0.99941	0.0029	13560.515
Pulp and paper			0.00			
Polygraphic	2.94	0.553 (0.001)	1.04	0.99999	0.0004	833324.499
Glass and ceramics	3.21	0.505 (0.001)	1.07	0.99995	0.0011	161282.25
Food industries	1.50	0.804 (0.002)	0.49	0.99994	0.0013	133325.33

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (4-14).

TABLE 4-9

TEST OF SIGNIFICANCE OF CMS PRODUCTION FUNCTION
AGAINST THE COBB-DOUGLAS PRODUCTION FUNCTION

Industry	$g = \frac{(n-k)\ (SERcd-SERcms)}{SERcms}$	$g = \frac{(n-k)\ (SERcd-SERcms)}{SERcms}$
	East Germany	West Germany
Metallurgy		4.72
Chemicals		0.81
Electrotechnical	1.27	2.47
Shipbuilding		1.04
Machinery	3.66	0.45
Precision instruments and optical equipment	4.30	5.60
Woodworking	2.52	1.50
Clothing		3.75
Leather goods	64.00	5.79
Pulp and paper	5.53	
Polygraphic	3.33	58.00
Glass and ceramics	2.18	21.81
Food industries	14.85	10.46

SOURCE: Tables 4-3, 4-4, 4-7, and 4-8.

$F_{1,8} = 5.32$.

TABLE 4-10

ELASTICITY OF SUBSTITUTION FOR EAST AND WEST GERMAN INDUSTRIES FOR THE CMS PRODUCTION FUNCTION

Industry	East Germany S	West Germany S
Leather goods	0.918	0.919
Food industries	0.839	0.891
Pulp and paper	0.959	
Precision instruments and optical equipment		0.938
Polygraphic		0.870
Glass and ceramics		0.864

SOURCE: Tables 4-7, 4-8, and 4-9. Appendix Tables B-1, B-6, D-1 and D-2.

estimate technical change by use of the standard Solow technique. In the process of estimating technical change, the relative contributions of capital and labor to the growth of output were obtained. The general conclusion was that the rate of growth of capital was more important than the rate of growth of labor in explaining the rate of growth of output in both countries. Such a conclusion is consistant with the fact that both countries chronically were short of labor over the ten-year period. A rather surprising result was the observation that technical change explained more of the rate of growth of output in East German industry than in West German industry. The effects of the 1967

recession undoubtedly tended to lower the estimate of technical change in West Germany. Another explanation is the nature of the index used to calculate the East German net output series. This particular point is examined in Chapter V.

After deflating output for the effects of technical change, the Cobb-Douglas, CES, and CMS production functions were again estimated to get an estimate of the elasticity of substitution. The CMS form did not prove to be useful for comparison purposes since only five of the seventeen West German industries and three of the seventeen East German industries could be successfully described by it. Of these industries, only two could be compared. In any case the elasticity of substitution was high enough (above 0.8) that it would be unlikely to be different from one. The Cobb-Douglas and CES production functions in the forms (4-10) and (4-12) provided the best results. These results together with the other estimates are analysed in Chapter V.

CHAPTER V

COMPARISONS AND CONCLUSIONS

Comparison of East and West German Industries

In Chapter IV the measures of Hicks neutral technical change were shown to be of greater significance in explaining the rate of growth of output in all East German industries other than for chemicals than in comparable West German industries. Technical change is simply defined as the "residual" after account is taken of the effects of the rates of growth of capital and labor. The nature of the residual is unknown, but as was shown in Chapter III, it may be due to measurement errors in the definition of capital, labor, or output. In Chapter IV three possible explanations for the lower rate of technical change in West German industry were the effects of the business cycle, a declining but unmeasured quality of the labor force, and diminishing returns, particularly where measured technical change was negative. The case for diminishing returns seems strong given the rapid rate of growth of capital compared to that of labor. This explanation should apply to East German industry as well, except that the rate of growth of capital vis a vis labor in East Germany was not as pronounced. There were in addition no business cycles in East Germany for the period under consideration. One method of indirectly checking for the existance of diminishing returns would be to observe the behavior of the capital-output ratio. A rising capital-output ratio would indicate

a decline in the effectiveness of capital over time. Table 5-1 shows a rising capital-output ratio in all of the West German industries except shipbuilding and chemicals. By comparison unambiguously rising capital-output ratios are found only for the mining and clothing industries in East Germany. For the East German industry metallurgy the capital-output ratio fell between 1958 and 1963 and then rose again in 1967. In the building materials, pulp and paper, and polygraphic industries the capital-output ratio rose between 1958 and 1963 and then fell again in 1967. In all five of these East German industries, however, the capital-output ratio in 1967 was lower than in 1958. While comparisons of capital-output ratios indicate higher productivity of capital in West Germany than in East Germany, i.e., the West German capital-output ratios in all West German industries except shipbuilding and clothing are lower, the trend over the ten-year period is clear. Of the seventeen East German industries, ten were utilizing their capital stock more efficiently, and only two were experiencing an unambiguously declining effectiveness of their capital stock. Of the seventeen West German industries only one, chemicals, was experiencing increased productivity of the capital stock.

There was one point brought up in Chapter IV dealing with the rate of growth of output that requires further explanation. The net output series for West German industry can be accepted without question despite some reservations raised by Jorgenson and Griliches in Chapter III about further disaggregation being desirable. The net output series for East German industry is based on the index of gross output. The point is made in Appendix B that gross output can increase without any corresponding increase in real output. If there are more stages of

TABLE 5-1

CAPITAL-OUTPUT RATIOS FOR EAST AND
WEST GERMAN INDUSTRY: 1958, 1963, 1967

Industry	Capital-Output Ratios					
	West Germany			East Germany		
	1958	1963	1967	1958	1963	1967
Mining	2.17	2.30	2.38	5.55	7.70	9.60
Metallurgy	1.54	1.67	1.77	3.35	2.97	3.26
Chemicals	1.88	1.52	1.32	3.15	2.62	2.48
Building materials	1.00	1.24	1.46	3.86	4.28	3.81
Electrotechnical	0.83	0.86	0.89	1.06	0.87	0.85
Shipbuilding	2.37	1.69	1.77	2.06	1.71	1.42
Machinery	0.79	0.93	1.05	2.00	1.51	1.48
Metal goods	0.65	0.72	0.87	1.72	1.38	1.24
Precision instruments and optical equipment	0.78	0.85	0.92	1.45	1.14	1.01
Woodworking	0.84	0.91	0.97	1.79	1.50	1.46
Textiles	1.32	1.42	1.51	2.28	2.20	2.06
Clothing	0.50	0.56	0.62	0.42	0.45	0.46
Leather goods	0.68	0.80	0.91	1.89	1.61	1.42
Pulp and paper	1.30	1.43	1.53	4.50	4.72	4.36
Polygraphic	0.93	1.01	1.08	1.68	1.77	1.71
Glass and ceramics	0.78	0.99	1.11	2.72	2.53	2.62
Food industries	1.11	1.20	1.28	1.99	1.86	1.71

SOURCE: For East German industries, Table 2-1; for West German industries, Appendix Tables B-1 and C-3.

production added to the production of a particular good, then the number of double countings will increase and gross output will rise. The trend noted in Chapter II for the growth of combines and vertical integration would tend to overstate the rate of growth of gross output to an unknown degree. The result would be a higher rate of growth of output and thus a higher measure of the rate of technical change. This same higher rate of growth of output could also explain in part the declining capital-output ratios experienced in ten of the East German industries. The extent of this effect on output, however, cannot be measured. Subject to this qualification, the conclusion stands that the trend of capital productivity in most of the East German industries has been better than in comparable West German industries.

In comparison of the sources of growth other than technical change, capital was overwhelmingly the most important factor in industries in both countries. The reasons why such a result could be expected was suggested in Chapter II, where the facts of full employment in West Germany between 1958 and 1966 and a slow population growth rate would both tend to reinforce the tendency to substitute capital for labor. The tendency would also be strong in East Germany where the labor force did not show any significant change over the ten-year period.

In Chapter IV two production functions, the Cobb-Douglas and the CES in forms (4-10) and (4-12) respectively, provided statistically satisfying results. There are no statistical reasons for choosing one production function over the other except in the six East German industries where the elasticity of substitution was not significantly different from one. One method of making a choice would be to directly calculate the share of labor in real output using

(5-1) $$S_L = wL/Q.$$

As is well-known, the Cobb-Douglas formulation gives constant factor shares of capital and labor in total industry output over time. If the share of labor in total industry output is not constant, then the CES formulation would be appropriate under the conditions that labor's share rises when the wage rate increases at a faster rate than neutral technical change and falls when the wage rate increases at a slower rate than neutral technical change when the elasticity of substitution is less than one. The relationship would be reversed if the elasticity of substitution were greater than one.[1] In Table (5-2) and (5-3) the percentage rate of change of the wage rate and technical change are given along with the share of labor in output for 1958, 1963, and 1967 for the industries for which the CES production function cannot be ruled out on a statistical basis. Where a Cobb-Douglas case appears appropriate, the corresponding estimated share of labor derived from the estimation of the Cobb-Douglas production function (4-10) is given.

In East German industry the share of labor is relatively constant in metallurgy and the food industries only. All of the other industries show declining labor shares. The elasticity of substitution is less than one, and except for the pulp and paper and the mining industries, the percentage rate of growth of real wages is less than the percentage rate of growth of neutral technical change. In the mining and the pulp and paper industries the share of labor declined despite the fact that

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[1] K. J. Arrow, H. B. Chenery, B. S. Minhas, and R. M. Solow, "Capital-Labor Substitution and Economic Efficiency," Review of Economics and Statistics, Vol. 43 (August 1961), p. 244.

TABLE 5-2

THE PERCENTAGE RATES OF GROWTH OF THE WAGE RATE AND NEUTRAL TECHNICAL CHANGE AND THE SHARE OF LABOR IN TOTAL OUTPUT FOR EAST GERMAN INDUSTRY

Industry	Percentage Rate of Growth		Labor's Share			
	Wage Rate[a]	Technical Change	1958	1963	1967	C-D[b]
Mining	30.34	21.69	0.91	0.86	0.85	
Metallurgy	13.61	16.13	0.53	0.53	0.52	0.54
Shipbuilding	24.03	77.97	0.73	0.56	0.48	
Machinery	27.92	82.97	0.73	0.55	0.51	
Precision instruments and optical equipment	39.23	102.69	0.76	0.61	0.53	
Woodworking	36.23	73.75	0.77	0.64	0.53	
Textiles	43.25	47.33	0.65	0.60	0.50	
Leather goods	30.91	55.58	0.64	0.55	0.50	
Pulp and paper	49.81	48.38	0.69	0.68	0.60	
Glass and ceramics	39.32	61.52	0.79	0.70	0.61	
Food industries	47.71	30.17	0.29	0.28	0.28	0.28

SOURCE: Appendix Tables B-6, D-2, G-2, and Table 4-4.

[a]The percentage rate of growth in wages is calculated by $\Delta w/w \times 100$.

[b]Actual Cobb-Douglas estimates of labor's share of output.

TABLE 5-3

THE PERCENTAGE RATES OF GROWTH OF THE WAGE RATE AND NEUTRAL TECHNICAL CHANGE AND THE SHARE OF LABOR IN TOTAL OUTPUT FOR WEST GERMAN INDUSTRY

Industry	Percentage Rate of Growth		Labor's Share			
	Wage Rate[a]	Technical Change	1958	1963	1967	C-D[b]
Mining	58.70	14.41	0.49	0.43	0.41	
Metallurgy	77.86	8.81	0.40	0.45	0.43	0.43
Chemicals	85.36	94.36	0.29	0.28	0.25	0.32
Building materials	74.35	-28.63	0.31	0.31	0.30	0.30
Electro-technical	88.41	25.77	0.42	0.47	0.48	
Shipbuilding	88.54	30.76	0.53	0.68	0.67	
Machinery	83.80	-9.41	0.39	0.47	0.53	
Metal goods	64.60	-7.43	0.39	0.43	0.44	
Precision instruments and optical equipment	85.32	11.64	0.45	0.51	0.52	
Woodworking	88.84	12.87	0.39	0.41	0.39	0.39
Textiles	60.77	14.95	0.48	0.43	0.43	0.43
Clothing	85.64	-0.66	0.37	0.43	0.44	
Leather goods	85.97	-2.88	0.41	0.46	0.52	
Pulp and paper	133.33	4.49	0.33	0.38	0.37	
Polygraphic	98.42	6.77	0.36	0.40	0.43	

TABLE 5-3--Continued

Industry	Percentage Rate of Growth		Labor's Share			
	Wage Rate[a]	Technical Change	1958	1963	1967	C-D[b]
Glass and ceramics	89.88	-5.78	0.43	0.45	0.45	0.42
Food industries	87.14	-7.75	0.17	0.19	0.19	0.18

SOURCE: Appendix Tables B-1, D-1, G-1, and Table 4-5.

[a]The percentage rate of growth in wages is calculated by $\Delta w/w \times 100$.

[b]Actual Cobb-Douglas estimates of labor's share of output.

the rates of growth in wages exceeded that of technical change, and the elasticities of substitution were 0.365 and 0.380 respectively.

In West German industry the share of labor is relatively constant in metallurgy, chemicals, building materials, woodworking, textiles, glass and ceramics, and the food industries. In all the other industries except mining the share of labor is rising where the elasticity of substitution is less than one and the percentage rate of growth in the wage rate exceeds the percentage rate of growth in technical change. As in East Germany the share of labor is declining despite the fact that the percentage rate of growth of the wage rate exceeds that of technical change, and the elasticity of substitution is 0.829. In mining in both countries and in pulp and paper in East Germany the possibility exists that Hicks neutral technical change does not adequately describe the type of technical change or that constant returns to scale represents a misspecification of the production

function. Since the CES function represents the more general case, it will be accepted with reservations as being the more nearly correct specification for mining in both countries and for pulp and paper in East Germany.

Table 5-4 shows the elasticity of substitution for each East and West German industry. In four cases in both countries--metallurgy, chemicals, building materials, and the food industries--the elasticity of substitution is one, implying a Cobb-Douglas production function. In only one CES case, machinery, are the elasticities of substitution in East and West Germany roughly equal, i.e., 0.54 and 0.52 respectively. In mining, precision instruments and optical equipment, woodworking, textiles, leather goods, pulp and paper, and glass and ceramics the elasticity of substitution is greater in West Germany.

Conclusions

The basic hypothesis of this study was that there should have been little or no difference in the use of resources in East and West German industry since the two countries were artificially created out of a formerly unified developed country. On one point there was little difference--the growth of capital was the major factor source of growth of output compared to labor. The rate of change of labor in fact was negative in most industries in both countries. Here similarity of performance essentially ceased. In East German industry the rate of growth of output exceeded that of West Germany in all but the chemicals industry. In addition the rate of technical change was a more important source of growth of output than capital or labor in all East German industries except for metallurgy and was more important than the rate of technical change for any West German industry

except chemicals.[2] One reason suggested for the higher rate of technical change in East Germany was the use of gross value output indices in computing net output series since the growth of gross output places an upward bias on the rate of growth of output. Another explanation for the relatively better performance of East German industry was diminishing returns to capital suggested by rising capital-output ratios in all but two West German industries and falling capital-output ratios in ten East German industries. One point of importance was the business cycle. East Germany did not have business cycles, where West Germany did. The proposition that an economy without business cycles will perform better over time as suggested in Chapter III appears valid, at least for the two Germanies. In any case there is little doubt as to which economy uses its capital more effectively. Fifteen of the West German industries had lower capital-output ratios compared to the same East German industries. The exceptions were shipbuilding and clothing. One probable explanation for higher capital-output ratios in East German industry is that some unknown degree of capital hoarding still takes place in East German industry despite the reforms instituted in 1958 and 1963 to eliminate this practice. Another possible explanation is the lower degree of automation in East German industry compared to West German industry.[3] These factors would be system specific. Capital hoarding is a well-known feature of centrally

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[2] See Tables 4-1 and 4-2.

[3] Herbert Wilkins, "Labor-Productivity in East and West German Industry--A Comparison," Economic Bulletin, Vol. 7 (June 1970), p. 56.

planned socialist economies.[4] The lower degree of automation can also be attributed to the political system which has prevented extensive economic contacts between its managers and those in foreign countries. The economic system with its emphasis on plan fulfullment would tend to discourage innovation which is risky and therefore might prevent plan fulfillment.[5] As Wilkins points out, the East German authorities have been pushing automation as a method of increasing productivity.[6] The falling capital-output ratios would be indicative of some degree of success in this area.

A final area of difference is in the elasticity of substitution. In only five industries in both countries--metallurgy, chemicals, building materials, the food industries, and machinery--were the elasticities of substitution the same. In the first four industries the elasticities of substitution were one. In machinery the elasticity of substitution was less than one. While real wages rose in all industries in both countries over the ten-year period, the share of labor in output declined in the East German industries which were described by the CES production function. The share of labor rose in the CES industries in West Germany. The implication is that East German workers

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[4] For a discussion of the tendency of managers to hoard capital see Herbert S. Levine, "Pressure and Planning in the Soviet Economy," in The Soviet Economy, 3rd edition, ed. Morris Bornstein and Daniel Fusfeld (Homewood, Ill.: Richard D. Irwin, Inc., 1970), pp. 64-82, especially pp. 68-70. In the same source a detailed explanation of managerial motivation is given by Joseph S. Berliner, "Managerial Decisionmaking: A Comparison of the United States and the Soviet Union," pp. 165-195. In particular see pp. 172-185

[5] See Joseph S. Berliner, "Managerial Decisionmaking," pp. 181-182 for a discussion of the Soviet experience in this area.

[6] Herbert Wilkins, "Labor-Productivity," p. 56.

did not benefit fully from the rise in technical change or, as it is so often called, total factor productivity. Accordingly an ever greater share of output went to the enterprises and the state. Theoretically this state of affairs should have been expected to have generated higher rates of investment and a more rapidly growing capital stock and thus a greater contribution of capital to the growth of output than in West Germany where the relationships are reversed. This was not, however, the case. The probable explanation lies in the fact that the East German authorities can allocate investment funds generated by enterprises to other areas of the economy. In West German industry the share of output going to a firm in an industry would be more likely to be reinvested in that firm. The above comparison suggests system specific sources of differences in both labor shares and in the growth of capital.

The above conclusions should be accepted only with reservations. The upward bias in the East German industrial output series has been noted. The manhour series for each East German industry may contain a downward bias in manhours worked, since the assumption was made that every employee worked the same number of hours as a socialist production worker. If manhours are understated, labor's contribution to the growth of output is understated, and technical change is overstated. In addition labor's share of output would be understated, if manhours were understated.

Other factors should be considered as limitations on the final conclusions. The econometric estimates of the elasticity of substitution are at best approximations because of the small number of observations on capital, labor, and output. To have more confidence in the

econometric results a much larger number of observations is needed. At least as serious a limitation on the production function estimates and the estimates of technical change is the assumption that labor and capital are paid their marginal products. Such an assumption is rather weak especially for a communist economy such as East Germany. The assumption does not seem as arbitrary, however, as simply assigning a factor weight to capital for the whole period under review as has been done by researchers such as Bergson for studies of the Soviet economy.[7]

Other weaknesses of the study stem from the use of manhours unadjusted for changes in the quality of the labor force and the use of the gross capital stock as a measure of capital services. The use of manhours understates labor's contribution to the rate of growth of output. The bias introduced by using manhours would cause labor's share of total output to be understated. This bias could be more serious for East German industry where a probability exists that manhours are already understated. The same conclusion holds for the failure to make adjustments in the quality of labor. The use of the gross capital stock as a measure of capital services would tend as noted in Chapter III to overstate the contribution of capital to the growth of output.

The conclusions in support of a better dynamic performance for East German industry need to be considered as very tentative in view of the restrictive assumptions and data limitations. To reach any firm

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[7] Abram Bergson, "National Income," in Economic Trends in the Soviet Union, edited by Abram Bergson and Simon Kuznets (Cambridge, Mass.: Harvard University Press, 1963), pp. 19-20.

conclusions more data of greater reliability is needed. Subject to these obvious limitations the hypothesis of no essential differences in the resource use in East and West Germany must be in general rejected. The major common feature found was the importance of capital compared to labor as a leading factor contributing to the growth of output. Such a conclusion could reasonably be expected for any advanced industrialized country. Apparently the type of system does matter for resource utilization.

APPENDIX A

METHOD OF COMPARING EAST AND WEST GERMAN INDUSTRIES

Since the definition of industrial boundaries in East and West Germany differs, it was first necessary to arrange the West German industrial classifications to conform to the East German classification scheme. The problem revolved around the fact that there are nineteen industries other than construction and agriculture in East Germany and 44 different industries in West Germany. The method used for comparison was developed by the Deutsches Institut für Wirtschaftsforschung (DIW) in Berlin in Bericht der Bundesrierung und Materialien zur Lage der Nation 1971 prepared for the West German government.[1]

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[1] Federal Republic of Germany, Bundesministerium für innerdeutsche Beziehungen. Bericht der Bundesregierung und Matierialien zur Lage der Nation 1971 (Kassel: A. G. Wenderoth, 1971), p. 107.

TABLE A-1

COMPARATIVE INDUSTRIAL CLASSIFICATION METHOD

East German Industrial Classification	West German Industrial Classification
1. Mining	1. Mining
2. Metallurgy	2. Metallurgy a. Iron working b. Iron and steel casting c. Wire and cold metal rolling
3. Chemicals	3. Chemicals a. Chemicals b. Mineral oils c. Rubber and asbestos d. Plastics
4. Building materials	4. Building materials
5. Electrotechnical	5. Electrotechnical
6. Shipbuilding	6. Shipbuilding
7. Machinery a. Heavy machinery b. Light machinery	7. Machinery a. Steel girder and railway car construction b. Machinery
8. Metal goods	8. Metal goods a. Iron goods, sheet metal and hardware b. Steel stampings
9. Precision instruments and optical equipment	9. Precision instruments and optical equipment
10. Woodworking	10. Woodworking a. Sawmills b. Woodworking c. Musical instruments, toys, sporting goods, and ornaments
11. Textiles	11. Textiles
12. Clothing	12. Clothing
13. Leather goods	13. Leather goods a. Leather equipment b. Leather processing c. Shoe production
14. Pulp and paper	14. Pulp and paper a. Paper and glue b. Pulp
15. Polygraphic	15. Polygraphic

TABLE A-1--Continued

East German Industrial Classification	West German Industrial Classification
16. Glass and ceramics	16. Glass and ceramics a. Glass industry b. Ceramics and pottery
17. Food industries	17. Food industries

SOURCE: Federal Republic of Germany, Bundesministierium für innerdeutsche Beziehungen, Bericht der Bundesregierung und Matierialien zur Lage der Nation 1971 (Kassel: A. G. Wenderoth, 1971), p. 107.

APPENDIX B

OUTPUT SERIES FOR EAST AND WEST GERMANY

TABLE B-1

NET OUTPUT IN WEST GERMAN INDUSTRY: 1958-1967 IN 1962 PRICES
(MILLIONS OF DM)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	10687	10328	10569	10720	10779	10965	11180	10854	10331	9613
Metallurgy	11232	12221	14246	14250	13776	13206	15527	15688	14893	15051
Chemicals	13969	16362	18892	20505	22708	24975	28484	31419	34225	36391
Building materials	4826	5497	5901	6401	6846	7051	7969	8071	8222	7784
Electrotechnical	9658	10571	12554	13924	14226	14557	16006	17847	17590	17191
Shipbuilding	1265	1171	1170	1147	1090	1008	1097	1178	1232	1243
Machinery	17226	17753	20287	22257	22499	22008	23460	25035	24650	22723
Metal goods	6836	7503	8690	9004	9057	9330	10418	11088	10801	10032
Precision instruments and optical equipment	1657	1781	1995	2041	2021	2043	2350	2496	2492	2381
Woodworking	4623	4926	5438	5672	5967	5870	6533	6994	7197	6978
Textiles	6547	7108	7915	8158	8393	8511	8829	9216	9216	8569
Clothing	3523	3790	4105	4447	4691	4738	5019	5484	5596	5010
Leather goods	2025	2140	2213	2263	2294	2317	2387	2451	2355	2089
Pulp and paper	2974	3210	3543	3605	3809	3947	4264	4522	4659	4645
Polygraphic	3033	3200	3521	3779	3965	4096	4350	4623	4790	4778
Glass and ceramics	2165	2304	2567	2667	2781	2827	3094	3304	3324	3124
Food industries	15925	16689	17690	18697	19832	20724	22033	23065	23719	24155

SOURCE: Rolf Krengel, Egon Baumgart, Arthur Boness, Rainer Pischner, and Käthe Droege, Produktionsvolumen und -potential, Produktionsfaktoren der Industrie im Gebiet der Bundesrepublik Deutschland, (Berlin: D.I.W., 1968, p. 5. Referred to hereafter as Krengel, et al., Produktionsvolumen 1968.

TABLE B-2

POTENTIAL NET OUTPUT IN WEST GERMAN INDUSTRY: 1958-1967 IN 1962 PRICES
(MILLIONS OF DM)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	10824	11224	11516	11757	11896	11878	11845	11821	11591	11218
Metallurgy	13541	14175	14814	15712	16808	17810	18661	19730	19906	20243
Chemicals	15153	17250	19258	21575	24017	26646	29533	32826	36785	41102
Building materials	5462	5724	6188	6803	7410	7860	8265	8753	9117	9210
Electrotechnical	11142	12145	13309	14752	16345	17814	19096	20368	21660	22808
Shipbuilding	1265	1342	1385	1406	1424	1436	1458	1494	1521	1540
Machinery	19645	20329	21279	22662	24065	25083	25851	26775	27583	28008
Metal goods	7931	8391	9040	9819	10532	11159	11750	12350	12884	13232
Precision instruments and optical equipment	1754	1864	1995	2133	2273	2418	2543	2666	2792	2910
Woodworking	4944	5220	5561	5941	6345	6747	7109	7498	7896	8225
Textiles	7306	7648	8085	8593	8999	9292	9562	9890	10213	10428
Clothing	3761	4032	4325	4625	4928	5163	5387	5640	5883	6003
Leather goods	2266	2314	2370	2441	2490	2514	2539	2570	2582	2555
Pulp and paper	3029	3274	3543	3838	4166	4464	4680	4889	5122	5355
Polygraphic	3117	3404	3757	4074	4344	4627	4887	5130	5362	5592
Glass and ceramics	2300	2443	2608	2817	3018	3179	3338	3535	3720	3813
Food industries	16330	17261	18352	19452	20453	21475	22545	23583	24569	25536

SOURCE: Rolf Krengel, et al., Produktionsvolumen 1968, p. 9.

TABLE B-3

INDEX OF GROSS OUTPUT IN EAST GERMAN INDUSTRY: 1958-1967
(1955 = 100)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	114	118	115	119	126	130	135	136	135	141
Metallurgy	125	139	154	162	168	170	180	189	199	208
Chemicals	128	142	153	165	177	189	205	223	243	260
Building materials	142	163	178	187	200	201	231	243	255	266
Electrotechnical	152	183	211	227	259	275	301	327	362	389
Shipbuilding	109	137	153	138	143	157	176	197	196	211
Machinery	131	158	177	195	214	225	243	258	273	292
Metal goods	148	176	195	213	232	251	272	289	315	345
Precision instruments and optical equipment	138	159	171	179	197	214	232	269	299	329
Woodworking	126	147	161	173	186	186	196	207	219	239
Textiles	120	133	139	142	146	147	150	158	167	178
Clothing	132	146	149	163	177	161	167	174	183	188
Leather goods	120	137	145	154	163	162	168	178	188	197
Pulp and paper	119	129	135	142	147	150	158	164	172	182
Polygraphic	120	132	142	147	147	149	158	162	167	175
Glass and ceramics	115	129	140	147	156	162	177	189	198	212
Food industries	122	127	138	144	144	150	157	165	171	179

SOURCE: German Democratic Republic. Staatlichen Zentralverwaltung für Statistik, Statistisches Jahrbuch der Deutschen Demokratischen Republik 1966, (East Berlin: Staatsverlag der Deutschen Demokratischen Republik, 1966), pp. 152-153. Referred to hereafter as SJBDDR followed by date. SJBDDR, 1968, pp. 152-153.

TABLE B-4

GROSS OUTPUT OF EAST GERMAN INDUSTRY: 1958-1967
(MILLIONS OF MDN)

Industry	1958	1959	1960	1961	1962	1963	1964	1965[a]	1966	1967
Mining	2616	2700	2626	2730	2872	2980	3089	3109	3086	3224
Metallurgy	4415	4897	5409	5705	5912	5984	6340	6666	6990	7332
Chemicals	8777	9747	10470	11302	12176	12982	14066	15306	16679	17846
Building materials	1108	1272	1392	1492	1559	1567	1801	1896	1990	2076
Electrotechnical	3964	4779	5501	5923	6755	7182	7851	8540	9454	10159
Machinery	5871	7089	7910	8715	9608	10078	10876	11565	12222	13069
Metal goods	1313	1562	1728	1892	2058	2230	2411	2565	2795	3062
Precision instruments and optical equipment	1162	1337	1438	1508	1657	1802	1950	2263	2515	2767
Woodworking	2050	2384	2607	2801	3024	3020	3185	3357	3552	3876
Textiles	5649	6256	6534	6671	6881	6911	7059	7452	7855	8373
Clothing	1963	2178	2219	2428	2637	2401	2490	2596	2730	2804
Leather goods	1199	1370	1452	1543	1628	1616	1677	1780	1880	1970
Pulp and paper	1015	1105	1157	1215	1261	1281	1350	1405	1473	1559
Polygraphic	545	601	655	668	670	679	717	738	761	797
Glass and ceramics	738	831	899	948	1003	1041	1137	1217	1275	1365
Food industries	8901	9300	10129	10526	10529	10963	11518	12082	12522	13107

SOURCE: SJBDDR, 1962, pp. 282-283; SJBDDR, 1965, pp. 150-151; Appendix Table B-3.

[a]The output series beginning in 1965 were computed from the gross output indexes given in Appendix Table B-3.

TABLE B-5

RATIO OF WEST GERMAN NET OUTPUT TO GROSS OUTPUT: 1962

Industry	Net Output (NO)	Gross Output (GO)	NO/GO
Mining	10779	16004	0.674
Metallurgy	13776	32936	0.417
Chemicals	22708	43846	0.518
Building materials	6846	10421	0.657
Electrotechnical	14226	25622	0.557
Shipbuilding	1090	2600	0.419
Machinery	22499	40443	0.556
Metal goods	9057	16344	0.554
Precision instruments and optical equipment	2021	3131	0.646
Woodworking	5967	11579	0.515
Textiles	8393	18398	0.456
Clothing	4691	10347	0.453
Leather goods	2294	4859	0.472
Pulp and paper	3809	8033	0.474
Polygraphic	3965	5941	0.667
Glass and ceramics	2781	4237	0.656
Food industries	19832	45503	0.436

SOURCE: Federal Republic of Germany, Statistisches Bundesamt, "Industrie und Handwerk, Fachserie D," Zenzus im Produzierenden Gewerbe 1962 (Stuttgart und Mainz: W. Kohlehammer, GmbH, 1966), pp. 125-127.

CALCULATION OF ESTIMATED NET OUTPUT SERIES FOR EAST GERMAN INDUSTRY

Since the East German authorities do not publish time series on net output by industry, estimates of net output by industry were computed. The Deutsches Institut für Wirtschaftsforschung or DIW in Berlin computed the ratio of gross output of East German industry to gross output of West German industry. Where possible the DIW used physical output to compute these ratios. The DIW study used 1967 as the base year. The ratio of East to West gross output was multiplied by West German gross output in 1962, and gross output for East German industry was then extended by use of the gross output indexes presented in Table B-3. Similar gross output figures for West German industry were created by extending West German gross output series back by use of the index of net output by industry.[1]

The use of gross output series did not seem desirable for purposes of estimating a production function because of the problem of double counting. The approach used was to impose the West German ratio of net output to gross output on East German industry and then to construct an estimated net output series by industry. Such an approach has certain disadvantages. The obvious disadvantage is that nothing happens to the rate of change of output from year to

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[1] Federal Republic of Germany. Bundesministerium für innerdeutsche Beziehungen, Bericht der Bundesregierung und Materialien zur Lage der Nation 1971, (Kassel: A. G. Wenderoth, 1971), p. 106.

year. Stolper points out that the whole concept of gross output is undesirable because it is possible for gross output to increase without any corresponding increase in real output. If there are two products, x and y, and there are more stages of production in producing x than in producing y, then a shift from y to x would cause gross output to increase because the number of double countings increases. Simply increasing the stages of production--a likely occurrence as an economy develops--gives an upward bias to gross output statistics.[2] Nothing can be done about this problem since there is no reliable method of separating out inter-industry flows, given East German data reporting.

The advantage of constructing net output series is that the share of labor in output is more accurately represented. The contribution of labor to gross output is substantially smaller than its contribution to estimated net output. While there is some uncertainty as to the validity of imposing West German net output to gross output ratios on East German industry, the disadvantages of using the gross output method for industries in both countries seemed greater. In addition the upward bias in the East German industrial statistics gives the East German economic system the benefit of any doubts about its performance vis a vis the West German system.

As discussed above, the DIW used 1967 as the year for computing gross output ratios and then applied these ratios to West German

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[2] Wolfgang F. Stolper, The Structure of the East German Economy, (Cambridge, Mass.: Harvard University Press, 1960), pp. 71-72.

gross output in 1962. The DIW method was to compute the coefficient of production in each East German industry to production in each West German industry from a sample of physical units. This coefficient was then multiplied by the value of West German gross output to get East German gross output in West German marks. Such a procedure does provide an excellent method of comparison of gross output. To get estimates of net output, however, it would still be necessary to compute the coefficient of West German net output to West German gross output and then apply this ratio to the resulting estimate of East German gross output. This procedure was in fact carried out by Herbert Wilkins in an earlier DIW study. Wilkins points out that because of the similarity of the assortment of goods produced, the amount of distortion does not seem excessive.[3]

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[3] Herbert Wilkins, "Labor Productivity in East and West German Industry," Economic Bulletin, Vol. 7 (June 1970), pp. 53-56.

TABLE B-6

EAST GERMAN INDUSTRY: ESTIMATED NET OUTPUT: 1958-1967
(MILLIONS OF MDN)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	1763	1820	1770	1840	1936	2008	2082	2096	2080	2173
Metallurgy	1841	2042	2256	2379	2465	2495	2644	2780	2915	3058
Chemicals	4546	5049	5424	5855	6307	6725	7286	7929	8640	9244
Building materials	728	836	915	980	1024	1030	1183	1245	1307	1364
Electrotechnical	2208	2662	3064	3299	3763	4000	4373	4757	5266	5658
Shipbuilding	401	504	564	508	526	580	649	725	722	777
Machinery	3264	3941	4398	4845	5342	5603	6047	6430	6796	7266
Metal goods	727	865	957	1048	1140	1236	1336	1421	1549	1696
Precision instruments and optical equipment	751	864	957	974	1071	1164	1260	1462	1625	1788
Woodworking	1056	1228	1342	1442	1557	1555	1640	1729	1829	1996
Textiles	2576	2853	2979	3042	3138	3152	3219	3389	3582	3818
Clothing	889	987	1005	1100	1195	1088	1128	1176	1237	1270
Leather goods	566	647	686	728	769	763	791	840	887	930
Pulp and paper	481	524	548	576	598	607	640	666	698	739
Polygraphic	364	401	437	445	447	453	479	492	508	532
Glass and ceramics	484	545	590	622	658	683	746	799	837	896
Food industries	3881	4055	4416	4589	4591	4780	5022	5268	5459	5715

SOURCE: Appendix Tables B-4 and B-5.

APPENDIX C

EAST AND WEST GERMAN CAPITAL STOCK

TABLE C-1

GROSS CAPITAL STOCK OF WEST GERMAN INDUSTRY IN 1962 PRICES: 1958-1967
(MILLIONS OF DM)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	23447	24661	25619	26467	27086	27342	27542	27735	27404	26673
Metallurgy	20889	22201	23543	25343	27544	29661	31577	33270	34692	35760
Chemicals	28422	30434	32732	35381	37966	40538	43290	46483	50532	54326
Building materials	5465	5972	6735	7722	8774	9707	10647	11760	12777	13462
Electrotechnical	9300	10204	11259	12565	14017	15381	16600	17827	19087	20236
Shipbuilding	2999	2154	2249	2312	2370	2420	2488	2580	2660	2726
Machinery	15482	16546	17904	19709	21610	23252	24746	26443	28154	29531
Metal goods	5129	5606	6241	7005	7757	8051	9250	10046	10830	11494
Precision instruments and optical equipment	1361	1475	1609	1753	1904	2065	2213	2365	2524	2681
Woodworking	4159	4477	4861	5278	5719	6174	6610	7071	7554	7976
Textiles	9646	10248	10998	11867	12616	13225	13816	14507	15209	15765
Clothing	1868	2051	2254	2480	2696	2894	3094	3319	3547	3708
Leather goods	1553	1634	1728	1839	1935	2012	2092	2180	2253	2299
Pulp and paper	4044	4412	4828	5305	5845	6372	6795	7209	7677	8196
Polygraphic	2914	3234	3629	4000	4337	4696	5043	5383	5720	6065
Glass and ceramics	1798	2160	2371	2632	2899	3139	3338	3690	3996	4215
Food industries	18179	19447	20989	22580	24143	25764	27469	29194	30918	32678

SOURCE: Krengel et al., Produktionsvolumen 1968, p. 32.

TABLE C-2

RATIO OF ACTUAL TO POTENTIAL NET OUTPUT OF WEST GERMAN INDUSTRY: 1958-1967

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	0.987	0.920	0.918	0.910	0.906	0.923	0.944	0.918	0.891	0.857
Metallurgy	0.829	0.862	0.962	0.907	0.820	0.741	0.832	0.795	0.748	0.744
Chemicals	0.922	0.949	0.981	0.950	0.945	0.937	0.964	0.957	0.930	0.883
Building materials	0.883	0.960	0.954	0.941	0.924	0.897	0.964	0.922	0.902	0.845
Electrotechnical	0.867	0.870	0.943	0.944	0.873	0.817	0.838	0.876	0.812	0.754
Shipbuilding	1.000	0.873	0.845	0.816	0.765	0.702	0.752	0.788	0.810	0.807
Machinery	0.879	0.873	0.953	0.982	0.935	0.877	0.908	0.935	0.894	0.811
Metal goods	0.862	0.894	0.961	0.917	0.861	0.836	0.887	0.898	0.838	0.758
Precision instruments and optical equipment	0.945	0.955	1.000	0.957	0.889	0.845	0.924	0.936	0.893	0.818
Woodworking	0.935	0.944	0.978	0.955	0.940	0.870	0.919	0.933	0.911	0.848
Textiles	0.896	0.929	0.979	0.949	0.933	0.916	0.923	0.932	0.902	0.822
Clothing	0.937	0.940	0.949	0.957	0.952	0.918	0.932	0.972	0.951	0.835
Leather goods	0.893	0.925	0.934	0.927	0.921	0.922	0.940	0.954	0.912	0.818
Pulp and paper	0.982	0.980	1.000	0.939	0.914	0.884	0.911	0.925	0.910	0.867
Polygraphic	0.973	0.940	0.937	0.928	0.913	0.885	0.890	0.901	0.893	0.854
Glass and ceramics	0.941	0.943	0.984	0.947	0.921	0.889	0.927	0.935	0.894	0.819
Food industries	0.975	0.967	0.964	0.961	0.970	0.965	0.977	0.978	0.965	0.946

SOURCE: Appendix Tables B-1 and B-2.

TABLE C-3

ESTIMATED UTILIZED CAPITAL STOCK IN WEST GERMAN INDUSTRY: 1958-1967
(MILLIONS OF DM)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	23150	22692	23512	24092	24543	25240	25996	25466	24425	22856
Metallurgy	17327	19141	22640	22985	22575	21993	26274	26454	25955	26588
Chemicals	26201	28867	32110	33626	35896	37996	41752	44491	46848	47967
Building materials	4829	5735	6423	7266	8106	8708	10266	10844	11523	11378
Electrotechnical	8061	8882	10620	11860	12234	12568	13914	15621	15501	15252
Shipbuilding	2999	1880	1900	1886	1814	1699	1872	2034	2155	2200
Machinery	13607	14449	17069	19357	20204	20402	22457	24725	25160	23958
Metal goods	4421	5013	5999	6424	6677	6731	8201	9019	9079	8714
Precision instruments and optical equipment	1286	1409	1609	1677	1693	1745	2045	2214	2253	2193
Woodworking	3889	4225	4753	5039	5378	5371	6074	6596	6885	6766
Textiles	8645	9524	10767	11266	11766	12113	12757	13518	13724	12955
Clothing	1750	1928	2139	2374	2566	2656	2283	3227	3374	3095
Leather goods	1387	1511	1614	1705	1783	1854	1967	2079	2055	1880
Pulp and paper	3871	4326	4831	4983	5344	5634	6191	6668	6983	7109
Polygraphic	2835	3040	3401	3710	3959	4157	4489	4851	5110	5182
Glass and ceramics	1692	2037	2334	2492	2671	2791	3094	3049	3571	3453
Food industries	17728	18803	20232	21704	23410	24863	26845	28553	29848	30911

SOURCE: Appendix Tables C-1 and C-2. The formula used was $K_u = Q_A/Q_p\ (K_A)$ where K_u is the utilized capital stock, Q_A and Q_p are actual and potential output respectively, and K_A is actual capital stock.

TABLE C-4

GROSS CAPITAL STOCK IN EAST GERMAN INDUSTRY IN 1962 PRICES: 1958-1967
(MILLIONS OF MDN)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	9870	10740	12010	13280	14340	15460	16940	18500	20060	20860
Metallurgy	6170	6350	6450	6540	6920	7420	8010	8650	9570	9980
Chemicals	14320	14760	15330	15980	16770	17630	19350	20460	22440	22970
Building materials	2810	3000	3340	3700	4090	4410	4780	4940	5040	5200
Electrotechnical	2420	2550	2700	2910	3160	3490	3850	4100	4490	4810
Shipbuilding	830	830	840	870	900	990	1020	1060	1060	1100
Machinery	6530	6880	7220	7710	8140	8460	9120	9590	10350	10780
Metal goods	1250	1290	1350	1420	1590	1710	1840	1940	2070	2110
Precision instruments and optical equipment	1090	1120	1160	1200	1240	1330	1440	1600	1760	1810
Woodworking	1890	1940	2080	2160	2220	2340	2530	2720	2850	2910
Textiles	5880	6000	6230	6480	6700	6930	7300	7520	7810	7880
Clothing	370	380	400	430	470	490	520	540	560	590
Leather goods	1070	1100	1120	1150	1210	1230	1290	1260	1310	1320
Pulp and paper	2320	2360	2410	2450	2650	2820	2990	3090	3200	3220
Polygraphic	610	650	670	720	720	800	830	860	890	910
Glass and ceramics	1320	1380	1420	1500	1570	1730	1920	2080	2250	2350
Food industries	7740	7790	8030	8250	8490	8910	9620	9230	9680	9750

SOURCE: Manfred Meltzer, "Das Anlagevermögen der mitteldeutschen Industrie 1955 bis 1966," Viertelsjahrshefte zur Wirtschaftsforschung (Erstes Heft, 1968), p. 110; DIW, DDR Wirtschaft, (Frankfurt am Main: Fischer Bucherei, GmbH, 1971), pp. 271-272.

APPENDIX D

LABOR INPUTS FOR EAST AND WEST GERMAN INDUSTRY

TABLE D-1

MANHOURS IN WEST GERMAN INDUSTRY: 1958-1967
(MILLIONS OF MANHOURS)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	1379	1248	1156	1092	1015	955	915	854	766	643
Metallurgy	1332	1324	1408	1432	1347	1298	1331	1343	1252	1147
Chemicals	1275	1341	1422	1456	1463	1468	1514	1566	1581	1513
Building materials	565	587	592	595	590	573	597	590	569	506
Electrotechnical	1481	1530	1684	1774	1743	1716	1738	1791	1749	1589
Shipbuilding	236	213	208	199	187	167	165	164	160	152
Machinery	2347	2341	2515	2598	2592	2522	2536	2618	2577	2339
Metal goods	1027	1062	1111	1117	1074	1064	1075	1092	1061	956
Precision instruments and optical equipment	297	294	310	311	293	283	287	286	280	269
Woodworking	800	778	778	775	755	718	716	717	704	648
Textiles	1228	1197	1217	1170	1108	1055	1028	1004	977	874
Clothing	664	661	679	686	694	689	687	695	689	620
Leather goods	377	357	353	340	328	317	313	306	292	267
Pulp and paper	398	399	419	416	415	413	409	408	405	380
Polygraphic	395	396	395	404	413	410	410	411	411	401
Glass and ceramics	375	374	376	373	359	339	337	338	331	304
Food industries	1100	1095	1097	1093	1100	1097	1083	1070	1062	1034

SOURCE: Krengel et al., Produktionsvolumen 1968, p. 21.

CALCULATION OF EAST GERMAN MANHOURS

East Germany does not provide manhour series, only employment series. From other information it seemed plausible to create an estimated manhour input series indirectly from four separate data series provided on an industry basis. These series were hours per 1000 MDN of gross output produced by production workers in socialist industry, production workers, gross production in socialist industry, and total workers employed. All series are for each industry.

The first step was to calculate total production worker input in millions of manhours. This was set up in the form

$$(1) \quad MH_{pw} = H_{MDN} \times Q_s$$

where MH_{pw} is total manhours of production workers in socialist industry, H_{MDN} is the number of hours needed to produce one East mark (MDN) of gross output in socialist industry by a production worker, and Q_s is gross output in socialist industry.

The next step was to divide total production worker manhours by production workers to get manhours per production worker per year in socialist industry. Then the manhours per production worker per year can be multiplied by total employment. This procedure in effect converts all workers into socialist production worker equivilants and allows an estimate of total manhours worker in each industry.

TABLE D-2

ESTIMATED MANHOURS IN EAST GERMAN INDUSTRY: 1958-1967
(MILLIONS OF MANHOURS)

Industry	1958[a]	1959[a]	1960[a]	1961[a]	1962[b]	1963[b]	1964[b]	1965[c]	1966[c]	1967[c]
Mining	425	426	396	388	390	400	402	399	396	375
Metallurgy	260	268	308	308	300	298	308	355	376	368
Chemicals	483	526	536	529	532	536	558	570	567	555
Building materials	181	184	187	181	180	172	180	180	180	178
Electrotechnical	393	416	419	417	434	448	455	482	480	483
Shipbuilding	81	81	81	75	75	78	82	84	80	83
Machinery	684	714	722	762	767	769	794	820	830	837
Metal goods	170	173	173	167	172	178	175	180	178	181
Precision instruments and optical equipment	185	192	192	185	187	190	196	214	211	219
Woodworking	298	301	303	298	295	306	292	291	288	283
Textiles	669	645	642	610	586	587	575	559	545	524
Clothing	231	231	229	222	218	222	226	225	220	214
Leather goods	132	135	134	130	126	126	128	129	129	129
Pulp and paper	125	125	125	123	121	122	121	118	118	112
Polygraphic	119	123	120	117	118	117	115	114	112	109
Glass and ceramics	130	132	132	126	127	124	133	133	130	132
Food industries	423	422	428	429	400	408	415	400	398	402

SOURCE: SJBDDR, various years.

[a] SJBDDR, 1962, pp. 276-277, 282-283, 317-319.

[b] SJBDDR, 1965, pp. 150-152, 180-181, 184-186.

[c] SJBDDR, 1968, pp. 150-152, 180-181, 184-186.

APPENDIX E

CROSS SECTION ESTIMATES OF THE COBB-DOUGLAS AND CES PRODUCTION FUNCTIONS FOR EAST AND WEST GERMANY

TABLE E-1

CROSS SECTION ESTIMATES OF THE COBB-DOUGLAS PRODUCTION FUNCTION FOR EAST GERMAN INDUSTRY BY YEAR

Year	log A	a	R^2	F^a	SER
1958	0.970 (0.229)	0.248 (0.096)	0.264	5.380	0.275
1959	1.170 (0.231)	0.207	0.186	3.428	0.275
1960	1.291 (0.244)	0.180[b] (0.100)	0.125	2.143	0.283
1961	1.402 (0.251)	0.159[b] (0.100)	0.087	1.429	0.281
1962	1.483 (0.266)	0.148[b] (0.103)	0.062	0.991	0.293
1963	1.434 (0.277)	0.172[b] (0.105)	0.095	1.575	0.302
1964	1.488 (0.281)	0.168[b] (0.105)	0.089	1.465	0.300
1965	1.584 (0.290)	0.146[b] (0.107)	0.052	0.823	0.307
1966	1.694 (0.306)	0.123[b] (0.110)	0.016	0.234	0.316

TABLE E-1--Continued

Year	log A	a	R^2	F[a]	SER
1967	1.746 (0.305)	0.129[b] (0.108)	0.026	0.400	0.313

SOURCE: Appendix Tables B-6, C-4, and D-2; and equation (4-6).

[a]Critical value for $F_{1,15}$ = 4.54 at the 5 percent level of significance.

[b]Not significant at the 5 percent level of significance.

TABLE E-2

CES CROSS-SECTION ESTIMATES OF THE ELASTICITY OF SUBSTITUTION FOR EAST GERMAN INDUSTRY BY YEAR

Year	B_0	$B_1 = S$	R^2	F^a	T value for B_1 different from one[b]
1958	0.718[c] (0.514)	0.754[c] (0.466)	0.092	1.520	-0.528
1959	0.611[c] (0.535)	0.875[c] (0.447)	0.150	2.647	-0.279
1960	0.589[c] (0.574)	0.919[c] (0.465)	0.153	2.710	-0.175
1961	0.751[c] (0.572)	0.816[c] (0.448)	0.127	2.182	-0.410
1962	0.676[c] (0.566)	0.925[c] (0.442)	0.174	3.160	-0.170
1963	0.662[c] (0.518)	0.952[c] (0.404)	0.222	4.280	-0.118
1964	0.736 (0.537)	0.919 (0.412)	0.199	3.727	-0.196
1965	0.755[c] (0.582)	0.916[c] (0.436)	0.175	3.182	-0.192
1966	0.721[c] (0.599)	0.970 (0.442)	0.192	3.564	-0.068
1967	0.755[c] (0.621)	0.972 (0.447)	0.189	3.495	-0.062

SOURCE: Appendix Tables B-6, D-2, and G-2; and equation (4-7).

[a]Critical value for $F_{1,15}$ is 4.54 at the 5 percent level of significance.

[b]Critical value for T_{15} is 2.131 at the 5 percent level of significance.

[c]Not significant at the 5 percent level of significance.

TABLE E-3

CROSS-SECTION ESTIMATES OF THE COBB-DOUGLAS PRODUCTION FUNCTION FOR WEST GERMAN INDUSTRY BY YEAR

Year	log A	a	R^2	F^a	SER
1958	1.280 (0.174)	0.336 (0.084)	0.486	14.183	0.201
1959	1.230 (0.169)	0.384 (0.079)	0.584	21.058	0.180
1960	1.272 (0.188)	0.380 (0.084)	0.549	18.259	0.190
1961	1.193 (0.176)	0.439 (0.075)	0.676	31.296	0.179
1962	1.198 (0.200)	0.438 (0.085)	0.616	24.063	0.189
1963	1.182 (0.206)	0.453 (0.085)	0.630	25.541	0.192
1964	1.300 (0.230)	0.406 (0.094)	0.524	16.513	0.189
1965	1.249 (0.223)	0.448 (0.086)	0.616	24.062	0.185
1966	1.218 (0.225)	0.464 (0.086)	0.641	26.783	0.185
1967	1.139 (0.217)	0.502 (0.080)	0.706	36.020	0.183

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (4-6).

[a]Critical value for $F_{1,15} = 4.54$ at the 5 percent level of significance.

TABLE E-4

CES CROSS-SECTION ESTIMATES OF THE ELASTICITY OF SUBSTITUTION FOR WEST GERMAN INDUSTRY BY YEAR

Year	B_0	$B_1 = S$	R^2	F^a	T value for B_1 different from one[b]
1958	1.323[c] (0.434)	0.639[c] (0.407)	0.084	1.375	-0.887
1959	1.269[c] (0.428)	0.736[c] (0.414)	0.119	2.026	-0.637
1960	1.280[c] (0.453)	0.741[c] (0.407)	0.126	2.162	-0.636
1961	0.885[c] (0.564)	1.064[c] (0.457)	0.217	4.157	-0.140
1962	1.038[c] (0.637)	0.896[c] (0.487)	0.130	2.241	-0.213
1963	0.754[c] (0.688)	1.104 (0.507)	0.190	3.519	0.206
1964	1.211[c] (0.620)	0.766[c] (0.446)	0.110	1.854	-0.525
1965	1.173[c] (0.788)	0.813[c] (0.530)	0.079	2.361	-0.352
1966	0.842[c] (0.855)	1.025[c] (0.556)	0.131	2.261	0.044
1967	0.681[c] (0.846)	1.128[c] (0.532)	0.180	3.293	0.240

SOURCE: Appendix Tables B-1, D-1, and G-1; and equation (4-3).

[a]Critical value for $F_{1,15} = 4.54$ at 5 percent level of significance.

[b]Critical value for $T_{15} = 2.131$ at 5 percent level of significance.

[c]Not significantly different from zero.

APPENDIX F

THE HICKS NEUTRAL SHIFT FACTOR A(t) FOR EAST AND WEST GERMANY

TABLE F-1

THE HICKS NEUTRAL SHIFT FACTOR A(t) IN WEST GERMAN INDUSTRY: 1958-1967

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	1.000	1.024	1.063	1.089	1.120	1.151	1.175	1.187	1.212	1.255
Metallurgy	1.000	1.027	1.057	1.040	1.042	1.030	1.090	1.093	1.081	1.119
Chemicals	1.000	1.084	1.145	1.196	1.266	1.338	1.418	1.434	1.554	1.638
Building materials	1.000	0.998	0.985	0.978	0.971	0.959	0.955	0.933	0.922	0.913
Electrotechnical	1.000	1.022	1.054	1.075	1.090	0.104	1.144	1.184	1.236	1.273
Shipbuilding	1.000	1.150	1.161	1.170	1.172	1.196	1.268	1.332	1.390	1.434
Machinery	1.000	0.991	0.995	0.999	0.985	0.970	0.980	0.979	0.964	0.957
Metal goods	1.000	1.003	1.021	1.011	1.009	1.038	1.025	1.024	1.006	1.001
Precision instruments and optical equipment	1.000	1.027	1.044	1.041	1.056	1.069	1.129	1.153	1.153	1.139
Woodworking	1.000	1.024	1.049	1.053	1.075	1.079	1.119	1.139	1.150	1.163
Textiles	1.000	1.046	1.078	1.099	1.128	1.148	1.169	1.192	1.195	1.203
Clothing	1.000	1.013	1.016	1.027	1.038	1.031	1.043	1.063	1.060	1.045
Leather goods	1.000	1.026	1.024	1.029	1.032	1.035	1.040	1.047	1.035	1.007
Pulp and paper	1.000	1.018	1.027	1.026	1.037	1.042	1.065	1.079	1.083	1.094
Polygraphic	1.000	1.007	1.034	1.040	1.040	1.045	1.060	1.075	1.080	1.080
Glass and ceramics	1.000	0.949	0.974	0.977	0.996	1.013	1.050	1.051	1.047	1.041
Food industries	1.000	0.998	0.995	0.992	0.988	0.983	0.984	0.981	0.974	0.969

SOURCE: Appendix Tables B-1, C-3, and D-1. The A(t) series is computed from equations (3-8) and (3-9).

TABLE F-2

THE HICKS NEUTRAL SHIFT FACTOR A(t) IN EAST GERMAN INDUSTRY: 1958-1967

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	1.000	1.023	1.062	1.117	1.156	1.160	1.183	1.183	1.173	1.283
Metallurgy	1.000	1.076	1.096	1.148	1.178	1.158	1.162	1.094	1.062	1.105
Chemicals	1.000	1.055	1.100	1.164	1.214	1.248	1.254	1.305	1.287	1.416
Building materials	1.000	1.120	1.181	1.258	1.284	1.289	1.399	1.453	1.514	1.566
Electrotechnical	1.000	1.141	1.276	1.329	1.426	1.412	1.450	1.485	1.562	1.606
Shipbuilding	1.000	1.255	1.405	1.292	1.322	1.367	1.467	1.598	1.632	1.680
Machinery	1.000	1.154	1.259	1.310	1.411	1.454	1.491	1.523	1.545	1.614
Metal goods	1.000	1.165	1.271	1.392	1.418	1.463	1.511	1.543	1.640	1.762
Precision instruments and optical equipment	1.000	1.112	1.184	1.262	1.366	1.435	1.479	1.561	1.683	1.790
Woodworking	1.000	1.150	1.228	1.327	1.429	1.370	1.448	1.488	1.550	1.700
Textiles	1.000	1.129	1.167	1.214	1.298	1.285	1.300	1.375	1.451	1.576
Clothing	1.000	1.100	1.106	1.210	1.287	1.138	1.140	1.174	1.232	1.254
Leather goods	1.000	1.116	1.180	1.268	1.332	1.313	1.325	1.411	1.466	1.533
Pulp and paper	1.000	1.079	1.127	1.190	1.224	1.213	1.262	1.318	1.371	1.498
Polygraphic	1.000	1.055	1.157	1.165	1.161	1.133	1.191	1.211	1.244	1.308
Glass and ceramics	1.000	1.106	1.192	1.283	1.290	1.325	1.337	1.393	1.446	1.503
Food industries	1.000	1.041	1.105	1.127	1.127	1.128	1.115	1.217	1.220	1.266

SOURCE: Appendix Tables B-6, C-4, and D-2. The A(t) series is computed from equations (3-8) and (3-9).

APPENDIX G

THE TOTAL REAL WAGE PAYMENTS FOR EAST AND WEST GERMANY

TABLE G-1

THE TOTAL REAL WAGE PAYMENTS IN WEST GERMAN INDUSTRY: 1958-1967
(MILLIONS OF DM)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	5318	4848	4714	4834	4810	4725	4717	4897	4420	3932
Metallurgy	4518	4640	5402	5901	6043	5993	6468	6928	6658	6409
Chemicals	4092	4535	5205	5876	6434	6938	7668	8242	9066	9007
Building materials	1518	1656	1817	2007	2171	2245	2481	2595	2610	2372
Electrotechnical	4093	4443	5308	6059	6624	6797	7335	8154	8461	8255
Shipbuilding	680	645	687	718	755	691	738	784	809	831
Machinery	6674	7020	8217	9288	10244	10362	11158	13074	12860	12172
Metal goods	2695	2851	3282	3611	3854	3975	4295	4689	4793	4454
Precision instruments and optical equipment	747	778	893	972	1018	1033	1121	1208	1255	1255
Woodworking	1794	1836	1732	2215	2366	2423	2571	2760	2881	2738
Textiles	3187	2957	3344	3525	3601	3648	3744	3870	3927	3652
Clothing	1293	1355	1532	1750	1937	2032	2145	2329	2447	2247
Leather goods	834	847	933	997	1028	1066	1114	1186	1184	1098
Pulp and paper	968	1036	1200	1318	1431	1507	1601	1701	1794	1747
Polygraphic	1096	1175	1259	1413	1557	1656	1771	1919	2053	2068
Glass and ceramics	928	970	1073	1178	1274	1258	1343	1437	1492	1425
Food industries	2651	2821	3087	3385	3714	3947	4156	4375	4606	4662

SOURCE: Rolf Krengel, et al., Produktionsvolumen 1968, p. 40; Statistisches Bundesamt, Statistisches Jahrbuch für die Bundesrepublik Deutschland, 1971 (Wiesbaden: W. Kohlhammer Verlag, 1971), p. 443.

TABLE G-2

THE TOTAL REAL WAGE PAYMENTS IN EAST GERMAN INDUSTRY: 1958-1967
(MILLIONS OF MDN)

Industry	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Mining	1612	1745	1615	1649	1671	1725	1810	1873	1867	1852
Metallurgy	994	1050	1259	1332	1323	1332	1396	1511	1544	1596
Chemicals	1554	1894	2018	2056	2084	2131	2253	2421	2469	2522
Building materials	570	633	670	683	663	650	686	714	727	744
Electrotechnical	1302	1459	1523	1595	1635	1707	1818	1945	2005	2092
Shipbuilding	293	325	327	310	303	323	337	358	355	373
Machinery	2404	2679	2807	3046	3062	3147	3287	3526	3597	3758
Metal goods	492	560	571	594	614	638	654	694	710	733
Precision instruments and optical equipment	575	641	661	677	685	715	763	855	886	948
Woodworking	822	941	986	1024	1022	993	1008	1025	1042	1064
Textiles	1687	1847	1921	1933	1903	1877	1859	1912	1891	1892
Clothing	556	653	677	689	692	643	655	675	679	686
Leather goods	363	412	433	433	424	417	432	453	461	465
Pulp and paper	331	388	407	417	413	412	423	437	442	445
Polygraphic	254	265	269	266	260	254	259	265	266	272
Glass and ceramics	383	430	472	471	469	479	506	523	524	543
Food industries	1110	1250	1342	1385	1339	1358	1394	1432	1487	1556

SOURCE: SJBDDR, 1962, pp. 336-337; SJBDDR, 1968, pp. 190-191; SJBDDR, 1969, p. 354.

APPENDIX H

REGRESSION RESULTS FOR CES, COBB-DOUGLAS, AND CMS PRODUCTION FUNCTIONS

TABLE H-1

CES ESTIMATES FOR EAST GERMAN INDUSTRY: FERGUSON MODEL[a]

Industry	b_0[d]	b_1[d]	$b_2=s$[d]	R^2	F	T value for b_2 different from one
Mining	1.209[b] (0.692)	0.030 (0.014)	0.146[b] (0.520)	0.938	52.952	0.876[c]
Metallurgy	0.824 (0.286)	0.004[b] (0.004)	0.884 (0.208)	0.786	12.855	-0.750[c]
Chemicals	2.462 (0.313)	0.071 (0.087)	-0.261[b] (0.997)	0.985	229.833	1.265[c]
Building materials	0.551[b] (0.312)	0.051 (0.072)	0.699 (0.265)	0.991	385.389	-1.135[c]
Electro-technical	0.106[b] (0.788)	0.041[b] (0.018)	1.348[b] (0.657)	0.976	142.333	0.530[c]
Shipbuilding	-0.509[b] (0.637)	0.031 (0.010)	1.644 (0.483)	0.958	79.833	1.333[c]
Machinery	-0.586[b] (0.859)	0.021[b] (0.016)	1.714 (0.677)	0.968	105.875	1.055[c]
Metal goods	0.086[b] (0.245)	0.040 (0.008)	1.251 (0.224)	0.994	579.833	1.121[c]
Precision instruments and optical equipment	0.591[b] (0.344)	0.053 (0.010)	0.670[b] (0.304)	0.996	871.500	-1.085[c]

TABLE H-1--Continued

Industry	b_0[d]	b_1[d]	$b_2=s$[d]	R^2	F	T value for b_2 different from one
Woodworking	0.287[b] (0.151)	0.042 (0.004)	0.924 (0.140)	0.992	434.000	-0.539[c]
Textiles	0.695 (0.207)	0.041 (0.007)	0.655 (0.212)	0.983	202.382	-1.625[c]
Clothing	0.600 (0.185)	0.026 (0.005)	0.788 (0.187)	0.933	48.739	-1.130[c]
Leather goods	0.489[b] (0.255)	0.030 (0.006)	0.923 (0.239)	0.977	148.674	-0.320[c]
Pulp and paper	0.975 (0.159)	0.043 (0.006)	0.322[b] (0.154)	0.986	246.500	-4.406
Polygraphic	0.557 (0.213)	0.036 (0.004)	0.739 (0.286)	0.975	136.500	-0.912[c]
Glass and ceramics	0.621 (0.108)	0.045 (0.003)	0.599 (0.095)	0.996	871.500	-4.227[c]
Food industries	1.948 (0.123)	0.041 (0.005)	0.228[b] (0.124)	0.993	496.500	-6.249

SOURCE: Appendix Tables B-6, C-4, and D-2; and equation (4-7).

[a]The number of observations is ten.

[b]Not significant at the 5 percent level of significance.

[c]Not significantly different from one at the 5 percent level of significance.

[d]Standard errors are given in parentheses.

TABLE H-2

CES ESTIMATES FOR WEST GERMAN INDUSTRY: FERGUSON MODEL[a]

Industry	b_0[d]	b_1[d]	$b_2=s$[d]	R^2	F	T value for b_2 different from one
Mining	2.172 (0.408)	0.079 (0.018)	-0.143[b] (C .322)	0.991	385.389	3.552
Metallurgy	2.496 (0.703)	0.060[b] (0.034)	-0.316[b] (0.599)	0.910	35.389	2.198[c]
Chemicals	2.413 (0.225)	0.091 (0.015)	-0.085[b] (0.204)	0.997	1163.167	5.310
Building materials	1.661 (0.160)	0.032 (0.011)	0.478 (0.170)	0.994	579.833	3.068
Electro-technical	1.868	0.059[b]	-0.043[b]	0.989	314.682	2.591
Shipbuilding	2.955 (0.561)	0.146 (0.041)	-1.386 (0.567)	0.949	65.127	4.210
Machinery	1.165 (0.187)	-0.028[b] (0.014)	0.837 (0.190)	0.956	76.045	-0.857[c]
Metal goods	1.457 (0.312)	0.020[b] (0.024)	0.464[b] (0.350)	0.971	117.189	-1.532[c]
Precision instruments and optical equipment	1.441 (0.538)	0.035[b] (0.046)	0.279[b] (0.631)	0.957	77.896	-1.143[c]
Woodworking	1.786 (0.083)	0.077 (0.095)	-0.105[b] (0.117)	0.991	385.389	-7.622
Textiles	0.937 (0.196)	0.016[b] (0.014)	0.842 (0.229)	0.956	76.045	-0.692[c]

TABLE H-2--Continued

Industry	b_0[d]	b_1[d]	$b_2=s$[d]	R^2	F	T value for b_2 different from one
Clothing	1.370 (0.122)	0.014[b] (0.015)	0.461[b] (0.198)	0.982	190.944	-2.726
Leather goods	0.887 (0.165)	-0.035[b] (0.016)	1.080 (0.219)	0.977	148.674	0.367[c]
Pulp and paper	1.012 (0.240)	-0.031[b] (0.026)	1.139 (0.300)	0.964	93.722	0.464[c]
Polygraphic	1.361 (0.408)	0.000[b] (0.031)	0.684[b] (0.426)	0.984	215.250	-0.742[c]
Glass and ceramics	1.199 (0.231)	0.023[b] (0.021)	0.598[b] (0.274)	0.987	269.230	-1.465[c]
Food industries	2.457 (0.104)	0.041 (0.009)	0.184[b] (0.125)	0.997	1163.167	-6.520

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (4-7).

[a]The number of observations is ten.

[b]Not significant at the 5 percent level of significance.

[c]Not significantly different from one at the 5 percent level of significance.

[d]Standard errors are given in parentheses.

TABLE H-3

COBB-DOUGLAS ESTIMATES FOR EAST GERMAN INDUSTRY[a]

Industry	log B[b]	c[b]	a[b]	R^2	F
Mining	0.317[c] (0.587)	0.001[c] (0.018)	0.351[c] (0.190)	0.958	79.833
Metallurgy	1.444[c] (0.875)	0.010[c] (0.008)	0.177[c] (0.285)	0.320	1.647
Chemicals	1.125[c] (0.585)	0.049[c] (0.008)	0.314[c] (0.179)	0.988	288.167
Building materials	0.710[c] (0.390)	0.051 (0.011)	0.246[c] (0.145)	0.987	265.731
Electrotechnical	3.117 (0.995)	0.122 (0.033)	-0.812[c] (0.579)	0.971	117.190
Shipbuilding	3.519 (1.369)	0.087 (0.021)	-0.813[c] (0.778)	0.912	36.273
Machinery	6.238 (1.711)	0.134 (0.027)	-2.116 (0.778)	0.970	113.167
Metal goods	1.753[c] (1.151)	0.090 (0.035)	-0.159[c] (0.601)	0.969	109.403
Precision instruments and optical equipment	1.327 (0.460)	0.075 (0.012)	0.012[c] (0.271)	0.993	496.500
Woodworking	1.887[c] (0.997)	0.086 (0.033)	-0.347[c] (0.568)	0.946	61.315
Textiles	0.966[c] (2.355)	0.051[c] (0.068)	0.174[c] (1.115)	0.961	86.243
Clothing	0.831 (0.259)	-0.042[c] (0.039)	1.340[c] (0.633)	0.856	20.805
Leather goods	0.299[c] (0.866)	0.036 (0.013)	0.566[c] (0.419)	0.943	57.903

TABLE H-3--Continued

Industry	log B[b]	c[b]	a[b]	R^2	F
Pulp and paper	2.338 (0.920)	0.073 (0.017)	-0.364[c] (0.325)	0.981	180.711
Polygraphic	1.334[c] (0.800)	0.054[c] (0.029)	-0.144[c] (0.510)	0.952	69.417
Glass and ceramics	2.317 (0.816)	0.094 (0.025)	-0.461[c] (0.369)	0.979	163.167
Food industries	2.462 (0.540)	0.052 (0.007)	-0.101[c] (0.189)	0.990	346.500

SOURCE: Appendix Tables B-6, C-4, and D-2; and equation (4-1).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

[c]Not significant at the 5 percent level of significance.

TABLE H-4

COBB-DOUGLAS ESTIMATES FOR WEST GERMAN INDUSTRY[a]

Industry	log B[b]	c[b]	a[b]	R^2	F
Mining	-0.469 (0.136)	-0.002[c] (0.004)	0.892 (0.049)	0.999	3496.500
Metallurgy	-0.305 (0.129)	-0.125 (0.003)	0.966 (0.051)	0.998	1746.500
Chemicals	1.033[c] (0.498)	0.064 (0.008)	0.434 (0.168)	0.999	3496.500
Building materials	0.038 (0.004)	-0.042 (0.001)	1.002 (0.002)	0.999	3496.500
Electrotechnical	0.188 (0.002)	-0.007 (0.000)[d]	1.000 (0.001)	0.999	3496.500
Shipbuilding	1.114 (0.177)	0.039 (0.005)	0.214 (0.080)	0.953	70.968
Machinery	0.281 (0.010)	-0.032 (0.001)	0.994 (0.006)	0.999	3496.500
Metal goods	0.912 (0.212)	-0.006[c] (0.013)	0.685 (0.151)	0.991	385.389
Precision instruments and optical equipment	0.272 (0.003)	-0.019 (0.001)	1.000 (0.002)	0.999	3496.500
Woodworking	0.373 (0.059)	-0.005[c] (0.003)	0.877 (0.039)	0.999	3496.500
Textiles	0.768 (0.271)	0.033 (0.011)	0.444 (0.135)	0.949	65.127
Clothing	0.719 (0.003)	-0.025 (0.001)	1.006 (0.003)	0.999	3496.500
Leather goods	0.447 (0.018)	-0.028 (0.001)	0.968 (0.014)	0.999	3496.500

TABLE H-4--Continued

Industry	log B[b]	c[b]	a[b]	R^2	F
Pulp and paper	-0.172 (0.037)	-0.012 (0.001)	0.957 (0.017)	0.999	3496.500
Polygraphic	0.079 (0.005)	-0.017 (0.001)	1.003 (0.003)	0.999	3496.500
Glass and ceramics	0.936 (0.243)	0.016[c] (0.017)	0.516 (0.164)	0.991	385.389
Food industries	-0.155[c] (0.180)	-0.017 (0.005)	1.025 (0.067)	0.999	3496.500

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (4-1).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

[c]Not significant at the 5 percent level of significance.

[d]The standard error is less than 0.0001.

TABLE H-5

CES ESTIMATES FOR EAST GERMAN INDUSTRY: KMENTA MODEL[a]
(OUTPUT NOT DEFLATED FOR TECHNICAL CHANGE)

Industry	log B^b	d^b	$(1 - d)^b$	$pvd(1 - d)^b$	R^2	F
Mining	-8017.710 (5294.087)	26.529 (1463.636)	1434.147 (1355.389)	172.370 (402.800)	0.919	22.691
Metallurgy	19325.757 (66003.526)	-20770.463 (41149.459)	23219.457 (40956.259)	6946.718 (13045.304)	0.908	19.739
Chemicals	-60578.966 (68959.966)	-4548.039 (39853.199)	14152.672 (40369.963)	3717.483 (11273.465)	0.978	88.909
Building materials	-9896.551 (3892.106)	-4380.329 (1704.313)	7464.706 (1812.877	1760.449 (557.020)	0.980	98.000
Electrotechnical	-36462.081 (12544.725)	390.050 (8627.935)	5489.246 (9476.273)	1819.130 (4120.500)	0.984	123.000
Shipbuilding	19325.757 (66003.526)	-20770.463 (41149.459)	23219.457 (40956.259)	6946.718 (13045.304)	0.908	19.739
Machinery	-115473.24 (26599.399)	42418.231 (27444.931)	-32984.482 (28984.880)	-15091.872 (11063.376)	0.991	220.222
Metal goods	-4853.738 (10239.836)	-1199.770 (4757.795)	2282.086 (4481.339)	1253.666 (2163.116)	0.955	42.444

TABLE H-5--Continued

Industry	log B^b	d^b	$(1 - d)^b$	$pvd(1 - d)^b$	R^2	F
Precision instruments and optical equipment	-12992.717 (6903.254)	2072.042 (5314.654)	-83.869 (5048.786)	-168.818 (2798.632)	0.981	103.263
Woodworking	-10392.927 (13083.923)	5057.390 (6509.069)	-4173.759 (8342.428)	-1649.492 (3201.482)	0.902	18.408
Textiles	44140.168 (26140.005)	-7048.877 (5720.867)	2022.780 (5628.735)	2782.561 (2226.366)	0.934	28.303
Clothing	9206.123 (4914.210)	875.750 (679.248)	-2459.409 (1026.650)	-616.782 (917.842)	0.894	16.868
Leather goods	39326.424 (17116.163)	20564.877 (12471.360)	-17379.265 (11918.575)	-8539.950 (5598.464)	0.918	22.390
Pulp and paper	337.231 (3318.579)	2344.320 (2882.811)	-3155.596 (3308.388)	-646.141 (946.599)	0.743	33.088
Polygraphic	-1285.427 (2073.362)	239.893 (1146.894)	14.658 (1463.545)	45.177 (637.455)	0.881	14.807
Glass and ceramics	-5247.780 (3216.276)	1698.781 (1510.479)	-1095.157 (1364.013)	-414.574 (579.530)	0.967	58.606

TABLE H-5--Continued

Industry	log B^b	d^b	$(1 - d)^b$	$pvd(1 - d)^b$	R^2	F
Food industries	17650.738 (102302.21)	-31338.261 (59979.754)	35636.001 (59030.640)	12200.675 (19612.468)	0.867	13.038

SOURCE: Appendix Tables B-6, C-4, and D-2; and equation (4-2).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

TABLE H-6

CES ESTIMATES FOR WEST GERMAN INDUSTRY: KMENTA MODEL[a]
(OUTPUT NOT DEFLATED FOR TECHNICAL CHANGE)

Industry	log B^b	d^b	$(1 - d)^b$	$pvd(1 - d)^b$	R^2	F
Mining	-85922.72 (2637.40)	7471.98 (1801.38)	2726.58 (2087.93	451.19 (646.58)	0.994	331.333
Metallurgy	-96077.68 (10606.72)	-20514.97 (11397.76)	37708.55 (12455.53)	11029.70 (4068.44)	0.993	283.714
Chemicals	320813.74 (76481.95)	-399045.64 (60236.24)	438955.29 (60852.18)	134370.46 (18186.40)	0.998	998.000
Building materials	-49820.67 (2937.20)	-1109.43 (1806.03)	9385.12 (2380.98)	1969.27 (699.25)	0.998	998.000
Electrotechnical	-84864.95 (6266.55)	-37795.32 (14851.15)	54597.87 (16665.44)	24966.01 (7334.97)	0.997	664.667
Shipbuilding	-96077.68 (10606.72)	-20514.97 (11397.76)	37708.55 (12455.53)	11029.70 (4068.44)	0.993	283.714
Metal goods	-74418.13 (8723.83)	2175.27 (4644.46)	8787.51 (5924.63)	1841.11 (2581.23)	0.990	198.000
Precision instruments and optical equipment	-129[illegible].55 (1705.75)	-345.45 (867.40)	2788.81 (1045.54)	1083.94 (490.90)	0.992	248.000

TABLE H-6--Continued

Industry	log B^b	d^b	$(1 - d)^b$	$pvd(1 - d)^b$	R^2	F
Woodworking	-44467.42 (2162.69)	543.87 (532.15)	6250.99 (730.47)	2251.27 (286.57)	0.999	1998.000
Textiles	-8889.15 (15907.15)	24170.09 (13311.92)	-26147.79 (15327.67)	-9308.55 (6040.34)	0.840	10.500
Clothing	-37631.17 (2021.23)	-400.94 (783.37)	6609.22 (1032.12)	2609.43 (599.34)	0.998	998.000
Leather goods	-18569.31 (670.85)	2498.60 (280.80)	496.64 (333.83)	-499.92 (180.66)	0.994	331.333
Pulp and paper	-21345.59 (647.39)	-3407.59 (1768.61)	7689.09 (2102.60)	2467.83 (683.58)	0.999	1998.000
Polygraphic	-21969.93 (3265.24)	-719.04 (1275.92)	4617.23 (1803.12)	1602.80 (548.81)	0.999	1998.000
Glass and ceramics	-17698.61 (4695.36)	-818.79 (1193.96)	4103.48 (1844.08)	1387.79 (655.28)	0.978	88.909
Food industries	-151562.38 (20934.62)	-13553.03 (8195.52)	37605.82 (12263.67)	9505.90 (2751.95)	0.999	1998.000

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (4-2).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

TABLE H-7

CES ESTIMATES FOR WEST GERMAN INDUSTRY: KMENTA MODEL[a]
(OUTPUT DEFLATED FOR TECHNICAL CHANGE)

Industry	log B^b	d^b	$(1 - d)^b$	$pd(1 - d)^b$	R^2	F
Mining	-0.014 (0.188)	0.756 (0.128)	0.218 (0.149)	0.029 (0.046)	0.997	664.667
Metallurgy	0.039 (0.212)	1.225 (0.228)	-0.264 (0.249)	-0.233 (0.081)	0.999	1998.000
Chemicals	2.871 (2.884)	-2.002 (2.272)	3.273 (2.408)	0.795 (0.686)	0.995	398.000
Building materials	0.387 (0.255)	0.102 (0.157)	-0.032 (0.207)	-0.158 (0.061)	0.999	1998.000
Electrotechnical	0.325 (0.074)	0.666 (0.175)	0.371 (0.197)	0.111 (0.087)	0.999	1998.000
Shipbuilding	0.955 (0.187)	0.414 (0.151)	0.550 (0.151)	-0.039 (0.063)	0.999	1998.000
Machinery	0.792 (1.051)	2.261 (1.265)	-1.451 (1.414)	-0.842 (0.613)	0.976	81.082
Metal goods	0.593 (0.871)	1.212 (0.464)	-0.231 (0.591)	-0.317 (0.254)	0.992	248.000

TABLE H-7--Continued

Industry	log B^b	d	(1 - d)	pd(1 - d)	R^2	F
Precision instruments and optical equipment	-0.153 (0.559)	0.568 (0.284)	0.594 (0.343)	0.113 (0.161)	0.996	567.279
Woodworking	0.292 (0.310)	0.803 (0.076)	0.224 (0.105)	0.008 (0.041)	0.999	1998.000
Textiles	6.507 (1.825)	3.491 (1.528)	-3.763 (1.759)	-1.366 (0.693)	0.871	13.504
Clothing	-0.085 (0.377)	0.747 (0.146)	0.416 (0.193)	-0.060 (0.112)	0.999	1998.000
Leather goods	-1.581 (0.300)	1.237 (0.126)	0.085 (0.149)	-0.301 (0.081)	0.994	331.333
Pulp and paper	0.883 (0.198)	1.181 (0.525)	-0.379 (0.624)	-0.152 (0.203)	0.999	1998.000
Polygraphic	0.496 (0.602)	1.344 (0.235)	-0.445 (0.332)	-0.259 (0.101)	0.999	1998.000
Glass and ceramics	0.825 (1.556)	0.204 (0.396)	0.851 (0.611)	0.240 (0.217)	0.982	109.111

TABLE H-7--Continued

Industry	log B^b	d^b	$(1 - d)^b$	$pd(1 - d)^b$	R^2	F
Food industries	0.056 (0.719)	1.056 (0.282)	-0.051 (0.421)	-0.090 (0.095)	0.999	1998.000

SOURCE: Appendix Tables B-1, C-3, D-1, and F-1; and equation (4-11).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

TABLE H-8

CES ESTIMATES FOR EAST GERMAN INDUSTRY: KMENTA MODEL[a]
(OUTPUT DEFLATED FOR TECHNICAL CHANGE)

Industry	log B^b	d^b	$(1 - d)^b$	$pd(1 - d)^b$	R^2	F
Mining	1.996 (2.738)	0.176 (0.757)	0.602 (0.701)	0.044 (0.208)	0.918	22.390
Metallurgy	12.669 (34.132)	-7.253 (21.279)	8.287 (21.179)	2.423 (6.746)	0.857	11.945
Chemicals	-15.362 (11.648)	6.013 (6.732)	-4.177 (6.819)	-1.377 (1.904)	0.968	60.500
Building materials	-8.215 (3.628)	-1.180 (1.589)	4.143 (1.690)	0.707 (0.519)	0.982	109.111
Electrotechnical	-10.353 (4.962)	5.940 (3.413)	-4.035 (3.749)	-2.448 (1.630)	0.965	55.143
Shipbuilding	-7.636 (40.335)	2.229 (30.353)	-0.099 (29.668)	-0.273 (12.397)	0.754	6.130
Machinery	-29.897 (8.106)	18.095 (8.364)	-15.720 (8.833)	-7.186 (3.372)	0.980	98.000
Metal goods	-5.489 (9.677)	5.140 (4.496)	-4.109 (4.235)	-1.697 (2.044)	0.946	35.037

TABLE H-8--Continued

Industry	log B^b	d^b	$(1 - d)^b$	$pd(1 - d)^b$	R^2	F
Precision instruments and optical equipment	-12.443 (6.354)	9.823 (4.892)	-8.197 (4.647)	-4.309 (2.576)	0.976	81.333
Woodworking	-4.913 (9.707)	6.068 (4.829)	-5.221 (6.190)	-2.382 (2.375)	0.881	14.807
Textiles	18.719 (8.866)	-0.913 (1.940)	-0.575 (1.909)	0.358 (0.755)	0.923	23.974
Clothing	14.041 (4.725)	1.076 (0.653)	-2.474 (0.987)	-0.927 (0.882)	0.887	15.699
Leather goods	-60.066 (20.084)	38.174 (14.634)	-33.659 (13.985)	16.222 (6.569)	0.938	30.258
Pulp and paper	1.651 (6.604)	6.710 (5.411)	-8.074 (6.209)	-1.977 (1.777)	0.927	25.397
Polygraphic	0.435 (4.935)	1.367 (2.730)	-0.591 (3.483)	-0.322 (1.517)	0.867	13.038
Glass and ceramics	-5.817 (5.522)	5.199 (2.578)	-4.286 (2.342)	-1.650 (0.995)	0.956	43.455

TABLE H-8--Continued

Industry	$\log B^b$	d^b	$(1 - d)^b$	$pd(1 - d)^b$	R^2	F
Food industries	1.854 (21.904)	-1.093 (12.842)	2.147 (12.639)	0.773 (4.199)	0.863	12.599

SOURCE: Appendix Tables B-6, C-4, D-2, and F-1; and equation (4-11).

[a]The number of observations is ten.

[b]Standard errors are given in parentheses.

TABLE H-9

CMS ESTIMATION FOR WEST GERMANY: ESTIMATES OF R^2 AND SER

Industry	R^2		SER		Occurrence of maximum R^2		
	m=0.0	m=0.5	m=0.0	m=0.5	R^2	m	SER
Mining	0.9996	0.9996	0.0043	0.0041	0.9996	0.50	0.0041
Metallurgy	0.9981	0.9979	0.0058	0.0058	0.9981	0.00	0.0058
Chemicals	0.9987	0.9989	0.0113	0.0080	0.9991	1.00	0.0074
Building materials	0.9999	0.9998	0.0022	0.0028	0.9999	0.00	0.0022
Electrotechnical	0.9999	0.9996	0.0001	0.0030	0.9999	0.00	0.0001
Shipbuilding	0.9532	0.9522	0.0321	0.0302	0.9532	0.00	0.0321
Machinery	0.9999	0.9997	0.0008	0.0017	0.9999	0.00	0.0008
Metal goods	0.9907	0.9912	0.0154	0.0141	0.9916	1.00	0.0130
Precision instruments and optical equipment	0.9999	0.9999	0.0010	0.0014	0.9999	0.00	0.0010
Woodworking	0.9998	0.9994	0.0027	0.0046	0.9998	0.00	0.0027
Textiles	0.9497	0.9601	0.0465	0.0437	0.9601	0.50	0.0437
Clothing	0.9998	0.9999	0.0018	0.0012	0.9999	0.50	0.0012
Leather goods	0.9997	0.9996	0.0025	0.0027	0.9997	0.00	0.0025
Pulp and paper	0.9998	0.9999	0.0027	0.0017	0.9999	0.50	0.0017
Polygraphic	0.9999	0.9997	0.0011	0.0028	0.9999	0.00	0.0011
Glass and ceramics	0.9909	0.9908	0.0197	0.0187	0.9909	0.00	0.0197
Food industries	0.9999	0.9993	0.0016	0.0041	0.9999	0.00	0.0016

SOURCE: Appendix Tables B-1, C-3, and D-1; and equation (4-9).

TABLE H-10

CMS ESTIMATION FOR EAST GERMANY: ESTIMATES OF R^2 AND SER

Industry	R^2		SER		Occurrence of maximum R^2		
	m=0.0	m=0.5	m=0.0	m=0.5	R^2	m	SER
Mining	0.9665	0.9570	0.0281	0.0196	0.9665	0.00	0.0281
Metallurgy	0.3208	0.3214	0.0508	0.0477	0.3214	0.50	0.0508
Chemicals	0.9901	0.9876	0.0194	0.0203	0.9901	0.00	0.0194
Building materials	0.9870	0.9881	0.0242	0.0212	0.9891	1.00	0.0188
Electrotechnical	0.9702	0.9717	0.0402	0.0369	0.9730	1.00	0.0340
Shipbuilding	0.9111	0.9155	0.0569	0.0517	0.9195	1.00	0.0473
Machinery	0.9686	0.9702	0.0333	0.0301	0.9702	0.50	0.0301
Metal goods	0.9686	0.9713	0.0440	0.0389	0.9737	1.00	0.0347
Precision instruments and optical equipment	0.9931	0.9935	0.0191	0.0170	0.9936	1.00	0.0155
Woodworking	0.9463	0.9479	0.0471	0.0422	0.9488	1.00	0.0383
Textiles	0.9607	0.9613	0.0376	0.0341	0.9614	1.00	0.0313
Clothing	0.8562	0.8569	0.0509	0.0459	0.8576	1.00	0.0419
Leather goods	0.9433	0.9975	0.0391	0.0017	0.9975	0.50	0.0017
Pulp and paper	0.9801	0.9791	0.0230	0.0216	0.9801	0.00	0.0230
Polygraphic	0.9522	0.9531	0.0310	0.0271	0.9535	1.00	0.0242
Glass and ceramics	0.9787	0.9801	0.0282	0.0248	0.9815	1.00	0.0219
Food industries	0.9893	0.9894	0.0153	0.0146	0.9901	1.00	0.0136

SOURCE: Appendix Tables B-6, C-4, and D-2; and equation (4-9).

TABLE H-11

CMS ESTIMATES FOR WEST GERMAN INDUSTRY: PARAMETER ESTIMATES AND TEST OF THE SIGNIFICANCE OF THE CMS PRODUCTION FUNCTION[a]

Industry	A	c^c	a^c	m	R^2	F	g^b
Chemicals	2.84	0.058 (0.006)	0.461 (0.130)	1.00	0.9991	3885.389	3.689
Metal goods	3.18	-0.005 (0.011)	0.609 (0.128)	1.00	0.9916	413.166	1.292
Textiles	2.50	0.031 (0.010)	0.414 (0.127)	0.50	0.9601	84.219	0.422
Clothing	2.81	-0.020 (0.002)	0.853 (0.028)	0.50	0.9999	34996.500	3.500
Pulp and paper	1.01	-0.013 (0.001)	0.899 (0.017)	0.50	0.9999	34996.500	4.118

SOURCE: Appendix Tables B-1, C-3, D-1, and H-9; and equation (4-9).

[a]See Table H-4 for m=0, the Cobb-Douglas case.

[b]The statistic $g = (n - k)\ (SER_{cd} - SER_{cms})/SER_{cms}$ is distributed as F with (1, n - k) degrees of freedom. The critical value for $F_{(1,7)}$ is 5.59 at the 5 percent level of significance.

[c]Standard errors are in parentheses.

TABLE H-12

CMS ESTIMATES FOR EAST GERMAN INDUSTRY: PARAMETER ESTIMATES AND TEST OF THE SIGNIFICANCE OF THE CMS PRODUCTION FUNCTION[a]

Industry	A	c[b]	a[b]	m	R^2	F	g[c]
Metallurgy	4.64	0.009 (0.007)	0.169 (0.266)	0.50	0.3214	5.158	0.455
Building materials	3.02	0.045 (0.009)	0.180 (0.112)	1.00	0.9891	317.601	2.011
Electrotechnical	19.80	0.103 (0.028)	-0.642 (0.492)	1.00	0.9730	126.130	1.276
Shipbuilding	31.80	0.076 (0.017)	-0.712 (0.497)	1.00	0.9195	39.978	1.421
Machinery	31.30	0.120 (0.025)	-1.849 (0.710)	0.50	0.9702	113.950	0.744
Metal goods	6.65	0.077 (0.027)	-0.127 (0.470)	1.00	0.9737	129.580	1.876
Precision instruments and optical equipment	4.20	0.060 (0.010)	0.080 (0.221)	1.00	0.9936	543.375	1.626

TABLE H-12--Continued

Industry	A	c[b]	a[b]	m	R^2	F	g[c]
Woodworking	6.67	0.067 (0.027)	-0.216 (0.461)	1.00	0.9488	64.859	1.608
Textiles	3.86	0.046 (0.055)	0.100 (0.090)	1.00	0.9614	87.174	1.409
Clothing	3.15	-0.035 (0.032)	1.110 (0.521)	1.00	0.8576	21.079	1.504
Leather goods	2.33	0.001 (0.001)	0.341 (0.018)	0.50	0.9975	1396.500	154.000
Polygraphic	4.78	0.043 (0.022)	-0.111 (0.397)	1.00	0.9535	71.769	1.967
Glass and ceramics	9.46	0.074 (0.019)	-0.322 (0.285)	1.00	0.9815	185.689	2.014
Food industries	12.30	0.048 (0.007)	-0.080 (0.175)	1.00	0.9901	350.035	0.875

SOURCE: Appendix Tables B-6, C-4, D-2, and H-10; and equation (4-9).

[a]See Table H-3 for m=0, the Cobb-Douglas case. [b]Standard errors are in parentheses.

[c]The statistic $g = (n - k)\ (SER_{cd} - SER_{cms})/SER_{cms}$ is distributed as F with (1, n - k) degrees of freedom. The critical value for $F_{(1,7)}$ is 5.59 at the 5 percent level of significance.

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