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The Causes and Consequences of Steel Subsidization in Germany*⁺

by

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The Causes and Consequences of Steel Subsidization in Germany

I. Introduction

A subject of much concern in recent years has been the re-surgent tendency among developed nations to adopt sectoral policies designed to protect aging domestic industries from foreign competition. The decision taken by the West German government in late 1983 to step up its subsidies to the iron and steel industry is yet another example of this general protectionistic trend. Seen through the lens of standard trade theory, using the benchmark assumptions of full wage and price flexibility, this development appears quite paradoxical; the central message of that theory being, of course, that everyone could be made better off by adhering to the principles of free trade and specializing in what each does best. Once the full flexibility assumptions are relaxed, however, and also more attention is paid to the distributional consequences of changed economic conditions, the normative message of traditional trade theory becomes less compelling and the attempts by governments to interfere in the economy more understandable. Various frictions and market imperfections have the effect that the adaptation to altered circumstances entails considerable costs and hardships. Moreover, these adjustment costs and the eventual benefits accruing from a more efficient resource allocation tend not to be equally borne and received by all members of a society. Governments generally lack the instruments and information to effect the compensating transfers from gainers to losers, such that the structural readjustments required in a free market would be found acceptable by all. So it is not surprising that those adversely affected members would be reluctant to make those adjustments, and would, instead, demand government policies that protect their particular interests. In representative democracies, such demands are likely to elicit some supply response from politicians in the market for protection. Under these circumstances, a positive analysis of the poli-

tical market for public intervention would be called for in order to understand why nations have chosen to adopt particular sectoral policies; what underlying objectives these policies are meant to satisfy. Having understood those objectives, it then falls within the realm of normative analysis to ask whether the policies actually adopted are the best available means of achieving them.

The position advanced in this essay is that sectoral subsidies are an inadequate means of combatting the problems which have arisen in Germany on account of the depressed steel industry. Regarding the objectives of the recent German steel subsidy program, we believe that this was intended mainly as a temporary measure to ease the adjustment burdens of unskilled workers, by maintaining stable employment levels in the regions where the steel industry is heavily concentrated. Our focus of criticism here lies on the misdirected use of sectoral policies to attain a regional objective. These subsidy measures achieve their employment goal largely by preventing the structural adjustments required by changed conditions in the world steel market, rather than facilitating the structural transition. As a result, once these subsidies are phased out, as intended, and market forces are allowed freer sway over the economy, the same readjustment burdens will reappear, along with the associated costs that triggered the initial round of subsidies. The same political forces would therefore be set in motion again which had succeeded in obtaining steel subsidies in the first place. Such a pattern, if continued, would lead to a gradual ossification of Germany's industrial structure.

A preferable alternative, suggested below, would be to adopt a regionally oriented wage subsidy program. This would have the effect of keeping regional employment levels stable, but without the same impediments to required structural readjustments as are provided by the sectoral measures. Also, this policy would be more compatible with a gradual phasing down of subsidies over time. That is not to say, however, that regional wage subsidies are the first-best measure conceivable in a world unconstrained

by political realities. They do have the drawback that mobile factor resources remain absorbed in regions which are locationally disadvantageous for producing a given set of commodities, relative to other regions. Our claim is simply that this is a smaller price to pay for attaining certain politically determined objectives, independent of whether those objectives are considered desirable or not.

The purpose of this essay is to investigate the possible economic consequences of the recent German steel subsidy program and assess to what extent those consequences conform with the objectives which motivated that program's adoption. The paper is organized as follows: Particular developments in the steel industry are briefly described in section II, while in section III, the political economy of protection in Germany is examined to determine the primary beneficiaries of previous protectionist policies. Both serve as a basis for identifying the revealed political objectives behind the current steel program. The next step is to simulate the economic consequences of a decline in the world market price of steel in the absence of any government intervention, using a multi-sectoral general equilibrium model of an open economy that resembles Germany. The economic impacts of a sectoral policy response and a regional policy response are then likewise examined and compared. This occurs in section V. The main elements and assumptions of the model used are outlined in section IV; the complete model specification is presented in an appendix. Conclusions are drawn in section VI.

II. Crisis in the Steel Industry

The well-publicized hardships currently confronting the iron and steel industries in North America and Western Europe did not appear overnight and there is also little hope that they will soon disappear. Once regarded as the shining flagships of industrial prosperity, these industries have in recent years acquired the dull patina of senescent dreadnoughts barely able to remain afloat. Since 1974, which marks the last major steel boom, the

general economic picture in this sector has been dismal; declining production, continuing layoffs, extreme levels of capital underutilization and high operating losses are typically observed¹. Partly, these difficulties can be traced to the cyclical decline in demand resulting from the worldwide stagnation in economic activity over most of the 1970s. However, the more important and lasting threat to the survival of these industries is attributable to the increasing labor and locational cost disadvantages vis-à-vis producers in Japan and the newly industrialized countries such as Brazil, Mexico and South Korea (Dicke (1983), Walter (1982), Wolter (1977)).

As conditions worsened for the iron and steel industry, the demands for protection intensified. While various rounds of negotiations under the auspices of the GATT had largely succeeded in removing the tariff instrument from the national armories of protective weapons, governments were quick to respond with a new array of sophisticated measures. Beginning in 1968, when the United States first succeeded in pressuring foreign (mainly Japanese) suppliers into accepting Voluntary Export Restraints, there soon followed import quotas and trigger price mechanisms coupled with threats of anti-dumping suits. Members of the European Community soon responded with their own brands of similar arrangements; negotiating voluntary export restraints, then installing minimum price and mandatory production quotas, coordinated through the Eurofer cartel which was formally established in 1976. Exciting narratives of this escalating trade war are provided in Jones (1983) and Walter (1979). In spite of each measure taken, the competitive pressures from abroad did not abate for long, as each country responded to its competitors' policies in a protectionistic carrousel. In the European Com-

¹ In Germany, which accounts for about one-third of steel produced in the EC, crude steel production declined from 53 million tons in 1974 to 36 million tons in 1982. The capacity utilization ratio meanwhile declined from 87% to around 60%. Registered employment in the iron and steel industry fell over this period from 174 thousand to 126 thousand workers (Iron and Steel Yearbook).

munity, this sheltering process increasingly led to the adoption of direct subsidies, continuing to the point where most of these industries are now nationalized². In this respect, Germany has provided the exception, with most of its steel industry still in private hands.

While the German steel industry has not been exempt from the difficulties mentioned, it has generally been able to survive until now without the massive infusions of government subsidies received by its EC neighbors. Until very recently, only the Arbed Saarstahl company in Germany received any significant direct aid; amounting to approximately three billion DM between 1978 and 1983 with another one billion DM scheduled until 1985. However, in 1983 an additional three billion DM in subsidies were allotted toward steel, to be paid out over the period 1984-85³. Although these figures are still small in comparison to those granted the steel industries in the rest of the EC (estimated around 66 billion DM between 1980-85), they signal an increased government involvement in the German steel industry⁴.

² With tariffs no longer a viable alternative, the increasing emphasis placed on subsidies as a means of stemming the decline of the iron and steel industries is not surprising. Steelmaking involves easily available, relative standardized techniques, and the main bulk of products falling under this category are fairly homogenous and freely traded internationally. As Jones (1979) points out, these characteristics make attempts to cartelize the industry over any significant period (as intended by the EC's Davignon Plan) extremely difficult. Similarly, experience has shown that selective quotas and bilateral export restraint agreements quickly tend to develop into bureaucratic nightmares and are frequently circumvented unless those measures can be applied comprehensively against all outside suppliers; see e.g. Canto, Eastin and Laffer (1982). The last recourse, then, for nations intent on propping up their faltering industries is to grant subsidies.

³ The financial burden is to be carried by the federal and state governments in a 2/3 to 1/3 proportion.

⁴ Interestingly enough, the decision to step up subsidies occurred after the Christian Democratic Party replaced the Social Democrats in national office (late 1982) on a platform of less public interference, which seems to indicate that protectionist responses in Germany are largely independent of party lines.

The decision to subsidize German steel was taken in concert with other EC members through the offices of the EC Commission. Under the guidelines set up by this commission, member countries are to terminate subsidization by the end of 1985⁵. During the negotiations which led to this agreement, the problem of over-capacity in steelmaking existing in Europe became explicitly recognized. The current subsidy measures were therefore intended as a temporary program to facilitate an orderly adjustment toward reduced levels of operation⁶. However, there are strong reasons to doubt that these subsidy programs will be soon dismantled. Among them is the inertial tendency, observed often enough in previous policies adopted toward other sectors, for programs to persist once they have been installed. Also, there are already signs that some EC members are not prepared to abide by the 1985 subsidy termination date agreed to previously⁷. The defection of some members from the agreement will therefore make it easier for others to defend their violation of the same. Most important, however, we feel is the fact that the final objectives which these temporary subsidies were intended to fulfill, will not continue to be satisfied once the subsidies are removed. That is the central conclusion to emerge from the analytic experiments later on. Therefore, unless the political configuration of pressure groups which succeeded in obtaining subsidies in the first place is drastically altered, there is little ground for hope that they will not succeed again.

Judging from various past and recent pronouncements by government spokesmen, the preservation of a German steel industry

⁵ The German government has been a persistent force behind the multilateral elimination of subsidies within the EC, with the support of spokesmen from the iron and steel industry; another reflection, perhaps, of the relatively strong competitive position of German steelmakers vis-à-vis its European neighbors.

⁶ See, for example, Presse- und Informationsamt der Bundesregierung, Stand der Stahlpolitik (7 February 1984).

⁷ France, for example, has unilaterally decided to give an additional 30 billion FF in fresh subsidies to its steel industry between 1984 and 1987 in violation of the EC Code (Financial Times, 6 April 1984).

does not appear to be a primary policy objective. In the words of one government insider, Gerhard Ollig (1980), "The basic economic organization of the Federal Republic of Germany is such that there is no special policy for steel;...". Instead; "Many of the measures taken to aid reconversion [in parts of the steel industry] are social ones, taken primarily to alleviate the plight of the workers affected..." (pg. 530). Were the existence of a domestic steel industry to constitute a national objective (possibly to ensure self-sufficiency for strategic purposes), or to be regarded as an important symbol of prestige (as some countries view their nationalized airlines), then the adoption of sectoral measures might be more defensible. However, the underlying social goal behind these measures in Germany is a different one, and before we can judge the effectiveness of sectoral measures in meeting that target, it is first necessary to find out what that target may be.

III. The Determinants of Sectoral Protection in Germany

The general question of why polities often seek to protect ailing traditional industries has been a central focus of the rapidly expanding literature on the "international political economy of protection" (see e.g., Bhagwati (1982) and Frey (1984)). The public choice approach which underlies this literature views government policies as determined in a market for rents or public protection. One aim is to identify the separate actors competing in that market and their economic objectives. An early step in this thematic direction was taken by Stolper and Samuelson (1941), who show in the context of a standard 2 x 2 Heckscher-Ohlin model that the factor used intensively in the protected sector gains at the expense of the other factor. This conclusion suggests that views on protection would be divided along factor lines. However, subsequent work (Magee; 1978) has indicated that views on protection are divided along industry lines, with both factors within an industry usually espousing the same position. To generate incentive patterns leading to this behavior, attention has shifted away from the "long-run" Heck-

scher-Ohlin model toward other models. Magee (1978) himself, for example, resuscitates Cairnes' (1874) model as one extreme, which assumes all factors to be industry-specific in both the short- and long-run. Within that model, increased sectoral protection would benefit all factors employed in the sheltered industry. Mayer (1974), Mussa (1974) and Neary (1978), on the other hand, only assume capital to be fixed in the short-run within each sector while labor is mobile intersectorally, and Baldwin (1984) introduces sector-specific skills which take time to acquire by workers. The common ground emphasized in all of these approaches is that some form of factor immobility is necessary (at least in the short-run) in order to replicate key aspects of actually observed protection-seeking behavior⁸. Less mobility is simply another way of stating that the opportunity costs to factor owners of moving to different industries or occupations are greater, and so the incentive to retain the rents collected in the present employment situation is commensurately higher.

The theoretical models reviewed so far consider only capital and labor as distinct entities, each of which may or may not be bound sectorally. Several empirical studies on patterns of protection, however, suggest that, at least for Germany, an additional dimension be considered; namely that a distinction be drawn between skilled and unskilled labor. Anderson and Baldwin (1981) thus summarize the evidence obtained from various independent econometric studies on the determinants of protection in nine developed countries: "The results ... suggest that it is the

⁸ The proposition, that lack of mobility and active political participation are positively correlated, also draws support from the more traditional political science literature. For example, in reference to behavior patterns in developing countries, Huntington and Nelson (1976) write: "For the individual, political participation... is a means to an end, and that end is usually some form of improvement in his social and economic status. The individual also generally sees his own efforts at socioeconomic mobility - through migration, education, or job betterment - as more effective, more direct, less costly, and less risky routes to his goal than collective political action. Only if mobility is blocked does he turn to organization. His involvement in politics usually occurs when he sees no alternative to it." (pg. 113).

low-wage, labor intensive, low value-added, declining industries facing strong and growing import competition that are receiving the greatest boost over time or the least cuts in multilateral tariff-cutting concessions ..." (pg. 20). With particular reference to Germany, Glismann and Weiss (1980) arrive at similar results. In view of the particular institutional aid-granting framework existing in Germany, their study distinguishes between government aid channeled through regional development programs and non-regional project or industry-specific assistance, each accounting for about half of the total aid granted. They find, by way of cross-sectional analyses, that the number of employees in an industry is significantly (positively) correlated with at least the non-regional component of total domestic assistance to German manufacturing industries. On the other hand, human capital and physical capital intensity do not appear to exert a significant influence on domestic aid to industries, either total or non-regional. Riedel (1977) obtains support in Germany for the hypothesis, originally advanced by Cheh (1974), that changes in effective protection reflect a governmental policy of minimizing labor adjustment problems. He finds the reductions in effective protection barriers across various industries, between 1964 and 1972, to be significantly negatively related to industry employment, but significantly positively related to human capital (a measure obtained in part by comparing an industry's average wage to the unskilled wage). That would indicate that not all workers are the focus of protection, but rather the less skilled, lower paid workers⁹. This proposition is also advanced by Constanto-

⁹ For the United States, Cheh (1974) had also found industry employment to be a significant variable in explaining tariff changes. However, in contrast to Riedel's results, the percentage of unskilled workers in the industry did not emerge significantly, indicating that perhaps unskilled workers in the U.S. are not as politically active relative to other groups in pursuing their interests, as in Germany. Nie, Powell and Prewitt (1969) corroborate this conjecture. They note that in general there is a tendency for people with higher education, income and occupational status to be more involved in political activity than people with less of these attributes. In correlating measures of social status and organizational involvement in several countries, however, they obtain a coefficient value of .435 for the United States and only a value of .213 for Germany.

poulos (1974) in her investigation of tariff structures in five West European countries, including Germany, prior to the establishment of common tariffs by the EC. Her conjecture, that tariffs protect the wage of unskilled workers rather than labor income in general, is supported by the stronger correlation obtained for most countries (except France) between the height of nominal tariffs and indices of unskilled labor intensiveness across industries, as opposed to total labor intensiveness¹⁰.

According to the earlier line of reasoning, barriers to mobility are an essential element in the formation of protectionist pressures. In drawing a distinction between skilled and unskilled labor, it is therefore natural that we examine the mobility characteristics of each. In a comprehensive study sponsored by the German Labor Ministry, Siegel, Stevens and Werth (1976) analyze various aspects of labor mobility in member countries of the European Community. With respect to the German labor market, they observe that workers with high levels of formal education and highly placed in terms of social and occupational status (all of which are highly correlated among themselves) are considerably more geographically mobile than are workers at the other end of the scale. At the same time, these same higher qualified workers are considerably less mobile occupationally than are the lower qualified workers¹¹. These results suggest the following stereotypic pattern: skilled workers are regionally mobile and sectorally immobile, and conversely, unskilled workers are sectorally mobile but regionally immobile.

¹⁰ Most of the studies reviewed also point toward a positive relation between protection and increasing import penetration or declining industrial health, suggesting that the incentive to prevent a deterioration in one's economic position, through political channels, is stronger than to use those channels as a vehicle for improvement. That may explain the (apparently paradoxical) willingness, in Germany, to attract large numbers of unskilled immigrant workers during the booming sixties. Predictably, this enthusiasm has waned in recent years with the slowdown in economic growth.

¹¹ Some additional figures on mobility and occupational/educational status in Germany, which strongly support these findings, are contained in Quintessenzen; Berufswege und Arbeitsmarkt (1976).

This behavioral pattern can be easily explained from an economic perspective: To the extent that skills represent sector-specific human capital, as emphasized in Baldwin (1984), the owner of skills incurs a capital loss by moving from one sector to another. So, the opportunity costs of transferring to a different sector increase with the amount of human capital acquired, relative to the psychic and pecuniary costs involved in shifting geographic locations¹². Hence, a less qualified worker is more likely to find that regional migration costs outweigh the sectoral relocation costs reflected in changed earnings. Consequently, we would expect to find the market for unskilled labor to be segmented more along regional lines, the market for skilled labor along sectoral lines. These lines would increasingly overlap the higher is the regional concentration of the different sectors. In this respect, it is interesting to note the wide, and much commented, disparity of unemployment rates across states in Germany; for example, the average annual unemployment rates recorded for the Saarland since 1971 have consistently been twice as high as the levels recorded for the nearby state of Baden-Württemberg.

The empirical studies discussed earlier have indicated that industry protection in Germany (and in developed countries generally) largely protects the interests of unskilled labor. However, as these studies are based on single-equation estimation techniques, an identification problem exists: It is not possible to distinguish the demand and supply effects which have led to this particular outcome in the market for protection. So far, we have only considered the demand side, arguing that it is mainly regional mobility costs which prompt unskilled workers to seek protection in response to adverse economic developments. On the supply side, the argument is frequently voiced that labor re-

¹² Regarding regional relocation costs, the role of housing and rent regulations are not to be underestimated in Germany's particular case. With ceilings placed on the rate of rent increase after a tenant has moved in, length of tenure of an apartment is tantamount to accumulated capital which is lost by moving.

ceives the most protection because it has the most votes. The particular concern for unskilled labor then tends to be explained by "subjective" reasons, which cause politicians (and a philanthropic-minded society) to be especially sensitive to the conditions of these generally poorer members of society. Measures which safeguard their welfare are defended on grounds of social justice or, not quite so altruistically, to prevent possible social unrest. However, there is another motive for a strong responsiveness by politicians to unskilled labor interests in parliamentary democracies which is directly related to the fact that these workers tend to be regionally immobile. This is that voting districts are geographic demarcations, and therefore the regionally immobile factors would constitute the most stable component of a politician's constituency base. While higher skilled workers are more likely to exit into other voting districts in response to better opportunities or adverse conditions, less mobile unskilled workers would be more inclined to exit politicians if their demands are not met. Insofar as politicians' fortunes depend on regional power bases, there is therefore a good incentive to placate those demands. On the other hand, there is also an incentive for each politician to discourage the outflow of constituents from his district, since that may lead to an erosion of his influence within parliament (to the extent of complete elimination, should two voting districts be merged). Because elections generally occur more often than the redesign of district boundaries, however, this second incentive is likely to be less critical than the first. Nonetheless, it does suggest a greater inclination to offer policies which benefit unskilled labor by raising demands for those workers in the areas where they happen to be located (such as the sectoral or regionally-focused subsidies discussed in this paper), rather than policies which would facilitate the movement of unskilled workers into other more productive geographic regions, by reducing mobility costs.

In summary, the evidence and arguments advanced here indicate that a primary motivation behind industry protection in Germany is the protection of interests of unskilled labor. Since

the steel industry is highly regionally concentrated, and because of the regional immobility of unskilled labor, adverse developments in the iron and steel sector are likely to have an unequal regional impact on employment or wages. Our purpose, then, in the remaining sections is to assess at what cost a sector-specific, steel subsidy is able to solve what turns out to be, in effect, a regional labor market problem.

IV. A General Equilibrium Model of Germany

To analyze the questions raised earlier, we have constructed a general equilibrium model of an open economy, emphasizing the real sector, with parameter values chosen to reflect the West German economy. The general theoretical structure which underlies this analytic framework is the multi-sector, general equilibrium ORANI model system developed by Dixon et al. (1982), which in turn has its origin in Johansen (1960). One distinguishing characteristic of the ORANI-class models is the fairly firm rooting in conventional microeconomic theory: Producers minimize costs subject to certain technology constraints and prices, while consumers maximize utility subject to a budget constraint. Another trait is the detailed attention devoted to intersectoral linkages; input-output tables provide the structural backbone of the model.

In this model, we consider the West German economy as consisting of two regions (I and II), where each region is disaggregated into ten producing sectors. In effect, we may think of these regions as two countries having extremely close economic ties, trading with the rest of the world. The two regions differ only with respect to the proportions in which the ten sectors are represented in each; with Region I containing a relatively high concentration of iron and steel industries and also of coal industries. Their joint concentration is not surprising in view of the close production linkages between both sectors. In more concrete terms, and in view of the fact that accessible regional data was primarily available only at the state (Länder) level,

what we have done is to give Region I a sectoral structure that reflects the industrial composition of North Rhine-Westfalia and the Saarland, while Region II comprises the remaining 6 German states and 3 city-states. North Rhine-Westfalia and the Saarland combined account for about 59% of the total value of iron and steel produced in Germany and for about 86% of total coal production, while producing 29% of Germany's GDP.

The commodities produced by the ten sectors in both regions consist of nine traded goods, one of which is, of course, iron and steel, and a non-traded good, which includes all government services. The sectoral classification employed here is based on an aggregation of the 58-industries input-output table provided by the German Statistisches Bundesamt and is explained in Appendix A. We assume that the technology employed in each sector is the same across regions. Also each sector produces an identical good in both regions and, except for the non-traded good, there are no commodity trade barriers between both regions, so that the law-of-one-price obtains. On the other hand, domestically produced goods and similarly classified goods produced in the rest of the world are taken to be imperfect substitutes.

The primary factors of production have been classified into four types: On one hand, there are land and capital, and on the other there is labor, which again is subdivided into High Skilled and Low Skilled workers¹³. In line with our earlier discussion, High Skilled workers are assumed to be mobile between both regions (though not internationally) and immobile between sectors (i.e. skills are sector-specific). This means, essentially, that High Skilled workers in each sector receive the same wage in both regions, although that wage may, and generally will, differ be-

¹³ The German Statistisches Bundesamt (Fachserie 16, Reihen 2.1, 2.2) separates blue collar workers into three categories and white collar workers into four categories on a declining scale based on occupational qualifications and responsibilities. This ordering is also reflected in the wage and salary structure. In our model, Low Skilled labor represents an aggregate of the last two categories of both blue and white collar workers, while High Skilled labor represents the rest.

tween sectors. Low Skilled workers, in contrast, are mobile between sectors but regionally immobile. This has the consequence that all Low Skilled workers in a given region receive a uniform wage independent of the sector in which they are employed. Land is assumed to be totally immobile, i.e. fixed both regionally and sectorally. The mobility characteristics of capital will be discussed shortly, when we consider different model closures.

The model is written as a set of structural equations which are linear in all growth rates (another trademark of Johansen-class models), and these are presented in Appendix B. They were obtained by logarithmically differentiating an underlying system of non-linear equations and evaluating the derivatives at an equilibrium point (provided by the entries in the relevant input-output table). For a detailed discussion of these derivations, the reader is best referred to Dixon et al. (1982), as a full elaboration here would lead us too far astray. The system of equations can be divided into six groups:

(i) Equations (1)-(5) describe the final demands for commodities (both imported and domestically produced) by households, firms, government, and export demand¹⁴. With respect to the last of these, it is assumed that German producers face a downward sloping demand curve for their exports. On the import side, however, "small-country" assumptions prevail, so that Germany faces an exogenously given vector of imported goods prices.

¹⁴ These equations were derived using the following postulates:

- Households choose consumption to maximize an additive nested utility function subject to an aggregate budget constraint. The nests of commodity categories involve CES functions describing the substitution possibilities between domestic and imported sources of each category. Leisure is not considered here as a choice variable.
- Investment spending is modelled (somewhat rudimentarily) by postulating a declining marginal product of capital schedule in each industry. Total real investment is set exogenously, and is allocated across industries in such a way as to equate expected rates of return.
- Government expenditures fall entirely on the domestic non-traded commodity.

(ii) Equations (6)-(9) describe the industry demands for primary factors and intermediate inputs¹⁵.

(iii) The pricing equations (10)-(13) are obtained by setting pure profits from all activities to zero. I.e., perfectly competitive conditions are assumed to prevail.

(iv) Market clearing equations for primary factors and commodities are specified in (14)-(17).

(v) Balance of trade and government budget equations are given by (18)-(24). Since the financial sector is ignored in this model, money or bond finance of government activities are not considered. The government must finance its expenditures entirely through taxes, direct and indirect.

(vi) Eqs. (25)-(43) are miscellaneous definitional equations which, for example, describe aggregate output, various employment measures, aggregate wages and the consumer price index.

Perhaps we should repeat that all variables are expressed in the form of percentage changes rather than in absolute levels or changes. Due to its linear structure, this system can be solved by simple matrix methods. A highly attractive feature, from a computational viewpoint, is the flexibility with which endogenous variables can be interchangeably specified to conduct various comparative statics experiments.

¹⁵ Underlying these equations is the assumption that producers minimize costs subject to a nested, three-tier, CRS production function. At the highest tier, a Leontief technology is assumed, with fixed proportions between intermediate inputs and an aggregate of primary factors. At the second tier, CES functions describe the substitution prospects between (a) domestic and foreign produced intermediate inputs, and (b) between the three primary factors (capital, land and aggregate labor). At the third tier, CES functions describe the substitution prospects between Low Skilled and High Skilled Labor.

In the experiments performed in the following section, we consider two model closures, denoted as the short-run and the medium-run solutions. These are distinguished only by the assumption that physical capital is both sectorally and regionally immobile in the short-run, and totally mobile (sectorally and regionally, but not internationally) in the medium-run. This means that in the short-run sectoral capital stocks are exogenously fixed, while their rates of return are determined endogenously. In the medium-run, on the other hand, the sectoral and regional capital stocks are endogeneously determined subject to the condition of equal rates of return everywhere in the domestic economy. We reserve the term "Long-run" to cover the situation (not considered in this paper) where both types of labor become perfect substitutes; e.g., where they are totally mobile regionally, sectorally and occupationally. Admittedly, it remains a debatable point whether capital takes longer to reallocate than it takes to retrain skilled workers or to regionally relocate unskilled workers.

Finally, there are several items that have been placed on the list of exogenous variables in both model closures which deserve attention and perhaps some justification:

(i) The balance of trade is assumed always in equilibrium, while the exchange rate is determined endogenously. That necessarily implies that the capital account of the balance of payments is always in equilibrium. This assumption is motivated by two practical considerations: First is the fact that we have not explicitly incorporated a financial sector, including a service account, in our model. Secondly, our analytic focus revolves more around the relative distribution of capital across domestic sectors in response to various exogenous events rather than on the absolute amounts involved. The consequence of this assumption is that all factors impinging on the wealth position of domestic residents are captured internally, rather than becoming in part reflected in the asset-liability positions vis-à-vis foreigners.

(ii) The total capital stock of the economy is held constant in both the short- and medium-run. In the short-run, this is consistent with the previous assumption of sectoral and regional capital immobility. In the medium-run, this constraint serves to bring out more clearly the capital-redistribution effects across regions and sectors of various policies.

(iii) The consumer price index is held constant. Our model focuses entirely on the real sector with money regarded simply as a "veil" along traditional classical lines. This means that all real variables depend only on relative prices, leaving us to choose a numeraire for the system to determine the absolute price level. Our choice of a constant CPI is motivated by the German authorities' postwar emphasis on maintaining stable prices; something fairly clearly reflected in international inflation rate comparisons.

(iv) Low Skilled workers are assumed to be in abundant supply and largely unionized, so that their nominal wages are fixed exogenously, leaving LS employment to be determined by demand. Alternatively, the supply of High Skilled workers in each sector is assumed fixed, while their wages adjust freely to clear all HS labor markets.

This completes our specification of the model, highlighting the essential features. Next, we turn to the simulation results.

V. The Impact of and Solutions to the Steel Crisis

a) The effects of declining world steel prices.

We have argued in Section II that the current difficulties faced by German steelmakers are primarily attributable to the emergence of low cost steel suppliers in the newly industrialized countries, along with Japan's competitive lead in steelmaking, coupled with the protective measures taken by other developed nations to prevent any substantial declines in their domestic

steelmaking capacity. Both factors have led to an oversupply of steel in world markets, placing downward pressure on world steel prices. To simulate the effects of such a price decline in our model, we simultaneously reduce the price of imported iron and steel by 10% and shift down by 10% the export demand schedule for German iron and steel. (Referring to the model in Appendix B, this corresponds to an exogenous 10% reduction in the variables p_{i2}^m and $f_{i1}^{(4)}$, where i denotes iron and steel). The short-run and medium-run effects of this exogenous "shock" on our domestic economy are summarized in Table 1.

First of all, we notice that the world steel price decline affects sectoral outputs uniformly across both regions, leading to a contraction in some sectors and to an expansion in others. Not surprisingly, the largest percentage decline in output is registered by the domestic iron and steel industry (row 4). As for the other sectors, there are two opposing effects: To the extent that industries depend on steel as an intermediate input, they will benefit from the cost reduction due to lower steel prices. However, to the extent that an industry is linked to the iron and steel sector as a supplier of intermediate inputs, such as the coal industry, it will experience a decline in demand for its products. Whether an industry expands or contracts, then primarily depends, of course, on which of the two linkages is predominant.

Although the sectoral impact is the same in both regions, the overall regional impact will not be the same simply because the industrial sectors are represented in different proportions in both regions. This is clearly reflected in the effects on regional LS employment (row 12). In Region I, where iron and steel (and coal) are primarily concentrated, LS employment declines, while in Region II, the cost reduction effect of lower steel prices appears to predominate, thereby stimulating economic activity and leading to increased LS employment. This result obtains in the short-run as well as in the medium-run. In comparison to the regional employment effects, the effects on total LS employment over both regions (row 11) are fairly small in the

Table 1 The Effects of a 10% Decline in World Iron and Steel Prices

	Short Run		Medium Run	
	Region I	Region II	Region I	Region II
<u>Sectoral Outputs</u>				
1. Agriculture and Fisheries	.04	.04	.55	.55
2. Coal Mining	-.77	-.77	-.40	-.40
3. Other Primary	-.18	-.18	.37	.37
4. Iron and Steel	-10.61	-10.61	-11.41	-11.41
5. Electrotechnical	-.47	-.47	.62	.62
6. Textiles, Leather	-.09	-.09	.91	.91
7. Food Processing	-.06	-.06	.47	.47
8. Other Manufacturing	.43	.43	.96	.96
9. Other Tradeables	.29	.29	.00	.00
10. Non-Tradeables, Gov't.	-.13	-.13	-.02	-.02
<u>Labor and Capital</u>				
11. National Employment of LS Labor		-.16		-.04
12. Regional Employment of LS Labor	-1.31	.30	-1.10	.38
13. LS Employment in Iron and Steel	-25.70	-25.70	-23.34	-23.34
14. Aggregate Real Wage of HS Labor		-.21		-.15
15. Real Wage of HS Labor in Iron + Steel		-25.70		-23.34
16. Rate of Return to Capital in Iron + Steel	-75.10	-75.10		-.15
17. Capital Stock in Iron + Steel	O(EX)	O(EX)	-22.58	-22.58
<u>Macroeconomic Variables</u>				
18. Real Private Consumption		-.27		-.28
19. Real Gov't. Expenditures (net of transfers)		-.10		.06
20. Aggregate Domestic Output		-.15		.01
21. Balance of Trade		O(EX)		O(EX)
22. Aggregate Exports (= Agg. Imports)		-.81		-.51
23. Iron + Steel { exports		-20.75		-26.64
24. { imports		-.11		25.32
25. Exchange Rate		.00		.49
26. CPI		O(EX)		O(EX)

short-run (-0.16%) and negligible in the medium-run (-0.04%). This result illustrates our statement earlier, that the unemployment problem arising from increased steel import penetration is a regional, not a national problem. Only the LS workers in Region I have an incentive to seek government protection in response to these developments, not those in Region II.

As would be expected, the effects of falling steel prices are quite strong on the sector-specific factors in the steel industry, making for an equally strong incentive for these factors to demand protection. The negative effect on real wages of HS Labor in the steel sector is considerable, -25.7% and -23.3% in the short- and medium-run respectively, while the aggregate HS real wage only registers a marginal response (row 14). Similarly, the short-run impact on the rate of return to capital in iron and steel is -75.1%. (The capital rates of return in the other sectors, though not listed separately, follow in the same direction as changes in sectoral outputs). If the adjustment process following the price decline were left unimpeded, then by the medium-run the iron and steel sector would experience a capital outflow of 22.6%, to be distributed among the other sectors. This capital outflow would raise the return to capital remaining in the steel sector almost back to the pre-price shock level. (Since the other sectors have experienced a net inflow of capital the economy-wide rate of return will be somewhat lower, -0.15%).

The effects on the other macroeconomic variables are comparatively small. In the short-run, there occurs a decline in aggregate output, -0.15%, but by the time all adjustments have taken place, aggregate output recovers to approximately the same level as before the price shock (0.01%). However, the exchange rate (DM/foreign currency) depreciates somewhat in the medium-run (0.49%), resulting in a slight deterioration of the overall terms of trade. This result would appear to indicate that consumers in general have no particularly strong incentive to pressure the government into taking offsetting actions.

Finally, we note that the reduced competitive position of the domestic iron and steel industry in world markets is reflected primarily by reduced exports in the short-run, followed by increased import penetration in the medium-run (rows 23 and 24). In part, the lagged import response reflects the fact that the elasticity of substitution between imports and domestically produced commodities increases over time.

b) The effects of subsidizing steel production.

As we have observed earlier, the German government responded to the adverse developments emanating from the iron and steel sector by granting additional subsidies to that industry. The effects of such a sectoral measure are simulated in our model by reducing the production tax rate ($u_{j\ell}$ in Appendix B), or equivalently, by raising the production subsidy rate, applicable to the iron and steel sector in both regions.

From the preceding experiment we found that the three groups most strongly affected by the fall in world steel prices, and therefore the most likely to demand some form of government intervention, were HS workers in Iron and Steel, owners of capital in Iron and Steel, and LS workers in Region I. Of these three, however, the most likely to elicit a protective response from the government is thought to be LS labor. That was the conclusion, reviewed earlier, that emerged from numerous studies investigating the determinants of German protective measures. Accordingly, we shall regard the level of LS employment in Region I as a target variable in the subsequent experiments. For convenience, it is assumed that the objective of the subsidy program is to raise LS employment in Region I by 1.1%, i.e., by the same absolute amount that this variable falls in the preceding medium-run experiment on account of lower steel prices. Before examining the results of this policy experiment, let us restate briefly for later reference the two main conditions under which the subsidies were granted, in agreement with the Code set by the EC Commission: These are that (a) the subsidies be only intended as a temporary adjustment aid measure, not to be renewed after 1985,

Table 2 Effects of a Production Tax Rate Reduction in the Iron and Steel Sector

	Short Run		Medium Run	
	Region I	Region II	Region I	Region II
<u>Sectoral Outputs</u>				
1. Agriculture and Fisheries	.17	.17	.17	.17
2. Coal Mining	.80	.80	.38	.38
3. Other Primary	.68	.68	.42	.42
4. Iron and Steel	6.39	6.39	5.59	5.59
5. Electrotechnical	1.69	1.69	.21	.21
6. Textiles, Leather	.89	.89	.04	.04
7. Food Processing	.21	.21	.21	.21
8. Other Manufacturing	.68	.68	.30	.30
9. Other Tradeables	-.72	-.72	.30	.30
10. Non-Tradeables, Gov't.	-.21	-.21	-.38	-.38
<u>Labor and Capital</u>				
11. National Employment of LS Labor		.38		.64
12. Regional Employment of LS Labor	1.10 (EX)	.09	1.10 (EX)	.42
13. LS Employment in Iron and Steel	15.53	15.53	11.34	11.34
14. Aggregate Real Wage of HS Labor		.21		.55
15. Real Wage of HS Labor in Iron + Steel		15.53		11.34
16. Rate of Return to Capital in Iron + Steel	44.97	44.97		.09
17. Capital Stock in Iron + Steel	0(EX)	0(EX)	11.59	11.59
<u>Macroeconomic Variables</u>				
18. Real Private Consumption		.38		.72
19. Real Gov't. Expenditures (net of transfers)		-.97		-1.44
20. Aggregate Domestic Output		.17		.25
21. Balance of Trade		0(EX)		0(EX)
22. Aggregate Exports (= Agg. Imports)		.59		.34
23. Iron + Steel { exports		7.95		11.85
24. Iron + Steel { imports		1.44		-10.66
25. Exchange Rate		1.02		-.04
26. CPI		0(EX)		0(EX)
27. Absolute Percentage Change in Iron + Steel Production Tax Rate		-2.14		-2.11

and that (b) they not prevent the capacity cuts required to make the industry competitive in the free market.

From Table 2 we observe that while a reduction in iron and steel production tax rates will be effective in raising LS employment in Region I, they also have the effect that more resources become absorbed into the iron and steel sector. Focusing on the medium-run effects, LS employment in Iron and Steel rises by 11.3% and the capital stock rises by 11.6%. (High Skilled Labor in the Steel sector remains constant by assumption). When these figures are viewed in conjunction with the relevant figures in Table 1, -23.3% and -22.6% respectively, the net reduction of capacity in the steel sector would only be about one half of the amount that would be warranted under free market conditions. This would mean, in other words, that the second condition under which the subsidies were granted would be violated, or rather, would be incompatible with the objective of maintaining LS employment in Region I unchanged. Furthermore, this violation is not immediately obvious, since we do observe from these joint simulations that some capacity cuts in iron and steel (-11.0%) would take place. The problem facing the policymakers granting the subsidies, however, resides in not knowing beforehand what the appropriate amount to cut is without actually allowing the free market to prevail.

We now turn to the other conditional element contained in the subsidy package, namely that they are to be phased out after a few years. In row 27 are given the endogenously determined absolute percentage changes in production taxes that would be consistent with a target increase of 1.1% in LS employment in Region I. What is most remarkable about these figures is that they hardly differ in the short- and medium-runs (-2.14% versus -2.11%). That would mean that if the production subsidy rate were to be decreased by any substantial amount after some time, the government would no longer be able to meet its LS employment target in Region I. An eventual unilateral reduction in Iron and Steel subsidies would therefore have the consequence that the

level of LS employment in Region I would decline commensurately, possibly restimulating demands for continued protection.

For illustrative purposes, let us compute the absolute annual value of required subsidies in the short- and medium-run. Using 1978 as the basis year, the total output value in the German iron and steel sector amounted to, approximately, 123 billion DM. In the short-run, following the 10% steel price decline and the adoption of subsidies, a net decline of sectoral output takes place of about 4.2%, leaving a value of 118 billion DM as the subsidy base. Applying the short-run subsidy rate of 2.14%, would yield an annual subsidy bill of roughly 2.5 billion DM. Using the respective figures calculated from the medium-run experiments, would yield an annual subsidy bill of 2.4 billion DM; barely lower.

We may further observe in Table 2 that the production tax reductions have an overall expansionary effect on the economy, with equal regional impacts in all sectors. This is reflected also in the increase of national LS employment and in aggregate output (rows 11 and 20). Only the non-tradeables sector contracts in the medium-run. This exception to the rule can be traced back to the government budget constraint: With less tax revenue the government has less to spend on non-tradeables, the only commodity demanded by the government. This development becomes even more evident (in rows 18 and 19) by the switch in final demands away from public towards private consumption.

However, the subsidies to the iron and steel sector were not granted with the objective of stimulating aggregate economic activity. In fact, this by-product effect may turn out to be a disadvantage: Recall from the preceding experiment that falling world steel prices stimulate economic activity in Region II, while leaving aggregate output and national LS employment approximately unchanged in the medium-run. By granting steel subsidies to combat unemployment in Region I, however, unnecessary expansionary fuel is provided at the same time to Region II. If an aggregate expansion over both regions were desired, then the

more economical measure would be to grant subsidies to all sectors in both regions. Per unit of aggregate output or national LS employment increase, such a policy would involve a smaller overall subsidy bill and less structural distortions than do subsidies granted exclusively to steel.

Lower production taxes generally bring about an efficiency gain in terms of aggregate production, which is independent of the adverse structural effects brought about by lowering taxes in just one sector. However, that production gain does not necessarily represent a social improvement, for that would depend on the valuation of foregone public goods previously financed with those taxes; on whether market prices are used or social shadow prices. In order to circumvent this valuation problem, a separate experiment was conducted (not fully elaborated here), where lower steel production taxes are simultaneously offset by commensurately higher production taxes in all other sectors to keep total real government revenues constant. Under that restriction, it turns out that a target increase in LS employment in Region I by 1.1% is associated with a decline in aggregate output of -0.12%¹⁶.

c) The effects of regional wage subsidies.

An important insight obtained from the traditional literature on optimal government intervention is that policy measures should be applied at the closest possible point to the objective sought, so that other unintended effects on the rest of the economy are kept to a minimum. (Bhagwati and Ramaswami, 1963; Cor-den, 1974; Johnson, 1965). In different words, any distortions arising on account of, say, the existence of externalities or

¹⁶ We have here, in effect, a two-instruments, two-targets problem. A proportional increase of production tax rates in all regions and sectors, other than the steel sector, by 10% has the effect that LS employment in Region I and aggregate output fall by 1.23% and .52% respectively, while real government expenditures rise by 2.54%. Using these three figures along with the respective figures from Table 2 (resulting from lower production taxes in steel alone), and recalling the system's linear structure, yields the output figure stated in the text.

public goods are best dealt with through measures directly applied to the source of the distortion in order to avoid new by-product distortions (or upsetting marginal conditions) elsewhere in the economy. By this principle alone, the previously examined sectoral subsidies would clearly be suboptimal as a means of attaining the objectives sought. According to our story, it is not the conservation of the iron and steel industry, *per se*, which is desired by policymakers, but rather the preservation of jobs for workers classified as Low Skilled in the region where the iron and steel industry happens to be concentrated. A regionally focused policy aimed at the labor market would therefore be a more direct route toward meeting that objective, than would a sectoral policy aimed at the steel industry on a national level.

As was already stated in the introduction, regional wage subsidies are not the first-best solution to the economic problem arising from lowered steel prices. They have the by-product effect of tying down factor resources in regionally less advantageous production sites and also of distorting the factor intensity choice by firms. Both are likely to have deleterious growth effects in the long-run. The first-best measure, if feasible, would be to implement measures which facilitate or encourage the interregional mobility of LS workers, since that is precisely the source of friction in this model from which the regional LS unemployment problem of relevance to government policymakers arises. However, we have, in section III also pointed toward a disinclination on the part of politicians to offer policies which would involve a substantial relocation of constituents into other regions, *i.e.*, voting districts. For that reason we confine our present attention to regional wage subsidies, as a second-best measure.

Table 3 presents the effects in our model of an aggregate wage subsidy rate increase paid to producers and uniformly applied across all sectors in Region I ($ws_{1,j,\ell}$ in appendix B, for j referring to all 10 sectors and ℓ referring only to Region I). Following the same procedure as in the preceding experiment,

we raise these wage subsidies by enough to yield a 1.1% increase in Region I, LS Labor employment, using first the short-run closure and then the medium-run closure.

We observe that the regional wage subsidies, by reducing net labor costs to producers in Region I, stimulate overall economic activity in that region, while in general causing economic activity in Region II to contract. Mobile factor resources are drawn from Region II to be absorbed in Region I (HS Labor in the short-run, inclusive capital in the medium-run). Isolating the immobile factor, LS labor (row 12), we find that the increased employment in Region I is matched by reduced employment in Region II, in a proportion that almost precisely offsets the regional employment impact of falling steel prices, shown in Table 1. Furthermore, the macroeconomic impact of these wage subsidies is only slight in the short-run, and negligible in the medium-run; not involving, for example, the substantial shifts in private versus public expenditures observed under the iron and steel subsidy program. Thus unintended effects in the rest of the economy are minimal.

The most important consequence of this hypothetical regional wage subsidy program is that it does not seriously distort the sectoral production structure of the economy, and therefore does not impede the readjustment processes warranted by changing world economic conditions. That is quite in contrast to the preceding steel subsidy simulation, which creates jobs in Region I mainly by retaining resources in an already ailing industry threatened by further foreign competition. Viewing the medium-run experiment in Table 3 in conjunction with the Table 1 experiment, we see (from rows 13 and 17) that the wage subsidies do not prevent the capacity cuts in the iron and steel industry that would take place in a free market without any intervention at all. In other words, under the regional wage subsidy program, the objective of maintaining LS employment constant would be compatible with the condition that capacity cuts in the domestic iron and steel industry be made by the proper amount in view of the lowered steel prices abroad. Note also, by comparing row 24 in Table 1 and 3,

Table 3 Effects of a Ad-Valorem Wage Subsidy to All Producers in Region I

	Short Run		Medium Run	
	Region I	Region II	Region I	Region II
<u>Sectoral Outputs</u>				
1. Agriculture and Fisheries	.13	.04	.05	.01
2. Coal Mining	-.56	5.37	-.29	2.52
3. Other Primary	.38	.06	.32	-.13
4. Iron and Steel	1.79	-1.89	1.90	-3.39
5. Electrotechnical	1.92	.07	2.23	-.42
6. Textiles, Leather	1.20	-.16	1.39	-.55
7. Food Processing	.43	-.06	.56	-.16
8. Other Manufacturing	1.44	-.40	1.85	-.79
9. Other Tradeables	.34	-.26	.63	-.23
10. Non-Tradeables, Gov't.	.28	-.19	.32	-.14
<u>Labor and Capital</u>				
11. National Employment of LS Labor		.10		.01
12. Regional Employment of LS Labor	1.10 (EX)	-.31	1.10 (EX)	-.44
13. LS Employment in Iron and Steel	2.88	-1.14	2.24	-3.08
14. Aggregate Real Wage of HS Labor		.06		.00
15. Real Wage of HS Labor in Iron + Steel		1.67		.65
16. Rate of Return to Capital in Iron + Steel	7.09	-4.22		.01
17. Capital Stock in Iron + Steel	0(EX)	0(EX)	2.20	-3.09
<u>Macroeconomic Variables</u>				
18. Real Private Consumption		.10		.02
19. Real Gov't. Expenditures (net of transfers)		-.27		-.02
20. Aggregate Domestic Output		.04		.01
21. Balance of Trade		0(EX)		0(EX)
22. Aggregate Exports (=Agg. Imports)		.10		.02
23. Iron + Steel { exports		-.93		-.76
24. { imports		.43		.76
25. Exchange Rate		.24		.01
26. CPI		0(EX)		0(EX)
27. Absolute Percentage Change in Region I Wage Subsidy Rate		.33		.02

that this wage subsidy policy does not deprive domestic industries and consumers of the benefits from cheaper foreign steel.

Let us finally turn to the direct costs of the wage subsidy program. In row 27 of Table 3 we have listed the absolute wage subsidy percentage rates required to bring about a level of LS employment in Region I that is 1.1% higher than it would otherwise be. In the short-run, this rate is 0.33%, while in the medium-run, after all the adjustments have taken place, this figure dwindles to a trifling 0.02%. Interesting to note that this wage subsidy program is also more compatible with the intention of phasing out subsidies over time.

To continue with the illustration begun with the previous experiment, we can compute the annual subsidy bill under this program in the short- and medium-runs. In 1978, the total wage bill paid in all sectors in Region I (North Rhine-Westfalia and the Saarland) amounted to roughly 218 billion DM. With that as the base, the short-run subsidy bill would amount to 719 million DM per annum (multiplying the base times a rate of 0.33%), while in the medium-run this bill would drop to 44 million DM per annum (using the subsidy rate of 0.02%); considerably lower¹⁷.

VI. Summary and Conclusions

It could be argued, as many people have, that the competitive strength of the German iron and steel industry is still such that, in a free trade world without public interference, it would have little difficulty in defending its current share in world markets. Though perhaps not the most efficient producer in absolute terms, Germany would still rank high enough on the in-

¹⁷ Of course, if subsidies are stopped entirely, the economy would revert to the position, illustrated in Table 1, resulting in the medium-run after the steel price shock. So long as the barriers to regional mobility as modeled here persist, some intervention is necessary to attain certain employment objectives; the question is, however, at what cost.

ternational ladder of comparative advantage in steelmaking to guarantee the survival of its steel industry. However, it would be a costly mistake to act on the basis of this "natural" comparative advantage by propping up a domestic steel industry when the world environment is not freely competitive and other nations are willing to give away goods in the form of subsidized steel. That is a basic lesson of trade theory, and it appears to have been accepted by German policymakers insofar as they do not attach any special significance to the existence of a domestic steel industry, in contrast to any other industry. They have, nonetheless, felt compelled to grant subsidies to steel on the grounds (some might say pretext) that the transitional adjustment costs associated with a sudden decline of the industry would be too great to bear if left unattended. A steel program was therefore conceived with the intention of facilitating the adaptation process away from steel production, without preventing the required structural readjustments from taking place. That intention was made explicit by provisions in the program that set a deadline, after which subsidies are to be discontinued, and that link aid to capacity reductions by sufficient amounts to leave the industry in a competitive position again.

Evidence on industry protection patterns in Germany has indicated that the greatest beneficiaries of past protective policies have been the unskilled workers, which are characterized by a high degree of regional immobility. Using a model embodying some key structural characteristics of the West German economy, we have shown that a decline in world steel prices will result in pockets of unskilled labor unemployment in the regions where the iron and steel industry is heavily concentrated. These observations have led to our conjecture that the primary purpose behind the steel subsidy program was to alleviate the problem of regional unskilled labor employment.

What the comparative statics experiments in this essay have shown is that the objective of maintaining stable levels of unskilled labor employment by way of steel-sector subsidies is incompatible with the two central provisions of the steel pro-

gram. They have the effect that additional resources become absorbed into the iron and steel sector, above the amount that would result in the absence of any intervention, thereby impeding the structural adjustments warranted on account of lower world steel prices. Also, the subsidy bill needed to generate a given amount of regional employment does not become substantially less over time. As a second-best alternative, it was shown that a regionally focused program of wage subsidies could achieve the same regional employment objective without obstructing the structural readjustment process as much as sectoral subsidies, and would also cost substantially less in terms of the total amount transferred, particularly in the medium-run¹⁸. The fundamental principle underlying both programs is the same: They both raise employment in a given region by attracting more jobs into (or raising activity levels in) that region. Regional wage subsidies, however, lead to a sectorally balanced increase in industrial activity, while the sectoral measure primarily generates more jobs in the iron and steel sector; jobs which will again become threatened by further declines in world steel prices. It should be repeated, however, that both policies are dominated by an economically feasible first-best policy aimed at reducing the mobility costs of unskilled labor, even though this may be found politically infeasible.

These results lead to the conclusion that a unilateral reduction in domestic subsidies granted to the steel industry would result in a severe decline in unskilled labor employment in the regions with high steel concentration. That would in turn prompt demands for renewed protection. What could prevent this from happening is if other countries simultaneously eliminated their subsidies to steel. We recall that this is the explicit objective stated in the guidelines negotiated through the EC Commission. If

¹⁸ One step in this direction was taken by the EC Commission in January 1984, when it decided to allocate 0.5 billion DM (Germany is to receive 90 million DM) from its Regional Fund toward creating alternative jobs in the regions heavily afflicted by the depressed steel industry. Die Welt, 5 June 1984.

those guidelines are obeyed, and if it is true, as was speculated at the outset, that Germany has a competitive advantage in steel-making over most of its European neighbors, then a multilateral reduction in subsidies would have the effect that German steel production would largely displace the production of other EC members. These other member countries would then, however, be faced with the same structural adjustment problems which led to their initial adoption of subsidy measures. Unless the political power configurations in those countries have changed in the meantime, there is a good chance, therefore, that the previous steel subsidy programs will become reinstated. German policymakers would then be faced with the choice of doing the same or following a different course. Our results suggest a preferable alternative course.

References

- Anderson, K. and R.E. Baldwin, 1981, The political market for protection in industrial countries: Empirical evidence, World Bank Staff Working Paper No. 492, (October).
- Baldwin, R.E., 1984, Incentives and rent-seeking: Trade policy and subsidization, Paper presented at the Kiel conference on Economic Incentives in June 1984.
- Bhagwati, J.N., ed., 1982, Import Competition and Response, University of Chicago Press/National Bureau of Economic Research, Chicago.
- Bhagwati, J.N. and V.K. Ramaswami, 1963, Domestic distortions, tariffs and the theory of the optimum subsidy, Journal of Political Economy, 71, 44-50.
- Canto, V.A., A.B. Laffer, and R.B. Eastin, 1982, Failure of protectionism: A study of the steel industry, Columbia Journal of World Business, XVII, no. 4, 43-57.
- Cheh, J.H., 1974, United States concessions in the Kennedy Round and short-run labor adjustment costs, Journal of International Economics, 4, 323-340.
- Constantopoulos, M., 1974, Labour protection in Western Europe, European Economic Review, 5, 313-328.
- Corden, W.M., 1974, Trade Policy and Economic Welfare, Clarendon Press, Oxford.
- Dicke, H., 1983, Krise in der Stahlindustrie: Markt- oder Politikversagen? Die Weltwirtschaft, no. 1, 110-133.
- Dixon, P.B., P.R. Parmenter, J. Sutton, and D.P. Vincent, 1982, ORANI: A Multisectoral Model of the Australian Economy, North-Holland, Amsterdam.
- Frey, B.S., 1984, Die Politische Ökonomie des Protektionismus, Aussenwirtschaft, 39, Heft I/II, 17-42.
- Glismann, H.H. and F.D. Weiss, 1980, On the political economy of protection in Germany, World Bank Staff Working Paper No. 427, (October).
- Huntington, S.P. and J.M. Nelson, 1976, No Easy Choice: Political Participation in Developing Countries, Harvard University Press, Cambridge, Mass.
- Johansen, L., 1960, A Multi-Sectoral Study of Economic Growth, North-Holland, Amsterdam.
- Johnson, H.G., 1965, Optimal trade intervention in the presence of domestic distortions, in R.E. Caves et al., Trade, Growth and the Balance of Payments, North-Holland, Amsterdam.

- Jones, K., 1979, Forgetfulness of things past: Europe and the steel cartel, *World Economy*, 2, no. 2, 139-154.
- Jones, K., 1983, *Impasse and Crisis in Steel Trade Policy*, Trade Policy Research Centre, London.
- Lächler, U., 1984, The elasticity of substitution between imported and domestically produced goods in Germany, Kiel Institute Working Paper No. 200, Kiel.
- Lluch, C., A.A. Powell and R.A. Williams, 1977, *Patterns in Household Demand and Saving*, Oxford University Press, Washington.
- Magee, S.P., 1978, Three simple tests of the Stolper-Samuelson Theorem, in P. Oppenheimer, ed., *Issues in International Economics*, Oriel, London.
- Mayer, W., 1974, Short-run and long-run equilibrium for a small open economy, *Journal of Political Economy*, 82, No. 5, 955-968.
- Mussa, M., 1974, Tariffs and the distribution of income: The importance of factor specificity, substitutability, and intensity in the short- and long-run, *Journal of Political Economy*, 82, No. 6, 1191-1204.
- Neary, J.P., 1978, Short-run capital specificity and the pure theory of international trade, *Economic Journal*, 88, 488-510.
- Nie, N.H., G.B. Powell Jr., and K. Prewitt, 1969, Social structure and political participation: Developmental relationships, I, *American Political Science Review*, LXIII, No. 2, 361-378.
- Ollig, G., 1980, Staat und Stahl in Deutschland, *Annalen der Gemeinwirtschaft*, 49, No. 4, 423-438 and 529-531.
- Pusse, L., 1980, Aus sektoralen Produktivitätsfunktionen abgeleitete ökonomische Zusammenhänge für die Industrie der Bundesrepublik Deutschland, *Mitteilungen aus Arbeitsmarkt- und Berufsforschung*, No. 2.
- Riedel, J., 1977, Tariff concessions in the Kennedy Round and the structure of protection in West Germany, *Journal of International Economics*, 7, 133-143.
- Schmidt, J., 1982, *Das Anlagevermögen in der Bundesrepublik Deutschland 1960-1978*. RWI-Papiere Nr. 17, Essen.
- Siegel, K.D., W. Stevens and M. Werth, 1976, *Vergleichende Analyse der Mobilität in bzw. zwischen den Arbeitsmärkten der Europäischen Gemeinschaft*, Institut für Arbeitsmarkt- und Berufsforschung der Bundesanstalt für Arbeit, Nürnberg.

- Stolper, W. and P.A. Samuelson, 1941, Protection and real wages, Review of Economic Studies, 9, 58-73.
- Walter, I., 1979, Protection of industries in trouble: The case of iron and steel, World Economy, 2, No. 2, 155-188.
- Walter, I., 1982, Structural adjustment and trade policy in the international steel industry, Discussion Paper No. 220/82, Institut für Volkswirtschaftslehre und Statistik der Universität Mannheim.
- Winters, L.A., 1981, An Econometric Model of the Export Sector, Cambridge University Press, Cambridge, U.K.
- Wolter, F., 1977, Perspectives for the international location of the steel industry, Kiel Institute Working Paper No. 60, Kiel.
- Iron and Steel Yearbook, Statistical Office of the European Community, Luxembourg.
- Quintessenzen aus der Arbeitsmarkt- und Berufsforschung, Berufswege und Arbeitsmarkt, 1976, Institut für Arbeitsmarkt- und Berufsforschung der Bundesanstalt für Arbeit, Nürnberg.

Appendix A

The following table describes the aggregation scheme by which the 58 industries of the input-output table provided by the German Statistisches Bundesamt were converted into the 10 sectors used in our model. The latest available figures for the German input-output table are for the year 1978 (published in 1983). The three industrial categories which comprise our iron and steel sector are raw iron and steel (16), cast iron and other foundry products (18), and drawn and rolled steel products (19). Non-ferrous metals and products thereof (17) were aggregated into sector 8.

Sector	Input-output table industry classification no.
1 agriculture	1,2
2 coal mining	6
3 other primary products	3-5,7,8
4 iron and steel	16,18,19
5 electrotechnical and related products	26,27,29
6 textiles	35-37
7 food processing	38-40
8 other manufactures	9-15,17,20-25,28,30-34
9 other tradeables (services, construction)	41-43, 45-50, 52-55
10 non-tradeables (retail services, housing, government)	44, 51,56-58

Identifier	Equation ¹	Subscript Range	Number	Description
	<u>Final Demands</u>			
(1)	$x_{is}^{(3)} = x_i^{(3)} - \sigma_i^{(3)} (p_{is} - \sum_{s=1}^2 S_{is}^{(3)} p_{is})$	$i = 1, \dots, g$ $s = 1, 2$	2g	Household demands for commodities by source
(1a)	$x_i^{(3)} = \sum_{\ell=1}^d L_{i\ell}^{(3)} x_{i\ell}^{(3)}$	$i = 1, \dots, g$	g	Household demands for commodities undifferentiated by source
(2)	$x_{i,\ell}^{(3)} = q_{\ell} + \varepsilon_i (c_{\ell} - q_{\ell}) + \sum_{k=1}^g \eta_{ik} p_k + \eta_{ih} p_{h\ell}$	$\ell = 1, \dots, d$ $i = 1, \dots, gh$	dh	Regional household demands for commodities
(3)	$x_{(is)j}^{(2)} = Y_j - \sigma_{ij}^{(2)} (p_{is} - \sum_{s=1}^2 S_{(is)j}^{(2)} p_{is})$	$i = 1, \dots, g$ $s = 1, 2$ $j = 1, \dots, h$	2gh	Demands for inputs to capital creation
(3a)	$Y_j = \sum_{\ell=1}^d L_{j\ell}^{(2)} Y_{j\ell}$	$j = 1, \dots, h$	h	Industry investment, undifferentiated by region
(4)	$x_{h\ell}^{(5)} = g - p_{h\ell}$	$\ell = 1, \dots, d$	d	Government demands by region
(5)	$p_{i1}^e = -\gamma_i x_{i1}^{(4)} + f_{i1}^{(4)}$	$i = 1, \dots, g$	g	Export demands
	<u>Industry Inputs</u>			
(6)	$x_{(is)j}^{(1)} = z_j - \sigma_{ij}^{(1)} (p_{is} - \sum_{s=1}^2 S_{(is)j}^{(1)} p_{is})$	$i = 1, \dots, g$ $s = 1, 2$ $j = 1, \dots, h$	2gh	Demands for intermediate inputs
(6a)	$z_j = \sum_{\ell=1}^d L_{j\ell}^z z_{j\ell}$	$j = 1, \dots, h$	h	Activity level undifferentiated by region
(6b)	$x_{(hj)\ell}^{(1)} = z_{j\ell}$	$\ell = 1, \dots, d$ $j = 1, \dots, h$	dh	Regional demands for intermediate inputs of non-traded good h
(7)	$x_{(vj)\ell}^p = z_{j\ell} - \sigma_{vj}^p (p_{vj\ell}^p - I_{v,ws} p_{vj\ell} - \sum_{v=1}^3 S_{vj}^* (p_{vj\ell}^p - I_{v,ws} p_{vj\ell}^p))$	$v = 1, 2, 3$ $j = 1, \dots, h$	3dh	Demands for aggregate labor fixed capital, and land $I_{1j}=1, I_{2j}=I_{3j}=0$
(8)	$x_{1,1,j,\ell}^p = x_{1,j,\ell}^p - \sigma_{1,j}^p (p_{1,1,\ell}^p - p_{1,j,\ell}^p)$	$\ell = 1, \dots, d$ $j = 1, \dots, h$	dh	Demands for aggregate labor fixed capital, and land
	$x_{1,2,j,\ell}^p = x_{1,j,\ell}^p - \sigma_{1,j}^p (p_{1,2,j}^p - p_{1,j,\ell}^p)$	$\ell = 1, \dots, d$ $j = 1, \dots, h$	dh	
(9)	$p_{1,j,\ell}^p = S_{1,1,j} p_{1,1,\ell}^p + S_{1,2,j} p_{1,2,j}^p$	$\ell = 1, \dots, d$ $j = 1, \dots, h$	dh	Wages by industry and by region

¹ A general guide to the system of notation:

In the equations, all variables are stated in percentage changes and are denoted by lower case letters. The expression, $x_{(is)j}^{(a)}$ is used to denote the percentage change in the commodity i from source s demanded by industry j for purpose a . Possible sources are domestic production ($s = 1$) and imports ($s = 2$). The letter, a , refers to five possible use categories (1 = current production, 2 = capital creation, 3 = household consumption, 4 = assets, 5 = government demands). The range of letters i and j is determined by the number of sectors in the economy. The same system of notation applies to shares which are denoted by upper case letters, e.g. $S_{(is)j}^{(a)}$ or to parameters which are denoted by Greek letters, e.g. $\sigma_{ij}^{(a)}$. Similarly, the index v refers to primary factors (1 = aggregate labour, 2 = fixed capital, 3 = land), and the index ℓ refers to regions.

Identifier	Equation	Subscript Range	Number	Description
(10)	<p><u>Zero Pure Profits Conditions</u></p> $p_{j1} = \sum_{i=1}^g \sum_{s=1}^2 H_{(is)j}^{(1)} p_{is} + H_{hj}^{(1)} p_{hl} +$ $H_{1,1,j}^p p_{1,1,l}^{pq} + H_{1,2,j}^p p_{1,2,j}^p +$ $\sum_{v=2}^3 H_{vj}^p p_{(vj)l}^p + H_{j1}^T p_{j1} + (1+H_j^T) u_{jl} -$ $(H_{1,1,j}^p + H_{1,2,j}^p) w_{s_{1,j,l}}$	$l = 1, \dots, d$ $j = 1, \dots, g$	dg	- in production of traded goods
(10a)	$p_{hl} = \sum_{i=1}^g \sum_{s=1}^2 H_{(is)h}^{(1)} p_{is} + H_{hh}^{(1)} p_{hl} +$ $H_{1,1,h}^p p_{1,1,l}^{pq} + H_{1,2,h}^p p_{1,2,h}^p +$ $\sum_{v=2}^3 H_{vh}^p p_{(vh)l}^p + H_h^T p_{hl} + (1+H_h^T) u_{hl} -$ $(H_{1,1,h}^p + H_{1,2,h}^p) w_{s_{1,h,l}}$	$l = 1, \dots, d$	d	- in production on non-traded goods

Table continued

Identifier	Equation	Subscript Range	Number	Description
(11)	$\pi_j = \sum_{i=1}^g \sum_{s=1}^2 H_{(is)j}^{(2)} P_{is}$	$j = 1, \dots, h$	h	- in capital creation
(12)	$P_{i2} = P_{i2}^m + t_i + \phi$	$i = 1, \dots, g$	g	- in importing
(13)	$P_{i1} = P_{i1}^e + v_i + \phi$	$i = 1, \dots, g$	g	- in exporting
<u>Market Clearing</u>				Supply equals demand for
(14)	$z_i = \sum_{j=1}^h B_{(i1)j}^{(1)} x_{(i1)j}^{(1)} + \sum_{j=1}^h B_{(i1)j}^{(2)} x_{(i1)j}^{(2)} + B_{(i1)j}^{(3)} x_{(i1)j}^{(3)} + B_{i1}^{(4)} x_{i1}^{(4)}$	$i = 1, \dots, g$	g	- domestically produced tradable commodities
(14a)	$z_{h\ell} = \sum_{j=1}^h B_{(hj)\ell}^{(1)} z_{j\ell} + B_{h\ell}^{(3)} x_{h,\ell}^{(3)} + B_{h\ell}^{(5)} x_{h,\ell}^{(5)}$	$\ell = 1, \dots, d$	d	- non-traded goods
(15)	$l_{1\ell} = \sum_{j=1}^h B_{1,1,j,\ell}^D x_{1,1,j,\ell}^D$	$\ell = 1, \dots, d$	d	- Low Skilled labor by region
(15a)	$l_{2j} = \sum_{\ell=1}^d B_{1,2,\ell,j}^R x_{1,2,\ell,j}^D$	$j = 1, \dots, h$	h	- High Skilled labor by industry
(16)	$k_{j\ell} = x_{(2j)\ell}^D$	$\ell = 1, \dots, d$ $j = 1, \dots, h$	dh	- fixed capital
(17)	$n_{j\ell} = x_{(3j)\ell}^D$	$\ell = 1, \dots, d$ $j = 1, \dots, h$	dh	- land
<u>Balance of Trade, Budget</u>				
(18)	$100\Delta B = Ee - Mm$		1	Balance of trade
(19)	$e = \sum_{i=1}^g (P_{i1}^e + x_{i1}^{(4)}) E_{i1}$		1	Foreign currency exports
(20)	$m = \sum_{i=1}^g (P_{i2}^m + x_{i2}^{(4)}) M_{i2}$		1	Foreign currency imports
(21)	$x_{i2} = \sum_{j=1}^d B_{(i2)j}^{(1)} x_{(i2)j}^{(1)} + \sum_{j=1}^h B_{(i2)j}^{(2)} x_{(i2)j}^{(2)} + B_{i2}^{(3)} x_{i2}^{(3)}$	$i = 1, \dots, g$	g	Imports by commodities
(22)	$g_R = \sum_{\ell=1}^d L_{h\ell}^{(5)} x_{h\ell}^{(5)}$		1	Aggregate real government expenditure
(23)	$g = (1 - T^T) c + T^T t^T$		1	Budget
(24)	$t^T = \sum_{i=1}^g K_{i2}^m t_i + \sum_{i=1}^g T_{i2}^m (P_{i2} + x_{i2}^{(4)}) + \sum_{i=1}^g (T_{i1}^{(4)} - K_{i1}^{(4)}) v_i - \sum_{i=1}^g T_{i1}^{(4)} (P_{i1} + x_{i1}^{(4)}) + \sum_{j=1}^h (K_J^T - T_J^D) L_{j\ell}^Z K_{j\ell} + \sum_{j=1}^g T_j^D L_{j\ell}^Z (P_{j1} + z_{j\ell}) + \sum_{\ell=1}^d T_{h\ell}^D (P_{h\ell} + z_{h\ell}) - \sum_{j=1}^h (H_{1,1,j}^D + H_{1,2,j}^D) K_J^T L_{j\ell}^Z w_{1,j,\ell}$		1	Indirect taxes

Table continued

Identifier	Equation	Subscript Range	Number	Description
	<u>Miscellaneous</u>			
(25)	$r_{j\ell} + f^{RR} = Q_j (p_{(2j)}^p) \ell - \pi_j$	$\ell = 1, \dots, h$ $j = 1, \dots, d$	dh	Rates of return to capital
(26)	$y_{j\ell} = k_{j\ell} + B_j (r_{j\ell} - \lambda)$	$\ell = 1, \dots, d$ $j = 2, \dots, h+1$	dh	Industry investment by region
(27)	$\sum_{j=1}^h (\pi_j + y_j) T_j = i$		1	Aggregate investment (nominal)
(28)	$P_k = \sum_{s=1}^2 S_{ks}^{(3)} P_{ks}$	$k = 1, \dots, g$	g	General price of goods to households
(29)	$\epsilon^{(3)} = \sum_{i=1}^g \sum_{s=1}^2 W_{is}^{(3)} P_{is} + \sum_{\ell=1}^d W_{h\ell}^{(3)} P_{h\ell}$		1	Consumer price index
(30)	$\epsilon^{(2)} = \sum_{j=1}^h T_j \pi_j$		1	Capital goods price index
(31)	$c_R = c - \epsilon^{(3)}$		1	Aggregate real consumption
(32)	$c_{2\ell} = c + C_{2\ell} (\ell_{2\ell} - \ell_2)$	$\ell = 1, \dots, d$	d	Aggregate regional consumption
(33)	$q_{2\ell} = \ell_{2\ell} L_{2\ell}$	$\ell = 1, \dots, d$	d	Migration
(34)	$i_R = i - \epsilon^{(2)}$		1	Aggregate real investment
(35)	$i_R = c_R + f_R$		1	Relationship between real consumption and real investment
(36)	$\ell_q = \sum_{\ell=1}^d L_{\ell q}^L \ell_{q\ell}$		2	Aggregate employment by qualification
(37)	$P_{1,1,\ell,R}^p = P_{1,1,\ell}^p - \epsilon^{(3)}$	$\ell = 1, \dots, d$	d	Real wages by region for Low Skilled labor
(37a)	$P_{1,2,j,R}^p = P_{1,2,j}^p - \epsilon^{(3)}$	$j = 1, \dots, h$	h	Real wages by industry for High Skilled labor
(38)	$\ell_{2\ell} = \sum_{j=1}^h B_{1,2,j,\ell}^p x_{1,2,j,\ell}^p$	$\ell = 1, \dots, d$	d	Regional aggregate employment of High Skilled labor
(39)	$gdp_R = S_g g_R + S_i i_R + S_c c_R + S_e e - S_m m$		1	Real GDP
(40)	$rda = S_c c_R + S_i i_R + S_g g_R$		1	Real domestic absorption
(41)	$k = \sum_{j=1}^h \sum_{\ell=1}^d B_{2,j,\ell}^k \cdot R_{\ell}^k \cdot k_{j\ell}$		1	Aggregate capital stock
(42)	$z = \sum_{j=1}^h L_j^{za} \cdot z_j$		1	Aggregate net output
(43)	$P_{1,2,R}^p = \sum_{j=1}^h W_{1,2,j}^p \cdot P_{1,2,j,R}^p$		1	Aggregate real wage for High Skilled labor

Total number of equations: $9g + dg + 8d + 4gh + 5h + 12dh + 19$

Variable	Number	Description
$x_{is}^{(3)}$	2g	National household demands for domestic and imported goods
$x_i^{(3)}$	g	National household demands undifferentiated by source
$x_{i,\ell}^{(3)}$	dg	Regional household demands undifferentiated by source
$x_{h\ell}^{(3)}$	d	Regional household demand for non-traded good h
p_{is}	2g	Price of good i from source s
$p_{h\ell}$	d	Regional price of non-traded good h
q_ℓ	d	Number of households in region ℓ
c_ℓ	d	Regional aggregate nominal household expenditure
$x_{(is)j}^{(2)}$	2gh	National demands by industry j for domestic and imported good i for capital creation
y_j	h	National capital creation by using industry
$y_{j\ell}$	dh	Regional capital creation by using industry
$x_{h\ell}^{(5)}$	d	Other (mainly government) demand for non-traded good
g_R	1	Real government expenditure
g	1	Nominal government expenditure
p_{i1}^e	g	F.o.b. foreign currency export prices
$x_{i1}^{(4)}$	g	Export demands for good i
$f_{i1}^{(4)}$	g	Export demand shift variable
$x_{(is)j}^{(1)}$	2gh	National demands for domestic and imported inputs for current production
z_j	h	National industry outputs
$z_{j\ell}$	dg	Industry outputs of traded goods by region
$z_{h\ell}$	d	Regional output of non-traded good
$x_{(hj)\ell}^{(1)}$	dh	Regional demands for non-traded inputs for current production
$x_{(vj)\ell}^p$	3dh	Regional industry demands for primary factors (aggregate labor, fixed capital, land)
$p_{(vj)\ell}^p$	3dh	Rental prices of primary factors in each regional industry
$x_{1,q,j,\ell}^p$	2dh	Regional industry demands for labor by occupation
$p_{1,1,\ell}^{pq}$	d	Price of Low Skilled labor by region

Variable Number		Description
$P_{1,2,j}^D$	h	Price of High Skilled labor by industry
$u_{j\ell}$	dh	One plus ad valorem rates of production taxes net of subsidies by regions and industries
π_j	h	Costs of units of capital
P_{i2}^m	g	C.i.f. foreign currency prices for imports
t_i	g	One plus the ad valorem rates of protection on imports
ϕ	1	Exchange rate (DM/\$ US)
v_i	g	One plus ad valorem rates of export subsidies
$l_{q\ell}$	2d	Regional employment by occupation
l_{2j}	h	Sectoral employment of occupation
$k_{j\ell}$	dh	Capital stocks by industry and region
$n_{j\ell}$	dh	Land by industry and region
e	1	Foreign currency value of exports
m	1	Foreign currency value of imports
x_{i2}	g	Commodity import volumes
t	1	Total indirect tax income
$r_{j\ell}$	dh	Rates of return to capital by industry and region
λ	1	Economy-wide expected rate of return to capital
i	1	Nominal investment expenditure
i_R	1	Real investment expenditure
$e^{(3)}$	1	Consumer price index
$e^{(2)}$	1	Investment goods price index
c_R	1	Real household expenditure
c	1	Nominal household expenditure
l_q	2	National employment by occupation
gdp_R	1	Real GDP

Variable	Number	Description
ΔB	1	Balance of trade, 10^9 DM
k	1	Aggregate capital stock
rda	1	Real domestic absorption
$P_{1,1,\ell,R}^{pq}$	d	Real wages for Low Skilled labor by region
$P_{1,2,j,R}^p$	h	Real wages for High Skilled labor by industry
f^{RR}	1	Skift term in the rate of return to capital
$ws_{1,j,\ell}$	dh	Wage subsidies by industry and by region
z	1	Aggregate net output
$P_{1,2,R}^p$	1	Aggregate real wage for High Skilled labor.

Total number of variables: $12g + 2dg + 10d + 4gh + 7h + 15dh + 22$

$h = 10, g = 9, d = 2$

Coefficients of the German Model

Values for coefficients denoted IO were calculated from the data drawn from the 1978 input-output tables of the Statistisches Bundesamt (Federal Statistical Office)

$\sigma_i^{(3)}$ $\sigma_{ij}^{(1)}$ $\sigma_{ij}^{(2)}$	<p>CES import-domestic ("Armington") substitution elasticities for good i in household consumption ($\sigma_i^{(3)}$), demand for intermediate inputs for current production of good j ($\sigma_{ij}^{(1)}$), as inputs to capital creation in industry j ($\sigma_{ij}^{(2)}$). The elasticities are only assumed to differ with respect to industries, but not to uses. Econometric: see U. Lächler, 1984.</p>
$\sigma_{v,j}^p$ $\sigma_{1,j}^p$	<p>Substitution elasticities among primary factors (v=1: aggregate labor; v=2: capital; v=3: land), assumed to 1.0 thus yielding a Cobb-Douglas specification of the CES production function; and substitution elasticities between the two types of labor, assumed to 1.0 (see Leo Pusse, 1980). Casual experiments showed no marked sensitivity of the results to reasonable variations in these parameters.</p>
ϵ_i η_{ik}	<p>Expenditure (ϵ_i), own price (η_{ik}, $i = k$) and cross price (η_{ik}, $i \neq k$) elasticities. Since the assumed underlying household behaviour is reflected by the linear expenditure system, the matrix of uncompensated own price and cross price elasticities can be generated via the Frisch formula, using expenditure elasticities, budget shares (α_i) and the Frisch parameter (w)</p> $\eta_{ii} = \frac{\epsilon_i}{w} - \epsilon_i \alpha_i \left(1 + \frac{\epsilon_i}{w}\right)$ $\eta_{ij} = - \epsilon_i \alpha_j \left(1 + \frac{\epsilon_j}{w}\right) \quad i \neq j$ <p>Estimates based on Lluch, Powell, Williams (1977),</p>
γ_i	<p>Reciprocal of the foreign demand elasticities for German exports of commodity i. Estimates based on comparable results in L. Alan Winters (1981).</p>
Q_j B_j T_j	<p>Industry investment parameters. Q_j is the ratio of the gross (before depreciation) to the net (after depreciation) rate of return in industry j. B_j is the reciprocal of the elasticity of the expected rate of return schedule for industry j times the ratio of its gross investment to its following year capital stock. T_j is the share of total investment accounted for by industry j (IO. Computed from data on the capital stock in Z. Schmidt (1982)).</p>
S_c S_i S_g S_e S_m	<p>Respectively the shares of GDP accounted for by aggregate consumption, investment, government, export and import demand (IO).</p>
$S_{(is)j}^{(1)}$ $S_{(is)j}^{(2)}$	<p>Shares of good i from source s (1 = domestic, 2 = imported) in industry j's total purchases of good i for use as intermediate goods (1) or in capital creation (2). IO.</p>
$S_{is}^{(3)}$	<p>Share of good i from source s in total household purchases of good i. IO.</p>
$S_{v,j}$	<p>Share of primary factor v in total factor payments of sector j (v=1: aggregate labor; v=2: fixed capital; v=3: land). IO.</p>
$S_{1,q,j}$	<p>Share of labor of occupation q in industry j's total labour costs. Computed from data in: Statistisches Bundesamt, Fachserie 16, Reihe 2.1 and 2.2.</p>
$H_{(is)j}^{(1)}$ $H_{1,q,j}^p$ $H_{2,j}^p, H_{3,j}^p$	<p>Production cost shares in industry j of intermediate inputs of commodity of source s, labor of qualification q, fixed capital and land. IO.</p>
$H_{nj}^{(1)}$ H_j^T	<p>Share of non-traded intermediate inputs and of production taxes (subsidies) in industry j's production costs. IO.</p>

$H_{(is)j}^{(2)}$	Cost share of good i from source s in industry j 's total purchases of good i for input to capital creation. IO.
$B_{(i1)j}^{(1)}$	Respectively the share of the total sales of domestic good i absorbed by industry j for intermediate inputs for current production (1) and for capital creation (2), by households (3) and export demands (4). Government demand consists of the non-traded good only. IO.
$B_{(i1)j}^{(2)}$	
$B_{i1}^{(3)}$	
$B_{i1}^{(4)}$	
$B_{(hj)\ell}^{(1)}$	Respectively the share of the total output of non-traded good h of region ℓ absorbed by industry j for intermediate inputs for current production (1), by households (3) and government (5). Investment demand of the non-traded good is negligible. IO.
$B_{h\ell}^{(3)}$	
$B_{h\ell}^{(5)}$	
$B_{(i2)j}^{(1)}$	Shares of total imports of good i accounted for by industry j for inputs into current production (1) and capital creation (2), and by households (3). Re-exporting has been neglected. IO.
$B_{(i2)j}^{(2)}$	
$B_{(i2)j}^{(3)}$	
$B_{1,q,j,\ell}^P$	Share of sector j in regional employment of occupation q . Source as for $S_{1,q,j}$.
$B_{1,q,\ell,j}^R$	Share of region ℓ in sectoral employment of occupation q . Source as above.
$L_{j\ell}^Z$	Respectively regional shares in national sectoral output and national sectoral capital creation, household demand for good i , and government expenditures (expenditure on good h by governments). Statistical Yearbooks (Federal and Länder Statistical Offices); Statistisches Bundesamt, Fachserie 4, Reihe 4.2.2, 1978.
$L_{j\ell}^{(2)}$	
$L_{i\ell}^{(3)}$	
$L_{h\ell}^{(5)}$	
$L_{h\ell}^{(5)}$	
S_{vj}^*	Modified cost share of primary factor v in total primary factor costs in industry i . Equals the unmodified cost shares due to parameter choice in the production function.
M_{i2}	Share of total foreign currency cost accounted for by imported good i . IO.
E_{i1}	Share of total foreign currency export earnings accounted for by exported good i . IO.
M	Aggregate foreign currency value of imports. IO.
E	Aggregate foreign currency value of imports. IO.
T	Share of indirect taxes (net of subsidies) in financing government expenditure. IO.

T_{i2}^m	Respectively the shares in net indirect tax income represented by import tariffs on good i, export subsidies for product i, production taxes in sector j (j = 1,...,g) or on regional production of non-traded good h.IO.
$T_{i1}^{(4)}$	
T_j^P	
$T_{h\ell}^P$	
K_{i2}^m	Respectively the ratios of total values of product i imports (c.i.f.), of product i exports (f.o.b.), of production in sector j (j = 1,...,h) to total net indirect tax revenue. IO.
$K_{i1}^{(4)}$	
K_j	
$w_{is}^{(3)}$	Share of consumers' expenditure on good i from source s ($w_{is}^{(3)}$) and of non-traded good h in region ℓ ($w_{h\ell}^{(3)}$) in total consumers' expenditure. IO.
$w_{h\ell}^{(3)}$	
$C_{2\ell}$	Share of High Skilled labor in total regional labor income. Source as for $S_{1,q,j}$.
$L_{2\ell}$	Share of High Skilled labor in total regional employment. Source as above.
$L_{\ell q}$	Share of region ℓ in total employment of occupational labor of type q. Source as above.
$B_{2,j,\ell}^k$	Share of industry j in total capital stock of region ℓ . J. Schmidt (1982), and as for $L_{j\ell}^z$.
R_{ℓ}^k	Share of region ℓ in national capital stock. Source as above.
L_j^{za}	Share of industry j in total net output. IO.
$w_{1,2,j}^P$	Share of industry j in total wages for High Skilled labor. Source as for $S_{1,q,j}$.