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MACROECONOMETRIC MODELS OF THE SOVIET UNION AND EASTERN EUROPEAN ECONOMIES: A TABULAR SURVEY

BY H. T. SHAPIRO[1]

THIS STUDY EXAMINES and compares, in a concise and convenient form, the efforts and accomplishments of econometric model builders in constructing macroeconometric models of the Soviet Union and the countries of Eastern Europe. Although there already exists a sizeable number of valuable papers comparing the critical characteristics of a broad selection of models of Western market economies, no such set of studies exists for the models of socialist countries.[2] The only comprehensive study of this nature for the socialist countries of which I am aware is the one by Shapiro and Halabuk [**42**] comparing the models of Western market economies with those of centrally planned economies of both the Soviet Union and the countries of Eastern Europe. This latter study, however, concentrates on certain rather broad comparative issues regarding the main flow of the causal mechanisms involved rather than on the type of model by model detail that will be presented here.[3] The aim of this paper is to present the relevant information on econometric models of the Soviet Union and Eastern Europe in a form that not only provides an interesting record of the nature of the work done to date, but also provides the additional technical detail necessary for model builders themselves to appreciate the nature and scope of the work being done. In summary, it is in the spirit of the well known mid-1960's Nerlove studies of models of Western market economies [**38**, **39**].

The coverage of the relevant literature has been extensive including many works not available in English or other West European languages. Nevertheless, despite the somewhat later start (early 1960's) and the smaller number of completed experiments, current activity in this area is now so extensive that valuable efforts may have escaped my attention. It is my judgment, however, that virtually all significant contributions (through 1974) are included in this survey. It is important to note, however, that since 1974 there appears to have been a remarkable increase in both the interest and activity of economists in the Soviet

[1] I wish to thank Dr. Laszlo Halabuk for invaluable assistance in preparing this survey. I would also like to acknowledge the helpful comments of two referees. Responsibility for any errors is, of course, mine alone.

[2] With respect to econometric models of Western market economies we have the two early studies of Nerlove [**38**, **39**], Christ [**10**], and the more recent studies of Zarnowitz [**57**, **58**], Ball [**5**] (a comparison of models engaged in Project *LINK*), Hickman [**19**], Fromm [**11**], Fromm and Klein [**13**], Hilton and Heathfield [**21**] (models of the U.K.), and Waelbroeck [**48**] (short-run model building outside the United States).

[3] This survey is based in large part on information gathered initially for the Shapiro-Halabuk study. I am, therefore, greatly indebted to Dr. L. Halabuk and the staff of the Econometrics Laboratory of the Hungarian Central Statistical Office for making a growing literature available to me in English, as well as for great assistance in the analysis and interpretation of a number of the models.

Union and Eastern Europe (as well as some Western scholars) in the construction of econometric models of these centrally planned economies. Although I will discuss below the general nature and importance of these current developments, the model-by-model tabular summaries do not always incorporate all of these latest additions. In some cases there is not yet sufficient detail available for a complete analysis and in others the information is not yet accessible to me in English or other West European language.

The existence of central planning in the socialist countries of Eastern Europe and the Soviet Union plays, of course, a decisive role in shaping the institutional framework within which the economy develops, in establishing causal relationships, and in influencing the nature of the decisions made by enterprises and households. Consequently, models of these countries can be expected to reflect not only the direct importance of central planning in the evolution of the system, but the potential functions (uses) these models may play in the planning process. Indeed, the nature and objectives of the planning system are clearly visible in many of the critical characteristics of econometric models of these countries. In this respect we may note the following features which characterize almost all models of the Soviet Union and Eastern European socialist countries:

(i) *Medium- to long-term outlook.* In this respect the models follow the normal framework of the economic plan. Currently, however, there is developing some concern and interest in econometric models designed for the short-term outlook. This is true of the work of Sujan et al. [**46**] in Czechoslovakia as well as the current research of Maciejewski and Zajchowski at the Commission of Planning in Warsaw on a quarterly model of the Polish economy (the KP-III model). This latter work is being pursued despite the lack of a complete set of accounts on a quarterly basis. This new development is stimulated by the desire to use econometric models not only in the process of plan formulation (investigating alternative plans) but in the process of monitoring the actual implementation of a particular plan. This latter issue will be discussed more fully below.

(ii) *Annual data based on the material product system* (*MPS*). As one would expect, the framework and concepts of the socialist economic system exercise a very strong influence on the system of statistics developed to monitor economic activity. The national accounting systems of these countries reflect the "material" approach which accounts only for the contribution of "productive sectors" to the generation of national income. Thus most of the service sector is excluded. Accordingly, econometric models have either not paid any attention to "non-productive" sectors or have treated them separately from the productive sectors. Another important effect of the material product approach has been the concentration on flow of goods in volume terms. Prices and other monetary statistics simply do not take on the central role they play in market economy models. Thus not only are the relationships of econometric models expressed almost solely in real terms (as is the case in many market economy models), but they contain few if any nominal values either to explain or to be used as determinants of real magnitudes. Once again these characteristics are not quite so dominant in the most current research. First, as noted above, research on the effectiveness and

usefulness of quarterly models has begun. Second, the gradual expansion of the systems of national accounts beyond the conceptual structure of the MPS accounts themselves now makes possible the development of models of the non-material service sector. For example, because of the growing importance of financial transactions and the availability of appropriate data attempts have been made to construct models of the financial sector (see [**30**]). Research is also underway in such sectors as health and education.

(iii) *Heavy emphasis on the supply of output by industry with a recursive link from production to end-use.* In most models a relatively detailed treatment is given to the estimation of sectoral production functions matching inputs of capital and labor to output originating by sector. These functions are usually of a very simple linear form, but model builders in centrally planned economies look upon these production equations as the fundamental part of the model. In their view, the disaggregated study of the elasticities expressed in the supply equations, and their intersectoral comparison, is an indispensable tool for the analysis and planning of development. Often the factor inputs (capital and labor) are taken as exogenous and/or predetermined, reflecting the role of the plan in allocating productive factors. In many cases there is often only a one-way connection between the supply of output and other parts of the model.

(iv) With the exception of the most interesting current research there is relatively *little concern either with the feedback of end-use to production or with the complete allocation of production to various end-use categories.* To some extent feedbacks are much less important in centrally planned economies as the feedback between, say, private consumption and production is partially mediated by government policy variables which are exogenous. On the other hand, the feedback from investment to the capital stock cannot be mediated in this way, and failure to incorporate this directly can lead to a certain type of inconsistency. This latter type of difficulty characterizes a number of the models studied. The most striking examples are those models where the capital stock is taken as exogenous while investment is treated as an endogenous variable (e.g., [**16**, **46**]). Although the failure of a model to completely allocate production to end-use may seem reasonable for economies which do not rely on market mechanisms to ensure such an allocation, the failure to model this aspect of an economy's natural "circular flow" between production and use runs the risk of omitting explicit consideration of an important dimension of whatever adjustment mechanisms are characteristic of the economy.

(v) *Aggregate Demand.* According to the national accounting system of the socialist countries, utilization of national income (aggregate demand) can be decomposed into the following elements: personal consumption, public consumption (government), net capital accumulation (including inventories), and the balance of foreign trade. Initially, the analysis of movements in these items received relatively little attention from model builders. In some models the "balancing" of production and use was not considered an important issue. Increasingly, however, attention is being turned to this sector, although, not surprisingly, the specification of aggregate demand equations often includes

dummy variables reflecting the effects of government policy on the utilization of output.

(vi) *Notions of capacity utilization of either labor or capital play little or no role* in these models in that they are not perceived to have any significant variance, and, therefore, any important effect on the relationships of the models.

The first econometric models of centrally planned economies were developed in Poland and Hungary during the early 1960's. These models were highly aggregative, based on data in the form of base indices, and were considered experimental in nature. These experiments were designed both to investigate the application of econometric models to socialist economies, and to gain some experience with econometric tools and model solution procedures. On the basis of the experience gained from these initial experiments, work began on the construction of somewhat larger models, with the emphasis on the disaggregation of the aggregate production relationships that has played a central role in the initial models, although new relationships (e.g., for wage rates, personal income, etc.) were also introduced. Prominent in this second stage of development was the disaggregation by sector of origin (industry) of the supply or production equations. In addition, however, efforts were also made to disaggregate certain components of aggregate demand (output by end-use), especially private consumption. It is only with the latter half of the 1960's that work on econometric model building began to gain momentum and became widespread in the socialist countries. By the end of the 1960's work was ongoing in Poland, Hungary, Czechoslovakia, the Soviet Union, and the German Democratic Republic. Current (1976) research efforts are not only decidedly more widespread, but represent a third stage of development in terms of the sophistication and completeness of the models being developed.

In general, most of the models constructed during the two initial stages of development (through 1974) can be characterized as containing three principal blocks of equations:

(i) *An initial block of equations determining employment and output for a number of different producing sectors.* Employment by sector is often exogenous or at least largely predetermined while the sectoral capital stocks, although sometimes treated as endogenous variables, are heavily influenced by government policies.

(ii) *A second block of equations determining certain components of aggregate demand.* Typically there are equations for private consumption, investment, and foreign trade although investment is usually either exogenous or heavily influenced by exogenous factors. The proportion of output used for private consumption is often strongly influenced by government policy variables. It is on the question of the appropriate feedback of aggregate demand on other parts of the system where the models exhibit great variety. In some models there is no feedback, in others the feedback only operates through investment, etc.

(iii) *A sector containing identities that balance the supply of output and its final use. This sector is often missing completely.* In those models that confront the problem of balancing there is some variety of treatment as to which components of

economic activity act as buffers for imbalances. It is never prices (the models deal almost exclusively with flows in constant prices), but it may be imports, inventories, or occasionally a "flexible" supply sector.

With respect to some of the most interesting current research activities, we can now consider these efforts to be in the newest, or third stage of development, as noted above. This activity is centered in Hungary, Poland, and the U.S. The following general developments are worth noting:

(i) *A more serious attempt to articulate mechanisms of adjustment designed to ensure an equilibrium between demand and supply.* Inventories, capacity utilization, foreign trade quotas, and investment are all considered as possible avenues of adjustment (see [**16**, **23**]). Most prices, however, are taken as exogenous (SOVMOD1 [**15**] is an important exception).

(ii) *An attempt for many components of output to specify both demand and supply equations with policy variables, usually on the supply side, providing the necessary identifying restrictions* (e.g. [**33**, **49**]). Discrepancies between demand and supply then presumably affect other adjustment mechanisms, such as inventory accumulation, although variables expressing the nature of the discrepancy between requirements (demand) and supply as yet have little feedback effect on the rest of the model.

(iii) *Attempts to introduce a more adequate (realistic) role for government policy instruments.* Particularly interesting in this regard are the efforts of Higgins and Green [**15**] (SOVMOD1) and Maciejewski and Zajchowski [**33**] (KP-2).

(iv) *Incorporation of input-output tables into econometric models.* This was first introduced by Hulyak [**23**] in a model of the Hungarian economy. Similar efforts are now underway in a number of different research centers with one of the most interesting and ambitious attempts being made at the Institute of Econometrics and Statistics in Lodz under the direction of Welfe. This latter research is part of a larger project aimed at a new generation of medium-term models of the Polish economy.

(v) *The construction of models of the non-material service sectors and the initial investigation of the effectiveness of quarterly models.*

Before proceeding to the tabular survey itself, I would like to say a brief word about estimation and evaluation. With respect to estimation procedures, current practices in socialist countries may be summarized as follows: (a) Ordinary least squares is the "workhorse" of the hypothesis searching stage. (b) Most models employ some type of consistent estimator for obtaining final estimates of their model's parameters. (c) To date, most models have not employed efficient estimators such as FIML. These practices are very similar to those used in developing models of Western market economies, although computational facilities have in the past generally imposed a greater constraint on practices in the socialist countries. To date, relatively little information has been available regarding methods and practices of model evaluation in the socialist countries. Perhaps

this is reflective of the stage of development of econometric model building in these areas. In the initial stages of model development, typically much more effort is spent on model construction than on model evaluation. This was certainly true until very recently in the non-socialist countries. In any case it is now quite clear that increased attention has developed to this area among Eastern European model builders. An interesting example is contained in a recent paper by Maciejewski [**32**] which presents a rather full set of dynamic and static multipliers for the Polish model KP-2, as well as a set of experiments designed to test the sensitivity of this model's properties to changes in its parameters. Although there still remains some scarcity of information on the precise nature of the work being done, there have been a number of conferences organized by the Computing Research Center, UNDP in Bratislava (Czechoslovakia), and more recently by the Institute of Econometrics and Statistics of the University of Lodz and the Central Statistical Office in Warsaw which concerned themselves, in part, with the evaluation of model forecasts and other dynamic characteristics of particular econometric models. The primary focus of these conferences, however, remained on the issue of model specification.

Finally, since the evaluation of econometric models is heavily contingent on their intended use it is important to understand how they are expected (by their builders) to be incorporated into the economic planning and policy process. This is carefully articulated by Welfe [**50**, **51**] and Maciejewski [**32**] among others. The main idea is to produce a tool of analysis to aid in the process of plan formation, and it is important, therefore, to keep this objective in mind when analyzing and interpreting the work of these researchers. Increasingly, however, these models are also being used to monitor and adapt to necessary changes in the current plan. In either case, however, the models are primarily used in the context of policy simulations of alternative rather than "straight" forecasts.

The tabular survey presented below covers both the initial pioneering experiments carried out in Poland and Hungary in the early 1960's as well as the major macroeconometric model experiments which have gotten underway (in the Soviet Union and almost all countries of Eastern Europe) from the late 1960's to the current time. Although the early experimental models have now been superseded, they are retained in the survey as they yield very interesting insights into both the historical development of this area and the set of priorities that dominate so many considerations in the formulation of any econometric model. The tables themselves provide information on a number of key parameters describing each model, i.e., data period, type and periodicity of data, method of estimation, mathematical structure of model (linear, nonlinear, recursive, etc.), number of exogenous and endogenous variables, and the number of stochastic equations. In addition, the main exogenous and endogenous variables are noted, as well as the special features incorporated in each of the models. Finally, note is taken of whether or not the model itself ensures the consistency of the circular flow that characterizes all economies (i.e., whether the equality of demand and supply is assured).

I would like to conclude by taking note of a number of current research efforts whose final products were not yet available, at least in sufficient detail, for careful

analysis and inclusion in this survey. In Poland there is work of Kudrycka [**29**] and Lapinska-Sobchak [**30**] in addition to the continuing work of Maciejewski and Zajchowski at the Commission of Planning, and Welfe at the Institute of Econometrics and Statistics at the University of Lodz. In Hungary, there are the efforts of Nagy [**36**] (a small, but interesting attempt to use inventories as the buffer bringing the system into balance), and Simon [**43**] (a model constructed primarily as a vehicle to study foreign trade flows). There is also the continuing work of Halabuk and his staff at the Econometrics Laboratory of the Central Statistical Office—the original pioneer in this area. In Czechoslovakia there is the work of Sujan, et al. [**47**] (on medium-term models), and in the German Democratic Republic the continuing work of Wolfling [**52**, **53**]. Currently there are also some interesting new experiments in connection with the Yugoslav economy—an experimental model by Babić [**4**] and a new model being developed by Mencinger [**35**]. In the Soviet Union we currently have the efforts of Yemelyanov and Kushnirski [**56**] (which attempts to combine econometric models with various types of optimizing models and alternative sources of information), the work of Adirim, et al. (dealing with Latvia) [**2**], and the work of Levickij, et al. [**31**]. Finally there is the current research of Menshikov and others being undertaken at UNCTAD in New York, on econometric models of the Soviet Union and Eastern European countries.

With respect to work by scholars outside the Soviet Union and Eastern Europe, Niwa's Model #4 of Soviet Economic Growth is now being superseded by Model #5 which is primarily designed to test the feasibility of the ninth five-year plan. Like SOVMOD1 [**15**] (see below) it is built on a combination of Soviet and non-Soviet data sources. The Cobb-Douglas production functions of Model #4 are replaced with CES functions, a foreign trade sector is included, more disaggregation is introduced, and a consistent estimator is used where appropriate. The basic stance or approach of the model however, appears very similar to Model #4, although the number of endogenous variables is more than doubled. Model #5, however, still fails to insure the equality of income generated and income expended. Finally, I would like to add a special note about the work done by Green and Higgins [**15**] in constructing a model of the Soviet Union (SOVMOD1). While the data underlying this model is generated from both Soviet and Western sources and while they necessarily lack some of the critical information that is available to policy makers in the Soviet Union, they have produced a model of high quality which presents many new challenges to researchers in this area. Among the interesting new features of this model are its use of annual plan data as anticipatory variables, detailed treatment of aggregate demand (including appropriate supply constraints), and the detailed attention devoted to actual State budget allocations. In no other model is the institutionalized structure of central planning so evident. As far as I know it is also the most extensively tested of any of these models and has already been used to generate forecasts, on an experimental basis, to the year 1990, as well as a whole set of interesting simulations. Currently work is beginning on SOVMOD2 which will incorporate input-output tables into its structure. This along with the work of Welfe, Maciejewski, and Zajchowski in

Poland and Halabuk et al. in Hungary seems to mark the frontiers in this area of econometric model building.[4]

PRINCIPAL CHARACTERISTICS OF ECONOMETRIC MODELS OF SOCIALIST COUNTRIES

Unless otherwise noted, all data are measured in volume terms. With respect to estimation procedures, the following notation is used: OLS—ordinary least squares, 2SLS—two stage least squares, PC—principal components, IV—instrumental variables, and GLS—generalized least squares.

(1) *First Model of Poland* (see Barczak, Ciepielewska, Jakubczyk, Pawlowski [7])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual quantity indices 1950–61 (1950 = 100)	5	8	7	recursive	yes	no
OLS						
Main Endogenous Variables:	Net Material Product, Employment Labor Productivity, Real Per Capita Income, Capital Accumulation					
Main Exogenous Variables:	Government policy variables effecting the proportion of production allocated to investment, personal income and private consumption. Time trends.					
Special Features:	Purpose is to explore effect of industrialization on labor productivity, material output and personal income. Aggregate output (net material product) is determined by available inputs of labor and capital while its composition is primarily governed by government policy variables.					

(2) *M-1 Model of Hungary* (see Halabuk, Kenessey, Theiss, Kotasz, and Nyary [18])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1949–62 National Accounts Employment Statistics	9	9	5	simultaneous	yes	yes
OLS, 2SLS						
Main Endogenous Variables:	Aggregate Output (net material product), Production by Sector (agriculture and non-agriculture), Private Consumption, Imports					
Main Exogenous Variables:	Employment by Sector (2), Exports, Per Capita Income, Investment, Collective Consumption					
Special Features:	No feedback of demand on output. The equality of demand and supply is assured by defining imports as the residual between total output (value added) and other components of aggregate demand.					

[4] It has been difficult for me to assess the nature of some of the work currently being pursued in the Soviet Union, and I may have underestimated both its extent and importance. Their work on econometric models at times adopts a somewhat different framework (e.g., building certain stochastic equation systems "around" an input-output model) and I may have failed to perceive its appropriate connection to the work reviewed in this paper.

(3) *Second Model of Poland* (see Barczak, Ciepielewska, Jakubczyk, and Pawlowski [**6**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1950–64 National Accounts Employment Statistics 2SLS	3	17	12	simultaneous	yes	no
Main Endogenous Variables:	Production (net material product), Employment, and Investment by sector (agricultural and non-agricultural), Investment in Service, Imports, Exports, Wage Rates by sector (industrial and "other"), Ratio of Consumption to Net Material Product					
Main Exogenous Variables:	Government policy variables effecting: Wages, Investment, Share of Consumption in Net Material Product. Time Trends.					
Special Features:	No current feedback of demand on output. Even though all components of aggregate demand are considered in the model, their total is not reconciled with total production (output). First model in which employment is not a predetermined variable, but is determined simultaneously with net material product and total investment.					

(4) *M-2 Model of Hungary* (see Halabuk, Hulyak, Nyary, and Kotasz [**16**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1950–67 National Accounts Employment Statistics Retail Trade Statistics OLS, IV, PC	29	26	23	simultaneous	yes	yes
Main Endogenous Variables:	Production (value added in "material" sector) by sector (8), Private Consumption by category (6), Accumulation of Personal Savings Deposits, Real Personal Income, Employment in certain sectors (5) (mainly aggregative sectors), Exports, Imports.					
Main Exogenous Variables:	Employment in certain sectors, Fixed Capital by sector (8), Weather Index, Exports and Imports of CMEA countries, Relative Prices, Collective Consumption.					
Special Features:	This model attempts to articulate the allocation of the household's consumption expenditures as a function of incomes, relative prices, and savings deposit balances. Total consumption, however, is determined by aggregate output and government policy variables. The foreign sector reflects the importance of CMEA trade (exogenous) and the constraint placed on other imports by foreign exchange earnings. Despite these innovations, the model seems to contain a number of inconsistencies, one redundant equation and one missing definition. The most serious inconsistency is the two independent measures of national output. The use of one measure assures the equality of demand and supply, the use of the other does not. An element of final demand serves as a residual assuring the equality of demand and supply in this latter case.					

(5) *Comparative Model* (Hungary (M-3) and Czechoslovakia (VVS-1)) (M-3 see Hulyak and Nyary [24] and VVS-1 see Sujan, Gergelyi, and Kolek [44])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1949, 1950–1968 National Accounts Employment Statistics OLS, 2SLS, GLS	13	12	8	simultaneous	yes	yes
Main Endogenous Variables:	Production by sector (2), Consumption, Employment by sector (4), Labor Force.					
Main Exogenous Variables:	Investment, Exports and Imports of CMEA countries, Capital Stock, Weather.					
Special Features:	The model contains three main blocks. In the first block output and private consumption are determined simultaneously, then the second block explains aggregate employment and non-CMEA trade, and the third the distribution of output and employment between agricultural and non-agricultural sectors. An identity assures the equality of demand and supply.					

(6) *Long-Term Model of Czechoslovakia* (see Adamec, Fundarek, Hrabe, and Sykorova [1])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1948–70 National Accounts Labor Statistics OLS	4 (20 technical equations)	33	7	recursive	no	no
Main Endogenous Variables:	Agricultural Employment, Production by sector (4), Foreign Trade, Capital Stock, Investment, Sectoral Employment, Distribution of National Income					
Main Exogenous Variables:	Policy variables governing the proportion of output devoted to investment by sector and the proportion of the work force assigned to the "productive" sectors. Total Employment.					
Special Features:	This model is centered around a series of equations that assign the work force and investment expenditures to various sectors. These equations themselves are dominated by a series of government policy variables. Once these issues are set, time trends and lagged endogenous variables govern the determination of most of the remaining variables. Investment and foreign trade are the only demand components explained. Gross National Income (this model's aggregate output measure) defined as: gross output − intermediate output + imports − exports.					

(7) *WS-2 Model of Czechoslovakia* (see Sujan, Kolek, Gergelyi, Orsagova, and Tkac [**46**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1955–70 National Accounts Employment Statistics 2SLS—Principal Components	20	27	17	simultaneous	yes	no
Main Endogenous Variables:	Production (net material product) by sector (industry, construction, agriculture), Investment by sector (4), Employment by sector (4), Foreign Trade, Personal Consumption, Wage Rate, and Wage Income.					
Main Exogenous Variables:	Proportion of Machinery-Equipment in Total Fixed Capital by sector, Exports and Imports of CMEA countries, Weather, Collective Consumption, Non-Wage Income.					
Special Features:	Net material product (production), employment, foreign trade, and investment (with sectoral disaggregation) are determined simultaneously. However, production is not fully allocated to end uses. Further, the sectoral breakdown of investment and output is not consistent and the connection between investment by sector and the sectoral capital stock is not clear. The model contains an interesting attempt to articulate the nature of the dependence of industrial output on imports.					

(8) *WS-3 Model of Czechoslovakia* (see Sujan, Kolek, Gergelyi et al. [**45**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Quarterly (seas. adj.) 1961–71 National Accounts Employment Statistics Retail Trade Statistics OLS with autoregressive adjustments	43	52	37	recursive	no	no
Main Endogenous Variables:	Production (gross material output) by sector (8), Retail Sales, Personal and Personal Disposable Income (personal income adjusted for debt repayments), Trade with socialist and non-socialist countries, Employment by sector (8), Capital Stock by sector (8).					
Main Exogenous Variables:	Aggregate Investment, Factors effecting distribution of employment by sector, Ratio of Machinery and Equipment to Total Capital Stock (by sector), Labor Force, Consumer Prices, Wages Rates.					
Special Features:	The first quarterly model to be produced. Its scope and structure is limited by the availability of quarterly data. Thus, for example, the model had to center on gross material output rather than net value added by sector. There is, however, an eight sector industrial disaggregation of gross output, employment and capital stocks. Further, this model also contains an interesting attempt to model the relationship of CMEA and "other" trade both to each other and to industrial output. The model is "supply" determined with no feedback of retail sales on output and there is no balancing of supply and demand.					

(9) *M-4 Model of Hungary* (see Hulyak [**23**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1960–70 National Accounts Input/Output Tables OLS 2SLS	20	31	11	block recursive	yes	yes
Main Endogenous Variables:	Value Added by sector (7), Consumption (2 categories), Investment, Exports, Imports.					
Main Exogenous Variables:	Capital Stock and Employment (by sector), Agricultural Factors, Wages, Government Expenditures (collective consumption).					
Special Features:	I-O sector translates value added by sector into gross outputs and final uses by individual sectors. There is, however, no feedback from the I-O sector to the rest of the model. The I-O coefficients themselves are set at their 1968 values. Most elements of output and demand are, in effect, predetermined since they are themselves functions of exogenous variables. The model begins by deriving value added by sector from exogenous supplies of capital and labor. Investment, output of residual branches, exports and imports are then solved simultaneously in a final block of equations in order to assure equality of demand and supply.					

(10) *Hungary* (*Institute of Economic Research*) (see Ormos, Bignar, and Paizs [**41**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1958–68 National Accounts Employment Statistics 2SLS	13	35	27	simultaneous	yes	yes
Main Endogenous Variables:	Production (gross output) by sector (8), Employment by sector (4), Investment by sector (5), Inventories, Private Consumption (3 categories), Imports (from Socialist countries).					
Main Exogenous Variables:	Use of Materials in Production (intermediate demand), Agricultural Employment, Consumer Prices, Exports, Collective Consumption, Imports (from the West).					
Special Features:	Inventory accumulation assures a balance between demand and production and thus takes on whatever value is necessary to equate demand and supply. Imports from Western countries are exogenous as are total exports. The model does not, therefore, deal explicitly with any foreign exchange constraint. Other imports (from Socialist countries) are a function of material needs (intermediate goods) and investment activity.					

(11) *K*-3 *Model of Hungary* (see National Planning Office [**37**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1959–71 National Accounts Employment Statistics PC	20	64	41	simultaneous	yes	yes
Main Endogenous Variables:	Production (gross and net value added) by sector (6 sectors including trade), Consumption, Investment, Employment, Foreign Trade by sector (Socialist and Non-socialist), Inventories, Wage Income.					
Main Exogenous Variables:	Consumer Prices (relative prices govern allocation of personal consumption), Total Trade of CMEA Countries, Agricultural Factors, Collective Consumption.					
Special Features:	Employment is largely predetermined but sector outputs (gross and net), investment, inventories, wage income, personal consumption, and foreign trade are all determined simultaneously. The structure of the model, however, reveals that inventory accumulation is the mechanism that assures the balancing of supply and demand in this model. Balance of payments constraints, industrial output and investment play key roles in the foreign trade sector.					

(12) *GDR*-1 (*German Democratic Republic*) (see Wolfling [**52**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1955–70 National Accounts OLS	1	11	7	simultaneous	yes	yes
Main Endogenous Variables:	Gross and Net Output of "Productive" Sector, Consumption, Investment, and Material Inputs (also "productive" sector only).					
Main Exogenous Variables:	Time.					
Special Features:	Time is the only exogenous variable. There are no government policy variables. Total consumption is determined as a simple residual between output (net) and total investment. This assures a balance between demand and supply in this model, but foreign trade is totally ignored. The primary purpose of this small model is to investigate regularities in the relationships between output, material inputs, investment, depreciation, and capital stocks in the productive sector.					

(13) *GDR*-2 (*German Democratic Republic*) (see Wolfling [**53**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1963–71 National Accounts OLS	6	24	11	simultaneous	no	yes
Main Endogenous Variables:	Aggregate Output (gross and net), Personal Consumption, Aggregate Investment (plant and equipment), Exports, Wage Rates, Inventory Accumulation.					
Main Exogenous Variables:	Imports, Collective Consumption, Employment, Investment Outside Productive Sector.					
Special Features:	As in GDR-1 there is a careful articulation of the relationship between investment, output and the capital stock, but there is also an interesting set of equations explaining wage rates (as a function of labor productivity) and total wage income. Personal consumption expenditures, however, are determined by personal income which is derived directly from net output. Wage income, therefore, has no feedback effect in this model.					

(14) *Ukraine*–1 (see Yemelyanov and Kushnirski [**54**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1959–68 National Accounts Labor Statistics OLS (some constrained estimation)	13	15	13	simultaneous	no	yes
Main Endogenous Variables:	Ukrainian Output (both gross and net of output remitted to USSR), Personal Consumption, Employment, Population, Investment, Collective Consumption (social benefits and residential building).					
Main Exogenous Variables:	Time.					
Special Features:	This model is primarily concerned with articulating the interdependent relationships between aggregate output, capital stock and investment. Employment is a predetermined (as a function of time and population) factor input and personal consumption is determined as a residual after the amount of output needed for new investment is determined. Economic activity is unaffected by the level of economic activity outside the region! There is no role for any policy variables!					

(15) *Ukraine*–2 (see Yemelyanov and Kushnirski [**55**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1959–69 National Accounts Employment Statistics OLS (constraints)	1	101	79	simultaneous	yes	yes

Main Endogenous Variables: Production, Investment, Employment, Wages, and Profits—all by a six sector disaggregation (Industry, Agriculture, Construction, Transportation, Trade, and Other).

Main Exogenous Variables: Time.

Special Features: In addition to the six sector disaggregation noted above the model contains an aggregate activity block which contains both stochastic relationships and simple summations of certain sectoral variables. The interrelationship between the aggregate and disaggregated sectoral blocks is primarily designed to assist in evaluating alternative plans. Otherwise the model structure is very similar to that of UKR-1 noted above. It remains unaffected by economic activity outside this region, and the quantity of personal consumption acts as the balancing item between output (supply) and end-use (demand).

(16) *Model of the Polish Economy* (see Welfe [**49**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1950, 1955, 1960–69 (constant at current prices) National Accounts Employment Statistics Wages and Prices OLS *includes some alternative equations	106*	242*	137*	simultaneous	no	yes

Main Endogenous Variables: Production by sector, Consumption by type, Investment by sector, Inventory Accumulation by sector, Imports, Exports, Income originating by sector, Employment, Wages, Income, Prices (selected), Labor Force.

Main Exogenous Variables: Many dummy variables reflecting policy decisions, World Exports, Exports of COMECON countries, Price Indices (most).

Special Features: Careful consideration of both material ("productive") and non-material (non-"productive") sectors. Extensive disaggregation and the consideration of many avenues of adjustment of supply and demand by sector as well as in the aggregate. With many components of output, both demand and supply equations are specified with policy variables providing the necessary identifying restrictions. Emphasis is on quantity adjustment but inventories, capacity utilization, foreign trade quotas, and investment are all considered as possible avenues of adjustment. One of the first models of socialist economies to consider a role for capacity utilization of both the capital stock and the labor force. An extremely interesting experiment.

(17) *Econometric Model of the Polish Economy (KP-2)* (see Maciejewski and Zajchowski [33])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Annual 1960–72 National Income Employment Fixed Assets 2SLS-PC	47	190	121	simultaneous	yes	no
Main Endogenous Variables:	Production, Investment, Employment and Income by sector; Consumption by category and Foreign Trade Flows by category and distinction.					
Main Exogenous Variables:	Total Employment, Policy Variables governing the sectoral distribution of Investment, Relative Wages and Relative Prices, Agricultural Conditions and Policy Variables regarding availability of certain categories of Consumption, Exports, and Imports.					
Special Features:	Although the model is not recursive in form, the main causal flow runs from the supply of output by sector through a number of government policy instruments allocating investments and then to income generation and the distribution of national income to its other uses. Designed for use in the early stages of plan formation. The model itself does not ensure the equality of national income generated and national income distribution, leaving this problem to the planner. Model attempts to isolate both demand and supply equations for the output of producing sectors. Careful attention paid to agricultural sector. Also unusual detail regarding generation of personal income by sector. Like Welfe's model, there are interesting attempts to isolate both demand and supply curves for each industrial sector. Both "productive" and "non-productive" sectors carefully considered.					

(18) *Econometric Model of the Soviet Union* #4 (see Niwa [40])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
All index numbers 1935–1940, 1950–1963 OLS	8	20	14	recursive	linear or log linear	no
Main Endogenous Variables:	Production, Rural/Urban Population, Consumption, Employment, Real Wages, Supply of Goods from Agricultural Sector.					
Main Exogenous Variables:	Investment (by sector), Defense Expenditures, Population, Agricultural Acreage.					
Special Features:	Model is concerned with the pace at which the Soviet economy is able to increase the rate of growth in the industrial sector while at the same time providing an adequate flow of agricultural and other consumer goods to the growing urban population.					

(19) *Econometric Model of the Soviet Union* (*SOVMOD*1) (see Green and Higgins [**15**])

Data and Estimation	Exogenous Variables	Endogenous Variables	Stochastic Equation	Equation Structure	Linear	Equality of Demand-Supply Assured
Primarily Volume Data generated 1952–1971 OLS	65	113	81	almost recursive	no	only in some versions of model
Main Endogenous Variables:	Rural/Urban Population, Employment, Investment, Capital Function Production, Wages, Incomes, Price Consumption, Exports, Imports, State Budget Reserves, Selected State Budget Outlays.					
Main Exogenous Variables:	Certain State Budget Outlays and Expenditures, Annual Plan Data, some Investment Allocations, Agricultural Conditions, Total Population, Ruble/$ Exchange Rate, Import and Export Prices, Tax Rate, World Trade Volume, Miscellaneous Incomes (thirty dummy variables).					
Special Features:	A number of alternative versions of the model depending on how household consumption is handled. In all versions supply constraints play an important role in allocating aggregate demand. Government policies often represented by state budget allocations, while annual plan data introduced as anticipatory data. In no other model is the institutionalized structure of central planning so evident.					

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