TITLE: A Macroeconometric Model of a Centrally Planned Economy With Endogenous Plans: The Hungarian Case

AUTHOR: Edward A. Hewett

CONTRACTOR: University of Texas at Austin

PRINCIPAL INVESTIGATOR: Edward A. Hewett

COUNCIL CONTRACT NUMBER: 620-7

The work leading to this report was supported in whole or in part from funds provided by the National Council for Soviet and East European Research.
A Macroeconometric Model of a Centrally Planned
Economy with Endogenous Plans:
The Hungarian Case

SUMMARY

There is a substantial and increasing interest among various groups in the West in developing a capability to predict the economic performance of the Soviet and Eastern European countries. Banks have a great deal invested in those countries, are being asked to invest more, and need objective information on their economic performance. Governments, frequently asked to guarantee loans to Soviet and East European countries, share similar concerns. In addition, Western governments have an inherent interest in Soviet and East European economic performance grounded in the importance of economic performance for the political stability of these regimes, for economic and political relations between Eastern Europe and the Soviet Union, and for the capability of those countries as a group to sustain large and growing military expenditures.

All of these concerns coincide with the interests of some Western economists in using macroeconometric models to better understand the operation of Soviet and East European centrally planned economies (CPE's), and recent years have seen a substantial and increasingly sophisticated effort to use econometric techniques to generate predictions of economic performance in CPE's similar in scope and precision to predictions commonplace for western economies. The SOVMOD series of models (now under the direction of Wharton's CPE Projects) is the most well-known and ambitious of such efforts, but there are also others, both for the Soviet Union (for example the CIA's SOVSIM), and for many East European countries.
In predicting the economic performance of a CPE over, say, a five year period, one must start with a prediction of what planners themselves will do, then decide how their actions will affect economic performance, and finally decide how economic performance might feed back on planners' actions. Our ability to predict planners' behavior, and to build those predictions into a model of a CPE is still rather limited. To date no CPE model has successfully captured the richness and magnitude of planners' roles in determining macroeconomic aggregates in CPE's.

This paper attempts to improve on that situation by constructing a macroeconomic model of a CPE which fully incorporates a model of planners' behavior into the system. The three basic assumptions behind this effort are: 1) that planners are the major adjustment mechanism in the CPE, thus no major change in economic activity occurs unless they initiate it, 2) that planners monitor key performance variables in the economy (the balance of payments, the level of consumption, and so on), and that when those variables deviate from the values planners desire, they take action to bring the economy back on track, and 3) that planners act in a regular and predictable fashion when making adjustments in their policies in response to changes in various performance variables. The equations summarizing how planners respond to changes in economic activity are called "reaction functions", and they serve to predict changes in economic policy resulting from changes in economic performance. The remaining equations in the model are similar to those in any macroeconomic model: they explain variations in economic performance using many variables, including the economic policy
variables determined by the planners reaction functions. Section II of the paper discusses the structure of the model in detail.

Sections III-IV report on the application of this approach in the construction of a macroeconometric model of the Hungarian economy (the Hungarian Econometric Model #1, or HEM-1). Data on economic activity and economic policy are relatively good for Hungary (compared to the Soviet Union and the other Eastern European economies); consequently they provide a good test of the approach under relatively favorable conditions.

HEM-1 is a small annual model [21 equations] which highlights major interconnections between economic policy and economic performance. It predicts the plans for the key macroeconomic aggregates for which the Hungarians provide data (consumption, investment, GNP), and it predicts those aggregates themselves. One of the most important determinants of the plans is recent economic performance; and one of the most important determinants of consumption, investment, government spending and foreign trade is the plans. The details of the specification and estimation of the model are discussed in Section III.

Section IV uses the model to explore the impact on Hungary of the changes in its terms of trade flowing from the OPEC price increases. During the years 1973-78, Hungary's terms of trade in convertible currency fell about 20 percent; its terms of trade in rubles fell about 15 percent. The comparison of the economic performance of Hungary as modelled by HEM-1 with and without those terms of trade changes suggests that all of Hungary's short term dollar borrowing (about $1.5 billion) over 1973-78 was a result of those terms of trade changes. On the other hand, Hungarian planners did respond to the terms of trade changes by diverting GNP from consumption,
government spending, and investment to net exports; and consequently they borrowed much less than they would have if they had not reacted at all to the crisis.

In the 1980's as economic conditions grow more severe in the Soviet Union and Eastern Europe, it is extremely important that we in the West develop our own capability to analyze the economic performance of those systems, and the actions planners will take in response to changes in economic performance. Because econometric models rely heavily on the past they cannot form the sole source for our analyses, but they nevertheless provide one indispensable component in any analysis of present and future economic performance in those countries. The experience with HEM-I unambiguously supports the notions that planners do react with regularity to changes in the economic performance of their systems, and that where data permit, reaction equations modelling planners' behavior should play a key role in macroeconometric models of CPE's.
I. Introduction

This paper discusses a macroeconomic model of Hungary which utilizes planners' reaction function to explore the link between economic activity and plans, and plans and economic activity. This approach pulls together two separate, but interrelated, lines of research on centrally planned economies (CPE's). There is on the one hand research beginning with Kalecki, then Goldman and Kouba, and, more recently, Gács and Lacko, which suggests that planners in CPE's regularly behave in such a fashion that they produce investment cycles. Two points are important here: (1) there is a component of macroeconomic planning in CPE's which is regular and predictable, and (2) the plans resulting from that predictable behavior may contribute to cycles in the economic system. Many of these studies rely on qualitative or exceedingly crude empirical techniques to test their hypotheses, which means that they are suggestive, but hardly definitive. Furthermore their scope is limited in that they fail to consider the possibility of regular planners' behavior in determining macroeconomic aggregates other than investment, and they fail to incorporate what information they have on planners behavior into a macroeconomic model of the CPE, in order to explore the full macroeconomic consequence of that behavior. Kornai (1971, 1976) has provided some useful concepts for a more comprehensive approach in his discussions of planners' reaction functions, and what is needed now is to estimate empirical versions of those functions.

The second related line of research has been the construction in recent years of numerous macroeconomic models of CPE's (Shapiro; Shapiro and Halabuk; Green, et. al.; Green and Higgins; U.S. C.I.A.), including several
medium-sized models of the Hungarian economy (Halabuk, et al.; Simon; Hunyadi, et al.). These models are extremely valuable for exploring interrelationships in CPE's, and also for the discipline they impose on the model-builder as he/she must write out an internally consistent set of equations.

Existing macroeconometric models of CPE's fail to systematically take account of the regular elements of planners' behavior. This is understandable for the models constructed by Soviet and East European economists, since those models are usually built for planners, and one doubts that planners would appreciate receiving a model including planners' reaction functions. But even major western macroeconometric models of CPE's, such as SOVMOD, although it was pathbreaking in many ways, treat planners' behavior casually, leaving most of that behavior outside the model.

A complete macroeconometric model of a CPE must start from, and build on, both of these strands of research. On the one hand it must take account the role planners themselves play as a key macroeconomic adjustment mechanism in the system. In a CPE, when the terms of trade deteriorate, and the trade balance and foreign exchange reserves begin to fall, it is planners (and not automatic mechanisms such as the price system) which move to bring the economy back into balance through a myriad of measures beginning with postponing adjustment by borrowing, then introducing policy changes (including changes in centrally-determined prices), which in turn affect real variables (exports, imports, the growth rates of final demand elements, and so on). A model of a CPE without specific planners' reaction functions is a model without the major adjustment mechanism operating in CPE's. Predictions or counterfactual simulations in such a system are impossible, unless the model builder is willing to provide the missing link by "playing planner." When CPE planners themselves are using a forecasting model built for their use, that may be a
perfectly appropriate strategy. But when outsiders build the model, they should try as much as possible to integrate the regular elements of planners' behavior into the model.

A macroeconometric model with endogenous planners' behavior cannot, of course, capture all that transpires in macroeconomic policy and performance in a particular CPE. Planners do have tremendous power to change key macroeconomic parameters without very much warning, and they can do so in ways which are difficult to predict. The working hypothesis behind the current effort is not that all planners' behavior can be explained, but that enough of that behavior is regular and explainable so that it can and should play an integral role in the macro model.

A macroeconometric model of a CPE which includes planners' reaction functions makes it possible to obtain answers to several important questions which are quite difficult to address in any other way. For example, how have planners reacted to the OPEC induced terms of trade deterioration in the CPE's, how has that affected economic performance and the distribution of aggregate demand, and how in turn has that affected plans? Is there evidence that planners act as a destabilizing influence in the system? How do these systems respond to other exogenous shocks such as bad weather, which drives down agricultural output, national income, and the balance of trade? The answers to these and other questions are important both for increasing our understanding of how central planning actually works in CPE's, and also for enhancing our ability to predict the performance of these economies in the future.

Section II discusses a conceptual framework for constructing a macro-model with planners' reaction functions, and the impediments to such an approach presented by data typically available on CPE plans and performance.
Section III presents a small macroeconomic model for Hungary which includes planners' reaction functions. Section IV utilizes the model in a counterfactual simulation which explores what might have happened to Hungarian macroeconomic plans and performance if the OPEC price changes, the resulting terms of trade changes, and the world recession, had not transpired in the mid-1970's. Section V briefly discusses future research possibilities.
II. Conceptual Framework and General Empirical Constraints

The concern here is with macroeconomic policy and performance in a CPE, which removes from direct consideration much of what is traditionally discussed as "central planning" in CPE's. The goal is to construct a model which explains movements in the macroeconomic aggregates—consumption, investment, government spending, and net exports, and which illuminates the role planners play in determining these aggregates, and the role these aggregates play in determining what planners do. All of the myriad microeconomic functions which planners perform—determining individual investment projects, the output of individual products, the structure of exports and imports, and so on—are not explicitly considered here, except where these microeconomic decisions have macroeconomic consequences.

This section discusses the conceptual framework which motivates the specification of the macroeconometric model. This conceptual framework is suitable for constructing a macromodel of any CPE, even Hungary where the New Economic Mechanism implemented a major reform almost exclusively directed at microeconomic planning, while leaving the macroeconomic controls of the old system basically intact. The framework is discussed in terms of a linear model for convenience of exposition only. In the form discussed it is not estimatable using data publically available in any CPE, and this section ends by outlining the compromises one must make in estimating this model for any CPE, and the probable consequences of those compromises.

Conceptual Framework

Planners in CPE's have a range of macroeconomic variables which they use as measures of the performance of the system, and as signals when something has gone awry. For a typical CPE the list of these variables would include
national income (Marxian-value added in the material sphere), consumption, investment, measures of supply/demand imbalance in those two areas, payments balances with the Ruble (non-convertible currency) and Dollar (convertible currency) areas, and (an obviously related variable) foreign exchange reserves. These are, to borrow a term from control theory, the "state variables" for planners, so-called because they are used by planners to measure the state of the system. Planners will set targets for these variables, and when performance deviates from target, they eventually will (and usually must) do something. These state variables will be designated with the n-element vector "s"; the values of the state variables in the time "t" are $s_t$.

Planners in the CPE use various policy instruments to influence the values of the state variables. They control the level of investment through various taxes which draw investable funds into the government budget, through physical controls on the share of national income produced plus imports actually devoted to investment, or (indirectly) through controls on personal incomes, hence consumption. Consumption itself can be controlled through using many of the same instruments, as well as price and income policy (which is related to tax policy). Net exports can be controlled through the use of exchange rates, subsidies and taxes on foreign trade, and direct controls. Again, borrowing from the terminology of control theory, I shall name these variables "control variables," so called because planners can manipulate the variables, and in so doing have an effect on ("control") the states. The control variables will be designated by the m-element vector "c", and the value of the control variables in year "t" as $c_t$.

Finally, there are variables outside of planners' control, which nevertheless affect the state variables, hence the performance of the system.
These include the weather, economic performance in other countries, the terms of trade (which for most CPE's, in most of their trade relations, are given), population, and so on. These I shall designate using the k-element vector "e", whose values in year "t" are given as et.

The definition of planners follows from what has been said above: they are the individuals with authority to set values for the controls. In all CPE's this includes the central planning board, which is a committee reporting directly to the Council of Ministers. It also will include various other ministries and committees attached to the Council of Ministers with general responsibility for various areas of the economy; but in the case of macroeconomic planning it excludes ministries solely responsible for the production and distribution of individual products.

State variables are determined by the control variables and the exogenous variables.

\[(2.1) \quad s_t = Ee_t + Oe_t\]

The matrix "E" is nxm, representing the reduced form of equations describing the links between planners' "m" control variables and the "n" state variables. The matrix "O" is nxk, giving the links between the "k" exogenous variables, and the "n" state variables. For convenience the system is pictured as linear, and simultaneity among the state variables is ignored.

Although the Matrix E posits a link between controls and states, it in no way assumes that planners can exercise absolute controls over the states. Planners in CPE's share their power with many other interest groups in the system (the ministerial bureaucracy, enterprises, individuals), in the main because of the staggering information requirements associated with attempts at total central control. That planners share their power implies that, for
example, while they may move to restrain the level of investment through various measures, other elements in the system (enterprises and the ministerial bureaucracy) will resist those measures with enough success that the actual level of investment, while lower than it would have been had planners not acted, will be higher than planners would have liked. The matrix $E$ summarizes, then, the links between controls and states in light of the behavior of other elements in the system. And in that system, all one can say is that planners can influence the level of the states with their controls, but they cannot determine the value of the states.

Note that in the matrix $E$ the number of states and controls are not equal, although for successful control of the system, there must be at least as many control variables as there are state and exogenous variables. The $m$th column of $E$ expresses the relationship between the $m$th control and each of the $n$ state variables; and in any interesting model presumably many of the $E_{ij}$ elements are non-zero, indicating that one control has influence on several states. For example, a decrease in profits taxes which increases total investment will also increase machinery imports, which will cause the balance of trade in one or both currency areas to fall.

There are limits on the values of the various control variables either for technical reasons (for example the investment share of national income cannot exceed 100 percent) or for less easily quantified social reasons (for example, if consumer prices grow too rapidly, there may be demonstrations in the street). Some of these constraints are interconnected; for example, nominal wages and the level of consumer prices are really constrained vis-à-vis each other. For simplicity, the interconnections will be ignored and it will be assumed that constraints on control variables take the following form

\[(2.2) \quad c_{t}^{l} \leq c_{t} \leq c_{t}^{u}\]
where \( c_t^1 \) and \( c_t^0 \) are, respectively, vectors depicting lower and upper bounds on the control variables in time "t". The bounds will presumably change over time, but such refinements need not be pursued here.

The state variables are also subject to constraints, the most obvious one being that \( C+I+G+X-M = GNP \). Although planners may not think in terms of, or even keep accounts concerning, GNP, that constraint is still present and will, somehow, make itself felt. In addition, there may be constraints on the balance of payments deficit in either currency area (due to funds available to finance them), or there may be constraints flowing from the population's general notion of an acceptable minimum growth rate for per capita consumption. These and similar constraints can be depicted in the inequality:

\[
(2.3) \quad K_t^s \leq K_t
\]

where \( K_t^s \) is a \( \pi \)-element vector of maximum values for state variables, individually and in combination; and where the constraining equations are included in the \( \pi \times \pi \) matrix, "K". For example, one row of "K" will designate the Keynesian equality, and the same row of "k" will be GNP.

Equations (2.1) - (2.3) depict the influence planners and exogenous forces exert on the state variables, and the constraints planners face in exercising their influence. These equations in themselves outline a model which would be complete if it were being built for planners, since they could fill in the controls based on their own preferences over the states. Likewise, it would be sufficient to stop here if one wished to "play planner" by, for example, adding a quadratic loss function in the control and state variables, and then applying optimal control techniques to solve for values of the controls over time. While both of those approaches have their merits in particular circumstances, for reasons discussed earlier, a third path shall
be pursued here in which planners "reveal" their preferences through empirically-estimated planners' reaction functions.

Planners have preferences over the states and, based on those, as well as past performance of the system, assume they set targets for the states in the following way:

\[
(2.4) \quad s_t^* = \sum_{i=1}^{p} \alpha_i A(s_{t-i}^* - s_{t-i})
\]

where \(s_t^*\) is desired values for the state variables in time "\(t\)" and \(s_t\) is the actual values; \(A\) is a \(n \times m\) element matrix where the on-diagonal elements relate deviations of the \(i\)th state variable from its desired value in "\(t-i\)" to the desired value in "\(t\)" and the off-diagonal elements link deviations from desired performance in the \(i\)th state variable to changes in the desired performance for the \(j\)th state variables (e.g. deviations in the balance of trade from desired last year affects the investment plan for this year); the \(\alpha\)'s are weights planners place on each of the \(t-i\) previous years' performances; and "\(p\)" is the number of time periods back that influence planners' targets in year \(t\). Planners set targets for investment, consumption, national income, and so on, based on actual performance and plans in past years, presumably placing the highest weight (highest \(\alpha\)'s) on what has happened most recently. Equation (2.4) suggests that planners learn from their system what is possible, with a lag. The "\(A\)" matrix embodies their preferences in a complex fashion. If, for example, they have strong preferences for a particular level or growth rate of consumption, they will "learn" very slowly if they are wrong in either direction.

Given these targets, assume that planners behave in the following way when they determine the controls:
The matrix "B" is dimensioned mxn, and it denotes the link between deviations of state variables from their desired levels and changes in controls. It is assumed that the planners only look one period back, which is probably close to the truth. Notice that because there are more control than state variables, then the deviation of a particular state variable from its desired value last year will usually trigger changes in more than one control this period.

These equations (2.1)-(2.6) form a complete system which, given the dynamics of the exogenous variables, describes the dynamics of the CPE. The dynamic behavior of the system is determined by the coefficients in the equations, including the planners' reaction functions. One could specify a particular version of this system, solve it analytically, and specify stability conditions; or one could estimate a particular version, and examine its dynamic properties through simulation experiments. The latter approach is used here, using the model discussed in Section III. Before turning to that though, it is necessary to discuss how data limitations common to all CPE's force significant compromises in actually estimating the system outlined in equations (2.1)-(2.6).

The Impact of Data Availability on Estimating a CPE Macroeconometric Model

There are several difficult problems which arise whenever one attempts to build a macroeconometric model of a CPE: (1) Most of the control variables planners use are either difficult to quantify or, even if quantifiable, are not reported in regular statistical publications; (2) data on planned (i.e.
desired) values for the states are not available in all years, or in the same and consistent format over the years; and (3) frequently the published data do not permit a full reconstruction of the macroeconomic accounts.

The first problem is the most serious one, and it is probably best illustrated with an example from market economies. In the U.S. economy one of the key states is the rate of unemployment, and one of the key controls is the federal budget deficit. If unemployment deviates substantially from the level policy-makers have targeted for it, they may move to change government expenditures or taxes, which changes aggregate demand, production, income, consumption, and so on. One can clearly see the control that the policy makers use. In CPE's there are almost no controls of that sort. Many controls are administrative and typically difficult, if not impossible, to quantify. In the case of investment, for example, the problem in most CPE's today is that it can grow too rapidly, which causes some combination of shortages at home and a deteriorating balance of trade. The way central planners usually control investment is to freeze (or at least slow down considerably) the initiation of new projects, in order to take pressure off of aggregate demand and the balance of trade, and then push for the completion of projects in process, in order to speed up the addition of new capacity. The freeze is an administrative measure which, while it may be implemented in part through the banking system, is implemented primarily through the ministries. It is, in short, unquantifiable; at best, one might be able to capture some of the effects through the use of a binary variable in an investment equation. The same problems exist for controls designed to affect the level of consumption, most of which is handled through the enterprise wage funds, and through taxes on consumer goods. Again, these controls are primarily administrative, and difficult to quantify. In short, much of the vector "c" is unobservable as
far as an outsider is concerned, and the question is how to proceed without that crucial vector.

There are two ways to resolve this issue. One is to comb the literature discussing economic policy in a particular CPE in hopes one could construct a set of binary variables describing changes in controls. This would be an enormous task, and the results could well be disappointing since some administrative measures are not announced, and many are much more subtle than either being "on" or "off." The second way to resolve the issue, which is followed here, is to use changes in targeted values of the state variables as indications that controls have changed. Thus a significant change in the planned growth rate of investment (relative to past years) is taken to indicate that controls are being changed in order to affect the desired change in investment. In terms of the equations above, the system reduces to:

\[(2.1') \quad s_t = E_t \hat{s}_t + \theta_t\]

\[(2.2') \quad s^*_t = s^*_u \leq s^*_t \leq s^*_l \]

and equations (2.3) and (2.4), where \(s^*_u\) and \(s^*_l\) are, respectively, bounds on the targeted values for the states. For example, one line in the inequalities in (2.2) might state that planned aggregate demand must equal planned GDP.

Equations (2.1'), (2.2'), (2.3), and (2.4) form a semi-reduced form of equations (2.1)-(2.6) because the controls have disappeared. They are a less satisfactory version of the model because one can no longer explicitly follow the links between performance and controls, and between controls and performance. Still, as the empirical model in the next section illustrates, they do allow at least a partial depiction of planners' role in the system by tracking the interrelationship between plans and performance.
In either case, it is also obviously important that planners publish good data on their plans, namely, on the desired state variables. In all CPE's the annual plan is the operational plan, hence the appropriate source for plan values, and in many CPE's the published information on the annual plans is extremely scanty. Some years growth rates are given, other years levels, and in yet other years nothing is available for certain variables. In this respect Hungarian data are relatively good, although not without problems. Thus it has been possible to construct time series for $s^a$, and I will discuss those in the next section. Not all of the important elements of $s^a$ are published in Hungary, and in some other CPE's so few are published, that the approach used here might be impossible to implement empirically.

Finally, in many CPE's the published income accounts are inadequate in order to construct time series for all the elements of aggregate demand. For many CPE's this means it is impossible to quantify all of the constraints (and some of the structural equations) discussed above. Again, the Hungarian case is unusual here, and it is possible to construct a full set of accounts on the product side.
III. The Hungarian Econometric Model No. 1 (HEM-1)

An Overview

Hungary is a small country of ten million people at a level of economic development roughly equivalent in terms of per capita GDP to that of southern Europe. It is highly sensitive to developments in the world economy--exports comprise over 40 percent of GDP--and it is truly a "price-taker" on world markets. The economy has for over thirty years been centrally planned and, although much has changed in the way microeconomic decisions are handled in the system, macro-economic decision-making has always been primarily under the control of central planners. The Planning Office, the Ministry of Finance, the State Bank and the Development Bank together wield considerable control over the macroeconomic aggregates today, as they have for over a quarter-century.2

The Hungarian Econometric Model No. 1 (HEM-1) is a twenty-one equation annual model (seventeen stochastic equations and four definitional equations) estimated using data for the 1966-77 period.3 The model focuses almost exclusively on the interrelationships between the foreign sector and macroeconomic activity, interrelationships which are of fundamental importance in the Hungarian economy, as in all East European economies. As this model shows quite clearly, it is the dollar balance of trade (and limited convertible currency reserves) which disciplines planners to search for macroeconomically balanced plans.

All the data on actual economic activity (with the exception of a series on GDP in the European Community) are from official Hungarian statistical sources; and all income flows are in constant (1968) forints. Data on plans have been collected from Hungarian newspapers, and from official documents.
published by the Planning Office. The data are discussed in somewhat more
detail in the notes to Table 7.

Figure 1 presents a schematic view of the major interrelationships in
HEM-1; Table 1 lists the variables, and their definitions, and the data
sources; and Table 2 presents the model equations and the diagnostics asso-
ciated with their estimation. I will first discuss the model using Figure 1
in order to provide an overview of its structure, and then turn in the next
subsection to a discussion of the individual equations.

Figure 1 contains all of the model variables and their major intercon-
nections. Arrows indicate the direction of causality; dotted lines mean that
the coefficient is negative; and solid lines indicate the coefficient is
positive. Variables enclosed in hexagons are planners' variables; variables
enclosed in circles are exogenous to the model; and variables in rectangles
are for the most part activity variables.
Figure 1: The Basic Interrelationships in [Equation].
Table 1

Variables in HEM-1

(Note: Exogenous variables are indicated by a "-x". The planned values of variables are indicated by the suffix "-PL", for example, XPL is the planned value of X.)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOTR</td>
<td>Balance in all trade for dollars (and other convertible currencies), millions of dollars</td>
<td>(1)</td>
</tr>
<tr>
<td>BOTR</td>
<td>Balance in all trade for rubles (and other inconvertible currencies), millions of rubles</td>
<td>(1)</td>
</tr>
<tr>
<td>C</td>
<td>Total consumption, millions of 1968 forints</td>
<td>(2, 4)</td>
</tr>
<tr>
<td>CPL</td>
<td>Planned total consumption, millions of 1968 forints</td>
<td>(3)</td>
</tr>
<tr>
<td>E$</td>
<td>Quantum index of dollar exports, 1970 = 100</td>
<td>(1)</td>
</tr>
<tr>
<td>E$</td>
<td>Quantum index of ruble exports, 1970 = 100</td>
<td>(1)</td>
</tr>
<tr>
<td>G</td>
<td>Government expenditures, millions of 1968 forints</td>
<td>(2, 4)</td>
</tr>
<tr>
<td>GDPDEV</td>
<td>Ratio of actual GDP to GDP predicted from a second degree polynomial time trend</td>
<td>(8)</td>
</tr>
<tr>
<td>I</td>
<td>Total investment, millions of 1968 forints</td>
<td>(2, 4)</td>
</tr>
<tr>
<td>IDEV</td>
<td>Ratio of actual I to I predicted from a second degree polynomial time trend</td>
<td>(9)</td>
</tr>
<tr>
<td>I$</td>
<td>Planners' estimate of I, millions of 1968 forints</td>
<td>(3)</td>
</tr>
<tr>
<td>IINV</td>
<td>Inventory investment, millions of 1968 forints</td>
<td>(2, 4)</td>
</tr>
<tr>
<td>IPL</td>
<td>Planned value of I, millions of 1968 forints</td>
<td>(3)</td>
</tr>
<tr>
<td>K</td>
<td>Value of the capital stock on January 1, undepreciated, millions of 1968 forints</td>
<td>(4, 5)</td>
</tr>
<tr>
<td>KNET</td>
<td>Depreciated value of the capital stock on January 1, millions of 1968 forints</td>
<td>(7)</td>
</tr>
<tr>
<td>M$</td>
<td>Quantum index of dollar imports, 1970 = 100</td>
<td>(1)</td>
</tr>
</tbody>
</table>
MR  - Quantum index of ruble imports, \(1970 = 100\) (1)

NI  - National income (Marxian), millions of 1968 forints (2, 4)

NIPL  - Planned NI, millions of 1968 forints (3)

NETEX  - Net exports (in the national income accounts), millions of 1968 forints (2, 4)

**Exogenous Variables**

GDPECDEV  - Ratio of actual GDP in the European Community to GDP predicted from a second degree polynomial time trend (6)

\(N\)  - Total employment, thousands of persons (4)

PEP  - Price index for dollar exports, \(1970 = 100\) (1)

PEP  - Price index for ruble exports, \(1970 = 100\) (1)

PMR  - Price index for ruble imports, \(1970 = 100\) (1)

PM\(\dagger\)  - Price index for dollar imports, \(1970 = 100\) (1)

TIME  - Time, 1960 = 1

**Data Sources:**

(1) Központi Statisztikai Hivatal (KSH: Central Statistical Office), Kölkereskedelmi statisztikai évkönyv (Foreign Trade Statistical Yearbook), various issues.


(3) Information on planned values was obtained from Tervgazdasági Értesítő (Economic Planning Gazette), official journal of the Hungarian Planning Office; and from Népszabadság, the Hungarian Socialist Workers' Party daily newspaper. Planned values for investments are typically given in forints, and have been deflated here using a price index for investment. Plans for consumption and national income are given in growth rates, and the levels here are obtained by multiplying the planned growth rate times last year's consumption or national income (in 1968 prices).

(4) KSH, Statisztikai évkönyv (Statistical Yearbook), various issues.


(6) The GDP series is constructed from data in the United Nations Statistical Yearbook, 1977 and OECD, Main Economic Indicators (May 1980). The estimated time trend used to define the deviations is given in equation (3.19).
(7) Constructed from $K$, assuming a depreciation rate of 4 percent (see equation (3.21)).

(8) Constructed using an estimated time trend whose coefficients are given in equation (3.19).

(9) Constructed using an estimated time trend whose coefficients are given in equation (3.20).
Table 2

Equations in HEM-1

<table>
<thead>
<tr>
<th>Planners' Reaction Functions</th>
<th>R²</th>
<th>S.E.</th>
<th>D.W.</th>
<th>EST.</th>
<th>P₁</th>
<th>P₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3.1) NIPL - NI₁ = 51 ΔH -1 + .18 ΔK -1</td>
<td>.96</td>
<td>1980</td>
<td>1.97</td>
<td>MAV2</td>
<td>.65</td>
<td>.35</td>
</tr>
<tr>
<td>(3.2) CPL - C₁ = .54(NIPL-NI₁) - .82(C₁-CPL₁) - .37 NETEX -1</td>
<td>.48</td>
<td>3040</td>
<td>2.00</td>
<td>MAV2</td>
<td>.04</td>
<td>.95</td>
</tr>
<tr>
<td>(3.3) IPL₁ = 2780 + .11(NIPL-NI₁) - .49(I₁-IPL₁) + .03 NETEX -1 -1</td>
<td>.55</td>
<td>1540</td>
<td>1.83</td>
<td>MAV2</td>
<td>.60</td>
<td>.40</td>
</tr>
<tr>
<td>(3.4) ΔI = -547 TIME + .68 ΔI + .35(I₁-I₁)</td>
<td>.69</td>
<td>3080</td>
<td>2.09</td>
<td>MAV2</td>
<td>.41</td>
<td>.59</td>
</tr>
<tr>
<td>(3.5) G = .12 NIPL - .07 NETEX</td>
<td>.97</td>
<td>613</td>
<td>1.76</td>
<td>MAV2</td>
<td>-.70</td>
<td>-1.00</td>
</tr>
</tbody>
</table>

Foreign Trade

| (3.5) DEL = .00027 ΔGDP - .02 ΔHOT -2 + 3.23 ΔFECDEV | .76 | 3.835 | 2.19 | MAV1 | 1.00 | --- |
| (3.7) δS = -36.78 + .00842 GDP + .04 HOT -1 + 23.54 IDEV | .97 | 5.072 | 1.92 | AUTO | .69 | -.94 |
| (3.8) ΔER = .37 ΔNR -1 + .50 ΔNR -2 + .53 ΔNR -3 | .85 | 4.176 | 1.90 | MAV1 | 1.00 | --- |
| (3.9) MR = -37 + .00042 GDP + 0.01 BOT -1 - .02 HOT -1 + .50 IDEV | .98 | 4.941 | 1.75 | --- | --- | --- |
| (3.10) BOT -2 = .50 + 11.84(PEK-MS) - 13.22(PEK-MS) | .97 | 40.350 | 1.89 | --- | --- | --- |
| (3.11) BOT = 11.95(PEK-MR) - 12.92(PEK-MR) | .995 | 8.500 | 1.93 | AUTO | .74 | 1.00 |
Table 2 (Continued)

Consumption

\[(3.12) \Delta C = 4.340 + .23 \text{ GDP} + .26 \Delta \text{ NETEX} + .57 (\text{CPL-C}) \]
\[(9.011) (1.419) (.17) (.14) (.10) -1\]

\[R^2 = .91 \quad \text{S.E.} = 1.85 \quad \text{D.W.} = 1.06 \quad \text{FST.} = 1.00 \quad \text{P}_1 = 0 \quad \text{P}_2 = 0\]

Production and Accumulation

\[(3.13) \Delta K = .43 I + .38 I \]
\[(69092) (1.14) -1 (1.14) -1\]

\[R^2 = .92 \quad \text{S.E.} = 1.85 \quad \text{D.W.} = 1.06 \quad \text{FST.} = 1.00 \quad \text{P}_1 = 0 \quad \text{P}_2 = 0\]

\[(3.14) \log (\text{GDP}/N) = 1.39 + .45 \log (\text{NET}/N) + .03 \text{ TIME}\]
\[(4.139) (.65) (.13) (.005)\]

\[R^2 = .997 \quad \text{S.E.} = 0.26 \quad \text{D.W.} = 0.26 \quad \text{FST.} = 0.26 \quad \text{P}_1 = 0 \quad \text{P}_2 = 0\]

\[(3.15) \Delta I = .41 [(\text{IPL}/I - 1) \cdot I - 1] - .33 \text{ NETEX} + .29 \text{ GDP}\]
\[(6874) (.72) (1.11) (.06)\]

\[R^2 = .81 \quad \text{S.E.} = 3.05 \quad \text{D.W.} = 1.66 \quad \text{FST.} = 1.09 \quad \text{P}_1 = -1.09 \quad \text{P}_2 = -1.51\]

Income Accounts

\[(3.16) \text{ NI} = .82 \text{ GDP}\]
\[(27.499) (.002)\]

\[R^2 = .999 \quad \text{S.E.} = 0.00 \quad \text{D.W.} = 2.00 \quad \text{FST.} = 1.11 \quad \text{P}_1 = 0.11 \quad \text{P}_2 = 0.55\]

\[(3.17) \text{ NETEX} = -567 \text{ XR} + 505 \text{ ER} - 507 \text{ HS} + 461 \text{ E}$\]
\[(-326) (45) (54) (45)\]

\[R^2 = .99 \quad \text{S.E.} = 0.11 \quad \text{D.W.} = 2.34 \quad \text{FST.} = 0.34 \quad \text{P}_1 = 0 \quad \text{P}_2 = 0\]

Balance and Definitions

\[(3.18) \text{ IINV} = \text{ GDP} - \text{ C} - I - G - \text{ NETEX}\]

\[(3.19) \text{ GDPDEV} = \text{ GDP} - \text{ LN}^{-1} (12.003 + .0487 \text{ TIME} + .000351 \text{ TIME}^2)\]

\[(3.20) \text{ IDEV} = [I/\text{ LN}^{-1}(10.5049 + .08269 \text{ TIME} - .000256 \text{ TIME}^2)] - 1\]

\[(3.21) \text{ KNET} = .95 K_{-1} + \Delta K\]
Table 2 (Continued)

*Notes:*

Mean values for the dependent variables are in parentheses below those variables. Numbers in parentheses below the coefficients are the standard errors.

For each equation, the right-hand side of the table indicates (corrected) $R^2$, the standard error of the estimate, the Durbin-Watson statistic, and what (if any) estimation procedures were used to correct for serial correlation in the error terms (see the text for a discussion). A "-" in the last three columns of this table indicates that corrections for serial correlation were unnecessary.
Planners forecast the supply of national income available, based on recent trends in factor inputs. That influences plans for aggregate demand of consumer and investment goods, and those plans (along with GDP and net exports) affect the actual level of consumption and investment. Government spending is directly affected by planned national income (there are no plan data available for that aggregate demand category). Net exports (for which there is no published plan information) are affected by exports and imports; and they in turn are negatively related to the planned levels of consumption and investment and to each of the final demand categories. Inventories are a residual, balancing the difference between GDP and other final demand categories.

Actual GDP produced is determined by capital and labor inputs, capital being a function of previous investment levels. Exports and imports for dollars (convertible currency) and rubles (non-convertible currency) are primarily determined by macroeconomic activity variables and lagged balances of trade (although GDP in the EEC does influence dollar exports). The balances of trade are determined by exports and imports, and the prices of exports and imports.

The structure of the model is best illustrated by following through a somewhat simplified version of the results of a change in an exogenous variable, for example an increase in the dollar price of imports in year t. This causes a deterioration in the dollar balance of trade in year t, and nothing else happens that period. The following year dollar imports fall as planners seek to improve the trade balance, which increases net exports, decreasing planned consumption and investment, and all actual final demand categories. The fall in investment cuts dollar and ruble imports somewhat. The third year dollar exports increase to further improve the trade balance. The consequences
continue to work through the system, but they are too complicated to follow through and make simple qualitative statements on the direction of change of particular variables. Further discussion of the effects of terms of trade changes in the model will be deferred to Section IV which traces through the actual impact of the drop in Hungary's terms of trade stemming from the OPEC price changes.

**Estimation of the Equations**

Table 1 lists the variables in the model. Table 2 lists the equations and the diagnostics associated with their estimation. The model has been estimated and simulated using the TROLL system. The coefficients have been estimated by Two-Stage Least Squares (2SLS) using Principal Components. The 2SLS technique is not only appropriate in a model such as this where endogenous variables appear on the right-hand side of other equations, but also early experiments with a preliminary version of HEM-1 indicated that the 2SLS coefficients provided better within-sample simulation results than coefficients estimated using Ordinary Least Squares.

In many of the equations early estimates suggested rather complicated autocorrelation of the residuals. Further attempts to respecify the equations in order to identify the source of the unexplained pattern were only partially successful, and therefore it was necessary to utilize Cochrane-Orcutt-type iterative procedures to simultaneously estimate the coefficients characterizing the pattern of serial correlation, and the coefficients of the equations. In some of the equations the error process seemed to follow a two period autoregressive scheme (called here AUT02). In other cases, the error process was best described by a one or two period moving average (respectively, MAV1 and MAV2). In some cases it would appear that the error processes were
even more complex than those three possibilities allowed, however the limited
number of degrees of freedom precluded explorations into more complicated
error processes.

Table 2 lists the estimated coefficients for the stochastic equations,
and the coefficients in the definitonal equations. For each equation, the
number in parentheses under the left-hand side variable is the mean value of
that variable; numbers in parentheses under the coefficients are the standard
events of the estimated coefficients; and the far right-hand side of the
table records, respectively, the corrected $R^2$ for each equation, the Standard
Error of the Estimate, the Durbin-Watson statistic, the technique used (if
any) to correct for autocorrelation of the residuals, and—where corrections
were made—the resulting coefficients.

Planners' Reaction Functions

At the macro level planners serve two functions: they project aggregate
supply, and they balance aggregate demand against that projected aggregate
supply. The state variables for which they have targets are national output,
the components of aggregate demand for that output (consumption, investment,
government spending, net exports, and inventory investment), and the balance
of trade. The latter is probably the most important state variable for
planners in a small economy highly dependent on foreign trade. In such an
economy, the ultimate operative criterion for macroeconomic balance is whether
or not there are foreign exchange reserves sufficient to finance net imports
implied by the plan, and service existing debt. If not, then no matter how
"balanced" the plan may appear to be in domestic prices, it must be changed.

Hungarian planners do not publish a complete version of their annual
plans, the most unfortunate omissions from the viewpoint of this model being
targets for net exports, inventory investment, government spending, and exports and imports by currency area. As a consequence, the planners' reaction functions discussed in this section only cover a portion of the state variables for which planners set targets. The remainder of the reaction functions are left implicit in the other equations of the model, and will be discussed as we proceed.

Planners tend to work in terms of growth rates of, and increments to, the state variables; and this section of the model is specified to reflect that. Where possible, more general forms of these equations were estimated, which included the first difference specification as a nested hypothesis, and generally those specifications confirmed the first-difference specifications. However, those general specifications were so plagued by multicollinearity problems, that it was decided in some cases to accept the first-difference specification as adequate based primarily on East European planners' well-known propensity to work on the margin.

Dating is very important in these equations. In each case they are explaining the variation in plans for the activity variables in year "t". Planners make those plans late in year "t-1" using preliminary estimates on activity variables for "t-1" and (usually final) estimates of activity variables for t-2.

Equation (3.1) models the planned increments to the supply of national income as a function of recent changes in factor supplies. Planners seem to know with a great deal of accuracy what (barring poor weather) national income produced will be the following year, and they seem to base that primarily on their predictions of the growth of factor inputs.

Equation (3.2) and (3.3) model planned increments to consumption and investment as a function of the same variables or types of variables. The
planned increment to consumption this year is positively linked to the planned increment to national income. It is negatively linked to the difference between actual and planned consumption, reflecting the fact that planners constantly readjust for surprises in previous years. In fact the coefficient suggests that planners "take back" ("give back") about 80 percent of the previous year's overfulfillment (underfulfillment) of the consumption plan.

Finally, the increment to planned consumption this year is negatively related to planned net exports this year. Ideally this should be planned net exports this year, reflecting the fact that an increase in planned net exports must cause a decrease in planned consumption, investment, and so on. Because there are no data on planned net exports, actual net exports are used as an admittedly imperfect proxy variable.

Data problems concerning planned investment create special difficulties whose consequences can be seen in the several insignificant coefficients for equation (3.3). The difficulties are related to the timing, and preliminary data discussed above. It turns out that the "t-1" estimates of investment in Hungary have traditionally been low, particularly in the 1960's where they might easily be 10 percent below what investment actually turned out to be. 5

Equation (3.4) models planners' estimates of actual investment as a function of time, the actual increment to investment, and a correction factor equal to one-third of the previous year's difference between actual and estimated investment.

Because of this problem, the difference between planned investment in year "t" and what investment finally was in the previous year is usually negative, which would imply that planners constantly planned to decrease investment. Obviously that was not the case; on the contrary they planned most years up until very recently to increase investment over what they
thought it had been the previous year. It is the difference between planned investment and what planners estimated investment to be the previous year, which forms the dependent variable in equation (3.3), because that really explains how planners behaved in their investment plans in the context of economic performance as they saw it at that moment.

The investment equation is designed to operate identically to the consumption equation. Planned increments to national income are positively linked to increments to planned investment, although the relationship is statistically insignificant. As with consumption, when estimated investment rises above (falls below) plan in one year, planners cut (increase) planned investment the following year, but only by about one-half of the overfulfillment. Net exports are linked to planned investment with an unexpected sign, and the coefficient is insignificant. The insignificant results here may in part be a reflection of the use of estimated investment, but they may also have more substantive foundations. In reading the annual plan documents, and the discussions of what considerations go into the annual plan figures, one gets the impression that planners plan increments to investment not on the basis of aggregate supply, but mainly on the basis of whether the investment goods producers (particularly construction and construction materials producers) can handle the demand--for which equation (3.3) has a proxy in the overfulfillment of the investment plan--and whether there are balance of payments problems which require a reduction of investment. While I could find no direct link between the planned level of investment and previous balance of payments experience, there is a strong link through net exports in the investment equation, of which more below.

Equation (3.5) models government spending as a function of planned national income and net exports (as a proxy for planned net exports). The
implicit assumption here is that the actual value of \( G \) is virtually the same as its planned value, which in fact is probably the case judging from the stability of the data series and the fact that planners have absolute control over the major portion of this category of aggregate demand.

As a group, these planners' equations testify to the apparently stabilizing nature of plans as a macroeconomic adjustment mechanism. A rise in net exports does "crowd out" planned consumption and government spending; and while it has no significant effect on planned investment, we see below that it does operate directly and negatively on actual investment. When actual aggregate demands deviate from planned, planners move to change planned, therefore actual, consumption and investment to keep the system on track.

Finally, there is a direct link between the planned level of aggregate supply and all of the final demand categories, with planned consumption and government spending receiving (at zero net exports) 75 percent of the planned increment to national income, the rest being reserved for investment, net exports, and inventory accumulation.

**Foreign Trade**

Hungary trades in numerous currencies, which the statistics (and the planners) divide into dollars (convertible) currency trade and ruble (non-convertible) currency trade. Until very recently, published data on plans for these four trade flows are very scanty, and as a consequence it proved necessary to include in the foreign trade equations reduced-form links which implied planners' reaction functions. Thus, the dollar balance of trade appears in three out of the four equations, with the implication that when that trade balance deteriorates, planners take measures to cut dollar imports, increase ruble imports, and increase dollar exports.
Equation (3.6) models the first difference in dollar exports as a function of the increment to GDP (a supply variable), the change in the dollar balance of trade two periods back (as the balance of trade deteriorates, exports increase with a two period lag), and the deviation of European Community GDP from a long-term time trend. This latter variable captures the effect of changes in demand conditions for Hungarian exports on their major dollar markets, and it is specified to reflect the fact that Hungary is a marginal supplier on those markets, a kind of "last in, first out" supplier. In fact, while the coefficient is about three times its standard error, it is surprisingly small. It would be unusual for EEC GDP to deviate more than 4 percent from its trend (judging from the sample period), yet such a deviation would only change exports by .12 index points, a little over 1 percent of the average increment to dollar exports in a given year. Thus this equation suggests that Hungary is not greatly affected by fluctuations in West European economic activity.

The two period lag in the dollar trade balance explained far more than a one-, or one- and two-period lag, which may simply reflect the fact that when the balance of trade deteriorates (improves), it may take a while to seek out new customers in the West and make new contracts (finish old contracts).

Dollar imports are purely demand determined by GDP, last period's balance of trade (again a proxy for planners' intervention to change dollar imports as the balance of trade improves or deteriorates), and the deviation of investment from its trend. The latter has a positive sign (as expected) but an insignificant one. The coefficient is retained nevertheless because there is ample evidence that when investment surges in Hungary, dollar imports increase. It could be if the GDP term were replaced by a more precise
tern reflecting demand for non-investment importables, that the investment coefficient would be significant.

The first difference in ruble exports are treated here simply as a lagged function of the increment to ruble imports, which is indeed a fair representation of the bilateral trade relationships in Hungary's trade with other CPE's. The RHO coefficients sum up to 1.4, reflecting in part the absence of the increments to imports in "t", and in part to the fact that the net barter terms of trade have deteriorated over this period, thus so have the gross barter terms of trade.

Ruble imports are a function of all of the variables used to explain dollar imports, including the dollar balance of trade last period, and the ruble balance of trade. Again, GDP is a demand term, and the coefficient is identical to that on dollar imports. The ruble balance of trade last period has the expected sign, but is not significant, which is reasonable since unplanned fluctuations in this variable are less likely than for the dollar balance of trade. The dollar balance of trade enters negatively, and is two times its standard error, suggesting that a deteriorating dollar balance of trade will cause planners to increase ruble imports, making up for about half (compare this coefficient of .02 with the .04 in the dollar balance of trade term for equation (3.7)) of the decrease in dollar imports. The deviation of investments from trend also enter this equation with a positive, but insignificant, sign; and the coefficient is retained here for the same reason as above.

The export and import flows in equations (3.6)-(3.9) are quantity indices; there is no published series in fixed domestic prices for exports and imports by currency areas. Therefore it is necessary to combine the export and import quantity indices with price indices, and then link those
stochastically to the dollar and ruble balances of trade, which is accomplished in equations (3.10) and (3.11).

Consumption

Equation (3.12) models the change in consumption as a function of the deviation of GDP from trend (typically due to unusual weather, which affects agricultural production, hence real consumption), the change in net exports, and the planned increment to consumption. The change in net exports appears here as well as in the planned consumption equation on the hypothesis that when net exports change because of changes in exports and imports, planners take measures to directly affect real consumption (i.e. through price, tax, subsidy, and wage policy changes) which may not show up in planned consumption, even though they do comprise part of the plans for consumption. Equations (3.2) and (3.12) jointly suggest that a 1 Forint increase in net exports will cause planned consumption to fall .37 Forints, which decreases actual consumption by .57 \cdot .37 = .21 Forints, and in addition consumption falls another .26 Forint because of direct links between net exports and consumption, for a total of .47. Consumption's share of GDP over the 1960-77 period averaged .60, which indicates that consumption has been somewhat protected from net export fluctuations.

Production and Accumulation

Equation (3.13) models the increment to the undepreciated capital stock as a function of the previous two periods' investment. The actual lag is most assuredly longer than this, but equations with longer lags encountered severe multicollinearity problems. This equation does a fair job of tracking the sample period increments to capital stock, and it does quite well in the simulations.
Equation (3.14) uses a Cobb-Douglas production function to explain GDP as a function of an exogenously determined labor force, and a capital stock depreciated in equation (3.21). The equation fits well, and makes sense, suggesting a constant 3 percent rate of increase in total factor productivity.

The investment equation (3.15) again raises the issue of the role of planners' (biased) estimates of actual investment. This time the issue is what role those biased estimates play in determining actual investment. As planners discover early in year t that the "t-1" estimates were way too low, do they alter their plans and slow down the rate of investment? The hypothesis here is that they do not, that the inertia in the system is such that that planned level of investment sticks, and more importantly that all the measures set into force for increasing the rate of investment work on the actual investment to increase it. Therefore the first RHS variable of this equation is last year's investment multiplied by the growth rate implied by planned investment over the (biased) estimate of last year's investment. If planners plan in year t to increase investment 10 percent over what they thought it was in year "t-1", and if it turns out that their estimate of "t-1" investment was 10 percent too low, the actions they have taken (and cannot stop soon enough) will act to increase investment 10 percent over the actual (higher) figure. The coefficient, a little under twice its standard error, suggests that there may be something to that hypothesis.

The second explanatory variable in the investment equation is net exports, the hypothesis here being the same as in the consumption equation: that planners take measures to control investment and make room for net exports, aside from those they signal in the annual plan figures. In this case, a 1 percent increase in net exports has no significant effect on planned investments, but decreases actual investments directly by .33. Investment's average
share in GDP over the sample period was .27, suggesting that investment, unlike consumption, takes more than its share of the adjustment burden when net exports change. Finally, GDP is included in the investment equation to reflect a necessary link between changes in national output and changes in investment necessary to increase the capital stock, hence productive capacity.

**Income Accounts and Identities**

Equation (3.16) in the income accounts links national income to GDP. These series are virtually identical in their growth rates, hence the very tight fit. The other equation, (3.17), models net exports as a function of the four trade series. A stochastic equation is necessary here because the trade series are quantity indices, and, in any event, the national income concept of net exports is not identical to exports and imports as counted in the foreign trade statistics.

Equation (3.18) balances the system, treating inventories as a residual. The remaining equations in the system are identities defining endogenous variables used elsewhere in the model. The obvious identities (e.g., \( C = C_{-1} + AC \)) have been omitted.

**Within-Sample Simulation Errors**

Table 3 presents data on bias and Root Mean Squared Percent (RMSP) Errors for all endogenous variables (excluding definitions) in the model for the single equation forecasts and dynamic simulations over the 1964-77 period (the maximum possible given lags in several equations), and the 1970-77 period. For the inventory identity and the three equations which model balances (BOT$, BOTR, NETEX) simple RMS errors are given, since the denominator can easily approach zero, leading to enormous RMSP errors.
The single equation forecast results are quite satisfactory, predicting the endogenous variables with only a minimal amount of bias. The investment equation is one exception, where the RMSP error is over 5 percent, and the upward bias is almost that large. However the bias decreases during simulations, and in fact for the 1970-77 simulation there is only tiny bias and a considerably lower RMSP error. The foreign trade equations are somewhat more problematical, particularly dollar imports. These are never easy flows to model in any economy, and in addition, the reliance in this model on a few aggregate variables could exacerbate the problem. For example, the demand for dollar imports is basically composed of food, raw materials, and machinery, and variables reflecting these particular flows might do a better job of explaining dollar imports. In the interest of maintaining the small size of the model, these possibilities of disaggregation were not pursued, and instead are left to a possible second version of the model.

Two sets of within-sample dynamic simulation results are presented, the first--1964-77--because it covers the entire sample, and the second--1970-77--because it covers the period of most interest for further simulations. Most of the interesting macroeconomic shocks hit Hungary in the 1970's, and therefore that is where the most interesting possibilities exist for counterfactual simulations.

The 1964-77 simulation results are not terribly satisfactory, although they do an acceptable job, particularly for the major macroeconomic aggregates. Some of the RMSP errors are high, and most of the simulated variables are upwardly biased by 1 to 5 percent. The largest increase in errors over the single-equation errors is in the three balances, particularly the BOTR and NOTEX. All of these balances are the net result of the four foreign trade equations, which are the least satisfactory of the model, consequently this result is not surprising.
### Table 3

Error Properties of HEM-1

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relative Bias (%)</td>
<td>RMS Percent Error</td>
<td>Relative Bias (%)</td>
</tr>
<tr>
<td>BOTS</td>
<td>0.00&lt;sup&gt;b&lt;/sup&gt;</td>
<td>36.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-7.00&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>BOTR</td>
<td>2.00&lt;sup&gt;b&lt;/sup&gt;</td>
<td>15.00&lt;sup&gt;c&lt;/sup&gt;</td>
<td>9.00&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>.02</td>
<td>.96</td>
<td>3.98</td>
</tr>
<tr>
<td>CPL</td>
<td>.19</td>
<td>1.83</td>
<td>3.65</td>
</tr>
<tr>
<td>ES&lt;sup&gt;e&lt;/sup&gt;</td>
<td>-.13</td>
<td>4.18</td>
<td>.90</td>
</tr>
<tr>
<td>ER</td>
<td>.04</td>
<td>2.76</td>
<td>4.60</td>
</tr>
<tr>
<td>G</td>
<td>.13</td>
<td>2.69</td>
<td>1.38</td>
</tr>
<tr>
<td>GDP</td>
<td>.01</td>
<td>1.13</td>
<td>.87</td>
</tr>
<tr>
<td>I</td>
<td>4.73</td>
<td>5.51</td>
<td>3.66</td>
</tr>
<tr>
<td>I&lt;sup&gt;e&lt;/sup&gt;</td>
<td>.51</td>
<td>3.66</td>
<td>4.91</td>
</tr>
<tr>
<td>IINV&lt;sup&gt;e&lt;/sup&gt;</td>
<td>---</td>
<td>---</td>
<td>-7960&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>IPL</td>
<td>.03</td>
<td>2.64</td>
<td>4.37</td>
</tr>
<tr>
<td>K</td>
<td>.82</td>
<td>1.12</td>
<td>1.94</td>
</tr>
<tr>
<td>MS</td>
<td>.50</td>
<td>7.60</td>
<td>2.43</td>
</tr>
<tr>
<td>MR</td>
<td>.13</td>
<td>4.29</td>
<td>4.76</td>
</tr>
<tr>
<td>NETEX</td>
<td>-35&lt;sup&gt;b&lt;/sup&gt;</td>
<td>770&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-173&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>NI</td>
<td>.10</td>
<td>.72</td>
<td>1.76</td>
</tr>
<tr>
<td>NIPL</td>
<td>-.02</td>
<td>1.08</td>
<td>1.10</td>
</tr>
</tbody>
</table>

Notes:

- Root Mean Squared Percentage (RMS<sup>P</sup>) error is defined as

\[
RMS<sup>P</sup> = \sqrt{\frac{1}{N} \sum_{i=1}^{N} \left( \frac{X_i - \hat{X}_i}{X_i} \right)^2}
\]

where:

- \(X_i\) = actual value of \(X\)
- \(\hat{X}_i\) = estimated value of \(X\)
- \(N\) = number of observations
Notes, continued:

\[ ^{b} \text{Absolute bias, defined as } \overline{x} - \overline{x} \]

where:

\[ \overline{x} = \text{mean of the estimated value of } x \]
\[ \overline{x} = \text{mean of the actual value of } x \]

\[ ^{c} \text{The Root Mean Squared (RMS) error is defined as} \]
\[ \text{RMS} = \sqrt{\frac{1}{N} \sum_{i=1}^{N} (\overline{x}_i - x_i)^2} \]

where variables are defined as in note "a".

\[ ^{d} \text{Relative bias is defined as} \]
\[ \frac{\overline{x} - \overline{x}}{\overline{x}} \]

where variables are defined as in note "a".

"This comes from the simulation reduced, therefore there are no single-equation estimates or forecasts."
The 1970-77 simulation results are much better, which is important since this is the period on which the counterfactual simulations are focused. Here the RMSP errors are much lower than for the 1964-77 simulation, and, in many cases, they are lower than the single equation RMSP errors. None of the equations show more than a 2 percent bias in either direction, and many are far less than 1 percent. The errors on the trade balances and net exports remain high, but with the exception of net exports, there is no significant bias in the values of the variables.

The model considerably underestimates inventories in the 1964-77 simulations, but does a much better job in the 1970-77 simulations. In fact the downward bias in the 1970-77 simulations for inventories is virtually the same as the upward bias for net exports, suggesting that it would be better to estimate these together. However, the important role of net exports in determining final demand aggregates would be muddled in a net exports plus inventory term, and for purposes of simulation, it seems better to maintain the current treatment of these two variables.

In sum, the 1970-77 simulations suggest HEM-1 is a solid representation of the Hungarian macroeconomy, useful for counterfactual simulations covering that period. Before discussing those simulations, I turn briefly to the results of applying the model to a prediction of economic performance in 1978.

Predictions of 1978 Economic Activity Using HEM-1

After the bulk of the estimation was completed, data for 1978 became available, making it possible to check the model by predicting the values for that year, and comparing them with the actual values. The predicted and actual values are presented in Table 4.

This year was one in which planners began to discuss major modifications in the economic mechanism and the price system in order to dramatically
## Table 4

Predictions for 1973 Using HEM-1

<table>
<thead>
<tr>
<th>Variable</th>
<th>Actual</th>
<th>Predicted</th>
<th>Percent Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCTW</td>
<td>-1111.0</td>
<td>-370.0</td>
<td>741.00&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>BOTR</td>
<td>-507.0</td>
<td>-328.0</td>
<td>179.00&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>269910.0</td>
<td>268371.0</td>
<td>-0.57</td>
</tr>
<tr>
<td>CPL</td>
<td>271831.0</td>
<td>267435.0</td>
<td>-1.62</td>
</tr>
<tr>
<td>ES</td>
<td>177.6</td>
<td>180.3</td>
<td>1.88</td>
</tr>
<tr>
<td>ER</td>
<td>202.2</td>
<td>211.9</td>
<td>4.82</td>
</tr>
<tr>
<td>G</td>
<td>47359.0</td>
<td>46370.0</td>
<td>-2.08</td>
</tr>
<tr>
<td>GDP</td>
<td>497259.0</td>
<td>501970.0</td>
<td>0.95</td>
</tr>
<tr>
<td>I</td>
<td>148053.0</td>
<td>155198.0</td>
<td>4.93</td>
</tr>
<tr>
<td>Ū</td>
<td>120128.0</td>
<td>124323.0</td>
<td>3.93</td>
</tr>
<tr>
<td>IINV</td>
<td>35823.0</td>
<td>18515.0</td>
<td>-17308.00&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>IPL</td>
<td>115154.0</td>
<td>119941.0</td>
<td>4.12</td>
</tr>
<tr>
<td>K</td>
<td>1960060.0</td>
<td>1968273.0</td>
<td>0.40</td>
</tr>
<tr>
<td>KS</td>
<td>177.0</td>
<td>151.0</td>
<td>-14.88</td>
</tr>
<tr>
<td>KR</td>
<td>176.0</td>
<td>179.0</td>
<td>1.65</td>
</tr>
<tr>
<td>NETX</td>
<td>-3887.0</td>
<td>13514.0</td>
<td>+17401.00</td>
</tr>
<tr>
<td>NI</td>
<td>405990.0</td>
<td>412252.0</td>
<td>1.52</td>
</tr>
<tr>
<td>NIPL</td>
<td>410389.0</td>
<td>408438.0</td>
<td>-0.43</td>
</tr>
</tbody>
</table>

### Notes:

<sup>a</sup> Absolute error.
increase enterprise efficiency and improve the dollar balance of trade (see Hewett [1980a] for details). As a result, enterprises became uncertain about future prices and they accumulated inventories, primarily through dollar imports. Thus, while the model accurately predicts the macroeconomic aggregates and the plans, it missed much of the unusual inventory accumulation phenomenon, severely underestimating inventory accumulation and the dollar imports which resulted from it, and the balance of trade deterioration that it caused, therefore overestimating net exports.

The Stability of HEM-1

Even in a model of this modest magnitude, it is difficult to tell just by "looking" at the equations whether they portray a stable system which returns to equilibrium when it is perturbed. Obviously there are many negative feedbacks built into the model, so that instability could only come through their complex interaction in an unanticipated fashion. Several experiments with the model testified to its stability. In one case, for example, the dollar terms of trade in one year (1973) were increased 10 percent, and then the effects through 1979 were compared with those of a baseline solution for 1970-78 (discussed in the next section). There is no need to go into the details of that exercise here. Briefly, what happens is that the terms of trade improvement, hence balance of payments improvement sets off damped oscillations in dollar imports (hence the dollar balance of trade, net exports, and the final demand elements) which are large but diminishing the first three years, and insignificant thereafter.
One of the most important developments in Hungary's (and the rest of Eastern Europe's) economic environment in the 1970's was the precipitate decline in its terms of trade in hard currency, and then its terms of trade in Rubles. As Figure 2 illustrates, the dollar terms of trade dropped about 18 percent during 1974-78, most of that occurring in 1975-76. The Ruble terms of trade followed with a lag after the Soviet Union and its East European trade partners agreed to introduce the terms of trade changes into their own bilateral trade through a lagged moving average. (Hewett [1980b])

A decline on this scale in a country's terms of trade represents a massive cut in the world value of its exportables, and hence creates the necessity for a combination of borrowing (assuming there are willing creditors available), and domestic austerity to increase the fixed-price value of net exports. Naturally, borrowing only postpones the austerity to a later date, assuming the terms of trade changes remain. The question, then, for a country such as Hungary, is how much additional borrowing they undertook in the 1974-present period in order to postpone adjustment to the new terms of trade shift, and accordingly, how much adjustment have they undertaken? HEM-1 was constructed to provide an answer to such a question, and this section discusses the counterfactual simulation developed using HEM-1.

A base line simulation of HEM-1 for 1970-78 will be used to represent what actually transpired during these years. It is necessary to use these simulated data, in lieu of the actual data, in order to separate out the deviations from actual performance which exist because the model cannot perfectly predict reality, from the deviations which occur because conditions
Figure 2

Hungarian Terms of Trade in Ruble and Dollar Trade

Source: HEM-1 Data Bank.
in the counterfactual simulation are not the same as in reality. The implicit assumption is that the errors in the baseline simulation and in the counterfactual simulation are proportional, thus differences between the two simulations will accurately reflect what actually would have happened if the terms of trade had been better. Even though 1978 data were not used in the estimation, 1978 is included in the baseline simulation because there are so few years in which to study the terms of trade decrease.

To represent what could have happened, HEM-1 was simulated under the assumption that Hungary's terms of trade with the dollar and ruble areas remained at their 1973 values through 1978. This introduces approximately a 20 percent improvement in the dollar terms of trade (relative to baseline) by 1976, and about a 15 percent improvement in ruble terms of trade by 1977. That in turn improves the trade balances in dollars and rubles, which subsequently causes changes in imports, exports, net exports, and therefore final demands. I turn now to a discussion of the results, which are presented in Table 5. In all cases the terms "fall" or "rise," and so on, are relative to the baseline simulated values.

Ruble imports fall, as the improved dollar balance of trade allows a shift to dollar imports, and ruble exports, which depend solely on ruble imports, fall by approximately the same amount. The net effect is to leave the ruble trade balance in surplus and substantially improved due to the improved ruble terms of trade over 1974-78. Dollar imports rise considerably, all of the increase coming in 1975-78 (due to the one year lag), as planners respond to the much improved foreign exchange reserve situation. Dollar exports fall, but by a smaller amount, and with a two year lag. The result leaves Hungary with a 1974-78 trade balance $1.52 billion more than baseline. During the 1974-78 period, Hungary's net hard currency debt
Table 5
Baseline and Hypothetical Economic Performance
(Assuming No Changes in the Terms of Trade): 1974-78

<table>
<thead>
<tr>
<th>Selected Endogenous Variables</th>
<th>Baseline (1)</th>
<th>Hypothetical (2)</th>
<th>Ratio (2)/(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income Accounts (Planned and Realized Values):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP (Mln Ft.)</td>
<td>448570</td>
<td>448742</td>
<td>1.0003</td>
</tr>
<tr>
<td>CNIPL (Mln Ft.)</td>
<td>365732</td>
<td>365813</td>
<td>1.0002</td>
</tr>
<tr>
<td>C (Mln Ft.)</td>
<td>249847</td>
<td>254754</td>
<td>1.0200</td>
</tr>
<tr>
<td>CPL (Mln Ft.)</td>
<td>289838</td>
<td>255359</td>
<td>1.0220</td>
</tr>
<tr>
<td>G (Mln Ft.)</td>
<td>41770</td>
<td>42234</td>
<td>1.0110</td>
</tr>
<tr>
<td>I (Mln Ft.)</td>
<td>136511</td>
<td>137431</td>
<td>1.0110</td>
</tr>
<tr>
<td>IPL (Mln Ft.)</td>
<td>102691</td>
<td>103128</td>
<td>1.0040</td>
</tr>
<tr>
<td>NETEX (Mln Ft.)</td>
<td>8619</td>
<td>2313</td>
<td>-5306^b</td>
</tr>
<tr>
<td>Foreign Trade:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOT$ (Mln Dollars)</td>
<td>-2000^c</td>
<td>-560^c</td>
<td>1520^b</td>
</tr>
<tr>
<td>BOTR (Mln Rubles)</td>
<td>-740^c</td>
<td>563^c</td>
<td>1303^b</td>
</tr>
<tr>
<td>EDO (1968 = 100)</td>
<td>157.90</td>
<td>154.6</td>
<td>.975</td>
</tr>
<tr>
<td>ER (1968 = 100)</td>
<td>161.60</td>
<td>179.6</td>
<td>.989</td>
</tr>
<tr>
<td>MDO (1968 = 100)</td>
<td>136.40</td>
<td>146.4</td>
<td>1.073</td>
</tr>
<tr>
<td>MR (1968 = 100)</td>
<td>154.41</td>
<td>152.1</td>
<td>.985</td>
</tr>
</tbody>
</table>

Notes:

^a Assumes dollar and ruble terms of trade remained at their 1973 values during 1974-78.

^b Column (2) - Column (1)

^c Sum of trade balances over the 1974-78 period.

^d 1970-78 simulated values based on the actual values of all exogenous variables.
actually rose $3.962 billion, of which $1.552 billion was increased short-term debt. (Hungarian National Bank) Thus this simulation suggests that Hungary could have avoided all of that increased short-term debt if the terms of trade changes had not transpired. The increased long-term debt, a good deal of which had gone to financing new investments, might well have been incurred in any event.\textsuperscript{13}

GDP itself changes only slightly due to the terms of trade changes, and that because investment goes up somewhat, which increases the capital stock and therefore GDP. GNIPL is included here only for its growth rate to confirm that planners do not noticeably increase GNIPL, which makes sense since all that has changed is the relative price of exportables.

But the final demand elements do change because net exports fall considerably--due mainly to large increases in dollar imports--and the additional goods are distributed among final demand categories. This happens both indirectly through the visible links between net exports, plans, and realized values; and it happens directly (although planners' actions are definitely behind it) in the link between net exports and the final demand categories. Consumption benefits the most from the terms of trade improvement, lying 2 percent above the baseline simulation over the five years. Government spending and investment increase somewhat less.\textsuperscript{14}

In sum, the simulation suggests that Hungary has paid a considerable price because of the terms of trade decline. Part of the cost was in real goods to the population, as planners adjusted the utilization of GDP demand in order to free up net exports, hence reduce what otherwise would have been a considerable hard currency deficit resulting from the terms of trade changes. Shaving 2 percent off consumption, and over 1 percent off investment and government spending on average over a four period is considerably
more of an adjustment than Hungary (or other East European countries) are usually given credit for.

Nevertheless the adjustment was not immediate, and the government borrowed $1.8 billion more than it would have in the absence of the terms of trade changes (which is all of the short-term borrowing actually undertaken during 1974-78). That debt, amounting to about one-half of 1978 dollar exports, can only be repaid through further austerity measures, which is precisely what the government introduced this year. (Hewett [1980a])
V. Future Research Possibilities

The fact that it was possible to identify significant links between economic performance and plans, and plans and economic performance, suggests that this is a promising approach to constructing macroeconometric models of centrally planned economies. There are several areas in which this model could be improved, and several other possible applications for this, or an expanded version of this model.

It would seem useful and necessary to enlarge this model at least enough to include an agricultural sector, which is important in Hungary, into the supply side and into the foreign trade equations. This would make it possible to trace the effects of weather on the system, an important source of macroeconomic disturbances. Secondly, the importance of energy to Hungary's future economic performance suggests the importance of building energy into the supply side of the model, possibly along with other raw materials in, for example, a KLEM production function. The crucial importance of this latter change is that it would link imports to aggregate supply, an important and real link in the Hungarian economy.

In 1980, as part of its austerity program designed to improve the hard currency trade balance, the Hungarian government introduced stiff controls on imports, which appear to be exerting an effect on production. With a model modified as discussed here, it would be possible to explore the consequences of such a move for aggregate supply, and therefore for the aggregate demand categories. In addition, by adding explicitly an agricultural sector, it would be possible to explore the potentially important contribution of that sector to easing the hard currency balance of payments.

The planners' reaction function in the model might be improved through experimenting with asymmetric responses to deteriorating and improving...
economic performance. One suspects that planners are less worried about redistributing unforeseen windfall gains, than they are (and must be) about distributing losses. No such hypotheses were explored in HEM-1, which assumes symmetric responses, and such a line of inquiry might produce interesting results.

Finally, an expanded version of HEM-1 would allow one to explore what might transpire in the early 1980's as Soviet energy supplies to Hungary stagnate, as the hard currency trade balance deteriorates, and therefore as planners must make difficult choices concerning adjustment or further increases in hard currency debt.
Footnotes

1SOVMOD does include some endogenous planners' reactions, e.g. in the foreign sector, but in the main planners' behavior is left outside the model.

2Hungarian economic institutions are discussed by Balassa, Portes, Hare, and Hewett (1980a).

3For many variables, data for the 1960's were available, but they were not used because: (1) planners were learning a good deal about their job in those years, which shows up in the erratic nature of some of the series; (2) the data are less reliable and somewhat more limited in scope than from 1950 on; and (3) political events in the Soviet Union (the transition from Stalin to Khrushchev) and in Hungary (the 1956 uprising) affects much of the data for those years.

4The direct negative relationships between net exports and actual consumption, investment and government spending imply that when net exports rise, planners take measures to cut final demands to "make room" for net exports. I cannot quantify the measures they take (direct controls on investment, various controls on wage funds, and so on), because there are no planned values for net exports, it is necessary to reduce these links to a simple one between net exports and aggregate demand.

5Marxian national income (value added in material sectors) is used in the planner's reaction functions because that is the state variable they use in making their plans. On the other hand GDP is the appropriate variable for tracking macroeconomic balance. Because Hungarian statistical publications provide data for both income measures, each are used where appropriate in the model, then linked through a stochastic equation.

6The AUTO2 scheme assumes
\[ u_t = \beta_1 u_{t-1} + \beta_2 u_{t-2} + \epsilon_t \]
where \( \epsilon_t \) is an independently distributed random variable, and \( u_t \) is the disturbance in period \( t \). The procedure consists of assuming values for \( \beta_1 \) and \( \beta_2 \), and then running the regression, choosing new values which will reduce the residual sum of squares, rerunning the regression and continuing to do so until the change in \( \beta_1 \) and \( \beta_2 \) is below a set criterion. For further details see the National Bureau of Economic Research, Section 7.11.

7Here the processes are assumed for MAV1 to be
\[ u_t = \epsilon_t - \beta_1 \epsilon_{t-1} \]
and for MAV2 to be
\[ M_t = \epsilon_t - \beta_1 \epsilon_{t-1} - \beta_2 \epsilon_{t-2} \]
The iterative procedure works as described in the previous footnote.
The estimated value of investment which planners use is apparently derived from data for the first three quarters, and is reported as part of the discussion of the plan for the following year.

There is always a plan for balance, exclusive of credits, in trade flows among Soviet and East European trade partners, and if there are any problems in fulfilling its export obligations, then further negotiations resolve how balance will be restored, that year or the next. The weak positive coefficient here would seem to indicate that most of the time Hungary’s deficits or surpluses with the Ruble area either were planned or else resolved within the same year, and therefore did not require further exports the following year.

There is one inventory series available for Hungary, which lumps together finished goods and intermediate goods inventories, consequently, this is a difficult series to model. In any event it makes sense to suppose that inventories, which are very large in Hungary, can act as a buffer whenever there is strong divergence between other final demand elements and aggregate supply.

All the price indices were set at their 1973 values for 1974-78, hence setting the terms of trade at their 1973 value. Because HEM-1 has foreign trade price levels in it, the results are somewhat different depending on how one freezes the terms of trade; however experiments with various assumptions suggested that the effects on the results were minor.

Actually such a surplus would be unlikely, and indeed unwise, since the planners would have trouble buying anything with their accumulated Rubles. What would be more likely is that the potential Ruble exports would have been diverted to the domestic market, thus increasing final demand categories somewhat more than is indicated here.

Of course it is hard to say with any certainty, since the increased borrowing for new investments was, in part, stimulated by hard currency balance of payments problems which intensified East European (including Hungarian) planners’ interests in improving the supply of hard currency exportables through new investments.

In the earlier discussion of the consumption and investment equations, it was stated that consumption takes less than its share, and investment more than its share, of any change in net exports; yet this simulation result suggests the opposite. What in fact happens is that because net exports play virtually no role in determining planned investment, planned investment does not "catch on" to the lower net exports, but actual investment does, and those two combine in the investment equation to slow down actual investment somewhat as planned investment divided by estimated investment in the previous year is somewhat below the base line value.
References


László Hunyadi, Judit Neményi, Péter Subicz, and András Piala, A rövid távú tervezés ökonometriai modellje (A Short-Term Planning Econometric Model), Two Volumes, mimeo, Budapest, 1979.


