An Econometric Analysis of Investment in Hungary

Fink, G. and Simon, A.

IIASA Collaborative Paper
April 1983
AN ECONOMETRIC ANALYSIS OF INVESTMENT IN HUNGARY

Gerhard Fink
Andras Simon

April 1983
CP-83-23

Collaborative Papers report work which has not been performed solely at the International Institute for Applied Systems Analysis and which has received only limited review. Views or opinions expressed herein do not necessarily represent those of the Institute, its National Member Organizations, or other organizations supporting the work.

INTERNATIONAL INSTITUTE FOR APPLIED SYSTEMS ANALYSIS
A-2361 Laxenburg, Austria
Input-output analysis has found widespread empirical application, in studies of how certain industrial sectors react to changes in national and international economic conditions and in static and dynamic investigations of the interrelationships between industries. Since 1979 IIASA has been consistently active in this field, primarily through extensive collaboration with the Inter-Industry Forecasting Program (INFORUM) coordinated at the University of Maryland by Clopper Almon and Douglas Nyhus. IIASA's aims have been to further the development of econometric input-output models, to assist in the linkage of national models, and to participate in and extend the international network of collaborating scientists.

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

Gerhard Fink (Vienna Institute for Comparative Economic Studies) and Andras Simon (Institute for Economic and Market Research, Budapest) are collaborating in the development of an INFORUM-type input-output model for Hungary. In this paper they describe a study of Hungarian investment policy over recent decades, dealing with both the sectoral allocation of total investment and the cyclical investment patterns observed. The results are being used in the construction of an econometric submodel of investment for the Hungarian INFORUM model.

Anatoli Smyshlyaev
Patterns of Economic Structural Change and Industrial Adjustment

-iii-
CONTENTS

1. INTRODUCTION 1

2. THE "CYCLE" APPROACH 2
   2.1 The Model 2
   2.2 The Empirical Model 6
   2.3 Modeling Economic Policy 10
   2.4 An Evaluation of the Cycle Approach 14

3. THE "EXPANSION" APPROACH 15
   3.1 The Model 16
   3.2 The Data 22
   3.3 The Method of Estimation 24
   3.4 The Results 26

4. RECONCILING THE APPROACHES 32

REFERENCES 33
AN ECONOMETRIC ANALYSIS OF INVESTMENT IN HUNGARY

Gerhard Fink* and Andras Simon**

1. INTRODUCTION

This paper describes research aimed at setting up an econometric model of investment in Hungary to be used as a submodel in the Hungarian INFORUM input-output model*** (see C. Almon and Nyhus, 1977).

To meet the INFORUM requirement of explaining investment in sectoral detail, we had to move into an area that is relatively unexplored in the Hungarian economic literature. Much has been written about investment, especially in the context of investment cycles in Hungary; following the pioneering observations of Bródy (1967), the work of Soós (1978), Tarján and Tényi (1977), and Bauer (1981) has covered almost every aspect of the subject. However, all this work has dealt with total investment and not with the sectoral allocation of investment.

*Vienna Institute for Comparative Economic Studies, Arsenal Obj. 20, A-1103 Vienna, Austria.

**Institute for Economic and Market Research, Dorattya 6, 1051 Budapest, Hungary.

***The submodel described in this paper has been implemented within the Hungarian input-output model by Gábor Kornai.
Our aim was twofold. We set out first to select the most important relationships formulated verbally by these earlier authors and to formulate the "economic policy" interpretation of investment cycles into a model-like logical system. Building on former studies of this kind (Lackó, 1980), we quantified the parameters of the model using real data. Our application of Ragnar Frisch's explanation of the persistence of economic cycles to the Hungarian investment case is another extension of the work of the authors mentioned above.

Our second objective was to model the sectoral allocation of investment. In this respect, most authors have stressed the overwhelming role of central decisions (Deák, 1978; Bauer, 1978) but none have tried to identify regularities in the behavior of decision makers that could be a basis for an empirical model. Thus, while the first part of our paper makes no claim to be anything more than an empirical verification of a rather broadly accepted hypothesis, the second part provides and verifies a new hypothesis at the same time.

It is noteworthy that this new hypothesis was developed without recourse to the cyclical hypothesis. Thus the "cycle" approach of the first part of the paper and the "expansion" approach of the second part show marked differences, which cannot be explained purely by the fact that the former deals with total investment while the latter investigates sectoral investment. The range of validity and application of the two approaches will be discussed in Section 4.

2. THE "CYCLE" APPROACH

2.1. The Model

The existence of investment cycles can be deduced from the following three assumptions:

1. Domestic supply is not flexible enough to follow all the fluctuations in investment demand. "Too much" investment leads to tension between supply and demand. This tension can be eased either by reducing consumption or by increasing imports. In Hungary, increasing imports in order to cover the additional
Demand for investment is a fairly typical method. Thus, an immediate relationship is established between investment and the balance of trade. When the level of investment is low the balance of trade shows a surplus or a relatively small deficit, while when the level of investment increases the balance of trade shows a larger deficit.

2. The long-term development of investment is determined by the long-term strategy of the planning and economic control agencies regarding rates of consumption and investment. In the short run, however, investment policy depends on the actual tensions between supply and demand in the economy, and primarily on the balance of trade. The more favorable the trade balance, the more investment can be "afforded", and vice versa. It seems a relatively trivial extension to emphasize that investment depends on present tensions and not on expected or probable future tensions, but when investigating the emergence of cyclical behavior this qualification is absolutely fundamental.

3. A certain time elapses between the formulation of economic policy and the appearance of its results. In contrast with the first two assumptions, this statement requires some further explanation.

Let us assume that for some reason the balance of trade is less favorable than desired in a given year and that economic policy makers wish to improve the situation by cutting back on investment. It is often almost impossible to do this within the year concerned, since decisions on investment have been taken at an earlier date and projects are either in progress or otherwise beyond recall. There are also numerous other reasons why investment cannot be immediately reduced. Time is needed for making decisions on investment restriction, even after tensions have been observed. First the situation has to be assessed and discussed, in conjunction with the proposed remedial measures, their timing, and their form. The measures are usually of many kinds and they affect the different types of investment in different ways. Efforts are made to restrict investment decided by the enterprises by controlling enterprise incomes, by
means of credit policy, and by numerous other measures. Investment projects that are centrally decided can be influenced mainly by rescheduling the starting dates of new projects, although speeding up or slowing down those already in progress is also possible. But all these measures have a common characteristic: a certain amount of time elapses before their effect becomes manifest in terms of reduced investment. And because the resources of individual enterprises for investment projects depend on the income of preceding years, not on that of the current year, time once again elapses between the granting and paying of credit and between the starting and completion of such projects.

In order to show how these three assumptions lead to investment cycles, let us formulate them as simple mathematical functions.

For the development of tensions (assumption 1),

\[ B_t = b(I_t) \]  \hspace{1cm} (1)

where

- \( B_t \) = balance of trade in year \( t \), and
- \( I_t \) = investment in year \( t \).

For the economic policy reaction (assumption 2),

\[ I_t = i(B_{t-k}) \]  \hspace{1cm} (2)

where \( B_{t-k} \) is the balance of trade in year \( t-k \).

According to our assumptions, in eqn. (1) \( B \) is a decreasing function of \( I \), while in eqn. (2) \( I \) is an increasing function of \( B \). This situation is illustrated in Figure 1. The possible combinations of investment and foreign trade balance are located along the curve of the tension function. The point of intersection of the two curves is the equilibrium combination; this is the possible combination which is held to be most desirable by economic policy makers, for example, one which achieves a zero balance of trade.
Let us assume that the initial numerical value of the balance of trade is $B_0$ and that this is unacceptably low. The policy reaction is to reduce investment. According to the reaction function, investment falls to $I_k$ after $k$ periods have elapsed. This results in an improvement in the trade balance to $B_k$. Thus, after $k$ periods we reach point $Q_k$, but in so doing the original target, corresponding to point $Q$, has been overshot; the policy makers now consider the question of increasing investment again, which eventually produces an overshoot in the opposite direction, and so on ...

With the signs that we have assumed for the slopes of the functions, investment develops cyclically in the course of time. Depending on the magnitudes of the slopes, the cycle has a growing, a constant, or a diminishing amplitude and, accordingly, investment diverges from or converges toward the equilibrium point $Q$. 

Figure 1. Assumed interrelations between balance of trade and investment.
It is easy to recognize that, formally, the model fully agrees with the "cobweb model" of Tinbergen (1950), well known from textbooks. The tension function replaces Tinbergen's demand function, while the behavior described by the reaction function is analogous to demand reacting to price with a time lag.

On the basis of the arguments above, it can be seen that if our three assumptions are valid then they will necessarily give rise to investment cycles. But simple logical reasoning is not sufficient for us to decide whether the cycles have growing, unchanged, or damped amplitudes: for this we need to know the parameters of the functions.

2.2. The Empirical Model

We estimated characteristic parameters explaining Hungarian investment behavior over the last 20 years with the help of regression equations. The estimated parameters give not only the amplitude of the cycle but also its length. We realize of course that the two functions outlined above constitute a very much simplified model of investment behavior. It is obvious that investment and balance of trade depend not only on each other but also on innumerable other factors and events.

In the course of estimating the parameters, a step is made from abstraction towards reality insofar as the model is expanded by the addition of a few other explanatory variables.

Gross domestic product is included as a factor determining the long-term development of investment, while the balance of trade is assumed to be affected somewhat by the terms of trade. Even so, many other important explanatory variables are missing from the model. A model that incorporated more details from the real situation would certainly have yielded better results for the parameters of the interrelations producing the cyclical behavior, but for our fairly limited purposes this relatively simple model should suffice.

Our aims here are restricted to the following. First, to verify with the tools of mathematical statistics that interrelations similar to those represented in the model do play a
role in the development of investment; and second, to establish whether the parameters of the cycle given by the model (damping coefficient and length of period) are of the right order of magnitude to help explain the investment cycles actually observed. The estimated model is sufficient for these purposes, even if we reckon on a certain bias in the estimated parameters.

The function describing economic policy reaction was estimated using the following equation:

\[ I = -52.7 + 0.018 \text{BALANCE}_2 + 0.46(\text{GDP}+\text{GDP}_1+\text{GDP}_2)/3 \]  
(4)

with \( R^2 = 0.991 \), \( DW = 1.654 \), and the relative error = 3.51%.

The observation period was 1963-1979, and the following notation is used:

- \( I \) = total investment in the economy (billion forints) at constant 1976 prices,
- \( GDP \) = gross domestic product (billion forints) at constant 1976 prices, and
- \( \text{BALANCE} \) = balance of trade transacted in dollars (million dollars).

The negative subscripts indicate the lag of the variable concerned in years, while the figures in parentheses below the coefficients are the ratios of the estimated parameters to the standard error of parameter estimation. \( R^2 \) is the multiple correlation coefficient adjusted for the number of degrees of freedom of the equation, \( DW \) is the Durbin-Watson statistic, and the relative error is the standard error of the estimation of the dependent variable relative to its average value.

The second term of eqn. (4) expresses the lagged effect of any measures induced by tensions indicated in the balance of trade; a negative balance reduces, and a positive balance increases investment. Logical reasoning cannot in itself determine the length of the lag, so that statistical criteria were used. When we compared regression equations computed with either one- or two-year lags, the two-year variants consistently gave a better
fit. Of course, two years is an average value, and the precise length of the lag may differ from this average depending on the kind of policy action or the type of investment concerned. The estimation of an integral value of two years was an obvious technical necessity based on the annual data available.

The third term of the equation explains the long-term trend of investment. In the long run, investments are obviously determined by the gross domestic product, which affects both sources of investment and the uses to which it is put. We eliminated the effects of short-term fluctuations in GDP by using three-year moving averages.

The tension function used has the following form:

\[
\text{BALANCE} = -2342.1 - 32.6 I + 1188.0 \text{ TERMS} + 251.9 T
\]

with \( R^2 = 0.844 \), \( DW = 2.538 \), and the relative error = 60%. Once again the observation period was 1963-1979, and the following additional notation is introduced:

- TERMS = terms of trade = ratio of export to import prices in hard currency foreign trade, and
- \( T \) = time (years) \( (T = 0, 1, 2...) \).

Equation (5) represents the fact that the import requirements generated by investment result in a simultaneous deterioration in the balance of trade. The impact of the terms of trade on trade balance is self-evident. Many other factors affect the balance, but they are represented in this simple model by a trend.

The relative error of the estimate in this case tells us nothing about the fit of the estimated values to the actual data, since the dependent variable is fluctuating around zero and thus its average value—the denominator in the formula for relative error—is very small. However, the \( R^2 \) value indicates a relatively good fit.

Substituting the right-hand side of eqn. (5) for the BALANCE variable of eqn. (4), it is easy to see that, because of the
interrelations of the system, a unit change in investment produces a -0.59-times change in investment two years later \((-32.6 \times 0.018 = -0.59\). That is, the change after two years will have the opposite sign to the original unit change and will be damped in amplitude by a factor of 0.59. After another two years, the effect of the same original unit change will be +0.35 (i.e., \(-0.59 \times -0.59\)); in other words, the change will be back in the original direction but with an amplitude of 0.35-times the original.

This indicates a damping cycle within the model, but this must be reconciled with the empirical observation that the cycles of real investment processes do not seem to diminish at all. One explanation is that investments are continually affected by external shocks that release new cycles, replacing the diminishing waves produced by earlier investment events.* In our model these external shocks are generated partly by the exogenous variables (terms of trade, GDP) and partly by the residual term representing those effects considered as random.

Our simple econometric model of two equations can quantify the parameters of a theoretical model, but it is by no means capable of proving or disproving the theory. The observed data show that investment fluctuations are in general of opposite sign every two years, thus exhibiting cyclical behavior. From the numerical results we have learned that these cyclical fluctuations become damped after four years by a factor of 0.35, corresponding to a 0.8-times change for each year of the four. It has also been verified that there is an interrelation between the balance of trade in a given year and investment two years later.

But the assumption that this lagged reaction is indeed an effect of economic policy has not been proven. Numerous other known or unknown factors might lead to the same numerical results. We might get nearer to verifying the theory if we could formulate an equation in which economic policy appears

---

*This is the theory of Frisch (1933) on the survival of economic cycles.
explicitly; in what follows, we report on an attempt to construct such an equation.

2.3. Modeling Economic Policy

On exploring investment mechanisms in greater detail it soon turned out that there was such a great difference between the instruments of economic policy used in Hungary before and after 1968 that there are no relevant statistical time series covering both periods. Thus we were only able to study the period after 1968, and this was further restricted to the period starting in 1970 as regular information on post-economic reform variables was unavailable for earlier years.

Naturally, these restrictions on the length of the period studied impose severe limitations on the conclusions that can be drawn from the mathematical and statistical results. Before the reader develops any exaggerated hopes of getting well-founded information from these econometric methods, we must stress that a firm proof of the theory is unfortunately not possible here. Nevertheless, we still feel it is of some interest to see whether or not the data of the last ten years contradict the theoretical hypothesis.

In order to take economic policy explicitly into account, eqn. (2) of the theoretical model will be replaced by two new equations (6 and 7). The influence of the balance of trade on investment is exerted through economic policy, and the theoretical model is thus expanded as follows:

\[ B_t = b(I_t) \]  \hspace{1cm} (1)

\[ G_t = g(B_{t-i}) \]  \hspace{1cm} (6)

\[ I_t = i(G_{t-k}) \]  \hspace{1cm} (7)

where \( G_t \) is some quantitative indicator of economic policy controlling investment in year \( t \). Economic policy reacts to changes in the balance of trade with a time lag of \( i \) periods, while investment follows the indicator of economic policy with a lag of \( k \) periods.
For the successful quantification of the model it is vital to find a time series that adequately represents "economic policy". From the point of view of the tools transmitting economic policy it was found expedient to distinguish between investment projects that are centrally decided and those decided upon by the individual enterprises. In the former category, economic policy clearly can influence the starting dates and scheduling of the projects, but unfortunately there are no data available to provide information about this area so that we had to exclude centrally decided investment projects from our model.

In contrast, a number of the instruments shaping enterprise investments are statistically observable, including enterprise incomes and corporate taxes, investment loans and subsidies, other financial factors influencing the financial position of the firms (such as obligatory deposits), various minimum fund requirements, etc. Thus, in this area it is at least possible that the theoretical model can be quantified. The difficulty here is that the Hungarian financial regulatory system changes almost every year, not only in terms of the quantities (sums collected or allocated), but of the instruments themselves (introduction of deposit systems, abolition of compulsory division of funds, changes in methods of financing inventories, etc.). Fortunately we were able to find one instrument of financial control that existed throughout the ten-year period and which was quantifiable as well: the total of investment loans made available. We assume here that this time series represents many tools of economic policy, including instruments of a financial nature, selective regulations, preference recommendations, "expectations", etc.

As with the more restricted model described earlier, we include a number of exogenous variables that are considered essential in explaining the dependent variable.

Enterprise investment is represented by the following equation:
EI = 12.7 + 0.7 DEPOSIT + 0.86 (CREDIT\textsubscript{-1} - CREDIT\textsubscript{-2}) (8) 
(3.97) (23.9) (2.8)

with $R^2 = 0.993$, $DW = 1.902$, and the relative error = 2.2%.

The observation period used was 1972-1979, and the notation is as follows:

$\text{EI} = \text{enterprise investment (billion forints) at current prices}$, 
$\text{DEPOSIT} = \text{total deposits (billion forints)}$, and 
$\text{CREDIT} = \text{investment loads granted (billion forints)}$.

The variable DEPOSIT represents the sources that firms themselves have available for development purposes. The major part of DEPOSIT is formed during the preceding year from the share of depreciation allowances left with the enterprises, the share of profit put into the development fund, and other revenues.

Economic policy measures involve great efforts to use this variable for influencing investment, but it would be untrue to state that this variable moves in perfect conformity with the objectives of economic policy. In fact, there are few areas where the discrepancies between objectives and realization are as great as in the planning of enterprise incomes. As an example, in 1976 the abolition of the compulsory division of profit into development funds and dividends in predetermined proportions was expected to reduce development funds, but the effect was precisely the opposite, namely, an unprecedented increase in development funds. Similarly, the steep rise in enterprise incomes in 1970-1971 was quite contrary to earlier plans.

Thus, the development of enterprise resources cannot be used as a reliable indicator of short-term economic policy intentions. These resources have followed a somewhat unpredictable path over the last ten years, as a result of continued experiments with a variety of different systems of enterprise income formation. From the modeling viewpoint, this is best considered as an exogeneous factor that causes considerable shocks in investment but is almost impossible to explain by econometric methods. (This does not mean that we have no explanation for
the long-term development of enterprise resources: economic policy eventually determines an optimal ratio between enterprise and central incomes through repeated trial and error.

As mentioned earlier, the investment loans variable (CREDIT) represents many other variables not appearing explicitly. We assume that the unobserved policy variables move in parallel with the investment loans variable. The lag of this variable indicates that enterprises invest part of their own resources depending on the amount of credit obtained: in other words, complementary investments are used to finance credit-assisted projects.

Equation (8) shows only the increment in credit from one year to the next. This allows us to exclude the effects of long-term strategic credit policy (shifts in the role of credit relative to other factors) from the equation and to concentrate on short-term economic policy reactions.

The tension function used is analogous to the second equation of the reduced model (eqn. 5):

\[
\text{BALANCE} = -4178.2 - 36.9 \text{ EI} + 1705.3 \text{ TERMS} + 189.2 T
\]

\( (2.9) \quad (2.2) \quad (4.3) \quad (2.23) \)

with \( R^2 = 0.894, \text{ DW} = 3.151, \) and the relative error = 37.1%.

The function describing economic policy reaction is now given by:

\[
\text{CREDIT} = 37.5 + 12. \text{ GDP} + 0.0084 \text{ BALANCE} + 133.8 \text{ PRICE}
\]

\( (5.9) \quad (8.5) \quad (3.8) \quad (3.0) \)

with \( R^2 = 0.97, \text{ DW} = 2.908, \) and the relative error = 5.6%. The new variable PRICE is the percentage change in the Hungarian investment price index. The observation period for eqns. (9) and (10) was 1972-1979.

Any developments in the GDP influence investment policy from the source side. Since GDP figures are given in constant prices, whereas credits are made available in current forints,
investment prices had to be included as an explanatory variable. As our primary interest here is in investment cycles, the crucial features of the system are that economic policy reacts to a deterioration in the balance of trade with the dollar area by restricting credit and to an improvement in this balance by increasing credits, and that both of these reactions occur with a time lag of one year.

Calculation of the length and damping factor of the investment cycle is somewhat more complicated here than for the two-equation model so we will present only the results: the length of the cycle is 5.13 years and the damping factor is 0.73 per year.

2.4. An Evaluation of the Cycle Approach

In summary, the experience of the last ten years does not contradict the hypothesis that the cyclical development of Hungarian enterprise investment is caused by interaction between investment policy measures and investment itself. It is interesting to note that the causes of this cyclical movement in Hungary differ from those of the much-studied cycles characteristic of market economies.

Let us recall the classic example of the pig cycle. The cycle is based on the fact that the millions of individual economic decision makers have no foresight whatsoever. Thus, they make their decisions regarding supply on the basis of present prices, since they have no way of knowing future prices. But the effects of these decisions appear only after some time has elapsed, when prices have already changed. Thus their present supply never agrees with what they would like to offer at present prices. Furthermore, the producers never learn from their mistakes, since they never have any more information at their disposal than the present price.

But in our system the decision makers are not the millions of participants in the market; they are the central authorities that shape economic policy. The present balance of trade (a notion analogous to the "market price" of the pig cycle) is not the only information available to the decision makers and they
have numerous ways of assessing the possible effects of their decisions. Nevertheless, it often appears that those shaping short-term policy are under pressure from so many simultaneous events that they give too much weight to present needs at the expense of future requirements.

Can the cycles be eliminated altogether or can the fluctuations in investment be minimized? There is surely some hope of the latter. In recent years enterprise investment has experienced several shocks from sudden changes in enterprise financial resources. The greatest annual fluctuation in total deposits was between ten and twelve billion forints, while fluctuations in credits granted attained at most half of that value. These fluctuations were not themselves parts of a cyclical process, but they played a decisive role in reviving the cycle again and again and causing relatively large amplitude changes. With accumulating experience regarding the impact of policy tools it should be possible to minimize these shocks in future.

Of course, in principle it is also possible to change the behavior of the economic policy makers producing the cycles. It is open to question to what extent policy makers can free themselves from short-term pressures when formulating investment policy, but it is likely that experience, combined with improved knowledge of just how decisions can generate cyclical behavior, may prompt them to take greater account of the delayed effects of their decisions.

3. THE "EXPANSION" APPROACH

Many Hungarian economists are rather dissatisfied with the economic results of investment in Hungary. They point out that the actual outcome of investment measures does not come anywhere near meeting either expectations or theoretical possibilities, citing the close involvement of central authorities in investment decision making as one reason for this low capital productivity (Bauer, 1978; Deák, 1978). Investment decisions are not so much guided by "efficiency considerations" as by so-called "necessities" (Barta, 1981), and the enterprises' shares of 54.3% in investment financing within the socialized
sector and 61.2% within state and cooperative industry (Table 1) do not convey an accurate picture of the location of real decision-making power.

A special investigation into the process of investment decision making showed that in 1976 the enterprises could only independently allocate 10% of the total volume of investment; in all other cases either the banks, the supervising ministry, or the planning authorities participated in the process (Figure 2). This situation raises two questions: Has the role of enterprises in investment decision making remained so small in subsequent years? And is there virtually no way for enterprises to influence the investment decisions of central authorities and banks? On the other hand we cannot accept the proposition that ignorance dominates the central authorities' decision-making process, which has been said to pursue imaginary interests rather than real economic considerations (Barta, 1981).

3.1. The Model

We shall start from the hypothesis that investment decision making basically follows economic considerations, irrespective of whether the decisions are taken by central authorities or by enterprises. This hypothesis makes it possible to describe the process by means of a model that can be tested.

As a first step we note that enterprises dispose of a large portion of the finance earmarked for investment, and they are clearly interested in spending the money and not in keeping it in a bank account. From a medium-term perspective, an enterprise gains only advantages when investing: increases in output are more easily achieved, prestige is improved, and today's investment secures future reinvestment via depreciation allowances (Mocsáry, 1981). Central authorities also dispose of a substantial share of investment finance. These finances may be used for establishing new branches in the economy (such as pipeline transport) or for setting up new and modern enterprises, but the central authorities are also free to invest in existing enterprises.
Table 1. Percentage shares of investment in the state/co-operative sector of the economy decided by central authorities (state) or by the enterprises.

<table>
<thead>
<tr>
<th>Year</th>
<th>In the whole economy</th>
<th>In industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>State Enterprises</td>
<td>State Enterprises</td>
</tr>
<tr>
<td>1975</td>
<td>43.9 56.1</td>
<td>31.9 68.1</td>
</tr>
<tr>
<td>1976</td>
<td>45.7 54.3</td>
<td>37.9 62.1</td>
</tr>
<tr>
<td>1977</td>
<td>43.7 56.2</td>
<td>34.5 65.5</td>
</tr>
<tr>
<td>1978</td>
<td>43.0 57.0</td>
<td>33.6 66.4</td>
</tr>
<tr>
<td>1979</td>
<td>45.4 54.6</td>
<td>36.3 63.7</td>
</tr>
<tr>
<td>1980</td>
<td>45.7 54.3</td>
<td>38.8 61.2</td>
</tr>
</tbody>
</table>

SOURCE: Statisztikai évkönyv 1979, pp. 113 and 117.

Figure 2. Overlapping decision levels in investment, 1976; the numbers show percentages of total investment in each category (Source: Deák, 1978).
Since the enterprises can only gain from investment and from increasing their stock of fixed assets, they try to attract as much finance as possible from the central authorities for their own investment projects. There is strong competition for the central funds. On the basis of our assumption that decision making follows economic considerations, the enterprises must therefore put forward economic arguments to influence the decision makers.

The strongest argument in this respect is a pressing need for more capital equipment, based on fully utilized existing capacities and excess demands that cannot be met because of lack of capital equipment. In most cases an enterprise will try to prevent the situation of substantial excess demand from arising, by forward planning. During periods of increasing capacity utilization, when output is growing fast, the enterprise managers will already be starting to plan further investment in increased capacity. If this hypothesis of enterprise investment decision making is correct, we can formulate a criterion to help distinguish between enterprise induced and centrally originated investment decisions. If investment is positively correlated with the previous development of output, then it has very probably arisen from an enterprise decision, whereas in other cases investment has probably originated from a decision by the central authorities.

Of course, output is not the only factor in investment decision making. We must also mention the capital coefficient (the ratio of capital to output), which helps to formulate the relationship between planned output increase and the investment needed to achieve this increase. In addition, worn out equipment must be replaced and this influences the investment demand of enterprises. Finally, relative prices may have some influence. An enterprise whose value added per unit of output is rather high can attract substantial funds for investment, but on the other hand, if prices for equipment are relatively high, the purchasing power available for investment goods is limited.

These considerations lead us to propose a sectoral investment function of the following general form:
where
\[ I = \Delta K = f(Q,K,d,Pv,Pe) \]  \hspace{1cm} (11)

where
- \( I \) = net investment,
- \( \Delta K \) = increase of capital stock (fixed assets),
- \( Q \) = output,
- \( K \) = capital stock (fixed assets),
- \( d \) = rate of depreciation,
- \( Pv \) = value added per unit of output, and
- \( Pe \) = price of investment goods.

These elements can be easily transformed into an investment function of the type used in Western economic literature, without conflicting with our remarks above on investment behavior.

Starting from a CES production function (C. Almon and Barbera, 1978)
\[ Q_t^\beta = A_t (\nu L_t^\beta + (1-\nu)K_t^\beta) \]  \hspace{1cm} (12)

where
- \( L \) = labor,
- \( A \) = a function of time, and
- \( \nu, \beta \) = constants,

we differentiate with respect to \( K \), hold \( L \) constant, and solve for \( K \), leading to
\[ K_t = B_t Q_t \left( \frac{\partial Q}{\partial K} \right)_t \]  \hspace{1cm} (13)

where \( \sigma = 1/(1-\beta) \), and \( B_t \) is a function of time only.

We shall further assume that enterprises invest only up to the point where investment costs exceed the discounted returns on investment. Returns in the year of investment amount to \( Pv(\partial Q/\partial K) \); in the year \( t \) after investment, under the assumption of a constant rate of depreciation \( d \), the returns amount to only \( Pv(\partial Q/\partial K) \exp(-dt) \).
There is no need to consider further components in our investment function. The tax on fixed assets previously in force had a rather limited allocative effect because of the extensive subsidization policy which accompanied the tax in all years after its introduction in 1968; it was only logical that this tax was finally abolished in 1980. Interest rates in Hungary are extremely low and expectations of price increases were also low during the period under investigation. We can therefore assume that a rational investment policy will lead to continued investment up to the point where either

\[
Pe = \int_{t=0}^{\infty} P_{v} \left( \frac{\partial O}{\partial K} \right) e^{-dt}
\]  

(14)

or

\[
Pe = P_{v} \left( \frac{\partial O}{\partial K} \right) \frac{1}{d}
\]  

(15)

and

\[
\left( \frac{\partial O}{\partial K} \right) = \frac{Pe \cdot d}{P_{v}}
\]  

(16)

Substituting from eqn. (16) into eqn. (13) leads to

\[
K_{t} = B_{t} Q_{t} \left( \frac{Pe \cdot d}{P_{v}} \right)_{t}^{-\sigma}
\]  

(17)

Equation (17) implies that capital stock changes immediately when either output or capital cost changes. However, such behavior cannot realistically be expected. It will take some time before the enterprise managers convince the civil servants in the central authorities that investment is urgently needed. The enterprise itself will not be able to step up investment immediately when its income (value added per unit of output) increases; neither will it be in a position to reduce planned
investment immediately when prices for investment goods go up. In view of these factors it is more realistic to introduce lags into our equation. After defining*

$$r_t = \left( \frac{Pe \cdot d}{Pv} \right)$$  \hspace{1cm} (14)

we can replace eqn. (17) by

$$K' = B_t \prod_{i=0}^{m} Q_{t-i} \prod_{i=0}^{n} r_{t-i}$$  \hspace{1cm} (15)

where

$$\sum_{i=0}^{m} w_i = 1, \quad \sum_{i=0}^{n} \sigma_i = \sigma.$$  

Under the assumption that $B_t = B_0 e^{at}$, where $a$ is a small number (on the order of 0.01), we take logarithms and then first differences of both sides of eqn. (15), and obtain

$$\Delta K_t = a + \sum_{i=0}^{m} w_i \Delta Q_{t-i} - \sum_{i=0}^{n} \sigma_i \Delta r_{t-i}$$  \hspace{1cm} (16)

where the symbol $\Delta$ denotes first difference of logarithm, which we shall approximate by the fractional changes:

$$\Delta Q_t = \frac{Q_t - Q_{t-1}}{Q_{t-1}} \quad \text{and} \quad \Delta r_t = \frac{r_t - r_{t-1}}{r_{t-1}}$$  \hspace{1cm} (17)

After multiplication of eqn. (16) by $K_{t-1}$ we get

*Definition (14) is introduced by analogy with the procedure followed by C. Almon and Barbera (1978), so that the investment function that follows (and transformations thereof) are identical to Almon and Barbera's. In this way we are able to use for our eqn. (18) the estimation program developed by Almon et al.; the provision of this program is gratefully acknowledged.
3.2. The Data

It is beyond the scope of this paper to describe in detail all sources of data used and all the adaptations that were necessary. The period under investigation is 1961-1980. In Statisztikai évkönyv* (1980, p. 110 ff.) we find data on investment for 1970-1980 at current and constant prices for nine industrial branches and for five broader sectors of the economy, which are further disaggregated into a number of subsectors. Since it was impossible to find all the data needed classified in the same way, we finally used a 23-sector classification in our investigation; details are given later in Tables 2-5.

Data for the years before 1970 can be found in older yearbooks (SY 1976, pp. 75-83; SE 1971, p. 86 for agriculture; SY 1970, pp. 83-103 for all other sectors). The time series were linked to each other and preference was given to data published in more recent yearbooks. In most cases, therefore, time series were linked twice: those for 1966-1969 were linked to later series on the basis of 1970 data, and 1961-1965 series were linked to those for 1966-1969 on the basis of 1966 information. Data for 1961-1965 on the subsectors of the construction industry were estimated under the assumption that investment in all four subsectors developed at the same rate as in construction as a whole.

Data on output for 21 branches of industry at constant prices in the period 1970-1980 are found in SE 1980 (pp. 166, 167); these data were aggregated and linked to time series given

*Yearbook of Hungarian economic statistics; elsewhere in the text we shall use the abbreviations SE (Statisztikai évkönyv) for the Hungarian edition and SY (Statistical Yearbook) for the English edition.
in older yearbooks. The same procedure, in the main, was applied to the data on other sectors of the economy. Sometimes data from older yearbooks were used for interpolating between data for the years 1960, 1965, or 1970, which are published in more recent yearbooks.

Particular problems were encountered when putting together time series on output in the transport sectors. Here, only data expressed in current prices are published; moreover, the data are disaggregated into subsectors for a few years only. We therefore derived an index of output in real terms from quantity data published elsewhere. For rail transport, freight-ton-kilometers and passenger-kilometers were aggregated with the respective weights 1.5 and 1. These weights were derived from data for the FRG (Statistisches Jahrbuch der BRD 1977, pp. 258-260) and are similar to data for Italy (1.6:1) (Annuario Statistico Italiano 1973, p. 273). Similarly, an output index for road and urban transport was created; missing data on freight-ton-kilometers for 1961-1963 had to be estimated (based on the same rate of growth as in 1964-1968) and data on passenger-kilometers had to be interpolated for the periods 1961-1964 and 1966-1969. We assumed the same weights as in rail transport.

For the output of "other transport" we assumed the following weights for freight-ton-kilometers,

- Water transport: 150
- Air transport: 1500
- Pipelines: 75

and for passenger-kilometers,

- Water transport: 1000
- Air transport: 1000

The same problem arose for "communications" where we assumed the following weights,

- Letters: 100
- Telegrams: 1000
- Parcels: 500
- Telephone (local calls): 100
- Telephone (long distance calls): 500
- Newspapers: 30.
Missing data on telephone calls for 1961-1964 were interpolated; for the years after 1976, the published numbers of impulses were converted to unit calls (one local call = 1000 impulses, and one long distance call = 5000 impulses).

Time series on value added (at current prices) per unit of output were derived via the data on net production, which is calculated (at current prices) as the difference between output and production costs. The time series of indexes of net production were divided by the time series of indexes of output at constant prices. In cases where data are available for a broad sector only (e.g., construction) but not for subsectors, we assumed the same development in all subgroups. Missing data for the years before 1968 were estimated with the help of information derived from the input-output tables for 1958, 1965, and 1968 and appropriately interpolated.

Price indexes for investment were calculated by dividing the investment time series at current prices by those at constant prices. For the years 1961-1967 the published price indexes for broad sectors (industry, agriculture and forestry, etc.) are assumed to hold for all the respective subsectors.

The rate of depreciation is calculated as the ratio of depreciation allowances to fixed assets (both at current prices). Missing single data (mostly for subsectors in transport and construction) are estimated or interpolated.

3.3. The Method of Estimation

Assuming that the theory behind the investment model of eqn. (18) holds, a number of results should follow:

If investment is determined solely by economic considerations, the development of output and capital costs should be sufficient to explain the development of net investment. Thus we would expect the constant term in eqn. (18) to be relatively small.

In the case of a constant capital coefficient, and an explanation of investment solely in terms of output, we can expect the sum of the weights in the lag structure to be equal
to unity. Thus, even without formulating any detailed hypothes-

sis on the development of the capital coefficient, we think

that the sum of weights can be expected to be not too far from

unity.

As regards the time distribution of the lags, we expect

a regular pattern; for example, it seems implausible that the

years two and four should have higher weights than years one

and three. We would expect that years farther back would have

a smaller weight than more recent years. As the lags become

shorter, the weight increases; but the weight may decrease

again for the most recent year (e.g., because only incomplete

or preliminary information is available for the previous year).

The estimation technique applied was developed by Clopper

Almon and co-workers (Reimbold and C. Almon, 1970; C. Almon

et al., 1974) based on Dantzig's "quadratic programming"

(Dantzig, 1963). This technique allows us to use a priori ex-

pectations as to the results of the estimation procedure for

interpretation. Almon and his colleagues were interested in

achieving results well suited for projections; for this purpose,

the most appropriate features are a constant term close to zero,

the sum of the weights close to unity, and a distribution of

lags of the type developed by Shirley Almon (S. Almon, 1965).

To achieve such results without losing too much of the

explanatory value of the estimated coefficients, an objective

function was introduced to minimize

\[ Z = G_1(1-R^2) + G_2(1-Iw_i)^2 + G_3\left(\frac{a}{v}\right)^2 \]  

(19)

where \( G_1, G_2, \) and \( G_3 \) are the chosen weights in the objective

function, and

\[ R = \text{coefficient of determination}, \]

\[ w_i = \text{weights of the Almon-distributed lags}, \]

\[ a = \text{constant term}, \] and

\[ v = \text{variance of observed investment}. \]

In other words, we are willing to give up some explanatory value

(as measured by the coefficient of determination) if the sum
of the weights comes closer to unity or the constant term closer to zero.

We shall use these features of the estimation procedure in the following way. If it is possible to keep the constant term small and the coefficient of determination remains significant, we can assume that investment decisions have not been made independently by the central authorities. In such cases the enterprises do have an influence on the investment decision. If, in addition, we can identify a significant sigma value (larger than 0.1), then the investment decision was also influenced by efficiency (productivity) considerations, such as enterprise income, prices of investment goods, or depreciation costs.

3.4 The Results

We estimated the investment equations with four different sets of weights in objective function (18): first, with \( G_1 = G_2 = G_3 = 1 \); second, with \( G_1 = 10 \) and \( G_2 = G_3 = 1 \); third, to suppress the constant term, with \( G_1 = G_2 = 0.1 \) and \( G_3 = 10 \); and fourth, so that \( \sum w_i = 1 \), with \( G_1 = 1 \), \( G_2 = 10 \), \( G_3 = 1 \). For each of the equations we estimated four Almon-distributed lags. The results of these estimations are given in Tables 2-5.

The previous findings of Hungarian economists (Bauer, 1978; Soós, 1978) that capital costs have little influence on investment decision making* are confirmed by our results. For only four branches (mining, chemical industry, non-building construction, and telecommunications) did we obtain, in all four variants of the estimations, a sigma value greater than 0.1. The possibility of coincidence cannot be completely excluded, because of the substitution effect between the constant term and sigma. When the constant term is suppressed (Table 4) we get sigma values higher than 0.1 in eight cases.

The results of the estimated equations show that the development of output in the four preceding years has a high explanatory value for investment. Suppressing the constant term

*Similar results were obtained for the FRG (Uhlmann, 1981, p. 31)
Table 2. Estimated investment equations using $G_1 = 1$, $G_2 = 1$, $G_3 = 1$ in objective function (19).

<table>
<thead>
<tr>
<th>Sector</th>
<th>Coefficient of determination (R)</th>
<th>Constant term (a)</th>
<th>Sum of weights ($\sum w_i$)</th>
<th>Sigma (σ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>0.858</td>
<td>612.9</td>
<td>0.842</td>
<td>0.500</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.938</td>
<td>-608.8</td>
<td>1.153</td>
<td>0.062</td>
</tr>
<tr>
<td>Metallurgy</td>
<td>-0.362</td>
<td>779.7</td>
<td>0.858</td>
<td>0.001</td>
</tr>
<tr>
<td>Machine building</td>
<td>0.767</td>
<td>0.0</td>
<td>0.946</td>
<td>0.0</td>
</tr>
<tr>
<td>Construction material</td>
<td>0.433</td>
<td>934.4</td>
<td>0.963</td>
<td>0.033</td>
</tr>
<tr>
<td>Chemical industry</td>
<td>0.872</td>
<td>-502.8</td>
<td>0.875</td>
<td>0.113</td>
</tr>
<tr>
<td>Light industry</td>
<td>0.586</td>
<td>1084.9</td>
<td>0.987</td>
<td>0.0</td>
</tr>
<tr>
<td>Other industry</td>
<td>0.881</td>
<td>42.1</td>
<td>1.099</td>
<td>0.0</td>
</tr>
<tr>
<td>Food processing</td>
<td>0.707</td>
<td>1112.0</td>
<td>1.125</td>
<td>0.0</td>
</tr>
<tr>
<td>Building</td>
<td>0.868</td>
<td>534.6</td>
<td>1.196</td>
<td>0.002</td>
</tr>
<tr>
<td>Nonbuilding construction</td>
<td>0.837</td>
<td>267.6</td>
<td>1.188</td>
<td>0.071</td>
</tr>
<tr>
<td>Fitting and mounting</td>
<td>0.681</td>
<td>64.0</td>
<td>1.119</td>
<td>0.0</td>
</tr>
<tr>
<td>Designing</td>
<td>0.396</td>
<td>100.3</td>
<td>0.941</td>
<td>0.0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.704</td>
<td>6384.1</td>
<td>1.153</td>
<td>0.063</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.648</td>
<td>193.1</td>
<td>1.006</td>
<td>0.104</td>
</tr>
<tr>
<td>Water management</td>
<td>-0.094</td>
<td>1907.1</td>
<td>0.377</td>
<td>0.0</td>
</tr>
<tr>
<td>Rail transport</td>
<td>0.528</td>
<td>2131.5</td>
<td>0.236</td>
<td>0.089</td>
</tr>
<tr>
<td>Road and urban transport</td>
<td>0.770</td>
<td>0.0</td>
<td>0.546</td>
<td>0.0</td>
</tr>
<tr>
<td>Other transport</td>
<td>0.348</td>
<td>256.1</td>
<td>0.694</td>
<td>0.093</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>0.397</td>
<td>807.4</td>
<td>0.052</td>
<td>0.720</td>
</tr>
<tr>
<td>Home trade</td>
<td>0.796</td>
<td>1354.0</td>
<td>1.152</td>
<td>0.116</td>
</tr>
<tr>
<td>Foreign trade</td>
<td>0.846</td>
<td>123.5</td>
<td>1.145</td>
<td>0.0</td>
</tr>
<tr>
<td>Services</td>
<td>0.901</td>
<td>1807.3</td>
<td>0.980</td>
<td>0.008</td>
</tr>
</tbody>
</table>
Table 3. Estimated investment equations using $G1 = 10$, $G2 = 1$, $G3 = 1$ in objective function (19).

<table>
<thead>
<tr>
<th>Sector</th>
<th>Coefficient of determination ($R$)</th>
<th>Constant term ($a$)</th>
<th>Sum of weights ($\sum w_i$)</th>
<th>Sigma ($\sigma$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>0.838</td>
<td>1470.9</td>
<td>0.315</td>
<td>0.500</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.952</td>
<td>-3170.9</td>
<td>1.705</td>
<td>0.085</td>
</tr>
<tr>
<td>Metallurgy</td>
<td>0.087</td>
<td>2387.9</td>
<td>0.016</td>
<td>0.005</td>
</tr>
<tr>
<td>Machine building</td>
<td>0.767</td>
<td>-2539.3</td>
<td>1.374</td>
<td>0.0</td>
</tr>
<tr>
<td>Construction material</td>
<td>0.441</td>
<td>1260.7</td>
<td>0.739</td>
<td>0.028</td>
</tr>
<tr>
<td>Chemical industry</td>
<td>0.873</td>
<td>-97.4</td>
<td>0.809</td>
<td>0.112</td>
</tr>
<tr>
<td>Light industry</td>
<td>0.589</td>
<td>1499.8</td>
<td>0.820</td>
<td>0.0</td>
</tr>
<tr>
<td>Other industry</td>
<td>0.881</td>
<td>17.8</td>
<td>1.189</td>
<td>0.0</td>
</tr>
<tr>
<td>Food processing</td>
<td>0.715</td>
<td>-252.4</td>
<td>1.724</td>
<td>0.0</td>
</tr>
<tr>
<td>Building</td>
<td>0.869</td>
<td>247.7</td>
<td>1.581</td>
<td>0.014</td>
</tr>
<tr>
<td>Nonbuilding construction</td>
<td>0.843</td>
<td>116.3</td>
<td>1.734</td>
<td>0.133</td>
</tr>
<tr>
<td>Fitting and mounting</td>
<td>0.682</td>
<td>39.4</td>
<td>1.691</td>
<td>0.0</td>
</tr>
<tr>
<td>Designing</td>
<td>0.391</td>
<td>140.4</td>
<td>0.665</td>
<td>0.0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.720</td>
<td>7667.7</td>
<td>1.067</td>
<td>0.089</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.649</td>
<td>241.4</td>
<td>0.882</td>
<td>0.085</td>
</tr>
<tr>
<td>Water management</td>
<td>-0.094</td>
<td>5171.1</td>
<td>0.009</td>
<td>0.009</td>
</tr>
<tr>
<td>Rail transport</td>
<td>0.752</td>
<td>2794.9</td>
<td>0.008</td>
<td>0.067</td>
</tr>
<tr>
<td>Road and urban transport</td>
<td>0.771</td>
<td>-4157.1</td>
<td>0.996</td>
<td>0.007</td>
</tr>
<tr>
<td>Other transport</td>
<td>0.369</td>
<td>745.9</td>
<td>0.383</td>
<td>0.057</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>0.475</td>
<td>1062.3</td>
<td>0.0</td>
<td>0.514</td>
</tr>
<tr>
<td>Home trade</td>
<td>0.803</td>
<td>947.7</td>
<td>1.411</td>
<td>0.002</td>
</tr>
<tr>
<td>Foreign trade</td>
<td>0.847</td>
<td>82.0</td>
<td>1.366</td>
<td>0.0</td>
</tr>
<tr>
<td>Services</td>
<td>0.901</td>
<td>3133.1</td>
<td>0.939</td>
<td>0.009</td>
</tr>
</tbody>
</table>
Table 4. Estimated investment equations using G1 = 0.1, G2 = 0.1, G3 = 10 in objective function (19).

<table>
<thead>
<tr>
<th>Sector</th>
<th>Coefficient of determination (R)</th>
<th>Constant term (a)</th>
<th>Sum of weights (Σ wi)</th>
<th>Sigma (σ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>0.864</td>
<td>26.9</td>
<td>1.132</td>
<td>0.500</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.929</td>
<td>-25.8</td>
<td>1.060</td>
<td>0.073</td>
</tr>
<tr>
<td>Metallurgy</td>
<td>-0.356</td>
<td>47.5</td>
<td>1.111</td>
<td>0.012</td>
</tr>
<tr>
<td>Machine building</td>
<td>0.767</td>
<td>-29.3</td>
<td>0.950</td>
<td>0.0</td>
</tr>
<tr>
<td>Construction material</td>
<td>0.403</td>
<td>69.9</td>
<td>1.348</td>
<td>0.037</td>
</tr>
<tr>
<td>Chemical industry</td>
<td>0.873</td>
<td>-14.3</td>
<td>0.811</td>
<td>0.112</td>
</tr>
<tr>
<td>Light industry</td>
<td>0.570</td>
<td>62.2</td>
<td>1.307</td>
<td>0.0</td>
</tr>
<tr>
<td>Other industry</td>
<td>0.881</td>
<td>2.1</td>
<td>1.196</td>
<td>0.0</td>
</tr>
<tr>
<td>Food processing</td>
<td>0.718</td>
<td>86.5</td>
<td>1.337</td>
<td>0.0</td>
</tr>
<tr>
<td>Building</td>
<td>0.868</td>
<td>42.8</td>
<td>1.505</td>
<td>0.0</td>
</tr>
<tr>
<td>Nonbuilding construction</td>
<td>0.842</td>
<td>25.6</td>
<td>1.507</td>
<td>0.109</td>
</tr>
<tr>
<td>Fitting and mounting</td>
<td>0.681</td>
<td>7.7</td>
<td>1.359</td>
<td>0.0</td>
</tr>
<tr>
<td>Designing</td>
<td>0.353</td>
<td>6.0</td>
<td>1.407</td>
<td>0.0</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.601</td>
<td>304.1</td>
<td>1.738</td>
<td>0.0</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.647</td>
<td>13.4</td>
<td>1.328</td>
<td>0.117</td>
</tr>
<tr>
<td>Water management</td>
<td>-0.094</td>
<td>77.9</td>
<td>0.546</td>
<td>0.0</td>
</tr>
<tr>
<td>Rail transport</td>
<td>0.068</td>
<td>100.2</td>
<td>0.848</td>
<td>0.146</td>
</tr>
<tr>
<td>Road and urban transport</td>
<td>0.770</td>
<td>-74.3</td>
<td>0.554</td>
<td>0.0</td>
</tr>
<tr>
<td>Other transport</td>
<td>0.342</td>
<td>16.5</td>
<td>0.792</td>
<td>0.100</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>0.218</td>
<td>45.8</td>
<td>0.181</td>
<td>1.239</td>
</tr>
<tr>
<td>Home trade</td>
<td>0.782</td>
<td>105.2</td>
<td>1.438</td>
<td>0.311</td>
</tr>
<tr>
<td>Foreign trade</td>
<td>0.843</td>
<td>10.7</td>
<td>1.371</td>
<td>0.0</td>
</tr>
<tr>
<td>Services</td>
<td>0.901</td>
<td>75.6</td>
<td>1.026</td>
<td>0.009</td>
</tr>
</tbody>
</table>
Table 5. Estimated investment equations using \( G_1 = 1, G_2 = 10, \)
\( G_3 = 1 \) in objective function (19).

<table>
<thead>
<tr>
<th>Sector</th>
<th>Coefficient of determination ( (R) )</th>
<th>Constant term ( (a) )</th>
<th>Sum of weights ( (\sum W_i) )</th>
<th>Sigma ( (\sigma) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining</td>
<td>0.843</td>
<td>719.7</td>
<td>1.000</td>
<td>0.132</td>
</tr>
<tr>
<td>Electricity</td>
<td>0.935</td>
<td>-27.0</td>
<td>1.021</td>
<td>0.060</td>
</tr>
<tr>
<td>Metallurgy</td>
<td>-0.348</td>
<td>559.3</td>
<td>0.983</td>
<td>0.000</td>
</tr>
<tr>
<td>Machine building</td>
<td>0.767</td>
<td>-512.0</td>
<td>1.010</td>
<td>0.000</td>
</tr>
<tr>
<td>Construction material</td>
<td>0.431</td>
<td>897.4</td>
<td>0.995</td>
<td>0.035</td>
</tr>
<tr>
<td>Chemical industry</td>
<td>0.868</td>
<td>-1110.5</td>
<td>0.973</td>
<td>0.113</td>
</tr>
<tr>
<td>Light industry</td>
<td>0.585</td>
<td>1062.4</td>
<td>0.998</td>
<td>0.000</td>
</tr>
<tr>
<td>Other industry</td>
<td>0.880</td>
<td>65.2</td>
<td>1.016</td>
<td>0.000</td>
</tr>
<tr>
<td>Food processing</td>
<td>0.704</td>
<td>1361.7</td>
<td>1.014</td>
<td>0.000</td>
</tr>
<tr>
<td>Building</td>
<td>0.868</td>
<td>668.5</td>
<td>1.025</td>
<td>0.000</td>
</tr>
<tr>
<td>Nonbuilding construction</td>
<td>0.831</td>
<td>315.5</td>
<td>1.022</td>
<td>0.051</td>
</tr>
<tr>
<td>Fitting and mounting</td>
<td>0.681</td>
<td>68.9</td>
<td>1.013</td>
<td>0.000</td>
</tr>
<tr>
<td>Designing</td>
<td>0.394</td>
<td>94.1</td>
<td>0.991</td>
<td>0.000</td>
</tr>
<tr>
<td>Agriculture</td>
<td>0.700</td>
<td>6923.6</td>
<td>1.022</td>
<td>0.048</td>
</tr>
<tr>
<td>Forestry</td>
<td>0.648</td>
<td>194.3</td>
<td>1.001</td>
<td>0.103</td>
</tr>
<tr>
<td>Water management</td>
<td>-0.101</td>
<td>-1769.6</td>
<td>0.832</td>
<td>0.000</td>
</tr>
<tr>
<td>Rail transport</td>
<td>0.138</td>
<td>1105.0</td>
<td>0.683</td>
<td>0.123</td>
</tr>
<tr>
<td>Road and urban transport</td>
<td>0.771</td>
<td>-3730.4</td>
<td>0.969</td>
<td>0.004</td>
</tr>
<tr>
<td>Other transport</td>
<td>0.334</td>
<td>-104.3</td>
<td>0.943</td>
<td>0.124</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>-0.116</td>
<td>-411.9</td>
<td>0.426</td>
<td>1.500</td>
</tr>
<tr>
<td>Home trade</td>
<td>0.732</td>
<td>1461.5</td>
<td>1.016</td>
<td>0.500</td>
</tr>
<tr>
<td>Foreign trade</td>
<td>0.845</td>
<td>149.7</td>
<td>1.020</td>
<td>0.000</td>
</tr>
<tr>
<td>Services</td>
<td>0.901</td>
<td>1367.4</td>
<td>0.996</td>
<td>0.007</td>
</tr>
</tbody>
</table>
has very little effect on the coefficient of determination, which remains larger than 0.5 for 16 out of 23 branches of the economy.

Output, however, was of little or no help in explaining investment in metallurgy, the construction material industry, designing, water management, the transport sectors, or telecommunications. In transport and telecommunications this may be connected with poor data, but infrastructures that were neglected for decades and relatively new developments in transport (pipelines) probably also play a role. Similar considerations may apply to water management. In the construction material industry we observe major fluctuations in investment since 1971, which can hardly be explained in terms of sector-specific arguments. It is difficult to avoid the conclusion that the investment process has suffered over the years due to frequent abrupt changes in the priorities of the central decision-making authorities.

Having achieved these results, we agree with most Hungarian economists that prices and capital costs play only a very limited role in Hungarian investment decision making. The tendency to base investment decisions on the development of output in preceding years seems to be dominant. In other words, an expansion-oriented rather than an efficiency-oriented investment policy has been pursued during the last 15 years. There seems to be little conflict between enterprises and central authorities in using past output as the main argument for future investment. In the infrastructure sectors, however, investment decisions follow a different set of arguments, which cannot be identified using the type of statistical analysis applied in this paper.
4. RECONCILING THE APPROACHES

We now have a model for total investment and a model for sectoral investment. In the first model investment depends on output, among other factors, but economic policy cycles lie at the center of the analysis. In the second model, policy cycles are completely ignored and output is the main explanatory variable for investment. How can we reconcile these different approaches when trying to set up a model explaining both total investment and its sectoral distribution? Several possibilities suggest themselves:

1. First, we could extend the sectoral model by introducing policy variables into each sectoral equation. If the policy-cycle model is correct, this should lead to better estimation results. However, we would soon run into practical problems caused by either the lack of sufficient degrees of freedom in the estimation or the difficulty of finding a sufficiently long time series to represent "economic policy".

2. Another way of retaining the best features of both models would be to model total investment using the policy cycle approach and then to distribute investment using the expansion approach model, replacing sectoral output and investment in the expansion model with shares of sectoral output and investment. This procedure seems theoretically feasible and it may be experimented with in the future.

3. But the simplest way to handle the problem is to consider our input-output model as a medium-term model and to ignore investment cycles as short-run phenomena. At present the model is set up along these lines. Further work, in which the simulated values of sectoral investments will be summed and compared to actual total investments, will show whether the errors arising from this omission are substantial or not. The results of this comparison are difficult to foresee. Cyclical behavior is already simulated adequately for some sectors by the expansion approach model without any explicit policy variables. However, if the aggregate results are not satisfactory in this respect, we may try to improve the short-term behavior of the model as outlined in point (2) above.
REFERENCES