# DUNA 1

A Multisectoral Model of Hungary to
**D**evelop **U**nderstanding of **N**ational **A**lternatives

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DUNA is a model for dynamic economic analysis of the Hungarian economy. It was constructed with support from Lockheed Martin, and one of its initial purposes is to help in analyzing the results of an industrial cooperation package which results in increases in exports. It includes a 21-industry input-output table, national accounts, and statistically estimated functions for:

household consumption in 25 product groups,
investment by each of the 21 industries, and
labor productivity in each of these industries.

From exogenous values of exports and government expenditures, it produces outputs of the 21 industries, their imports, and employment. For each of the 21 industries, DUNA also can show its sales to each of the other industries, to each category of households expenditure, to government, to capital investment (by investing industry), and to exports. Historical data are included up to 1995. It can be used to simulate the growth of the Hungarian economy under a variety of alternatives over the period from 1996 to 2010.

The name, DUNA, abbreviates a major purpose of the model — to Develop Understanding of National Alternatives. At the same time it is the Hungarian name of the Danube, and thus both quintessentially Hungarian and profoundly international.

The present report represents only a few researcher-months. While it shows some of the things that can be done, it leaves much for the future. At present, DUNA has only a real side; no attempt has been made to model inflation, prices, exchange rates, or other monetary variables. The model works in constant 1993 forints, for 1993 is the last year of a published input-output table. Even the modeling of the real side is necessarily incomplete. The Hungarian national accounts are currently incomplete in that they do not allow computation of the balance in the government budget. This calculation is therefore also missing in DUNA. Although relative prices have been used in estimating the consumer demand system, they are not modeled and are not changed endogenously by different scenarios. Imports have been kept at constant shares of domestic use in each cell of the input-output table. There has been no attempt to project input-output coefficients. Exports and government demands have been left exogenous. Despite these limitations, the model offers, we believe, a valuable — though limited -- tool for study of a variety of policy questions. At the same time, it offers a framework for integrating a variety of deeper studies of the Hungarian economy.

It has often been said that models cannot be used at a time of radical transition such as Hungary has undergone and continues to undergo. We feel, on the contrary, that it is exactly at such times that models are most valuable. For it is also at precisely such a time that a policy maker's intuitive feel for how the system works is least reliable. In the model, one is clear about what is assumed to remain unchanged and what changes and by how much. These assumptions may prove wrong, but they are clear and capable of being varied. Without a model, a policy maker simply goes on unspecified hunches and intuitions about how the system will work. It is the practically universal experience of model builders that the models show properties that surprise the people who built them. Anyone who has built a model, therefore, strongly suspects that the hunches and intuitions of those who do not build models are poor guides about how the economic system will work, especially in times of rapid change.

In this report, we will first describe the data and accounting system which forms the basis of DUNA. We then describe the three types of estimated behavioral equations: household consumption, investment, and labor productivity. We then examine the effects of increased exports of selected items, in look in particular at the effects of these changes on investment requirements. Finally, we describe how the model can be operated.

## Accounting Framework and Data

### *Framework tables*

The fundamental national accounting framework is taken from *Input-Output Tables of Hungary 1991-1993*, a 1996 publication of the Hungarian Central Statistical Office (KSH). These tables have the sectors shown in Table 1.

**Table 1. Industry Sectors**

1 Agriculture, hunting and fishing
2 Forestry
3 Mining and quarrying
4 Food and tobacco industry
5 Light industry (textiles, clothing, footwear, wood, paper, printing, publishing)
6 Chemicals (includes petroleum refining and rubber and plastic products)
7 Non-metallic mineral products (stone, clay and glass products)
8 Metals and metal products, except machinery
9 Machinery, including computers, instruments, and transportation equipment
10 Other Manufacture (furniture, misc. mfg., recycling)
11 Electricity, gas, steam and water supply
12 Construction
13 Trade and repair
14 Hotels and restaurants
15 Transport, storage
16 Post and telecommunications
17 Financial intermediation
18 Real estate, renting and business services
19 Public administration, membership organizations, recreation, and other services
20 Education
21 Health and social work

This publication has two tables for each of the three years. One table shows the flows of domestically made products among industries and final demands. The other shows the flows of imported goods. The flows are evaluated at producer prices without value added taxes (VAT) but including other indirect taxes. Thus, they follow the best practice for input-output tables, decidedly better than the practice of a number West European statistical offices which publish tables where the flows include the non-deductible VAT, thus making them non-comparable across the rows.

We entered the tables for all three years into the computer, converted them all to 1993 prices with the GDP deflator, and compared them, both in the absolute flows and in the input-output coefficients. The differences were rather large. These comparisons were shown to an official of the Central Statistical Office (KSH ) who had been close to the construction. He observed that the three tables were made quite independently of one another without an effort to insure comparability in the individual cells. He therefore felt that comparison of these three tables did not constitute firm grounds for projecting changes in the coefficients. We have, accordingly, left the coefficients constant at their 1993 values for the time being.

The second element of the accounting framework is provided by the "inter-institutional" tables of the Hungarian National Account. These are found on fold-out pages in the KSH publication *National Accounts Hungary 1991-1994*, also a 1996 publication. The numbers in this publication are, by the way, consistent down to the last decimal point with the numbers in the input-output tables. The Hungarian statisticians have not only converted to western-style accounts in a remarkably short period, they have produced publications that have a consistency and clarity that is quite remarkable. They have even managed to retain some comparability with their earlier statistics.

The part of this framework which we especially used and built into the model concerns how household income derives from wages and salaries, proprietor and partner income, interest, dividends, rent, transfers and other sources and how some of it is used to pay various taxes, leaving finally disposable income to be saved or spent. The details are found on pages 150 and 151 of the cited work.

These works did not include two "bridge" tables which we had to make ourselves. One of these converts household consumption from the categories used in the time-series data on household consumption found in *National Accounts* to consumption in by each of the 21 industries. The other converts investment by each of the 21 industries as purchasers of capital to demands for the goods of the 21 industries.

The first of these, the consumption bridge, was made basically on the basis of the names of the products and of the industries. One of the main things that this bridge must do is to strip of the trade and transportation margins from the amounts the consumer pays, place the margins as demands for trade and transportation, and place what is left as a demand on the industry that made the product in the first place.

For making the second, the investment bridge, we had information on the total investment by purchaser in the *National Accounts*, while we had investment by product purchased in the input-output tables. Somewhat surprisingly, every one of the 21 industries sells to “fixed capital investment,” although only four of the sectors show inputs of imported capital goods. The reason for this difference is well illustrated by Forestry, which has a large sale to capital investment. That sale is mainly the planting and tending of forests before they are ready for cutting. Thus, outside of the four capital goods industries, the sales to capital are probably for investment by the industry which produced them. Thus, all of the sales to investment by the 17 industries that do not make “investment goods” in the usual sense were considered sales to investment by the same industry. That left to be distributed to buyers only the sales of four industries. Here, a most helpful source was found in the “investment” section of the *Statistical Yearbook of Hungary, 1994* which divides investment by sector among (a) machinery (b) construction, and (c) other. These data, however, covered only legally organized companies and omitted family businesses and individual proprietors, so they had to be scaled up to the totals found in the *National Accounts.* The machinery and construction rows were then scaled to the totals found in the input-output tables, and the rest was distributed between metal products (industry 8) and furniture (industry 10). Thus, it was possible to construct this bridge with a minimum of guesswork.

*Time series data*

Building the model required time series data on:

- household consumption in consumer categories in both current and constant prices.
- output by industry
- investment by purchasing industry in constant prices
- employment by industry
- aggregates from the national accounts.

These data were put into a file for input into the G regression and model building program. This file is called **na.dat** , which originally stood National Accounts, though it came to contain much more. This file is the ultimate documentation of where the data came from and how they were reworked into what we needed. When passed through the G program, these data became the Hungary bank for G, which is automatically assigned when G is started within the Hungary or DUNA directory, which is where the model resides. To examine the data, after installing the model, simply type G at the DOS prompt. At the | prompt in G, type “look”. Use the up and down arrows to scroll through the list of series. It you wish to see one graphed, just put the cursor on it and tap g .

We have already met the two main sources of time series data, the National Accounts and various issues of the *Statistical Yearbook of Hungary*, especially the 1995 edition.

The *consumption* series was taken from the national accounts book. The data were available in two sets of data , first data from 1988 to 1991, and then data from 1991 to 1994. The values for 1991 were different in the two sets which indicated some definitional changes. Therefore the first thing to be done was to link these two series together with the “benchmark” function, *@bmk*, of G. This function took the 1991 value from the 1991-94 series and moved it back by the index of the values for 1988-91. Once we have one long series from 1988 to 1994, the next step was to aggregate the very detailed data for consumption of over a hundred different items to 25 consumption sectors more convenient for analysis.

*Output* data were found in the form of volume indexes. For the sectors in Industry (Sectors 3 - 11), these volume indexes were available from 1950 to 1995. They were available from 1991 to 1995 for all the other industries except that Forestry was combined with Agriculture and Communication was combined with Transportation. An index for Construction was also available back to 1970. Before 1991, for other sectors outside Industry, only four indexes were available to us (from *National Accounts* page 28):

Agriculture and fishery + Forestry
Trade +Hotels and restaurants
Transport + Communication
Finance + Real estate + Public administration + Education + Health and social work

Consequently, for these years before 1991, output for all the sectors on the same line above move with the same index. Direct contact with the KSH might substantially improve this database.

Note that Sectors 15 and 16, Transportation and Communication, were combined in the volume indexes for all years. Employment data, however, consistently separated them. We computed the productivity trend for the combination, assumed that both had the same trend in productivity, and thus used the two employment series to produce two different output series.

After we were engaged in the study of productivity, we came back and revised two of the output series, those of 5 Light industry and 6 Chemicals. Why would we tamper with the official growth rates? When we graphed productivity for these sectors we saw a decline of some thirty percent between 1989 and 1995, when output had stabilized in these two industries. It was somehow hard to believe that all the privatization had resulted in such a large drop in productivity in these two industries while it had increased productivity in most others. Could the problem be that the statistical measurements failed to account properly for quality change? The products produced in 1989 were sold in a highly protected market. Many of those products could not stand the competition with western products and were eliminated in the course of the reforms. Those that were being made in 1995 were fully competitive with the western products. Did the KSH adequately account for this difference? It would be easy and natural not to do so. We have therefore taken the liberty of modifying the output series, allowing for a thirty percent increase in quality between 1991 and 1994. With this change, the productivity equations for these two industries make much more sense.

With the volume indexes in hand, we used them to move the 1993 outputs from the input-output table forward and backwards.

*Investment* data were also derived mainly through volume indexes. The 1995 Yearbook has (page 251) volume indexes for investment by 15 sectors of the economy for the years 1990 - 1995. These correspond to our 21 sectors except for the following combinations:

Agriculture + Forestry (Sectors 1 and 2)
Transport + Communication (Sectors 15 and 16)
Manufacturing (Sectors 4 -10)

We accepted the inevitable and used the same index for both components of the first two combinations. The last combination however, was too large to ignore. Moreover, in the Yearbooks of 1990 and earlier years, it was easy to find volume indexes of investment in the manufacturing industries, as well as indexes for other "material" sectors, and a single series for the service sectors. What were we to do for the manufacturing sectors after 1990? Fortunately, the yearbooks (and the national accounts) contain current forint value of investment for each manufacturing industry for 1991 and later years. We recorded these and then deflated them by the deflator in the national accounts for fixed investment. This procedure, however, left a hole for the change between 1990 and 1991. Presumably the key lies in the Yearbook for 1991, but precisely this volume has been lost from our library's collection. Until we can fill in the gap, we have simply guessed the 1991 values of the volume indexes on the basis of earlier trends and then adjusted those guesses so that total manufacturing has the right movement.

The total investment by each of the 21 sectors was readily available in *National Accounts* for 1993. These values were then moved forward and back by the volume indexes. All the series should be fairly good back to 1975. To have longer series for computing capital stocks, we extended them back to 1950 by the index of total investment; this portion of the series should, of course, be taken as nothing more than a gross approximation, but better than taking them to be zero.

Some *Employment* data is in units of persons; other, in volume indexes. For Industry sectors , the volume indexes go back to 1950. Therefore, we can move actual employment in these sectors by the volume indexes to get a long series of employment. We were able to find a similar long series of volumes of employment for agriculture with which to move back the actual employment of a recent year. Services sectors were moved by a series called total services, and the rest of the series were moved by a long series of total employment.

All of the series from the "integrated accounts" of *National Accounts* have been entered into the data bank, although only some of them are currently used. These series are divided between the Uses side and the Resources side, and each column is also represented by a letter (which are defined in na.dat). Each row of the table from the integrated account has a letter-number code. This household column of this data has been used, earlier in na.dat, and has an important role to play in the accountant of the model. The major aggregates, such as real GDP and its components, have been extended back to the 1950's.

## Estimated Equations

Estimation of behavioral equations for Hungary poses unusual challenges. Usually equations are estimated on the basis of data from a period of growth to be used in forecasting a period of growth. In analyzing Hungarian experience, we have to use a period of sharp decline to estimate functions to be used during what will be, it is to be hoped, a period of steady rise in real incomes.

*Consumption Equations*

The consumption functions were estimated with the Perhaps Adequate Demand System form described in *The Inforum Approach to Household Consumption (*Inforum Working Paper 97-001). The results are contained in Table 2. The most important parameters to note here are the income elasticities (IncEl column), price elasticities (PrEl column) and the strength of the autonomous time trend, here expressed as the change in one year as a percent of the consumption of the item in 1994 (time% column).

**Table 2. Parameters of the PADS Consumption Functions**

The mu: -0.25 0.37 -0.34

| nsec | title | G | S | P | C | T | I | lamb | share | IncEl | DInc | time% | PrEl | Err% | rho |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Meat, poultry, eggs, f | 1 | 0 | 1 | 1 | 1 | 1 | 0.33 | 0.063 | 0.99 | 0.11 | -2.52 | -0.25 | 1.03 | -0.48 |
| 2 | Dairy products, margar | 1 | 0 | 1 | 1 | 1 | 1 | 0.46 | 0.029 | 0.99 | -0.16 | -3.65 | -0.35 | 1.14 | -0.43 |
| 3 | Bread and cereals | 1 | 0 | 1 | 1 | 1 | 1 | 0.10 | 0.030 | 0.49 | 1.66 | -3.56 | -0.01 | 1.66 | -0.28 |
| 4 | Fresh fruits and veget | 1 | 0 | 1 | 1 | 1 | 1 | 0.05 | 0.019 | 0.83 | -1.16 | 0.59 | 0.04 | 2.85 | -0.31 |
| 5 | Other processed food | 1 | 0 | 1 | 1 | 1 | 1 | 0.08 | 0.073 | 1.49 | 0.44 | -1.70 | -0.04 | 3.25 | 0.17 |
| 6 | Alcohol | 0 | 0 | 1 | 1 | 1 | 1 | 0.02 | 0.053 | 3.20 | -0.54 | 0.00 | -0.15 | 4.10 | 0.32 |
| 7 | Tobacco | 0 | 0 | 1 | 1 | 1 | 1 | 0.02 | 0.019 | 0.54 | 1.16 | -7.10 | -0.15 | 2.49 | 0.28 |
| 8 | Clothing | 0 | 0 | 1 | 1 | 1 | 1 | 0.03 | 0.050 | 3.23 | -0.48 | 0.00 | -0.16 | 4.05 | 0.24 |
| 9 | Fuels | 2 | 0 | 1 | 1 | 1 | 1 | 0.29 | 0.014 | 0.79 | -2.02 | -0.81 | -0.69 | 4.16 | -0.41 |
| 10 | Utilities | 2 | 0 | 1 | 1 | 1 | 1 | 0.05 | 0.038 | 0.47 | -1.91 | 2.07 | -0.28 | 3.44 | 0.41 |
| 11 | Furniture | 3 | 0 | 1 | 1 | 1 | 1 | 0.02 | 0.014 | 1.06 | 0.91 | -3.46 | 0.02 | 4.77 | 0.37 |
| 12 | Home appliances | 3 | 0 | 1 | 1 | 1 | 1 | 0.01 | 0.016 | 0.49 | 2.35 | 2.79 | 0.02 | 3.69 | -0.60 |
| 13 | Cars, cycles | 0 | 0 | 1 | 1 | 1 | 1 | 0.03 | 0.033 | 1.43 | 0.21 | 5.89 | -0.16 | 9.30 | 0.04 |
| 14 | TV, electronics, music | 0 | 0 | 1 | 1 | 1 | 1 | -0.13 | 0.014 | 0.98 | 1.32 | 4.49 | 0.00 | 2.84 | 0.04 |
| 15 | Household non-durables | 0 | 0 | 1 | 1 | 1 | 1 | 0.47 | 0.028 | 0.48 | -0.57 | -3.48 | -0.58 | 2.06 | 0.23 |
| 16 | Medical and toilet art | 0 | 0 | 1 | 1 | 1 | 1 | 0.81 | 0.038 | 0.98 | -0.77 | 4.77 | -0.88 | 1.94 | -0.25 |
| 17 | Motor Fuels and parts | 0 | 0 | 1 | 1 | 1 | 1 | 0.12 | 0.042 | 0.70 | -0.67 | 1.72 | -0.24 | 3.33 | 0.28 |
| 18 | Other products | 0 | 0 | 1 | 1 | 1 | 1 | 0.13 | 0.035 | 0.98 | -0.80 | 0.29 | -0.25 | 4.50 | 0.44 |
| 19 | Repair, cleaning | 0 | 0 | 1 | 1 | 1 | 1 | 0.00 | 0.009 | 0.91 | 0.06 | -8.82 | -0.14 | 9.42 | 0.08 |
| 20 | Medical services | 0 | 0 | 1 | 1 | 1 | 1 | 0.09 | 0.072 | 0.99 | -1.00 | 0.77 | -0.21 | 2.14 | 0.05 |
| 21 | Housing | 0 | 0 | 1 | 1 | 1 | 1 | 0.06 | 0.086 | 1.06 | -0.11 | 0.00 | -0.19 | 0.64 | -0.42 |
| 22 | Education | 0 | 0 | 1 | 1 | 1 | 1 | 0.09 | 0.079 | 0.78 | -0.46 | 1.32 | -0.21 | 1.18 | 0.12 |
| 23 | Financial Services | 0 | 0 | 1 | 1 | 1 | 1 | -0.48 | 0.003 | 0.99 | 1.23 | 8.74 | 0.35 | 5.75 | 0.22 |
| 24 | Postal Services | 0 | 0 | 1 | 1 | 1 | 1 | 0.14 | 0.011 | 1.05 | 0.21 | 10.49 | -0.27 | 7.86 | 0.42 |
| 25 | Other Services | 0 | 0 | 1 | 1 | 1 | 1 | 0.08 | 0.130 | 1.90 | 0.09 | 0.00 | -0.19 | 2.37 | 0.29 |

*Investment Equations*

Estimating investment equations from a period of predominantly falling output required an approach which we had not seen elsewhere. Investment fell during the worst of the transition in 1991 and 1992, but far less than one might have supposed given the declines in output. Consequently, with many of the forms which were tried, the constant term came out accounting for a significant fraction of total investment. Such forms would imply that output could be doubled will little change in investment. We felt such results implausible. We sought a function which would make a doubling in output require a doubling in the capital stock. The following form has this property:

$$inv_t = b_1 * out_t + b_2 dout_t + b_3 dout_{t-1} + b_4 dout_{t-2} + b_5 dout_{t-3} + b_6 inv_{t-1}$$

where *inv* is the investment by a particular industry, *out* is output of the same industry, and

$$dout_t = out_t - (1 - d) * out_{t-1}$$

where d is the rate of wearout of capital. We have assumed that d = .2. Note that if *out* is constant between two periods, dout will be the fraction d of that constant, that is, in our case, twenty percent of the constant rate of output. If *out* has been constant for five years and thus *dout* constant for four years, then the investment coming from the *dout* terms is

$$v = (b_2 + b_3 + b_4 + b_5) * dout$$

where *dout* and *out* are the constant values of the *dout* and *out* variables respectively. Now if depreciation is at the constant fraction *d* per year, then the capital stock is 1/d times the constant yearly investment. Thus, in our case, the capital stock becomes $(b_2 + b_3 + b_4 + b_5) * out$ and we see that $b_2 + b_3 + b_4 + b_5$ is the capital/output ratio implied by the *dout* terms, if there were no other terms.

Note that the *dout* variable, as defined above, will be positive unless output falls by more than twenty percent per year. Thus, even during the Hungarian transition in the early 1990's, this variable is positive for most industries in most years. It is, thus, very different from the first difference of output usually used in accelerator models of investment. Nonetheless, equations using only these *dout* terms proved more volatile than investment actually was. We could have added a constant term to the equation and obtained a satisfactory fit, but with the implausible implications noted above. Instead, we therefore added the *out* term, which certainly maintains the property of proportionality to output. This term can be taken as representing replacement of capital without which the rest of the capital cannot function. It is somewhat analogous to the one burned-out bulb in a string of old-fashioned, series-wired Christmas tree lights. Until the one burned-out bulb is replaced, the others cannot work.

The final term in the regression equation is the year-earlier value of the dependent variable. It was included to produce plausible forecasts one or two periods ahead. Such lagged values of the dependent variable are, in general, dangerous. If allowed to enter the equation with whatever coefficient gives the best fit, that coefficient is often close to 1.0, and that variable does all the work of explaining the dependent variable, so that we find very unreliable coefficients on the remaining variables. In our equations, therefore, it was introduced with a soft constraint towards zero. It came out at or below .33 in 16 of the 21 industries, including all the industrial sectors except Chemicals, where it was .66. The highest value was .70 in Real estate. Because of this variable, the graphs in Appendix A presenting these equations have three lines. The one marked with the square is the actual data. The one marked with the + is predicted by the equation using the actual value of the lagged dependent variable. The one marked with the x is computed using the equation and the predicted lagged value of the dependent variable. Thus, it shows what investment would have been predicted at the outset, in 1984, for the whole period had we known what would happen to output but had to generate ourselves the lagged values of investment. In general, this x line is close to the + line. Because of this sixth variable, the capital-output ratio is $(b_1+b_2+b_3+b_4+b_5)/(1 - b_6)$.

This equation was estimated for all industries. To insure that most of the investment was generated by the change-in-output terms — and therefore comes shortly after the increase in output — $b_1$ was softly constrained to be about twenty percent of the sum of $b_2+b_3+b_4+b_5$. These four coefficients were also softly constrained to lie on a smooth curve. In some cases, some of the individual coefficients had to be constrained to be positive.

In general, this form of equation worked fairly well, with results shown in Appendix A. It capture the general movement of investment in all but two, rather closely related industries: Industry 7, Non-metallic mineral products (mostly building materials) and Industry 12, Construction. Both of these industries had steadily rising investment despite falling or stable output. There is clearly something interesting happening here, but what it is it not apparent from the statistics.

*Labor productivity equations*

These equations have the task, in the model, of calculating employment, given output. Their dependent variable is simply the logarithm of output (in constant prices) divided by employment. The typical course of this variable was moderate growth from 1984 to 1988 or 1989, then a crash for two or three years as output fell but workers were retained in hopes of a reviving output, and then sharp rises after 1992, often associated more with the laying off of workers than with surging output. A quick glance at the graphs in Appendix B will show a number of examples of this pattern.

We clearly had to include in the productivity equations some variable to account for these large cyclical swings. Since the dependent variable was in logarithms, we used the first difference of the logarithm of output. It had the expected positive coefficient in all industries except Forestry.

Though the appearance of the graphs is dominated by the cyclical pattern, we were more concerned to find the effect of rising capital expenditures on productivity. We began by supposing a Cobb-Douglas production with neutral technical change. This assumption led to an equation of the form

$$\log(prod) = b_1 + b_2 time + b_3 \log(capout)$$

where *lprod* is the logarithm of productivity and *capout* is the ratio of capital to output in the industry in question. The capital stock was computed using depreciation rates of twenty percent per year, in line with the assumptions in the investment functions. Unfortunately, the coefficient on *capout* was often negative and the variable was never of any real help in the equation. We also tried replacing time with the average installation date of the capital, but without much success. Finally, determined to make new investment improve productivity, we assumed that capital has become six percent more efficient each year. The exact value of the improvement does not seem to matter much, as we shall see, so long as it is not zero. (Efforts in the U.S. to measure the improvement in the productive capacity of computers each year yielded values of about 13 percent per year. While this value is presumably faster than in machinery in general, there have been major improvements in all sorts of machinery, many connected with computer control.) To enjoy this improvement, however, a firm must invest. We thus rejected neutral productivity change — not because it did not fit the data but because it left no room for effects of capital investment. In its place, we put all the technological change into capital. We then created a new capital variable with exponential augmentation in the productivity of a constant forint of investment. The resulting equation then has the same form as above but without the *time* variable and with *capout* defined with "augmented" capital. If an industry invests each year so as to keep its capital - output ratio measured in the normal, non-augmented way constant, its augmented capital-output ratio will grow about six percent per year and thus its logarithm will be a time trend. The coefficient on this time trend would show, in that case, the rate of productivity improvement relative to six percent per year. Thus, a coefficient of 1 would mean about six percent productivity improvement each year while .5 would mean about three percent improvement. Thus, our variable is much like a time trend as long as investment is steady in the industry. But it may be quite different from a time trend if investment varies.

This form was used with industries with increasing productivity with the results shown in Appendix B. The fits seem generally acceptable. For industries where the data seems to show declining productivity were fit with a normal time trend with the origin of time set to 0 in 1995, so that in forecasts the rate of change in these equations can be readily changed.

**An Experiment with Industrial Cooperation**

If DUNA were a fully developed model, it might be possible to evaluate an industrial cooperation package along the following lines. An investment would be made in a particular industry. That investment would increase labor productivity in that industry; the prices of its products would decline; this price decline would promote exports; the exports would increase the output of that industry and increase demand for all its inputs, both direct and indirect. Increased output would mean more employment; the income of the additional workers would add to consumer demand and thereby to the demand for virtually all industries. The expansion thus set in motion would be limited by household saving and government taxation in the way familiar from the Keynesian multiplier analysis. If unemployment were sufficiently reduced, inflation would be accelerated and the comparative advantage conferred by the initial higher productivity would be offset by higher prices, so that unemployment would return to its normal value.

The beginning and end of this line of argument, however, make use of relations that are among the most difficult to quantify and uncertain in the economy. We have already seen the difficulties in determining how investment increases productivity. It does not seem wise to rest our whole argument on those results. How much that increase would reduce prices, and how much those price reductions would increase exports are again subtle questions. Similarly, the modeling of inflation is a most delicate matter and certainly not covered in the present DUNA. For the moment it seems better to try DUNA out on a less exacting task, that of the multiplier-accelerator analysis in the middle of the argument in the above paragraph.

We begin our application, therefore, with the assumption that the industrial cooperation package comes in two related pieces:

1. Assistance in finding export markets

2. Financing for the investment necessary for producing the extra output of the exporting industry.

More specifically, we shall assume an addition to exports of sector 9, Machinery, of 10 billion (1993) forints in 1998, 20 billion in 1999, and so on up to 50 billion in 2002, and then remaining at this level. The tables beginning on page 14 below show some of the results.

By 2004, demand -- the sum final consumption plus exports plus investment is up by 91 billion, 1.8 times the increase in exports. Imports, however, are up by 28 billion, meaning that GDP is up by only 63 billion, or just 1.26 times the increase in exports. On the whole, this result is not surprising for a small economy which must import many things.

Employment increases, while concentrated in Machinery, were also noticeable in Agriculture, Food, Light industry, and Trade.

Fixed investment, in total, is up by 13.6 billion forints per year by 2002. Of this 13.6, only 4.5 billion goes directly into the machinery industry. Thus, *most of the investment needed to support the increase in exports of Machinery is made outside the Machinery industry itself*. The biggest single increase, other than the 4.5 in Machinery itself, was 3.0 in Real estate and rental, the most capital intensive of the industries. Another 1.0 was required in Electricity, gas, and water; another .9 was needed in Communications, and so on. The details are on pages 16 and 17.

A further question is how much of the investment by the Machinery industry is primary and how much is induced by demands for machinery for investment by other industries. And of that which is directly caused by the increase in Machinery exports, how much is expansion — the object of the industrial cooperation package — and how much is replacement. To answer this question, we applied the investment equation for Machinery to the increment in exports alone. We also computed the replacement resulting from this stream of investment. The calculations were done by G with the following commands:

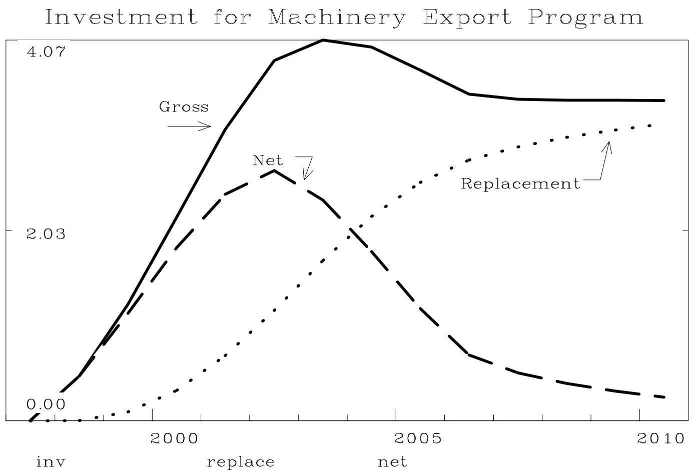
```
f out = 0
f dout = @zero(out -.8*out[1])
f inv = @cum(inv,.03314*out+.01446*dout+.03065*dout[1]+.03505*dout[2]+
      .02567*dout[3],(1.-.20606))
f replace = .20*@cum(stk,inv[1],.20)
f net = inv - replace
f nettot = @cum(nettot,net,0)
```

The results are shown on the following page.

| Date | out | inv | replace | net | nettot |
|---|---|---|---|---|---|
| 1998 | 10 | 0.476 | 0.000 | 0.476 | 0.476 |
| 1999 | 20 | 1.241 | 0.095 | 1.146 | 1.622 |
| 2000 | 30 | 2.171 | 0.324 | 1.846 | 3.468 |
| 2001 | 40 | 3.111 | 0.694 | 2.417 | 5.885 |
| 2002 | 50 | 3.847 | 1.177 | 2.670 | 8.555 |
| 2003 | 50 | 4.066 | 1.711 | 2.355 | 10.911 |
| 2004 | 50 | 3.988 | 2.182 | 1.805 | 12.716 |
| 2005 | 50 | 3.742 | 2.543 | 1.199 | 13.915 |
| 2006 | 50 | 3.486 | 2.783 | 0.703 | 14.619 |
| 2007 | 50 | 3.434 | 2.924 | 0.510 | 15.129 |
| 2008 | 50 | 3.423 | 3.026 | 0.397 | 15.526 |
| 2009 | 50 | 3.421 | 3.105 | 0.315 | 15.841 |
| 2010 | 50 | 3.420 | 3.168 | 0.252 | 16.093 |

Here, the *out* column shows the addition to exports, and *inv* shows the investment which this stream of output would generate via the investment function for the Machinery industry. The *replace* column shows replacement, and *net* shows net investment in each year. Finally, *nettot* shows the cumulation of *net*. Of the 4.5 billion increase in investment by the Machinery sector in 2004, 4.0 billion come directly from the increased exports and the other .5 billion from additional domestic demand for machinery. The *nettot* column is particularly noteworthy, for it shows the cumulated amount of net new investment necessitated by the export program. It corresponds roughly to the investment in Hungary under the industrial cooperation package. Accordingly, we can say that *the 50 billion per year increase in exports requires an initial investment of roughly 16 billion*. Replacement of this investment will eventually run at about 3.4 billion per year.

Although these calculations would seem to imply a rather precise time path for these investments, that path is calculated under assumptions of normal investment behavior which reacts to the growth output rather than pro-actively creating that growth. Consequently, our case of investment-created export growth would require more of this investment near the beginning of the program than is shown in these calculations. Nonetheless, the pattern is interesting and is shown graphically below.




This application gives some idea of the use of DUNA. Other export programs or domestically centered programs can be examined. As the model becomes more developed, budgetary consequences can be calculated. Effects on domestic prices, inflation and exchange rates could eventually be studied as the model increases in resemblance to the economy.

Page 1

Aggregates

Line 1: Base

Line 2: Deviation of Machinery Export Scenario

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2004 | 2006 | 2008 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Real GDP | 4145.9 | 4214.7 | 4263.2 | 4317.6 | 4385.6 | 4446.2 | 4575.7 | 4716.4 | 4872.7 | 5028.4 |
| | 0.0 | 10.2 | 22.3 | 35.2 | 48.2 | 60.8 | 63.2 | 61.9 | 61.4 | 61.3 |
| Household Consumption | 2941.4 | 2999.3 | 3020.0 | 3043.5 | 3074.7 | 3102.9 | 3162.9 | 3227.7 | 3299.3 | 3370.6 |
| | 0.0 | 4.4 | 9.7 | 15.3 | 20.9 | 26.4 | 27.5 | 26.9 | 26.7 | 26.6 |
| Government Consumption | 455.6 | 464.8 | 474.2 | 483.8 | 493.6 | 503.5 | 524.1 | 545.5 | 567.7 | 590.9 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Fixed Investment | 850.9 | 852.5 | 851.0 | 850.4 | 854.5 | 863.8 | 884.5 | 909.9 | 941.7 | 973.7 |
| | 0.0 | 0.0 | 2.2 | 5.2 | 8.3 | 11.0 | 13.6 | 12.1 | 11.5 | 11.4 |
| Exports | 1218.7 | 1239.7 | 1274.3 | 1314.4 | 1361.2 | 1396.4 | 1471.7 | 1552.6 | 1641.7 | 1728.5 |
| | 0.0 | 10.0 | 20.0 | 30.0 | 40.0 | 50.0 | 50.0 | 50.0 | 50.0 | 50.0 |
| Imports | 1449.4 | 1472.9 | 1490.3 | 1511.2 | 1537.8 | 1562.7 | 1615.6 | 1673.4 | 1738.1 | 1802.3 |
| | 0.0 | 4.2 | 9.6 | 15.3 | 21.1 | 26.6 | 27.9 | 27.1 | 26.8 | 26.8 |
| Proprietor Income | 875.7 | 890.9 | 901.6 | 913.8 | 928.8 | 942.2 | 970.9 | 1001.9 | 1036.0 | 1070.1 |
| | 0.0 | 1.8 | 4.0 | 6.3 | 8.6 | 10.9 | 11.4 | 11.1 | 11.0 | 11.0 |
| Operating Surplus | 1400.6 | 1425.0 | 1442.1 | 1461.6 | 1485.6 | 1507.0 | 1552.9 | 1602.5 | 1657.1 | 1711.6 |
| | 0.0 | 2.9 | 6.4 | 10.1 | 13.8 | 17.5 | 18.2 | 17.8 | 17.6 | 17.5 |
| Compensation of Employees | 2212.8 | 2251.2 | 2281.1 | 2314.1 | 2354.3 | 2390.8 | 2468.2 | 2552.0 | 2644.6 | 2736.9 |
| | 0.0 | 6.0 | 13.1 | 20.6 | 28.2 | 35.6 | 37.0 | 36.3 | 36.0 | 36.0 |
| Primary Income of Persons | 3088.5 | 3142.2 | 3182.7 | 3227.9 | 3283.1 | 3333.0 | 3439.1 | 3553.9 | 3680.6 | 3807.0 |
| | 0.0 | 7.8 | 17.1 | 26.9 | 36.9 | 46.6 | 48.4 | 47.4 | 47.0 | 46.9 |
| Current Taxes on Income and Wea | 300.2 | 271.5 | 275.0 | 278.9 | 283.7 | 288.0 | 297.1 | 307.0 | 318.0 | 328.9 |
| | 0.0 | 0.7 | 1.5 | 2.3 | 3.2 | 4.0 | 4.2 | 4.1 | 4.1 | 4.1 |
| Contributions to Social Insuran | 776.5 | 790.0 | 800.5 | 812.1 | 826.2 | 839.0 | 866.2 | 895.6 | 928.1 | 960.5 |
| | 0.0 | 2.1 | 4.6 | 7.2 | 9.9 | 12.5 | 13.0 | 12.7 | 12.6 | 12.6 |
| Disposable Cash Income | 2768.1 | 2834.9 | 2859.3 | 2886.9 | 2923.8 | 2957.1 | 3028.0 | 3105.1 | 3190.7 | 3276.1 |
| | 0.0 | 5.0 | 11.0 | 17.4 | 23.8 | 30.0 | 31.2 | 30.6 | 30.3 | 30.3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Disposable Income (inc. in-kind | 3339.3 | 3405.1 | 3428.5 | 3455.2 | 3490.7 | 3522.6 | 3590.8 | 3664.4 | 3745.6 | 3826.6 |
| | 0.0 | 5.0 | 11.0 | 17.4 | 23.8 | 30.0 | 31.2 | 30.6 | 30.3 | 30.3 |
| Taxes on Products | 72.5 | 73.8 | 75.1 | 76.4 | 78.1 | 79.4 | 82.4 | 85.5 | 89.0 | 92.4 |
| | 0.0 | 0.2 | 0.4 | 0.6 | 0.8 | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 |
| Subsidies to Products | 41.8 | 42.4 | 42.8 | 43.4 | 44.1 | 44.6 | 45.8 | 47.1 | 48.6 | 50.1 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |

Output

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2004 | 2006 | 2008 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, hunting, fishing | 631.4 | 639.2 | 643.9 | 650.0 | 658.2 | 663.1 | 675.6 | 689.6 | 705.4 | 720.4 |
| | 0.0 | 0.8 | 1.6 | 2.5 | 3.4 | 4.2 | 4.3 | 4.2 | 4.2 | 4.2 |
| Forestry | 35.7 | 36.8 | 37.7 | 38.5 | 39.4 | 40.1 | 41.3 | 42.8 | 44.5 | 46.0 |
| | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 |
| Mining and quarrying | 60.4 | 61.1 | 62.2 | 63.1 | 64.3 | 65.3 | 67.6 | 70.1 | 73.0 | 76.0 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 |
| Food and tobacco industry | 658.6 | 667.2 | 672.7 | 680.0 | 689.6 | 696.0 | 711.3 | 728.2 | 748.1 | 766.8 |
| | 0.0 | 0.9 | 1.9 | 2.9 | 3.9 | 5.0 | 5.1 | 5.0 | 4.9 | 4.9 |
| Light industry | 401.3 | 409.3 | 416.9 | 425.1 | 436.3 | 445.1 | 464.4 | 485.6 | 509.0 | 532.7 |
| | 0.0 | 0.6 | 1.5 | 2.5 | 3.5 | 4.5 | 4.8 | 4.7 | 4.7 | 4.7 |
| Chemicals | 580.9 | 593.6 | 607.8 | 622.8 | 640.3 | 654.7 | 684.4 | 716.0 | 750.2 | 783.6 |
| | 0.0 | 0.7 | 1.7 | 2.7 | 3.7 | 4.7 | 5.0 | 4.9 | 4.9 | 4.9 |
| Non-metallic mineral products | 100.4 | 101.7 | 103.5 | 105.5 | 107.8 | 110.1 | 114.6 | 119.4 | 124.9 | 130.6 |
| | 0.0 | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 |
| Metals and metal products | 268.7 | 273.1 | 279.3 | 286.3 | 294.4 | 301.3 | 316.0 | 332.2 | 350.5 | 368.8 |
| | 0.0 | 0.8 | 1.8 | 2.8 | 3.8 | 4.8 | 4.9 | 4.9 | 4.8 | 4.8 |
| Machinery | 536.0 | 540.8 | 548.7 | 559.5 | 573.5 | 585.9 | 612.1 | 641.6 | 676.3 | 709.9 |
| | 0.0 | 10.7 | 21.9 | 33.3 | 44.6 | 55.9 | 56.4 | 56.1 | 56.0 | 56.0 |
| Other Manufacture | 59.3 | 60.0 | 60.3 | 60.8 | 61.7 | 62.2 | 63.4 | 64.9 | 66.5 | 68.1 |
| | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Electricity, gas, steam, water | 384.8 | 389.1 | 394.5 | 399.8 | 406.3 | 412.7 | 426.0 | 440.4 | 456.1 | 471.8 |
| | 0.0 | 0.6 | 1.6 | 2.5 | 3.6 | 4.5 | 4.9 | 4.8 | 4.7 | 4.7 |
| Construction | 466.5 | 470.8 | 473.2 | 475.8 | 480.1 | 486.3 | 499.8 | 515.3 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 533.4 | 551.7 |
| | 0.0 | 0.2 | 1.2 | 2.5 | 3.9 | 5.2 | 6.2 | 5.6 | 5.4 | 5.3 |
| Trade and repair | 837.3 | 850.0 | 855.7 | 863.0 | 873.1 | 881.7 | 900.7 | 921.9 | 946.0 | 970.1 |
| | 0.0 | 1.9 | 4.2 | 6.5 | 8.9 | 11.2 | 11.5 | 11.3 | 11.2 | 11.2 |
| Hotels and restaurants | 134.3 | 138.6 | 139.4 | 141.2 | 143.6 | 145.7 | 150.1 | 155.0 | 160.3 | 165.6 |
| | 0.0 | 0.4 | 0.7 | 1.1 | 1.5 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 |
| Transport, storage | 421.4 | 429.7 | 434.4 | 440.2 | 447.2 | 453.8 | 467.8 | 483.0 | 499.6 | 516.4 |
| | 0.0 | 0.8 | 1.7 | 2.7 | 3.7 | 4.7 | 4.9 | 4.7 | 4.7 | 4.7 |
| Post and telecommunications | 149.9 | 154.1 | 156.9 | 160.2 | 164.0 | 167.6 | 175.3 | 183.3 | 191.7 | 200.0 |
| | 0.0 | 0.3 | 0.7 | 1.0 | 1.4 | 1.8 | 1.8 | 1.7 | 1.7 | 1.7 |
| Financial intermediation | 236.3 | 241.7 | 245.6 | 250.2 | 255.2 | 259.9 | 270.0 | 280.5 | 291.7 | 303.0 |
| | 0.0 | 0.3 | 0.6 | 1.0 | 1.3 | 1.7 | 1.7 | 1.6 | 1.6 | 1.6 |
| Real estate, renting, business | 710.5 | 722.9 | 730.0 | 738.3 | 748.7 | 758.4 | 779.0 | 801.1 | 825.7 | 850.3 |
| | 0.0 | 1.4 | 3.2 | 5.2 | 7.2 | 9.1 | 9.5 | 9.3 | 9.1 | 9.1 |
| Public administration and other | 688.2 | 702.7 | 713.1 | 724.8 | 737.7 | 750.2 | 776.3 | 803.9 | 833.4 | 863.6 |
| | 0.0 | 0.8 | 1.7 | 2.6 | 3.6 | 4.5 | 4.5 | 4.4 | 4.4 | 4.4 |
| Education | 261.5 | 265.7 | 270.5 | 273.7 | 277.1 | 280.8 | 288.0 | 295.4 | 303.4 | 311.3 |
| | 0.0 | 0.1 | 0.5 | 0.9 | 1.3 | 1.7 | 2.0 | 2.0 | 2.0 | 2.0 |
| Health and social work | 261.5 | 265.7 | 270.5 | 273.7 | 277.1 | 280.8 | 288.0 | 295.4 | 303.4 | 311.3 |
| | 0.0 | 0.1 | 0.5 | 0.9 | 1.3 | 1.7 | 2.0 | 2.0 | 2.0 | 2.0 |

Investment

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2004 | 2006 | 2008 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, hunting, fishing | 33.7 | 35.3 | 35.8 | 36.2 | 36.8 | 37.0 | 37.6 | 38.5 | 39.5 | 40.3 |
| | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.4 | 0.3 | 0.2 | 0.2 | 0.2 |
| Forestry | 5.2 | 5.8 | 6.0 | 6.2 | 6.4 | 6.5 | 6.6 | 6.9 | 7.2 | 7.4 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mining and quarrying | 6.0 | 6.1 | 6.2 | 6.3 | 6.4 | 6.5 | 6.7 | 7.0 | 7.3 | 7.6 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Food and tobacco industry | 43.6 | 43.3 | 42.9 | 43.2 | 43.8 | 44.2 | 45.1 | 46.2 | 47.6 | 48.7 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 |
| Light industry | 19.0 | 18.2 | 17.6 | 17.4 | 17.5 | 17.8 | 18.4 | 19.2 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 20.1 | 21.0 |
| | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Chemicals | 94.8 | 89.6 | 83.8 | 78.9 | 75.4 | 73.0 | 70.9 | 71.3 | 73.3 | 76.0 |
| | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 |
| Non-metallic mineral products | 6.1 | 5.6 | 5.2 | 4.9 | 4.7 | 4.5 | 4.3 | 4.1 | 4.1 | 4.1 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Metals and metal products | 23.4 | 23.2 | 23.0 | 23.2 | 23.6 | 24.4 | 25.6 | 26.8 | 28.3 | 29.9 |
| | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 |
| Machinery | 39.2 | 39.1 | 38.7 | 38.8 | 39.5 | 40.4 | 42.4 | 44.4 | 46.9 | 49.3 |
| | 0.0 | 0.5 | 1.4 | 2.4 | 3.5 | 4.3 | 4.5 | 3.9 | 3.8 | 3.8 |
| Other Manufacture | 5.5 | 5.3 | 5.3 | 5.3 | 5.4 | 5.5 | 5.6 | 5.7 | 5.9 | 6.0 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| Electricity, gas, steam, water | 93.2 | 85.5 | 80.1 | 76.8 | 75.4 | 74.9 | 75.6 | 77.5 | 80.1 | 82.7 |
| | 0.0 | 0.1 | 0.4 | 0.6 | 0.9 | 1.0 | 1.0 | 0.8 | 0.8 | 0.8 |
| Construction | 17.4 | 16.9 | 16.3 | 15.9 | 15.6 | 15.4 | 15.1 | 15.0 | 15.0 | 15.1 |
| | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 |
| Trade and repair | 35.6 | 35.9 | 35.5 | 35.6 | 35.8 | 36.1 | 36.9 | 37.7 | 38.8 | 39.8 |
| | 0.0 | 0.0 | 0.1 | 0.3 | 0.4 | 0.5 | 0.6 | 0.5 | 0.5 | 0.5 |
| Hotels and restaurants | 21.4 | 23.6 | 24.5 | 25.2 | 25.8 | 26.0 | 27.0 | 27.8 | 28.8 | 29.8 |
| | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 |
| Transport, storage | 52.0 | 54.2 | 55.3 | 56.2 | 57.1 | 57.9 | 59.7 | 61.7 | 63.9 | 66.0 |
| | 0.0 | 0.1 | 0.2 | 0.4 | 0.5 | 0.7 | 0.7 | 0.6 | 0.6 | 0.6 |
| Post and telecommunications | 102.6 | 95.9 | 90.4 | 87.1 | 85.6 | 84.9 | 85.4 | 87.4 | 90.4 | 93.6 |
| | 0.0 | 0.2 | 0.5 | 0.7 | 0.9 | 1.1 | 0.9 | 0.8 | 0.8 | 0.8 |
| Financial intermediation | 29.5 | 29.8 | 29.9 | 30.4 | 30.9 | 31.5 | 32.7 | 34.0 | 35.4 | 36.8 |
| | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| Real estate, renting, business | 178.5 | 187.4 | 194.3 | 200.5 | 206.3 | 211.5 | 221.1 | 229.6 | 238.0 | 246.0 |
| | 0.0 | 0.2 | 0.6 | 1.1 | 1.8 | 2.4 | 3.0 | 2.9 | 2.8 | 2.7 |
| Public administration and other | 61.4 | 67.0 | 70.5 | 72.9 | 74.8 | 76.5 | 79.5 | 82.4 | 85.5 | 88.6 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 |
| Education | 26.9 | 28.0 | 28.8 | 29.3 | 29.7 | 30.1 | 30.9 | 31.7 | 32.6 | 33.4 |
| | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Health and social work | 26.9 | 28.0 | 28.8 | 29.3 | 29.7 | 30.1 | 30.9 | 31.7 | 32.6 | 33.4 |
| | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 |

4

Employment

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2004 | 2006 | 2008 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, hunting, fishing | 291.5 | 276.8 | 263.1 | 249.4 | 237.5 | 226.8 | 204.9 | 185.6 | 168.5 | 152.3 |
| | 0.0 | 0.0 | 0.4 | 0.7 | 0.9 | 1.2 | 1.2 | 1.1 | 1.0 | 0.9 |
| Forestry | 54.1 | 55.9 | 57.4 | 58.8 | 60.4 | 61.6 | 64.2 | 67.2 | 70.4 | 73.7 |
| | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Mining and quarrying | 62.0 | 62.6 | 63.3 | 63.7 | 64.2 | 64.5 | 65.1 | 65.8 | 66.9 | 67.9 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.6 | 0.5 | 0.5 | 0.5 |
| Food and tobacco industry | 198.7 | 199.3 | 200.9 | 200.5 | 200.4 | 202.1 | 201.5 | 201.5 | 202.6 | 203.3 |
| | 0.0 | -0.2 | 0.1 | 0.4 | 0.7 | 1.0 | 1.5 | 1.4 | 1.4 | 1.3 |
| Light industry | 248.0 | 247.5 | 248.9 | 250.3 | 252.1 | 255.9 | 259.8 | 264.7 | 271.0 | 276.6 |
| | 0.0 | 0.0 | 0.5 | 1.1 | 1.7 | 2.2 | 2.9 | 2.7 | 2.6 | 2.5 |
| Chemicals | 128.9 | 133.5 | 137.0 | 140.6 | 144.2 | 148.3 | 154.8 | 161.3 | 168.6 | 175.5 |
| | 0.0 | 0.0 | 0.2 | 0.4 | 0.6 | 0.9 | 1.2 | 1.2 | 1.1 | 1.1 |
| Non-metallic mineral products | 50.1 | 51.4 | 52.0 | 52.9 | 53.9 | 55.0 | 57.1 | 59.3 | 61.8 | 64.3 |
| | 0.0 | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 |
| Metals and metal products | 93.6 | 94.1 | 93.4 | 93.0 | 92.7 | 92.4 | 91.3 | 90.3 | 89.9 | 89.2 |
| | 0.0 | 0.1 | 0.4 | 0.7 | 1.0 | 1.3 | 1.5 | 1.4 | 1.3 | 1.2 |
| Machinery | 248.8 | 266.2 | 270.4 | 273.8 | 277.3 | 282.3 | 287.8 | 293.2 | 302.5 | 309.6 |
| | 0.0 | -1.4 | 4.6 | 10.6 | 16.5 | 22.1 | 28.2 | 26.9 | 25.9 | 25.2 |
| Other Manufacture | 34.0 | 34.1 | 34.2 | 34.1 | 34.1 | 34.2 | 34.0 | 33.9 | 34.0 | 34.0 |
| | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Electricity, gas, steam, water | 103.3 | 102.2 | 101.7 | 101.9 | 102.3 | 103.0 | 104.4 | 105.8 | 107.4 | 108.6 |
| | 0.0 | 0.1 | 0.3 | 0.5 | 0.8 | 1.0 | 1.2 | 1.2 | 1.1 | 1.1 |
| Construction | 234.5 | 237.3 | 236.8 | 235.9 | 235.6 | 236.3 | 239.4 | 243.3 | 248.1 | 253.0 |
| | 0.0 | 0.0 | 0.3 | 0.9 | 1.6 | 2.3 | 3.2 | 2.9 | 2.7 | 2.6 |
| Trade and repair | 490.8 | 488.9 | 487.4 | 485.2 | 484.7 | 484.6 | 483.8 | 483.8 | 485.3 | 486.1 |
| | 0.0 | 0.7 | 2.0 | 3.4 | 4.7 | 6.0 | 6.4 | 6.0 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 5.8 | 5.6 |
| Hotels and restaurants | 121.9 | 115.9 | 116.1 | 112.8 | 111.4 | 111.0 | 109.8 | 109.3 | 109.6 | 109.7 |
| | 0.0 | -0.1 | 0.3 | 0.6 | 0.9 | 1.1 | 1.4 | 1.3 | 1.2 | 1.2 |
| Transport, storage | 259.9 | 266.2 | 270.8 | 273.4 | 276.3 | 279.3 | 284.6 | 290.0 | 296.3 | 302.4 |
| | 0.0 | 0.2 | 0.8 | 1.4 | 2.0 | 2.6 | 3.0 | 2.9 | 2.8 | 2.8 |
| Post and telecommunications | 79.1 | 81.3 | 83.0 | 84.4 | 86.1 | 87.9 | 91.2 | 94.4 | 97.7 | 100.8 |
| | 0.0 | 0.1 | 0.3 | 0.5 | 0.7 | 0.9 | 1.0 | 0.9 | 0.9 | 0.9 |
| Financial intermediation | 84.9 | 87.2 | 89.8 | 92.7 | 96.0 | 99.6 | 107.3 | 115.8 | 125.3 | 135.3 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 |
| Real estate, renting, business | 146.7 | 147.8 | 147.6 | 146.2 | 144.9 | 143.6 | 140.8 | 138.3 | 136.3 | 134.3 |
| | 0.0 | 0.2 | 0.6 | 1.0 | 1.4 | 1.8 | 1.9 | 1.7 | 1.5 | 1.4 |
| Public administration and other | 321.7 | 319.8 | 318.7 | 316.8 | 315.5 | 314.3 | 311.7 | 309.3 | 307.4 | 305.3 |
| | 0.0 | 0.2 | 0.5 | 0.9 | 1.3 | 1.7 | 1.8 | 1.7 | 1.6 | 1.6 |
| Education | 256.2 | 257.6 | 259.9 | 261.2 | 262.3 | 263.8 | 266.8 | 270.1 | 273.6 | 277.2 |
| | 0.0 | 0.1 | 0.4 | 0.7 | 1.1 | 1.5 | 1.9 | 1.8 | 1.8 | 1.8 |
| Health and social work | 256.2 | 257.6 | 259.9 | 261.2 | 262.3 | 263.8 | 266.8 | 270.1 | 273.6 | 277.2 |
| | 0.0 | 0.1 | 0.4 | 0.7 | 1.1 | 1.5 | 1.9 | 1.8 | 1.8 | 1.8 |

Imports

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2004 | 2006 | 2008 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Agriculture, hunting, fishing | 26.0 | 26.3 | 26.4 | 26.6 | 26.9 | 27.1 | 27.6 | 28.1 | 28.8 | 29.4 |
| | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Forestry | 2.0 | 2.0 | 2.0 | 2.1 | 2.1 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Mining and quarrying | 135.7 | 138.0 | 140.8 | 143.6 | 146.9 | 149.8 | 155.8 | 162.2 | 169.1 | 176.0 |
| | 0.0 | 0.2 | 0.5 | 0.8 | 1.1 | 1.4 | 1.5 | 1.4 | 1.4 | 1.4 |
| Food and tobacco industry | 54.0 | 54.6 | 54.7 | 54.9 | 55.3 | 55.5 | 56.1 | 56.8 | 57.8 | 58.7 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Light industry | 114.7 | 117.5 | 119.5 | 121.4 | 124.0 | 126.2 | 131.0 | 136.2 | 142.2 | 148.2 |
| | 0.0 | 0.3 | 0.6 | 1.0 | 1.5 | 1.9 | 2.0 | 2.0 | 2.0 | 2.0 |
| Chemicals | 231.7 | 236.5 | 241.4 | 246.3 | 252.0 | 257.1 | 267.5 | 278.6 | 290.5 | 302.3 |
| | 0.0 | 0.5 | 1.1 | 1.8 | 2.4 | 3.1 | 3.2 | 3.2 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 3.1 | 3.1 |
| Non-metallic mineral products | 22.2 | 22.5 | 22.8 | 23.1 | 23.5 | 23.8 | 24.7 | 25.6 | 26.6 | 27.6 |
| | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| Metals and metal products | 90.2 | 91.5 | 93.0 | 94.7 | 96.8 | 98.6 | 102.6 | 106.9 | 111.9 | 116.8 |
| | 0.0 | 0.5 | 1.1 | 1.7 | 2.3 | 2.8 | 2.9 | 2.9 | 2.9 | 2.9 |
| Machinery | 558.2 | 567.0 | 571.0 | 577.8 | 587.2 | 597.0 | 618.0 | 641.3 | 667.6 | 693.8 |
| | 0.0 | 2.1 | 4.9 | 7.8 | 10.8 | 13.7 | 14.3 | 13.8 | 13.6 | 13.6 |
| Other Manufacture | 23.6 | 23.9 | 23.8 | 23.8 | 24.0 | 24.0 | 24.3 | 24.5 | 24.9 | 25.2 |
| | 0.0 | 0.1 | 0.1 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Electricity, gas, steam, water | 6.7 | 6.7 | 6.8 | 6.9 | 7.0 | 7.2 | 7.4 | 7.6 | 7.9 | 8.2 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Construction | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.3 | 3.4 | 3.5 | 3.6 |
| | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Trade and repair | 102.4 | 104.2 | 105.6 | 107.3 | 109.4 | 111.2 | 115.1 | 119.3 | 123.9 | 128.6 |
| | 0.0 | 0.4 | 0.8 | 1.3 | 1.8 | 2.2 | 2.3 | 2.2 | 2.2 | 2.2 |

Household consumption

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2004 | 2006 | 2008 | 2010 |
|---|---|---|---|---|---|---|---|---|---|---|
| Meat, poultry, eggs, fish, lard | 166.2 | 164.7 | 161.0 | 157.9 | 155.3 | 152.5 | 147.1 | 142.1 | 137.6 | 133.1 |
| | 0.0 | 0.3 | 0.6 | 0.8 | 1.1 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 |
| Dairy products, margarine and o | 74.2 | 71.7 | 69.8 | 67.2 | 65.3 | 63.0 | 58.9 | 54.9 | 51.1 | 47.5 |
| | 0.0 | 0.1 | 0.2 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Bread and cereals | 77.2 | 76.2 | 74.4 | 73.0 | 72.1 | 70.8 | 68.6 | 66.4 | 64.3 | 62.2 |
| | 0.0 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 | 0.3 | 0.3 | 0.3 | 0.3 |
| Fresh fruits and vegetables | 54.3 | 54.7 | 55.6 | 56.0 | 56.3 | 56.8 | 57.7 | 58.6 | 59.6 | 60.6 |
| | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 |
| Other processed food | 205.8 | 210.0 | 206.7 | 206.3 | 206.8 | 206.4 | 206.6 | 207.4 | 208.8 | 210.3 |
| | 0.0 | 0.6 | 1.2 | 1.7 | 2.1 | 2.6 | 2.4 | 2.3 | 2.3 | 2.3 |
| Alcohol | 171.4 | 176.1 | 179.4 | 181.1 | 183.4 | 186.0 | 191.1 | 197.1 | 204.4 | 211.6 |
| | 0.0 | 0.3 | 0.9 | 1.5 | 2.2 | 2.9 | 3.3 | 3.2 | 3.2 | 3.2 |
| Tobacco | 44.3 | 43.1 | 40.9 | 39.2 | 37.5 | 35.8 | 32.4 | 29.1 | 25.9 | 22.7 |
| | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| Clothing | 160.8 | 166.4 | 170.0 | 172.5 | 175.7 | 179.0 | 185.7 | 193.3 | 202.0 | 210.8 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 0.0 | 0.3 | 0.9 | 1.6 | 2.3 | 2.9 | 3.3 | 3.2 | 3.2 | 3.2 |
| Fuels | 38.7 | 38.0 | 38.3 | 37.8 | 37.2 | 36.9 | 36.0 | 35.2 | 34.5 | 33.8 |
| | 0.0 | -0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 |
| Utilities | 110.8 | 112.4 | 115.1 | 116.8 | 118.5 | 120.4 | 123.9 | 127.3 | 130.8 | 134.1 |
| | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 |
| Furniture | 38.8 | 39.2 | 38.1 | 37.7 | 37.4 | 37.0 | 36.4 | 35.8 | 35.2 | 34.7 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 |
| Home appliances | 47.9 | 49.7 | 50.0 | 51.2 | 52.5 | 53.6 | 55.9 | 58.2 | 60.4 | 62.5 |
| | 0.0 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 |
| Cars, cycles | 108.2 | 114.5 | 117.2 | 121.0 | 125.2 | 128.9 | 136.9 | 144.9 | 153.0 | 161.0 |
| | 0.0 | 0.3 | 0.5 | 0.7 | 0.9 | 1.2 | 1.1 | 1.0 | 1.0 | 1.0 |
| TV, electronics, music | 40.9 | 43.0 | 42.8 | 43.8 | 44.9 | 45.8 | 47.7 | 49.7 | 51.6 | 53.5 |
| | 0.0 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 |
| Household non-durables | 67.3 | 66.1 | 65.3 | 64.3 | 63.2 | 62.2 | 60.2 | 58.2 | 56.4 | 54.5 |
| | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 |
| Medical and toilet articles | 127.4 | 132.8 | 138.7 | 143.7 | 148.7 | 153.9 | 164.0 | 174.0 | 184.1 | 194.1 |
| | 0.0 | 0.0 | 0.1 | 0.3 | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 |
| Motor Fuels and parts | 124.0 | 126.7 | 128.6 | 130.6 | 132.6 | 134.6 | 138.6 | 142.6 | 146.6 | 150.6 |
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| Other products | 99.8 | 101.0 | 102.1 | 102.6 | 103.0 | 103.6 | 104.7 | 105.9 | 107.3 | 108.6 |
| | 0.0 | 0.0 | 0.2 | 0.3 | 0.5 | 0.6 | 0.8 | 0.7 | 0.7 | 0.7 |
| Repair, cleaning | 20.7 | 19.9 | 18.8 | 17.9 | 16.9 | 16.0 | 14.1 | 12.3 | 10.6 | 8.9 |
| | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 |
| Medical services | 219.1 | 222.2 | 226.6 | 229.1 | 231.8 | 234.8 | 240.6 | 246.4 | 252.7 | 258.9 |
| | 0.0 | 0.0 | 0.3 | 0.6 | 0.9 | 1.2 | 1.5 | 1.5 | 1.5 | 1.5 |
| Housing | 251.7 | 255.5 | 256.6 | 258.2 | 260.5 | 262.4 | 266.5 | 271.0 | 275.8 | 280.7 |
| | 0.0 | 0.4 | 0.7 | 1.1 | 1.6 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 |
| Education | 238.3 | 244.0 | 248.4 | 252.5 | 256.8 | 261.1 | 269.7 | 278.3 | 286.9 | 295.5 |
| | 0.0 | 0.2 | 0.4 | 0.7 | 1.0 | 1.2 | 1.4 | 1.3 | 1.3 | 1.3 |
| Financial Services | 10.7 | 11.5 | 11.7 | 12.2 | 12.6 | 13.1 | 13.9 | 14.8 | 15.7 | 16.5 |
| | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Postal Services | 44.7 | 47.8 | 49.6 | 51.8 | 54.0 | 56.1 | 60.4 | 64.7 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 68.9 | 73.1 | | | | | | | |
| | | | 0.0 | 0.1 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 |
| | 0.2 | 0.2 | | | | | | | |
| Other Services | | | 398.3 | 412.4 | 414.0 | 419.3 | 426.4 | 432.3 | 445.3 | 459.4 |
| | 475.0 | 490.5 | | | | | | | |
| | | | 0.0 | 1.2 | 2.2 | 3.3 | 4.4 | 5.5 | 5.3 | 5.2 |
| | 5.1 | 5.1 | | | | | | | |

**Basic Operation of DUNA**

DUNA comes on two diskettes. Diskette 1 contains the basic Interdyme software, diskette 2 contains the DUNA model proper. To install the software, just copy Dyme-exe.zip file from Diskette 1 to the directory where you wish to have the programs. We suggest using the \pdg directory, but it does not matter. Be sure, however, that this directory is on the path. Then make a directory \duna and unzip the contents of diskette 2 into it.

We will deal here only with running the existing model. For full details on building and modifying the model, please refer to the Interdyme manual. The basic sequence of steps is:

1. Start with a clean slate. Do "copy hist.* dyme.* " This will copy the hist.vam file and the hist.bnk and hist.ind files to dyme.vam, dyme.bnk, and dyme.ind. The first of these is the file of vectors and matrices (vam) in the model. The second and third compose a G data bank with values of the "macro" variables, those which are single-variable time series, as opposed to the vectors and matrices, which are in the .vam file.

2. Set up the scenario you wish to run by using the Vam program. Start Vam with the line "vam -vDyme". With Vam running, give it the command "wsb dyme" to assign the dyme bank as the workspace bank, the one which can be changed. Use the commands of Vam to modify the exogenous variables in these two places. For example, to introduce values for the "invdel" vector which will be added to those calculated by the equations, one can give the command "add offset.add", and investment will be modified by the factors specified in the offset.add file.

3. Run the model. The command from the DOS prompt is just "dyme".

4. Examine the results with Vam and Compare.

All of these steps are performed by the file all.bat, which begins by building the basic model and running a base case scenario before going on to run the alternative.