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A Model of Ukrainian Macroeconomic Indicators

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Summary

In this paper we present the macroeconomic model elaborated by the Modeling Group of the International Center for Policy Studies. This paper includes the theoretical background as well as a detailed explanation of the two parts of the model: forecasting of nominal GDP and inflation and forecasting of consolidated budget revenue.
Introduction

After the collapse of the USSR, Ukraine became an independent state. There were many problems that had to be solved very quickly. Various international democratic groups began to assist Ukraine in this task.

The Soros International Economic Advisory Group (SIEAG), one of these organizations, formally began working in Ukraine in accordance with the agreement between George Soros and the Minister of Economy, Roman Shpek in August 1994. Now the project exists as a part of the International Center for Policy Studies.

One of the most important projects for the Ukrainian Government undertaken by the SIEAG under the supervision of Professor Georges de Menil and with financial support of TACIS, has been the macroeconomic forecasting model. The first goal of the model was to provide a monthly forecast of the rate of inflation and nominal GDP, and help with the planning and preparation of the consolidated budget for 1997 and 1998. This project became a high priority for the Cabinet of Ministers of Ukraine, as it allowed the Ukrainians to develop an independent forecast of macroeconomic indicators, with which they can negotiate more effectively with the IMF.

The model was worked out by close cooperation between the SIEAG and the relevant departments of the Ministry of Economy, the Ministry of Finance, and the National Bank of Ukraine (Ihor Shumylo, Maryna Shapovalova, Viktor Lysytski). At that time one of the greatest problems was that government institutions rarely cooperated, while only competing against each other. Therefore, the project was based on the principles of increasing the co-operation between the SIEAG and various governmental agencies, as well as strengthening the links among these agencies.

In this paper we give a brief description of this model. The structure of our paper is as follows. In part 1 a review is given of the relevant macroeconomic theories, a brief explanation of the tax system in Ukraine and some econometric notions about the modeling. Part 2 and part 3 explain the mechanism of forecasting the nominal GDP and inflation and the method of forecasting consolidated budget revenue respectively. Abilities of the model and its future development are given in the consequences.
1. Theoretical Background

The first part of the model, which is used to forecast the price level and nominal GDP, is based on the simple proposition that the overall level of prices equilibrates the supply and demand for money\(^1\).

We consider in keeping with the equation that Cagan (1956) developed to analyze the hyperinflations of the 1920s, that demand for money is a function of real output and inflationary expectations

\[ \frac{M^d}{P} = L(Y, \pi^e), \]

If we assume that the demand function is linear in logarithm, and let lower case letters represent the logarithm of upper case letters, this becomes

\[ m^d - p = \alpha_0 + \alpha_1 y - \alpha_2 \pi^e \quad (1) \]

We take the supply of money to be equal to the money multiplier times the monetary base. The monetary base moves with its counterparts in the balance sheet of the central bank - net credit to the government, net credit to the economy and net foreign assets. In logarithm, this can be written

\[ m' = k + b \quad (2) \]

This simple system is closed by the demand for money is equal to the supply of money

\[ m' = m^d = m \quad (3) \]

In developed, market economies, it is generally necessary to add to this system one or more aggregate demand equations of a Keynesian type. Such an equation or set of equations would relate aggregate output, Y, to the price level, expected inflation, monetary and fiscal and other variables. In the context of transition, in which movements of production are dominated by structural factors (see Blaschard (1997)), it is more reasonable to assume that output is supply constrained, and therefore, for our purposes, to take Y as exogenous.

Empirical evidence suggests further that inflationary expectations appear to be unbiased; i.e. though households and firms can err often in their inflationary predictions, those errors are not systematic. This allow us to write

\[ \pi^e = \pi \]

Under these conditions, the model of equation (1) through (3) can be written as

\[ m = k + b \]

\[ p^* = m - \alpha_0 - \alpha_1 y + \alpha_2 \pi \quad (2', 1') \]

We have put a star on the value of the price level which is determined by this system in order to indicate that this is an equilibrium price level that is dictated by underling monetary fundamentals. In the short run, the actual price level deviates above and below its monetary tendency. We model these short run dynamics with an error-correction mechanism, as follows:

\(^1\) For details see De Menil, G. et al. (1998).
\[ \Delta p = \delta (p^*_t - p_{t-1}) + \gamma Sh \]  \hspace{1cm} (4)

Sh is a price shock corresponding to increase in administrated prices, or the removal of price controls. In equation (4), Sh generates an immediate increase in inflation, but the error correction term, the first term in the equation, continually draws the actual price level back to its monetary equilibrium.

The theoretical framework of the second part of our model is a so-called aggregate tax revenue calculation approach and tax legislation of Ukraine.

The principal components of the Ukrainian tax system can be described in the following way. Currently, payments to the pension fund are the single most important source of revenue, accounting for about 24% of taxes raised by the Ukrainian government. Note the importance of the value added tax. It yields more revenue than either profit tax, personal income tax or payments to the Chernobyl fund. The fall of the relative importance of the profit tax is also of some interest. In 1996, it accounted for 18% of all revenue collected, but by 1997 this figure was down to 13%.

The system of tax collection is highly complicated. Even at the level of an enterprise it is rather difficult to forecast tax payments as too much information is necessary. If we operate at the macro level, such a task becomes impossible. Therefore, in our model we operate with aggregated across the whole economy data, which gives us the opportunity to simplify. In general, we use tax base and tax rate as basic variables in the model of budget revenues forecast. For example, in forecasting revenues from VAT we use the current tax rate and GDP as a proxy for tax base. However, for forecasting of the revenues from the Pension Fund; we use wage fund as a tax base.

Therefore, planned tax collection, namely tax rate multiplied by the tax base, is a good explanatory variable in the model of forecasting budget revenues. Such a model has a lot of advantages. Firstly, it reflects the real world, taking into account payments arrears, lags in payments etc. Econometric estimation shows us the coefficient of correlation between real and planned tax collection. Secondly, it uses trends of tax collection which prevailed during the historical period. Eventually, it is rather flexible as it gives the opportunity to introduce coefficients which reflect changes in government fiscal policy and tax legislature.

This description reveals the general approach to forecasting budget revenues. In our model, basing on the above described approach, we make forecasts for each kind of taxes independently.

To estimate the model we used the programming package Econometric Views, Version 2. Thus the EViews guide was a great necessity for us and gives a detailed explanation of the technique. We should note that, as a rule, all variables we use are in a logarithmic scale to make the time series and regressions linear.
2. Forecasting of Nominal GDP and Inflation

In this part of the description we consider the nominal GDP and Inflation forecast. We consider CPI as a major indicator that reflects the fluctuation of the general price level. Therefore, we devote much attention to the CPI forecast.

2.1. Estimation and forecasting of CPI

Since CPI is a major component of general price level it is rational to assume that short run deviation from the long run trend of general prices substantially influences CPI. Therefore, to forecast CPI we use an error correction model: first we estimate the long run equilibrium level of price-deflator and then, we use lagged difference between the long-run equilibrium level and actual price deflator level as an error correction term in the short-run regression for CPI.

2.2. Long-run equilibrium equation of CPI

This equation looks like:

\[
\ln(\frac{MM}{P}) = \alpha_0 + \alpha_1*D + \alpha_2*\ln(Y) + \alpha_3*\ln(Y[-1]) + \alpha_4*\ln(\pi_{cpi}(-1)) + \alpha_5*\ln(\pi_{cpi}(-2)),
\]

where:

- \(MM\) – M2 without foreign deposits,
- \(P\) – price deflator,
- \(D\) – a dummy, \(D_i=0, i<=February,1997, D_i=1, i>February,1997,\)
- \(Y\) – real GDP,
- \(\pi_{cpi}\) – consumer price inflation,
- \(\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5\) – coefficients,
- numbers in brackets stand for lag.

There are many disputes among different economic schools about what factors influence the demand for real money balance and, thus, long run equilibrium price level. Nevertheless, all of them agree that it is an aggregate output that influences the demand for real money balance the most. The logic behind this is as follows. The bigger the output produced in an economy, the more money is needed to serve it. This is why we include the output as an explanatory variable in our long-run equilibrium equation.

\[\text{For detailed regression output of all equations see appendixes.}\]
Furthermore, in transition economies, persistence of inflation is caused by various subjective factors that cannot be predicted by theory. These factors determine the inflation in the past and, thus, can help to predict its value in the next period. In addition, we assumed that in Ukraine people have adaptive expectation and, thus, that the agents (i.e. market participants) always expect that the most recently observed value of any variable will continue to prevail in the near future. For these two reasons we include CPI inflation lagged one and two periods as endogenous variables in the equation.

The dummy is used to reflect the change in real money balance trend. The trend has different slopes: $\alpha_0$ until some threshold date and $\alpha_0+\alpha_1$ afterwards. Using the stability breakpoint test we infer that February 1997 is such a threshold. Therefore, D takes value of 0 until February 1997 and 1 otherwise.

2.3. Short-run equation of CPI

From the equation (1) we can determine the value of our long-run price deflator level ($P^*$) which can be calculated as follows:

$$\ln(P^*) = \exp[\ln(MM) - (\alpha_0 + \alpha_1*D + \alpha_2*\ln(Y) + \alpha_3*\ln(\pi_{cpi}(-1)) + \alpha_4*\ln(\pi_{cpi}(-2))]$$

Then we can calculate the deviation of the actual price level from its equilibrium level and construct the short-run inflation adjustment of the actual price level towards its long-run value which looks like:

$$\ln(\pi_{cpi}) = \beta_1*[\ln(P^*[-1]) - \ln(P[-1])] + \beta_2*\ln(\pi_{cpi}(-1)) + \beta_3*SH + SFI$$, where:

\[ \sum_{i=1}^{12} SFI_i = 0 \]

(1 stands for January and 12 - for December). Thus, the index is designed to reflect the increase in food production prices in winter, and decline in them in summer.

- Consumer price inflation lagged one period. This variable takes into account inflation expectations.

$P$ _ GDP-deflator,
SH _ administrative price shock,
SFI _ seasonal fluctuation index,
$\beta_1$, $\beta_2$, $\beta_2$ _ coefficients.
To forecast CPI based on these two equations we should have expert estimates of money supply, real GDP, shocks and seasonal fluctuations in the future. Future money supply we estimate as a money base times money multiplier. For money multiplier we use 1.5 (the average level) adjusted on seasonal fluctuations. To forecast the level of real GDP we use official data from state budget and ARIMA model that we developed. Seasonal fluctuation index used with this purpose is the same as in the previous year and the shock variable usually takes a value of zero if the government does not announce an administrative price increase in the future. The other variables are given by statistics department (CPI and GDP-deflator data) or are calculated basing on the equation (1) results (level of P*).

2.4. Estimation and forecasting of WPI

To forecast WPI we use the following estimated equation.

\[ \pi_{wpi} = \gamma_1(\pi_p(-1)) + \gamma_2(E/E(-1)) + \gamma_3(\pi_{cpi}), \]

where

- \( E \) - exchange rate,
- WPI - wholesale price index,
- \( \gamma_1, \gamma_2, \gamma_3 \) - coefficients.

Here we assume that the change in wholesale prices is correlated with the change in consumer prices and with the previous change in the general price level because the nature of these variables are very similar. Since the wholesale prices are very sensitive to terms of trade conditions, we included in the RHS of the equation the change in exchange rate, as a proxy of change in terms of trade conditions.

Having estimated equation (3) we could forecast WPI. The value of \( (P/P(-1)) \) is lagged 1 period, so we do not need to make assumptions about its level. For CPI we use the value obtained from CPI forecasting. The only variable, which value we should assume is the change in exchange rate. Our estimates about exchange rate are based on the official data about the currency corridor.

2.5. Forecast of GDP-deflator

Experts of our group agree that the nature of this variable is such that it could be calculated as a weighted average of CPI and WPI in the following way:

\[ \pi_p = 0.7*\pi_{cpi} + 0.3*\pi_{wpi} \]
2.6. Forecast of nominal GDP

\[ PY = P \times Y, \text{ where:} \]

\[ PY \_ \text{nominal GDP.} \]

To forecast nominal GDP we should make assumptions about the real GDP level.

3. Forecasting of Consolidated Budget Revenue

In this part of the description of the model we consider the revenue side of the budget. We present the method of estimation of the major taxes, namely: value-added tax, profit tax, sales taxes, stamp tax, payments for land and payroll taxes. The methodology used in the excise tax case could be employed to forecast other taxes.

3.1. VAT Revenues

Firstly, we assume that all final goods and services produced and sold during a given period, i.e., the entire gross domestic product, are subject to a general VAT tax. This means that the tax is applicable to both consumers and capital goods and it would be paid by the last seller, whether this good is bought by a consumer, as a capital good by a firm or added to inventory by a firm. In the model this assumption is represented by the following equation:

\[ \text{VAT}_M = R \times \text{PY}, \text{ where:} \]

\[ \text{VAT}_M \_ \text{“maximum available” budget revenues from VAT,} \]
\[ R \_ \text{tax rate.} \]

In order to calculate real revenues from VAT we should take into account tax exemptions, delays in tax payments, tax evasion and other factors. Therefore, the final equation which estimates VAT revenues has the following form:

\[ \text{VAT}_R = \alpha_1 + \alpha_2 \times \text{VAT}_M + \alpha_3 \times \text{VAT}_M(-1), \text{ where:} \]

\[ \text{VAT}_R \_ \text{ the actual revenues to the budget from the VAT;} \]
\[ \alpha_2 \text{ and } \alpha_3 \_ \text{coefficients, which represent tax collection in current and previous months respectively.} \]
3.2. Profit tax revenues

Profit tax is levied on an enterprise's gross profit. Therefore, in order to calculate profit tax revenues for the budget we need to estimate taxable income. The basic principle in determining taxable income is simple enough. Gross income of the enterprise is reduced by costs incurred in doing business, and the net is net income subject to tax. For the purposes of our forecast we need to aggregate incomes of all enterprises across the country and here problems arise. Mostly they deal with exclusions and deductions such as capital gains, tax exemptions, charitable contributions, etc. This involves determining and forecasting the value of the items that should be deductible as business costs and what the timing of such changes should be. Unfortunately, this is not feasible on an aggregate level. In order to simplify we have taken nominal GDP as an explanatory variable of profits across the national economy. Econometric estimates have shown that a correlation between these two variables exist. In order to construct a final equation we have taken into account also seasonality effects due to accountancy practice of the enterprises to correct valuation of their profits before the end of each half of the year:

\[
\text{PROF} = \alpha_1 \times \text{PY} + \alpha_2 \times \text{SEAS}(6) + \alpha_3 \times \text{SEAS}(12)
\]

Finally, profit tax revenues are calculated as a function of above described variable “profit”. Again seasonality factor is present in order to take into account corrections of payments to the budget at the end of each year. Profit tax payments have also a lag of one period:

\[
\text{PROF}_R = \alpha_1 \times \text{PROF} + \alpha_2 \times \text{PROF}(-1) + \alpha_3 \times \text{SEAS}(12)
\]

3.3. Revenues estimated on the basis of the wage fund forecast

In this part of our model we consider taxes which are usually called payroll taxes. These taxes provide a source of revenue for the social security system. As a matter of administration, the payroll taxes are collected from the employer, including the contributions of both employer and employee, the latter being withheld at the source. These taxes are on gross earnings and usually no allowance is made for exemptions.

In Ukraine, the employer is required to make monthly contributions to pension, social security and Chornobyl funds. These social fund payments are made in lump sum for all Ukrainian employees of any employer and are calculated as a percentage of the employee's earnings. Therefore, for the purposes of the forecast we need to estimate the wage fund making distinction at the same time between the wage fund which is due and which is paid.

The total due wage fund is calculated by multiplying the average wage and the number of workers. Average wage is determined by the value of the average wage in the preceding period and by the change in the average over the present period:
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\[
A_{WT} = A_{WT-1} \times D_{AWT}, \text{ where:}
\]

- AWT - the value of the average wage
- DAWT - the change in the average over the present period.

The change in the average wage is estimated using an econometric technique where the dependent variables are change in the average wage over the previous period and change in consumer price index (CPI) in present and previous periods. We have also included two dummy variables for the last and first months of the year. They introduce seasonal effect on the average wage, which occurs due to a practice of additional payments to the employees at the end of each year. In general, the equation has the following form:

\[
D_{AWT} = f(D_{AWT-1}, D_{CPI-1}, SEAS(1), SEAS(12)).
\]

Calculation of the number of workers in the national economy is based on the research on payroll taxation in Ukraine. In particular, this study makes a conclusion that with the current payroll tax rates the labor force in Ukraine decreases each month by 0.4% (labor force shifts into the unofficial economy). From the other side, the study of the foreign experience showed that 25% payroll tax rate will lead to zero labor mobility. Therefore,

\[
N = N_{-1}(1 + f(t))
\]

where:

- \( t \) - tax rate,
- \( N \) - number of workers.

Next we assume exponential functional form of the dependence of changes in the labor force due to changes in payroll tax rate:

\[
f(t) = \alpha_0 e^{-\alpha_1 t} + \alpha_2, \text{ where:}
\]

\( f(t) \) - labor force mobility,
\( \alpha_0 \) and \( \alpha_1 \) - minimal and maximal number of workers in the national economy,
\( \alpha_2 \) - the maximal speed of labor force movement out of the official economy.

Combining two equations together we obtain the final one for the calculation of the number of workers in the official economy:

\[
N = N_{-1}(1 + \alpha_0 e^{-\alpha_1 t} + \alpha_2).
\]

Now it is easy to get a due wage fund:

\[
RWF = AWT \times N.
\]
The paid wage fund (the turnover account for wages in the National Bank of Ukraine in the historical period) is estimated as the part of the due wage fund. Although this method of estimation is rather simple, it gives us the opportunity to see how large the difference is between the paid wage fund and the due wage fund. Also a coefficient is introduced to take into account wage arrears:

\[ WFC = (0.7 + k) \cdot RWF \], where

- \( WFC \) - paid wage fund,
- \( k \) - coefficient of payments of wage arrears estimated using the data for the period 1996-1997.

Using the above mentioned technique of calculation of the paid wage fund, we form the basis for estimation of revenues from the payments to the Pension fund (variable R_PF), the Chornobyl fund (variable R_CHF) and also revenues for the personal income tax (variable R_PIT):

\[ R_{PF} = \alpha_1 WFC \]
\[ R_{CHF} = \alpha_2 WFC \]
\[ R_{PIT} = \alpha_3 WFC. \]

The observed correlation between these variables is robust enough to use them in our model and to make regular forecasts.

### 3.4. Sales taxes

The sales tax can be a general type when the same tax rate is imposed on purchases of all commodities, and a selective type, also referred to as an excise tax, which is levied at different rates on the purchase of different commodities. Sale taxes generally take one of the two forms: a unit tax is a given amount for each unit purchased, and an ad valorem tax is computed as a percentage of the value of the purchase. When considering the case with Ukraine, we shall deal with excise taxes and custom duties of ad valorem form as these are the kinds of taxes which are used here.

### 3.5. Excise taxes

Excise taxes are very popular in developing countries due to their ease of administration. They are collected from sellers at the retail level. Relative to an income tax, there are fewer individuals whose behavior has to be monitored by the tax authorities.

In Ukraine excise tax is imposed on such traditional excisable goods as alcoholic beverages, tobacco products, cars and tires for them, jewelry etc., with the tax rate in the range of 10 to 300% of the release price or purchase price in case of imported goods. Such a diversity of tax rates and product groups on which the tax is levied creates problems of forecasting because too much information is available.
Therefore, calculate excise revenues on the aggregate level. The main assumption here is that the nominal excise revenues for a month ‘j’ are equal to the real revenues for the same month in the previous year multiplied by the current CPI:

$$ R_{\text{EXC}} = (R_{\text{EXC}}(-12) / CPI(-12)) * CPI * EXC_{\text{COEF}}. $$

Here we have also introduced excise coefficient. It measures tax collection in the current year. This coefficient is calculated in the following way. Firstly, we calculate the level of tax collection for the first 6 months of the current year compared to the previous year:

$$ \gamma = \frac{\sum_{i=1}^{6} \text{EXC}_R^{97} / CPI^{97}}{\sum_{i=1}^{6} \text{EXC}_R^{96} / CPI^{96}}. $$

Now, if we multiply $\gamma$ by the sum of excise revenues collected in the previous year we will have an approximation of the sum of tax collection in the current year. Using this proxy and the sum of tax collection in the first 6 months of this year we can calculate the level of tax collection until the end of this year compared to the previous year:

$$ \beta = \frac{\gamma * \sum_{i=1}^{12} \text{EXC}_R^{96} / CPI^{96} - \sum_{i=1}^{6} \text{EXC}_R^{97} / CPI^{97}}{\sum_{i=1}^{12} \text{EXC}_R^{96} / CPI^{96}}. $$

Coefficient $\beta$ enters into the model as a variable “EXC_COEF”.

### 3.6. Customs duties

Customs duties are another kind of sales tax. In Ukraine, they are charged at a level from 0% to 200% of the contract value of import shipments. The value of import is the primary variable used for forecasting of customs duties revenue. As this value is in dollars in official statistics, we use the following equation to convert import value into the local currency:

$$ \text{IMH} = \text{IM} * E $$

where:

- IMH – the value of import in Hryvna,
- IM – value of import in dollars.

In order to calculate custom duties revenues we use value of import shipments multiplied by the weight of customs duties collected in the previous month in the last month’s value of import. This gives us an approximation of what should be collected
in the current period. However, such an approximation can be erroneous. In order to avoid accumulation of errors we introduce the following error correction mechanism: we calculate a proxy of custom duties revenue for the previous month in a way discussed above. Then we compare this proxy with the actual value. The final equation has the following form:

$$
R_{CUSTOMS} = \frac{R_{CUSTOMS(-1)} \cdot IMH(-1) + \alpha (R_{CUSTOMS(-1)} - \frac{R_{CUSTOMS(-2)} \cdot IMH(-2)}{IMH(-2)})}{IMH(-1)},
$$

where $\alpha$ is a coefficient which shows the significance of the error correction.

### 3.7. Stamp tax

In Ukraine stamp taxes are paid for transactions with securities, carrying out of auctions, stock exchange transactions, foreign travel passport issue etc. In general, the stamp tax is a fee on civil and some business transactions. This means that the size of business activity should cause a consequent increase in stamp tax receipts. The increase in the price level should also increase stamp tax receipts as in such a case the value of the civil transactions goes up. In our model we consider GDP and CPI as the primary variables explaining stamp tax receipts. The lagged variable of stamp tax receipts takes into account actual tax receipts during the historical period:

$$
R_{STAMPTAX} = \alpha \cdot NGDP \cdot CPI + \beta \cdot R_{STAMPTAX(-1)}. 
$$

### 3.8. Payments for land

We now turn to taxation of stocks, i.e., of wealth. Such taxes are imposed on pieces of property. The benefit rationale for wealth taxation is that public services increase the value of real properties and should therefore be paid for by the owners. In other words, the property owners should pay for particular services which go to raise property values.

In Ukraine payment for land depends on space and location of the plot of land. Theoretically, such payments in real terms should be constant since the supply of land is given. Therefore, the first variable in our model is the revenues for payments for land received in the corresponding period of the previous year corrected with CPI. However, in real life, payment for land is not a constant. The return to land is in the nature of economic rent, being a return to a factor of production in inelastic supply. Therefore, land taxation may change with business activity in order to encourage or discourage land utilization without creating excess burden on businesses. We introduced a change in the nominal GDP variable in order to account for this in our model:

$$
R_{LAND} = \alpha \cdot \frac{R_{LAND(-12)} \cdot CPI(-12)}{CPI(-12)} + \beta \cdot \frac{NGDP}{NGDP(-1)} + R_{LAND(-1)}. 
$$
3.9. Other taxes

The forecast uses the same methodology as in the excise tax case.

**Consequences**

Besides the direct use of the model for forecasting nominal GDP, inflation and budget revenue, the model has some application. One can use it to evaluate alternative scenarios of economic development. For example, it could tell us what would happen with GDP, inflation and budget deficit if the government decided to change exchange or tax rates, increase money supply, etc. Also, this model allows us to install so-called reverse ties: we could first assign a size of the budget deficit as an exogenous variable, and then the model will determine the appropriate level of GDP and inflation as well as the money base and the money supply.

Finally, we plan to expand the model by working out the forecast of real GDP, foreign trade balance and T-bills conditions.
Appendices

A. The principal scheme of the model

B. Notes on the general model specification

The monetary part of the model is represented by three equations. Tests are performed on each of the model components.

An integrated approach of the model verification assumes the following key stages:

- **Multicollinearity check.** The absence of multicollinearity was verified directly via the correlation matrix. The value of correlation coefficient greater than 0.9 immediately causes linear correlation of the regressors.

- **Stationarity of Series.** The stationarity check procedure underlying the Augmented Dicker-Fuller tests is used at this stage. Stabilized series of regressors is assumed in the derivation of the standard inference procedure for regression models. Nonstationarity of regressors invalidates many standard results.

- **Normality of residuals distribution.** As a rule, the distribution of residuals is standard Gaussian. This indicates that efficiency of estimation is not under the influence of residuals. The Jarque-Bera criteria test was applied to all squared residuals.

- **Homoskedasticity of disturbances.** The results of White’s heteroskedasticity tests shows that disturbances in all equations are both homoskedastic and independent of regressors. The F-statistic and a statistic with an asymptotic $\chi^2$-distributed distribution proof the null hypothesis. This is a general test for model misspecification and results of the test assume that the specification of the model is correct.
Analysis of the long-term money demand equation

Let us consider the equation for equilibrium price level estimation

\[ \text{mm-p} = f(y, y_{-1}, \pi_{\text{CPI-1}}, \pi_{\text{CPI-2}}, D, \mu), \]

where all lowercase variables are in a logarithmic scale, \( \mu \) stands for stochastic disturbances.

Correlation matrix is shown below.

<table>
<thead>
<tr>
<th>Correlation Matrix</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOG(MM/P)</td>
</tr>
<tr>
<td>LOG(MM/P)</td>
</tr>
<tr>
<td>LOG(Y)</td>
</tr>
<tr>
<td>LOG(CPI(-1)/CPI(-2))</td>
</tr>
<tr>
<td>LOG(CPI(-2)/CPI(-3))</td>
</tr>
</tbody>
</table>

The regressors are sufficiently linear independent to be included to the model.

The histogram of residuals is shown in the figure. According to the Jarque-Bera criteria, the distribution is normal with the probability of 0.597.

Figure 1
Distribution of residuals (P=0.59)

The results of White tests for the first equation can be found in the table.
White Heteroskedasticity Test

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.055629</td>
<td>0.122088</td>
<td>-0.455645</td>
<td>0.6523</td>
</tr>
<tr>
<td>C1</td>
<td>0.001623</td>
<td>0.001635</td>
<td>0.993028</td>
<td>0.3295</td>
</tr>
<tr>
<td>PDL01</td>
<td>0.044284</td>
<td>0.106947</td>
<td>0.414070</td>
<td>0.6821</td>
</tr>
<tr>
<td>PDL01^2</td>
<td>-0.008070</td>
<td>0.023999</td>
<td>-0.344867</td>
<td>0.7329</td>
</tr>
<tr>
<td>PDL02</td>
<td>-0.012191</td>
<td>0.015378</td>
<td>-0.792755</td>
<td>0.4348</td>
</tr>
<tr>
<td>PDL02^2</td>
<td>0.013382</td>
<td>0.031553</td>
<td>0.424118</td>
<td>0.6748</td>
</tr>
</tbody>
</table>

The hypothesis of heteroskedasticity is not accepted.

The following table represents ADF tests results on stationarity of levels and in the first differences (where it's necessary). Since the ADF statistic is smaller than the critical value for correspondent significant level, we accept the stationarity hypothesis.
Augmented Dickey-Fuller Unit Root Test on LOG(MM/P)

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value*</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.022055</td>
<td>-3.6353</td>
<td>-2.9499</td>
<td>-2.6133</td>
</tr>
</tbody>
</table>

Augmented Dickey-Fuller Unit Root Test on LOG(CPI/CPI(-1))

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value*</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.126822</td>
<td>-3.6422</td>
<td>-2.9527</td>
<td>-2.6148</td>
</tr>
</tbody>
</table>

Augmented Dickey-Fuller Unit Root Test on LOG(Y)

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value*</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.758905</td>
<td>-3.6496</td>
<td>-2.9558</td>
<td>-2.6164</td>
</tr>
</tbody>
</table>

Augmented Dickey-Fuller Unit Root Test on RESID

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>1% Critical Value*</th>
<th>5% Critical Value</th>
<th>10% Critical Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.499816</td>
<td>-3.6353</td>
<td>-2.9499</td>
<td>-2.6133</td>
</tr>
</tbody>
</table>

*MacKinnon critical values for rejection of hypothesis of a unit root.

All series are non-stationary. We check co-integration (in term of our equation). Test showed that residual of equation is stationary. We can use error correction mechanism discussed at the third part of this description.

**Analysis of the short-term money demand equation**

Let consider short-run inflation dynamic equation

\[
\pi_{CPI} = f\left( (p^*-p)_{-1}, \pi_{CPI_{-1}}, SH, SFI, \mu \right)
\]

The results of the tests, similar to those mentioned above are given here for Equation 2.

**Correlation Matrix**

<table>
<thead>
<tr>
<th></th>
<th>LDCPI(-1)</th>
<th>ZZ</th>
<th>LOG(PS1(-1))-LOG(P(-1))</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDCPI(-1)</td>
<td>1.000000</td>
<td>0.219103</td>
<td>-0.188758</td>
</tr>
<tr>
<td>ZZ</td>
<td>0.219103</td>
<td>1.000000</td>
<td>-0.040081</td>
</tr>
<tr>
<td>LOG(PS1(-1))-LOG(P(-1))</td>
<td>0.188758</td>
<td>-0.040081</td>
<td>1.000000</td>
</tr>
</tbody>
</table>
White's test shows the source of partial heteroskedasticity in the Equation 2 - non-homogeneous disturbance of SH regressor.

White Heteroskedasticity Test

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficients</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>4.35E-05</td>
<td>0.000148</td>
<td>0.294474</td>
<td>0.7706</td>
</tr>
<tr>
<td>LOG(PS1(-1))-LOG(P(-1))</td>
<td>0.000347</td>
<td>0.001672</td>
<td>0.207639</td>
<td>0.8371</td>
</tr>
<tr>
<td>(LOG(PS1(-1))-LOG(P(-1)))^2</td>
<td>0.013664</td>
<td>0.012377</td>
<td>1.104016</td>
<td>0.2793</td>
</tr>
<tr>
<td>LDCPI(-1)</td>
<td>0.000590</td>
<td>0.005684</td>
<td>-0.103776</td>
<td>0.9181</td>
</tr>
<tr>
<td>LDCPI(-1)^2</td>
<td>-0.007455</td>
<td>0.032600</td>
<td>-0.228679</td>
<td>0.8208</td>
</tr>
<tr>
<td>ZZ</td>
<td>0.033508</td>
<td>0.015106</td>
<td>2.218208</td>
<td>0.0351</td>
</tr>
<tr>
<td>ZZ^2</td>
<td>-0.312287</td>
<td>0.187741</td>
<td>-1.663397</td>
<td>0.1078</td>
</tr>
</tbody>
</table>

R-squared: 0.250748, Adjusted R-squared: 0.084248

Mean dependent var: 0.000239, S.D. dependent var: 0.000486
Analysis of the wholesale price index equation

The results for the WPI index estimation equation are shown below

\[ \frac{WPI}{WPI(-1)} = \text{f}(\frac{CPI}{CPI(-1)}, \frac{E}{E(-1)}) \]

<table>
<thead>
<tr>
<th>Series</th>
<th>LEXRATE</th>
<th>WPI</th>
<th>LCPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF Statistic</td>
<td>-4.966251</td>
<td>-2.731770</td>
<td>-3.281453</td>
</tr>
<tr>
<td>Signif. Level</td>
<td>1%</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>DWPI</th>
<th>DCPI</th>
<th>EXRATE(-1)/EXRATE(-2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DWPI</td>
<td>1.000000</td>
<td>0.748344</td>
<td>0.507076</td>
</tr>
<tr>
<td>DCPI</td>
<td>0.748344</td>
<td>1.000000</td>
<td>0.183999</td>
</tr>
<tr>
<td>EXRATE(-1)/EXRATE(-2)</td>
<td>0.507076</td>
<td>0.183999</td>
<td>1.000000</td>
</tr>
</tbody>
</table>

Augmented Dickey-Fuller Test Equation

LS // Dependent Variable is D(LCPI)

Date: 12/10/97  Time: 18:35

Sample (adjusted): 1995:01 1997:10

<table>
<thead>
<tr>
<th>ADF Test Statistic</th>
<th>-3.885990</th>
<th>1% Critical Value*</th>
<th>-3.5092</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5% Critical Value</td>
<td>-2.8959</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10% Critical Value</td>
<td>-2.5849</td>
</tr>
</tbody>
</table>

*MacKinnon critical values for rejection of hypothesis of a unit root.

White Heteroskedasticity Test:

<table>
<thead>
<tr>
<th></th>
<th>F-statistic</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.052015</td>
<td>0.129854</td>
</tr>
<tr>
<td>Obs*R-squared</td>
<td>7.20333</td>
<td>0.125525</td>
</tr>
</tbody>
</table>

Most of the series are autocorrelated with the first lag that leads to inference uncertainty. However, the first lags were mostly included into equations, so parameter estimation was legitimated. Additional testing by the Augmented Dicker-Fuller tests had shown the stationarity of regressors.

General model specification tests showed substantial adequacy level and stability of the model. Standard inference procedure is adequate underlying estimated
parameters values. The results of the tests confirm that the specification of the model is correct.

C. Regression Output of the Nominal GDP and Inflation Part of the Model

*Long-run equilibrium equation for CPI*

\[
\ln(MM/P) = 0.29 + 0.29*D + 0.51*\ln(Y) + 0.26*\ln(Y(-1)) - 0.35*\pi_{cpi}(-1) - 0.18*\pi_{cpi}(-2)
\]

LS // Dependent Variable is LOG(MM/P)
Date: 11/24/97   Time: 16:34
Sample(adjusted): 1995:01 1997:10
Included observations: 34 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.292406</td>
<td>0.180761</td>
<td>1.617640</td>
<td>0.1162</td>
</tr>
<tr>
<td>D</td>
<td>0.288186</td>
<td>0.024797</td>
<td>11.62171</td>
<td>0.0000</td>
</tr>
<tr>
<td>PDL01</td>
<td>0.513660</td>
<td>0.078579</td>
<td>6.536831</td>
<td>0.0000</td>
</tr>
<tr>
<td>PDL02</td>
<td>-0.350690</td>
<td>0.097158</td>
<td>-3.609487</td>
<td>0.0011</td>
</tr>
</tbody>
</table>

R-squared 0.877113  Mean dependent var 1.503341
Adjusted R-squared 0.864825  S.D. dependent var 0.150386
S.E. of regression 0.055291  Akaike info criterion -5.680155
Sum squared resid 0.091713  Schwarz criterion -5.500583
Log likelihood 52.31872  F-statistic 71.37574
Durbin-Watson stat 1.462166  Prob(F-statistic) 0.000000

<table>
<thead>
<tr>
<th>Lag Distribution of ln(Y)</th>
<th>i</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>T-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.</td>
<td>0</td>
<td>0.51366</td>
<td>0.07858</td>
</tr>
<tr>
<td></td>
<td>.</td>
<td>1</td>
<td>0.25683</td>
<td>0.03929</td>
</tr>
<tr>
<td>Sum of Lags</td>
<td></td>
<td>0.77049</td>
<td>0.11787</td>
<td>6.53683</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lag Distribution of ln(CPI(-1)/CPI(-2))</th>
<th>i</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>T-Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.</td>
<td>0</td>
<td>-0.35069</td>
<td>0.09716</td>
</tr>
<tr>
<td></td>
<td>.</td>
<td>1</td>
<td>-0.17535</td>
<td>0.04858</td>
</tr>
<tr>
<td>Sum of Lags</td>
<td></td>
<td>-0.52604</td>
<td>0.14574</td>
<td>-3.60949</td>
</tr>
</tbody>
</table>
**Short-run equation for CPI**

$$\pi_{cpi} = 0.05*\left[\ln(P^*[-1]) - \ln(P[-1])\right] + 0.24*\pi_{cpi}(-1) + 0.92*SH$$

LS // Dependent Variable is $\pi_{cpi}$
Date: 06/12/97   Time: 16:03
Sample(adjusted): 1994:01 1997:04
Included observations: 40 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(P*[-1])-ln(P[-1])</td>
<td>0.053000</td>
<td>0.017797</td>
<td>2.977933</td>
<td>0.0051</td>
</tr>
<tr>
<td>SH</td>
<td>0.921591</td>
<td>0.057683</td>
<td>15.97691</td>
<td>0.0000</td>
</tr>
<tr>
<td>$\pi_{cpi}(-1)$</td>
<td>0.244157</td>
<td>0.035413</td>
<td>6.894526</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared 0.927298  Mean dependent var 0.075630
Adjusted R-squared 0.92368  S.D. dependent var 0.097574
S.E. of regression 0.027011  Akaike info criterion -7.150984
Sum squared resid 0.026995  Schwarz criterion -7.024318
Log likelihood 89.26214  F-statistic 235.9634
Durbin-Watson stat 0.962344  Prob(F-statistic) 0.000000

**WPI Equation**

$$\frac{WPI}{WPI(-1)} =0.26\cdot(P[-1]/P[-2]) + 0.38\cdot(E/E(-1)) + 0.35\cdot(CPI/CPI[-1])$$

LS // Dependent Variable is WPI/WPI(-1)
Date: 09/30/97   Time: 17:47
Sample(adjusted): 1995:03 1997:08
Included observations: 30 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>P(-1)/P(-2)</td>
<td>0.268190</td>
<td>0.110056</td>
<td>2.436857</td>
<td>0.0217</td>
</tr>
<tr>
<td>E/E(-1)</td>
<td>0.378643</td>
<td>0.083289</td>
<td>4.546109</td>
<td>0.0001</td>
</tr>
<tr>
<td>CPI/CPI(-1)</td>
<td>0.353835</td>
<td>0.110870</td>
<td>3.191437</td>
<td>0.0036</td>
</tr>
</tbody>
</table>

R-squared 0.822547  Mean dependent var 1.029633
Adjusted R-squared 0.809402  S.D. dependent var 0.033242
S.E. of regression 0.014512  Akaike info criterion -8.370862
Sum squared resid 0.005686  Schwarz criterion -8.230742
Log likelihood 85.99478  F-statistic 62.57645
Durbin-Watson stat 1.115558  Prob(F-statistic) 0.000000
Regression Output of the Consolidated Budget Revenue Part of the Model

**VAT Equation**

\[
\text{VAT}_R = 46.22 + 0.06 \times \text{VAT}_M + 0.32 \times \text{VAT}_M(-1)
\]

Dependent Variable is \(\text{VAT}_R\)

Date: 12/18/97   Time: 15:48


Included observations: 23 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>46.21612</td>
<td>22.56489</td>
<td>1.804181</td>
<td>0.0863</td>
</tr>
<tr>
<td>(\text{VAT}_M)</td>
<td>0.061944</td>
<td>0.021012</td>
<td>3.336701</td>
<td>0.0033</td>
</tr>
<tr>
<td>(\text{VAT}_M(-1))</td>
<td>0.322076</td>
<td>0.098562</td>
<td>3.539709</td>
<td>0.0021</td>
</tr>
</tbody>
</table>

R-squared 0.989161 Mean dependent var 252.5648

Adjusted R-squared 0.988077 S. D. dependent var 157.7624

S.E. of regression 17.22615 Akaike info criterion 5.813964

Sum squared resid 5934.802 Schwarz criterion 5.962072

Log likelihood -96.49618 F-statistic 912.6211

Durbin-Watson stat 1.958462 Prob(F-statistic) 0.000000

**Equation for profits**

\[
\text{PROF} = 0.09 \times \text{PY} + 0.31 \times \text{PROF}(-3) + 0.23 \times \text{SEAS}(12) \times \text{CPI} + 0.48 \times \text{SEAS}(6) \times \text{CPI}
\]

Dependent Variable is \(\text{PROF}\)

Date: 07/30/97   Time: 19:25


Included observations: 17

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\text{PY})</td>
<td>0.085400</td>
<td>0.027720</td>
<td>3.080848</td>
<td>0.0088</td>
</tr>
<tr>
<td>(\text{PROF}(-3))</td>
<td>0.313353</td>
<td>0.109612</td>
<td>2.858737</td>
<td>0.0134</td>
</tr>
<tr>
<td>(\text{SEAS}(12) \times \text{CPI})</td>
<td>0.233049</td>
<td>0.317059</td>
<td>0.735035</td>
<td>0.4754</td>
</tr>
<tr>
<td>(\text{SEAS}(6) \times \text{CPI})</td>
<td>0.484369</td>
<td>0.279688</td>
<td>1.731822</td>
<td>0.1069</td>
</tr>
</tbody>
</table>

R-squared 0.441259 Mean dependent var 1064.250

Adjusted R-squared 0.312319 S. D. dependent var 543.1670

S.E. of regression 450.4295 Akaike info criterion 12.42273

Sum squared resid 2637528 Schwarz criterion 12.61878

Log likelihood -125.7151 F-statistic 3.422202

Durbin-Watson stat 1.232284 Prob(F-statistic) 0.049549
### Equation for profit revenues

\[
\ln(\text{PROF}_R) = 5.37 + 0.25 \times \ln(\text{PROF}) + 0.2 \times \text{SEAS}(12) - 0.16 \times \ln(\text{PROF}(-1))
\]

LS // Dependent Variable is \(\ln(\text{PROF}_R)\)

Date: 07/30/97   Time: 19:06
Included observations: 24 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>5.368587</td>
<td>0.821407</td>
<td>6.535841</td>
<td>0.0000</td>
</tr>
<tr>
<td>(\ln(\text{PROF}))</td>
<td>0.251541</td>
<td>0.095088</td>
<td>2.645348</td>
<td>0.0155</td>
</tr>
<tr>
<td>(\ln(\text{PROF}(-1)))</td>
<td>-0.159014</td>
<td>0.086583</td>
<td>-1.836551</td>
<td>0.0812</td>
</tr>
<tr>
<td>@SEAS(12)</td>
<td>0.203982</td>
<td>0.226322</td>
<td>0.901290</td>
<td>0.3782</td>
</tr>
</tbody>
</table>

R-squared: 0.464194  Mean dependent var: 6.030922
Adjusted R-squared: 0.383823  S.D. dependent var: 0.333229
S.E. of regression: 0.261575  Akaike info criterion: -2.531060
Sum squared resid: 1.368426  Schwarz criterion: -2.334717
Log likelihood: 0.318192  F-statistic: 5.775638
Durbin-Watson stat: 1.531498  Prob(F-statistic): 0.005163

### Equation for average wage

\[
\text{DAWT} = 0.21 \times \text{DAWT}(-1) - 0.18 \times \text{D1} \times \text{DAWT}(-12) + 0.1 \times \text{D12} \times \text{DAWT}(-12) + 0.35 \times \text{CPI/\text{CPI}(-1)} + 0.44 \times \text{\text{CPI}(-1)/\text{CPI}(-2)}
\]

LS // Dependent Variable is DAWT

Date: 05/30/97   Time: 17:46
Included observations: 26 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAWT(-1)</td>
<td>0.210509</td>
<td>0.096971</td>
<td>2.170853</td>
<td>0.0416</td>
</tr>
<tr>
<td>\text{D1} \times \text{DAWT}(-12)</td>
<td>-0.183947</td>
<td>0.028682</td>
<td>-6.413240</td>
<td>0.0000</td>
</tr>
<tr>
<td>\text{D12} \times \text{DAWT}(-12)</td>
<td>0.099003</td>
<td>0.019208</td>
<td>5.154292</td>
<td>0.0000</td>
</tr>
<tr>
<td>\text{CPI/\text{CPI}(-1)}</td>
<td>0.358753</td>
<td>0.198769</td>
<td>1.804872</td>
<td>0.0855</td>
</tr>
<tr>
<td>\text{CPI}(-1)/\text{CPI}(-2)</td>
<td>0.436547</td>
<td>0.215289</td>
<td>2.027722</td>
<td>0.0555</td>
</tr>
</tbody>
</table>

R-squared: 0.844008  Mean dependent var: 1.051208
Adjusted R-squared: 0.814295  S.D. dependent var: 0.074403
S.E. of regression: 0.210509  Akaike info criterion: -6.709080
Sum squared resid: 0.021588  Schwarz criterion: -6.467138
Log likelihood: 35.32563  F-statistic: 28.40556
Durbin-Watson stat: 1.988775  Prob(F-statistic): 0.000000
Equation for pension fund

\[ R_{PF} = 0.42 \times WFC \]

LS // Dependent Variable is \( R_{PF} \)
Date: 11/03/97   Time: 18:43
Included observations: 11 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFC</td>
<td>0.242384</td>
<td>0.007897</td>
<td>53.74098</td>
<td>0.0000</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.638818</td>
<td>Mean dependent var</td>
<td>610.7675</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.638818</td>
<td>S.D. dependent var</td>
<td>62.91262</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>37.80947</td>
<td>Akaike info criterion</td>
<td>7.351627</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>14295.56</td>
<td>Schwarz criterion</td>
<td>7.387799</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-55.04227</td>
<td>Durbin-Watson stat</td>
<td>0.399633</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.242384</td>
<td>Mean dependent var</td>
<td>53.74098</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.638818</td>
<td>S.D. dependent var</td>
<td>62.91262</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>37.80947</td>
<td>Akaike info criterion</td>
<td>7.351627</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>14295.56</td>
<td>Schwarz criterion</td>
<td>7.387799</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-55.04227</td>
<td>Durbin-Watson stat</td>
<td>0.399633</td>
<td></td>
</tr>
</tbody>
</table>

Equation for Chornobyl fund

\[ R_{CHF} = 0.08 \times WFC \]

LS // Dependent Variable is \( R_{CHF} \)
Date: 09/27/96   Time: 11:35
Included observations: 8

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFC</td>
<td>0.087862</td>
<td>0.001407</td>
<td>62.43801</td>
<td>0.0000</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.861557</td>
<td>Mean dependent var</td>
<td>11859.87</td>
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</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.861557</td>
<td>S.D. dependent var</td>
<td>1452.048</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>540.2765</td>
<td>Akaike info criterion</td>
<td>12.70063</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>2043291.</td>
<td>Schwarz criterion</td>
<td>12.71056</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-61.15403</td>
<td>Durbin-Watson stat</td>
<td>1.658771</td>
<td></td>
</tr>
</tbody>
</table>

Equation for profit income tax

\[ R_{PIT} = 0.14 \times WFC \]

LS // Dependent Variable is \( R_{PIT} \)
Date: 09/27/96   Time: 10:46
Sample: 1995:12 1996:08
Included observations: 9

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>WFC</td>
<td>0.143876</td>
<td>0.004604</td>
<td>31.25304</td>
<td>0.0000</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.349469</td>
<td>Mean dependent var</td>
<td>20263.96</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.349469</td>
<td>S.D. dependent var</td>
<td>2417.000</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>1949.444</td>
<td>Akaike info criterion</td>
<td>15.25504</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>30402655</td>
<td>Schwarz criterion</td>
<td>15.27695</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>-80.41812</td>
<td>Durbin-Watson stat</td>
<td>1.115636</td>
<td></td>
</tr>
</tbody>
</table>
**Equation for stamp tax**

\[
\ln(R_{\text{STAMPTAX}}) = -8.06 + 1.13 \times \ln(Y \times CPI) + 0.32 \times \ln(R_{\text{STAMPTAX}(-1)})
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-8.061173</td>
<td>2.094078</td>
<td>-3.849509</td>
<td>0.0006</td>
</tr>
<tr>
<td>ln(Y*CPI)</td>
<td>1.132107</td>
<td>0.282320</td>
<td>4.010008</td>
<td>0.0004</td>
</tr>
<tr>
<td>ln(R_{\text{STAMPTAX}(-1)})</td>
<td>0.328720</td>
<td>0.149449</td>
<td>2.199544</td>
<td>0.0363</td>
</tr>
</tbody>
</table>

**Payments for Land Equation**

\[
\ln(R_{\text{LAND}}) = 1.72 + 0.06 \times \ln(R_{\text{LAND}(-12)} \times CPI/CPI(-12)) + 1.51 \times \ln(PY/PY(-1)) + 0.52 \times \ln(R_{\text{LAND}(-1)})
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.720788</td>
<td>0.528534</td>
<td>3.255776</td>
<td>0.0036</td>
</tr>
<tr>
<td>ln(R_{\text{LAND}(-12)} \times CPI/CPI(-12))</td>
<td>0.064320</td>
<td>0.034401</td>
<td>1.869696</td>
<td>0.0749</td>
</tr>
<tr>
<td>ln(PY/PY(-1))</td>
<td>1.513870</td>
<td>0.213981</td>
<td>7.074788</td>
<td>0.0000</td>
</tr>
<tr>
<td>ln(R_{\text{LAND}(-1)})</td>
<td>0.517105</td>
<td>0.122256</td>
<td>4.229681</td>
<td>0.0003</td>
</tr>
</tbody>
</table>

| R-squared                 | 0.729368    | Mean dependent var | 4.158162 |
| Adjusted R-squared        | 0.692464    | S.D. dependent var  | 0.295723 |
| S.E. of regression        | 0.163996    | Akaike info criterion | -3.475189 |
| Sum squared resid         | 0.591683    | Schwarz criterion   | -3.281636 |
| Log likelihood            | 12.28506    | F-statistic         | 19.76377 |
| Durbin-Watson stat        | 2.020506    | Prob (F-statistic)  | 0.000002 |
**Equation for custom duties**

\[
CD-CD(-1)/IMH(-1)*IMH = -0.33* CD(-1)-CD(-2)/IMH(-2)*IMH(-1) - 0.89* MA(12)
\]

LS // Dependent Variable is CD-CD(-1)/IMH(-1)*IMH
Date: 09/11/97   Time: 19:05
Sample(adjusted): 1995:01 1997:06
Included observations: 30 after adjusting endpoints
Convergence achieved after 17 iterations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CD(-1)-CD(-2)/IMH(-2)*IMH(-1)</td>
<td>-0.331350</td>
<td>0.049945</td>
<td>-6.634355</td>
<td>0.0000</td>
</tr>
<tr>
<td>MA(12)</td>
<td>-0.885834</td>
<td>0.000108</td>
<td>-8229.441</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

R-squared: 0.809801, Mean dependent var: -1.686332
Adjusted R-squared: 0.803008, S.D. dependent var: 30.57815
S.E. of regression: 13.57173, Akaike info criterion: 5.280318
Sum squared resid: 5157.372, Schwarz criterion: 5.373732
Log likelihood: -119.7729, F-statistic: 119.2143
Durbin-Watson stat: 2.548793, Prob (F-statistic): 0.000000
D. The Model

\[ B = B(-1) + \text{emiss} 1 \]
\[ MM = \mu^* B^*(1 - \text{remtrend}) \]
\[ p^* = \exp(\ln(mm) - 0.29240614 \cdot C1 + 0.51365979 \cdot \ln(Y) + 0.2568299 \cdot \ln(Y(-1)) - 0.35069017 \cdot \ln(CPI(-1)/CPI(-2)) - 0.17534508 \cdot \ln(CPI(-2)/CPI(-3))) \]
\[ p = p(-1)^*(k_wpi*wpi/wpi(-1) + (1-k_wpi)*cpi/cpi(-1)) \]
\[ \pi_{cpi} = 0.052289654^*(\ln(P(-1))-\ln(P(-1))) + 0.26936003^*\pi_{cpi(-1)} + 0.92010804^*SH + FPI \]
\[ WPI/WPI(-1) = 0.26^*(P[-1]/P[-2]) + 0.38^*(E/E(-1)) + 0.35^*(CPI/CPI[-1]) \]
\[ PY = p^*Y \]
\[ R_{VAT} = 46.22 + 0.06^* VAT_M + 0.32^* VAT_M(-1) \]
\[ R_{PF} = 0.42^* WFC \]
\[ \ln(R_{LAND}) = 1.72 + 0.06^* \ln(R_{LAND}(-12)^*/CPI/CPI(-12)) + 1.51^* \ln(PY/PY(-1)) + 0.52^* \ln(R_{LAND(-1)))) \]
\[ R_{CHF} = 0.08^* WFC \]
\[ CD/CD(-1)^*/IMH(-1)^*/IMH = -0.33^* CD(-1)^/-CD(2)^*/IMH(-2)^*/IMH(-1) - 0.89^* MA(12) \]
\[ \ln(PROF_R) = 5.37 + 0.25^* \ln(PROF) + 0.2^* \text{SEAS(12)} - 0.16^* \ln(PROF(-1)) \]
\[ \ln(R_{STAMPTAX}) = -8.06 + 1.13^* \ln(Y*CPI) + 0.32^* \ln(R_{STAMPTAX}(1)) \]
\[ PROF = 0.09^* PY + 0.31^* PROF(-3) + 0.23^* \text{SEAS(12)^*/CPI + 0.48^* \text{SEAS(6)^*/CPI} \]
\[ R_{PIT} = 0.14^* WFC \]
\[ DAWT = 0.21^* DAWT(-1) - 0.18^* D1*DAWT(-12) + 0.1^* D12*DAWT(-12) + 0.35^* CPI/CPI(-1) + 0.44^* CPI(-1)/CPI(-2) \]
\[ R_{EXC} = (R_{EXC}(-12)^*/CPI(-12)^*)^* CPI^* EXC^* COEF. \]
\[ R_{CUSTOMS} = \frac{R_{CUSTOMS}(-1)}{IMH(-1)^* IMH + \alpha(R_{CUSTOMS}(-1)^* R_{CUSTOMS}(-2)^* IMH(-1))} \]
References


