Verbundplan

UNIVERSITÄT KLAGENFURT

SMEEM: The Slovenian Macro Economic Energy Model

Paper for presentation at the Institutions in Transition Conference in Bled, Slovenia, September 24-26, 1998

Klaus Weyerstraß
Verbundplan GmbH, Energieplanung und -management, 9020 Klagenfurt, Austria
Tel +43 463 20232285 Fax +43 463 239729
E-Mail weyerstrassk@verbundplan.at

Hubert Reisinger
Verbundplan GmbH, Energieplanung und -management, 9020 Klagenfurt, Austria
Tel +43 463 20232563 Fax +43 463 239729
E-Mail reisingerh@verbundplan.at

Norbert Wohlgemuth
UNEP Collaborating Centre on Energy and Environment, Ris National Laboratory (SYS-142)
P.O. Box 49, DK-4000 Roskilde, Denmark
Tel +45 46 32 22 88 Fax: +45 46 32 19 99
E-Mail: norbert.wohlgemuth@risoe.dk

1 Introduction

This paper presents SMEEM: The Slovenian Macro Economic Energy Model which – at the time of writing– is in the process of being built within the framework of the contract ”Integriertes Energieprogramm - Makroökonomisches Model für Slowenien (Austrian-Slovenian Co-operation for an Integrated Energy Program - Development and Implementation of a Macro Economic Model)” between the Slovenian Ministry of Economic Affairs and Verbundplan GmbH, financed by the Austrian Federal Chancellery.

Modeling Transition Economies is a challenging task. Of course this also applies to Slovenia. Short time series, many structural changes and the unconventional interpretation of available data make it difficult – sometimes almost impossible – to design a model able to cover economic linkages in the economy. The development of SMEEM is not an exercise per se but is integrated in a more comprehensive framework of efforts to assess the impacts of changes in the Slovenian energy sector and the Slovenian economy. These changes, essentially a transition towards more competition-oriented structures, can be expected to affect the ”rest of the economy” significantly. A classical example is the presence of energy prices not covering the cost of energy provision, resulting in a situation of resource misallocation. In view of a Slovenian accession to the European Union, the energy sector will have to be made ”compatible” with the Union's principles of market organization and competition. More concrete, this will require to raise energy prices to cost covering levels, in a first step, and, to introduce or increase energy taxes in a second step,.

In order to be able to assess the impacts of energy sector restructuring on other economic sectors, SMEEM will be linked with an already existing model of the energy sector. This model – the Integrated Resource Planning (IRP) Slovenia Model – is a detailed bottom-up energy model. The approach, therefore, is challenging: combining a top-down (SMEEM) with a bottom-up model (IRP Slovenia). The idea of combining the two approaches is to obtain a better understanding of the possible feed-backs of energy sector restructuring on the other economic sectors. These feed-backs include effects of employment, income, inflation and competitiveness which, in turn, also affect the energy sector. This approach of combining top-down with bottom-up models is not new (Wene, 1996). The link between the two models will be established by the ”Iterative Closed Loop IRP - Modeling Framework in Slovenia” project financed by the EU PHARE fund with the aim to improve the existing energy system model and to perform the energy system calculations under consideration of the changes in the economic frame.

The overall objective of the modeling exercise is to evaluate, over the horizon to 2020, the full economic implications of energy sector restructuring in the case of Slovenia and not only to give first order effects. This paper is structured as follows. Chapter two gives an overview of relevant economic models in Slovenia; chapter three presents the general framework of the SMEEM/IRP/ICL projects, and an overview of the – preliminary - structure of SMEEM is given in chapter four. The outlook for future activities completes the paper.

2 Model Overview

2.1 Multisectoral Model

Multisectoral models have been built for analyzing questions of economic structure. In socialist countries, they were used as an analytical and empirical tool for comprehensive economic planning. In developing countries, their purpose was to investigate issues such as long term growth, structural change, investment allocation, and income distribution (Robinson, 1989).

At the University of Maribor, School of Business and Economics, a multisectoral model of the Slovenian economy was developed (Kracun, 1997). The model is primarily based on an input-output table for 1995, disaggregated to 26 sectors. From this, a matrix of input coefficients is calculated that shows the input of intermediate goods of each sector from each other sector as a proportion of the market value of the respective sector's total domestic output, i.e. without exports. The model itself contains sectoral production functions as well as definition equations. The coefficients of the production functions are estimated by applying econometric techniques. This approach is of particular interest for the Slovenian Macro Economic Energy Model, but in the model built at the University of Maribor, the coefficients are estimated mainly for the purpose of determining the direct and indirect effects of economic policy on prices. For this reason, it can be called a price model.

2.2 Computable General Equilibrium (CGE) Model

In 1996, a computable general equilibrium model was built to calculate possible effects of Slovenian integration to the EU (Potocnik et al., 1996). CGE models can be characterized as non-linear, multisectoral models. The data framework is the Social Accounting Matrix (SAM). For each actor, an income-expenditure account is calculated (Robinson, 1989).

Basically, CGE models simulate the interaction of various economic agents across markets. This is designed by non-linear equations, solving for market prices and quantities simultaneously. General equilibrium models contain endogenous prices and an explicit specification of the demand and supply side of all markets. The supply side consist of production functions as well as demand functions for intermediate inputs and the primary factors labor and capital. The demand side of the economy comprises investment functions, consumption functions, and price equations, as well as the supply of labor.

The theoretical underpinning is the neo-classical theory. This comprises the following assumptions: The behavior of all actors can be described as optimizing: Firms maximize the profit, consumers maximize their utility, subject to a budget constrained. Further on, competition among firms is assumed to be perfect, as is the functioning of the markets. According to this theory, all prices are totally flexible, and there is free mobility of all products and production factors. The economy is treated as being in a Walrasian equilibrium, which means that the value of the excess supply of all products and factors of production sums up to zero.

CGE models are especially useful for an examination of long-run structural changes and for sorting out historical trends.

2.3 Two-Sector Equilibrium Model MACRO

At the Institute of Economic Research (IER) in Ljubljana a two-sector model was developed (Kuzmin et al., 1995). This model distinguishes between the energy sector and the other sectors of the economy. It is based on a model called MACRO that has been built at IIASA, Laxenburg, Austria. The model MACRO contains a constant elasticity of substitution (CES) production function which separates energy input and the input of labor and capital. The primary factors are included as a Cobb-Douglas production function.

The main purpose of the model developed at the IER is the calculation of price elasticities for energy. The model contains a production function, an investment equation, equations determining the demand for labor and capital, and public and private consumption. Also included are exports and imports of goods and services, as well as taxes, transfers to the population, and identities.

2.4 Macroeconometric Model

In 1996, a quarterly macroeconometric model of the Slovenian economy was estimated by Cimperman et al. (1996). The purpose of this model type can be characterized as the empirical estimation of economic relationships. This requires data on all the variables included in the model. The variables can be distinguished into endogenous, exogenous, and lagged endogenous. The former are variables that are explained by the model. Exogenous variables are those that are explained outside the model. Examples of the latter are the growth of the population and the world prices for raw material. Lagged endogenous variables are realizations of the endogenous variables from former periods (Dougherty, 1992).

The ingredients of macroeconometric models are economic theory, statistical theory, and facts. For the estimation of the empirical relations between the variables, time series of the variables are required.

Econometric models are designed for three main purposes (Intriligator et al., 1996): First, the structural relationship between the variables can be revealed. An example for this is the determination of multipliers. A second task of these models is forecasting. This means the calculation of the endogenous variables in the future under certain assumptions about the realizations of the exogenous variables. The third main task of a macroeconometric model is the evaluation of policy measures. An example can be the calculation of the impact of government expenditure and taxation programs. With view of the Slovenian Macro Economic Energy Model, the impact of the introduction of energy taxes on employment, the rate of inflation, and the growth rate of the gross domestic product (GDP) can be investigated.

The main advantages of macroeconometric models are their empirical relevance and, by the incorporation of lags, the dynamic structure as well as the adequate modeling of short-run adjustment processes.

The most important shortcomings of this model type are associated with problems arising from the data the estimations are based on (Intriligator et al., 1996): To be mentioned first, there is the degrees-of-freedom-problem: The available data may not include enough observations to allow an adequate estimation of the model. This is especially serious in Slovenia as for most of the variables consistent time series are only available since independence from the former Yugoslavia in 1991. Another problem is due to international discrepancies in definitions. As an example may serve the shift from a national classification of activities. to the Standard Classification of Activities (SCA) which took place in Slovenia in 1997.

A further serious problem arises when there are structural changes. This is related to the so-called Lucas critique (Intriligator et al., 1996). According to this theory, structural parameters of the economy depend on the nature of the policy regime, which means that a change in the policy regime will lead to a change in the structural parameters of the system.

3 Framework for Analysis

From the beginning of its existence in 1991, the Slovenian economy has been characterized by a relatively high energy consumption. This high energy intensity of the Slovenian economy can be related to the following factors:

- The early 1990ies were characterized by economic recession in Slovenia caused by the break up of the former Yugoslavia and the loss of important markets for Slovenia. This recession in turn caused the postponement of investments in new production technologies and energy efficient processes. This is true for the energy demand side and the energy supply side as well. This low willingness to invest was enforced by a lack of capital available for investments.
- Traditionally the Slovenian economy has been based on basic materials production with high energy intensity and relatively little value added. Though there is a general shift of value added from the basic material production to the services sector, this transition is kept at a slow pace to avoid unemployment and other social problems.
- The general price and income level in Slovenia is considerably lower than in the European Union, whereas the price level of efficient technologies corresponds to that in the Union. Thus investments in energy efficient technologies hold a longer payback time in Slovenia than in the EU.
- Based on the tradition of centrally planned economies, prices for fuels, electricity and district heat are relatively low – a situation which does not provide incentives for saving energy.

As all these problems are well known in Slovenia the Slovenian government has prepared a "Strategy of Efficient Energy Use and Supply of Slovenia" (Republika Slovenija Government, 1994). In a next step a study was prepared by ETSU in order to investigate the Slovenian energy system in detail (ETSU, 1995). A kind of inventory was prepared on the different processes and their characteristics applied in Slovenia and on possible measures to improve energy conservation. As the sectors of main interest for energy efficiency improvement the industry sector (with an economic energy saving potential of about 25 per cent) and the household sector (with an economic energy saving potential of about 10 per cent) were identified.

In 1995 and 1996 the PHARE project "Integrated Resource Planning for the Rational Use of Energy in Slovenia" (IRP-Slovenia) was performed (Verbundplan et al., 1997). The objective of this project was to integrate the different measures proposed on the demand side with measures on the supply side to one consistent strategy; to show the effect of such a strategy on the development of the Slovenian energy system to 2020; and to develop a planning instrument which can be used by the Slovenian government for a continuous update of the strategy.

In order to show the effect of IRP strategies and to optimize these strategies not only with respect to the development of the energy system but also with respect to the development of the economy as a whole, the planning system developed in IRP-Slovenia has to be complemented by SMEEM, as well as a model which improves the "market valuation" of the goods and services produced in Slovenia, and a model for the market penetration of energy efficient technologies. Figure 1 shows the outline of the whole modeling sequence.

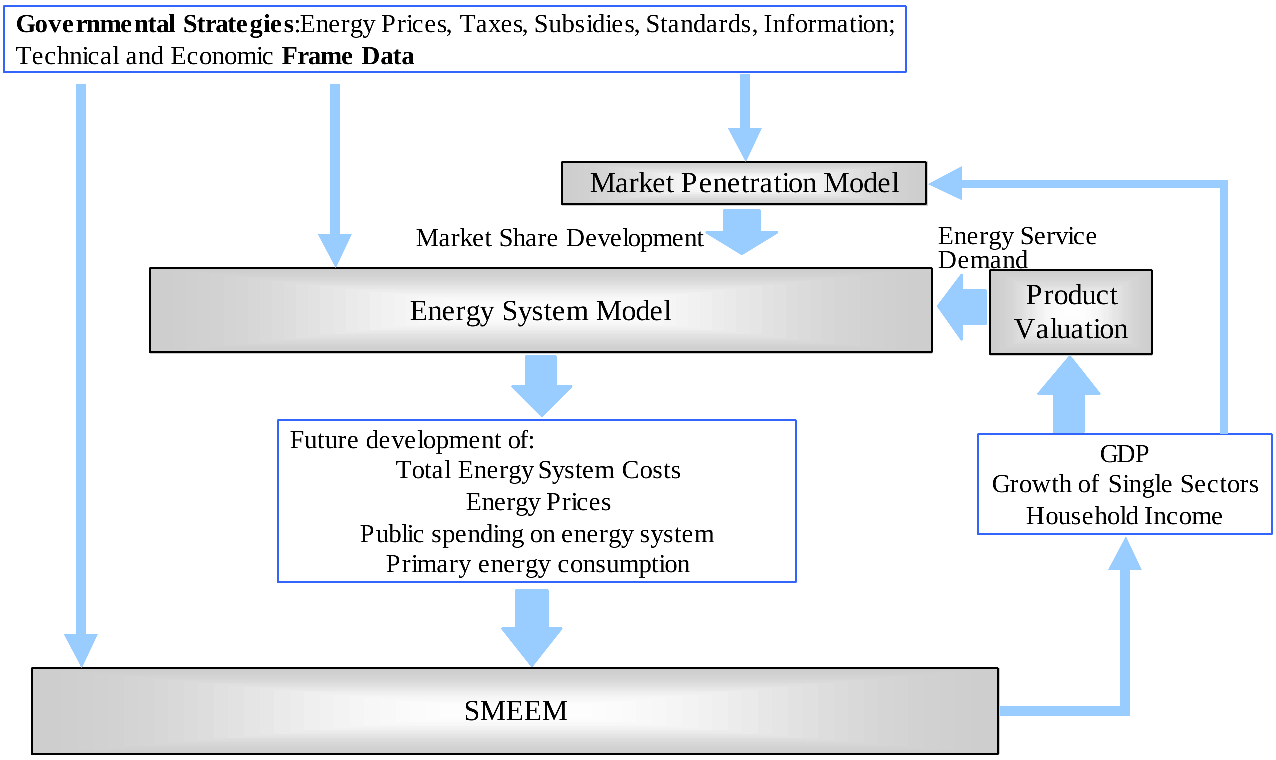

Figure 1: Energy System Model, Slovenian Macro Economic Energy Model (SMEEM) and other models necessary for a closed loop energy-economy investigation

The objective of the SMEEM project is to develop a governmental strategy for supporting the Slovenian economy and the rational use of energy in order to achieve a maximum of welfare. This objective is restricted by regulations on emissions and with certain strategies by EU regulations and a minimum amount of domestic coal to be consumed. Criteria for evaluating the investigated governmental strategies include gross domestic product, household income, sectoral value added, rate of unemployment, rate of inflation, current account of balance of payment, effects on the general government budget, emissions of SO_2, NO_x, dust and CO_2, primary energy consumption and the total costs of the energy system.

In principal the two main models can operate independently. But to show the effect of governmental strategies on the energy system and the economy the results of one model are to be considered in the other model. The link between the models is that the output of one model is considered when defining the input of the other model. There is no hard link between the two models. The modeling sequence works as follows:

- Based on the results of IRP-Slovenia calculations, based on the existing macro economic models and data in Slovenia and based on the agreed frame data and strategy measures, SMEEM can be created and the macro economic case study with SMEEM can be performed
- The results of the SMEEM case study are the changes of macro economic indicators like GDP, sectoral growth, household income, rate of unemployment, rate of inflation, etc. when applying different governmental strategies.
- Based on these results the demand on single energy services will be determined using a product valuation model.
- The results of SMEEM are also considered when calculating the market penetration of efficient technologies using the market penetration model.
- Energy service demand and time series of market shares of efficient technologies, together with the strategy measures, are the main input for the energy system model. Total costs for providing the energy service demand, emissions, final and primary energy consumption, government revenues and spending from/for strategy measures are calculated.
- If the results of these closed loop calculations do not deviate much from the IRP-Slovenia results, this is the end of the case study. If the results are very different, the calculation of the whole loop will be repeated, starting once again with the case study in SMEEM considering the new results from the energy system calculations.

4 SMEEM

4.1 Structure

The purpose of SMEEM is to show the effects of different energy policy measures on macro economic variables such as employment, rate of inflation, growth of GDP. This requires a modeling of the energy sector that is as detailed as possible. The energy demand in industry and in the household sector will be included. The production side will be disaggregated into different sectors. One of them will be the energy sector. For each sector a production function is estimated that contains as inputs labor and energy. The demand side is also disaggregated so as to explicitly explain the demand for energy. The notion behind the modeling of demand functions for different goods is that a change in the relative prices, for example because of the introduction of an energy tax, will lead to changes in the consumption structure. The other behavioral equations of the model will, among others, explain the demand for money, the growth rate of wages and the growth rate of the price index, i.e., the rate of inflation.

4.2 Data Availability

As it was not before June 1991 that Slovenia became an independent state, reliable statistical data is not available for the period before that date. Economic data for Slovenia that were collected in the former Yugoslavia before 1991 should not be used for econometric estimations because some statistical definitions in Yugoslavia were not in accordance with international standards.

The Slovenian transition from a socialist economy to a market economy caused considerable data problems. Only recently there was a methodological change to international statistical definitions. It was not before the first half of 1997 when the Standard Classification of Activities (SCA) was adopted in Slovenia. Before that date, data on production and employment in the different sectors of the economy were collected according to a national classification of activities. The shift now makes new data internationally more comparable, but comparisons to earlier years are difficult.

Another example of discrepancies between Slovenian and international standards is the use of different price indices as measures of inflation. In the European Union to which Slovenia strives for accession inflation is measured by the growth rate of the consumer price index (CPI). In Slovenia, this index has not been comparable to international standards until the end of 1997. This is the reason why until this time in Slovenia the retail price index (RPI) was used as the inflation indicator. Furthermore, quite a big share of the price index is made up of controlled prices. Though this share fell from 34 percent in 1991 to 28 percent in 1996, it is still quite high.

For some economic aggregates quarterly data are not available for the entire period 1992 to 1997. One example is fixed capital formation and the capital stock. Detailed sectorally disaggregated data on nominal capital formation and capital stocks only exist as annual data for the period 1991 to 1996. Quarterly data on capital formation in 1992 prices for the economy as a whole, i.e. not sectorally disaggregated, is only available for the years 1994 to 1997. Energy inputs in the different sectors of the economy were on hand for 1991 to 1995 for the estimations presented in this paper. When estimating a production function with employment, different energy carriers and capital as independent variables, a serious problem arises from the fact that the period for which data are at hand for all explaining variables only reaches form 1994 to 1995. Such a small number of degrees of freedom makes a reliable econometric estimation impossible.

Another problem arises from the fact that quarterly data on the expenditure side of gross domestic product only exists for the period 1995 to 1997.

Disposable income may serve as a further example for the difficult data situation. On this important economic aggregate which would be needed for the estimation of the behavioral equation for private consumption, only annual data is available; this data only exists for a very short time period, namely the years 1995 to 1997.

4.3 Some Preliminary Results

From the previous section it should be clear that the econometric estimations of behavioral equations are based on a very limited data base. Nevertheless, it was possible to run some estimations that are reliable and compatible with standard economic theory (showing the expected signs). In the following paragraphs some equations of the model will be presented. The equations were estimated by ordinary least squares (OLS) using quarterly data.

For providing the data, acknowledgement is dedicated to the following Slovenian institutions: Statistical Office of the Republic of Slovenia (SORS), Institute of Macro Economic Analysis and Development (IMAD), Bank of Slovenia, Elektroinstitut Milan Vidmar.

The results are only preliminary as future research may show that is appropriate to deseasonize the variables that exhibit a strong seasonal pattern. It is also possible that in some equations more explanatory variables will be included or some variables will be replaced by others in the final form. The time periods differ between the equations as not for all variables observations are available for the entire period first quarter of 1992 to last quarter of 1997. The estimations are based on the period for which observations exist for all variables included in the respective equation.[1] For a definition of the variables see the annex to this paper.

1 In the following estimations, the t-ratio shows if the true value of the estimated coefficient is significantly different from zero. The absolute value of the t-ratio should exceed the value 2. If the t-ratio indicates that the coefficient is insignificant this shows that the variable the respective coefficient belongs to has almost no influence on the dependent variable and should be excluded from the estimation.

The Durbin Watson (DW) indicates if there is any serial correlation in the residuals (i.e. in the difference between the actual value of the dependent variable and the value estimated with the model). Serial correlation means that a disturbance in one point in time influences the dependent variable also in the future. The DW should be around 2. If it is significantly below 2, this is a hint for a positive serial correlation, whereas negative serial correlation is present if the DW exceeds 2.

The adjusted R2 is a measure of the part in the variation of the dependent variable that can be explained by the model. The term ”adjusted” refers to the fact that the degrees of freedom are taken into account.

4.3.1 The Money Demand

According to Keynesian theory, the demand for money includes a transactions part and a speculative part. In SMEEM, the gross domestic product is used as an income variable. As GDP rises, more money is spent for purchases of goods (the transactions motive), which leads to a higher demand for money. The speculative part of money demand is modeled by including an interest rate. The notion behind this is that as interest rates rise the opportunity costs of money holdings increase as there are more favorable forms of assets like interest bearing government bonds. This leads to the following functional form of the money demand equation:

M1R = f (GDPR, SRDN).

The estimated equation is given by (t-ratios in brackets):

$$\ln (M1R) = \underset{(8.030)}{0.447} \ln (M1RL4) + \underset{(10.061)}{0.517} \ln (GDPR) - \underset{(-5.451)}{0.0064} SRDN$$

DW: 1.148 estimation period: 1993 / I – 1997 / IV (first quarter of 1993 to fourth quarter of 1997)

All coefficients have the right sign according to economic theory. The econometric specification shows that besides the mentioned variables the lagged dependent variable, i.e. the money demand one year ago has a positive influence on the money demand in the current quarter.

As both GDP and the demand for money are measured in logarithms the coefficient of GDPR can be viewed as the income elasticity of money demand. The results show that a one percent increase in the real GDP leads to an increase in the demand for money by around 0,52 percent. A higher interest rate results in a lower money demand.

When no constant is included, the R2 cannot be interpreted in the usual way, so it is not indicated here. In an estimation without constant the adjusted R2 was equal to 0.969. When a lagged endogenous variable is included, instead of the Durbin Watson the Durbin’ s H statistic should be used. As the results are only preliminary at this stage of the project, the Durbin Watson statistic is sufficient for a hint if serial correlation is a problem. In further research activities, the Durbin’ s H will also be calculated which will show more precisely if the estimations are reliable from an econometric point of view. In the money demand equation, the value of the Durbin Watson indicates positive serial correlation, but experiments with different functional forms of the money demand function didn’ t show better results than the form presented above.

4.3.2 Wages

The growth of gross wages is explained by the unemployment rate, the growth of the labor productivity, and the rate of inflation. This relationship can be expressed by the following function:

ΔAGWN = f (UR, ΔPROD, ΔCPI).

The estimated led to the following functional form:

$$\Delta AGWN = \underset{(3.303)}{53.913} - \underset{(-3.129)}{3.637}\, UR + \underset{(2.219)}{0.899}\, \Delta PROD + \underset{(6.002)}{0.826}\, \Delta CPI$$

DW: 1.360 adjusted R2: 0.914 estimation period: 1994 / I – 1997 / IV

All variables are significant at least at the five percent level. As this equation is estimated in growth rates rather than logarithms, the coefficients cannot be interpreted as elasticities. But nevertheless it can be concluded that the signs of all variables are in accordance to economic theory. The unemployment rate has a negative influence on the growth of gross wages, as a higher unemployment rate leads to a smaller power of trade unions in wage negotiations. Productivity improvements allow the increase of gross wages without higher labor costs per piece if the increase in gross wages is smaller than the growth in productivity. Finally, a higher rate of inflation results in higher wages. In economic theory, this phenomenon is referred to as price-wage-spiral.

4.3.3 Prices

The price equation corresponds partly to the equation determining the growth rate of wages. The rate of inflation as measured by the annual change in the retail price index can be explained by a cost-push part and a demand-pull part. The growth rate of the retail price index was taken instead of the consumer price index because until the end of 1997 the former was used as a measure for inflation. The equation has the following general form:

$$\Delta RPI = f(\Delta AGWN, \Delta GDPR)$$

The estimated form is given by:

$$\Delta RPI = \underset{(28.07)}{0.559\, \Delta AGWN} + \underset{(5.318)}{0.784\, \Delta GDPR}$$

DW: 1.340 estimation period: 1993 / I – 1997 / 12

As the adjusted R2 in a model without a constant cannot be compared to the adjusted R2 with a constant, it was omitted here. The Durbin Watson indicates positive serial correlation, but trying other specifications of the equation with a trend variable did not improve the results significantly.

The cost push part of inflation is reflected by the positive influence of the growth of gross wages on the rate of inflation. When trying more cost components such as import prices, their coefficients were of the wrong sign, so they were not included in the functional form of the equation that is shown in the table. The demand-push hypothesis is confirmed by the positive coefficient of the growth rate of real GDP. Together with the wage equation, the price equation determines a Phillips Curve relationship: a higher unemployment rate leads to smaller increases in gross wages which results in a lower rate of inflation, i.e. there exists a negative relationship between the unemployment rate and the rate of inflation.

4.3.4 The Demand for Electricity

For the estimation of electricity demand it was assumed that it depends positively on income as measured by GDP, negatively on the relative price for electricity, and positively on the demand for electricity one year ago. The general form of the demand for electricity equation is given by:

$$E = f(E_{t-1}, GDPR, RPE).$$

As the demand for electricity exhibits a strong seasonal pattern with considerably higher demand in the first three months of each year, a seasonal dummy for the first quarter called "SEASON1" was added. The econometric equation resulted in the following specification. The equation was estimated in logarithms rather than levels of the variables.

$$\ln(E) = \underset{(-2.812)}{-11.404} + \underset{(2.162)}{0.194 \ln(E_{t-1})} + \underset{(5.793)}{1.928 \ln(GDPR)} - \underset{(-2.780)}{0.599 \ln(RPE)} + \underset{(5.482)}{0.148\, SEASON1}$$

DW: 1.834 adjusted R2: 0.792 estimation period: 1992 / I – 1995 / IV

The value of the DW is close to 2, so serial correlation is not a problem. According to the adjusted R2, around 79 percent of the variation in the demand for electricity can be explained with this equation. The t-statistics show that the coefficients are significant at the five percent confidence level.

The results can be interpreted as follows: If the relative price of electricity rises by one percent, in the short term, the demand for electricity decreases by around 0.6 percent. This value of the price elasticity is in accordance to studies carried out for other countries. The income elasticity that shows the percentage reaction of the electricity demand as GDP rises by one percent is quite high (about 1.9 percent). The long term elasticities, i.e. the elasticities that materialize after all adjustments to income and price have been made, amount to 2.4 (income) and -0.74 (price). The equation shows that most of the adjustment takes place already in the first period. If data on disposable income were available this would have been used instead of GDP as a measure of income. It is possible that the income elasticity would have been lower in this case. Unfortunately, as Slovenia is still in the transition phase, not for all economic aggregates data are available for a sufficient time period. But nevertheless the results shown are in accordance with economic theory and highly significant.

The specification is only preliminary in the sense that future research may indicate that it is more appropriate to deseasonized the variables instead of including a seasonal dummy. This would result in quantitatively different coefficients, but the signs of the coefficients would remain the same. If more data were available it would be possible to include different explanatory variables such as the number of heating degree days which was suggested in other studies.

4.3.5 The Demand for Oil

A microeconomically founded general form of a demand equation is given by:

OIL = f (GDPR, RPO).

As can be seen, the demand for oil depends positively on income as measured by GDP, and negatively on the relative price for oil. The latter is given as the Tolar price per ton of oil, deflated by the retail price index. The price of oil is calculated as the average of the price for light heating oil and the price for heavy heating oil. The estimated equation has the following form:

$$\ln(OIL) = \underset{(1.032)}{4.783} + \underset{(2.328)}{0.804} \ln(GDPR) - \underset{(-4.828)}{0.693} \ln(RPO) + \underset{(11.681)}{0.288}\, SEASON14$$

DW: 1.610   adjusted R2: 0.944   estimation period: 1992 / I – 1995 / IV

The dummy "SAESON14" is equal to one in winter, i.e. in the first and last quarter of each year, and zero in the rest of the year. All coefficients except the constant are significant at least at the 5 percent level. As the adjusted R2 indicates, almost 95 percent of the variation in the demand for oil can be explained by this behavioral equation. As all variables except the seasonal dummy are given in logarithms, the coefficients are elasticities. The results show that the demand for oil increases by around 0.8 percent as GDP increases by one percent (the income elasticity). The price elasticity is about -0.69, i.e. one percent increase in the relative price of oil leads to a reduction in the demand for oil by 0.69 percent.

5 Outlook

After refining the models, beside a Reference Strategy, two other strategies ("Liberal" and "Intensive") will be evaluated with respect to their overall economic impact. The Reference Strategy includes assumptions on cost covering energy prices, a support scheme for coal mining and a fixed minimum coal consumption in public power plants of 5 Mt p.a. In the Liberal Strategy, no taxes or subsidies are assumed and the fixed coal consumption is reduced to 3 Mt p.a. In the Intensive Strategy, energy prices and taxes are introduced, subsidies for energy efficient technologies and information campaigns are made, and coal consumption is fixed at 3 Mt p.a. Figure 2 shows the General Scenario Management Tableau.

The harmonized use of the bottom-up technology oriented model and the top-down macro economic model will be an excellent tool for identifying the chances and risks when following the one strategy (business as usual), the other strategy (let the market sort out the problems) or the third strategy (active support of the efficient use of energy in Slovenia also under liberal market conditions).

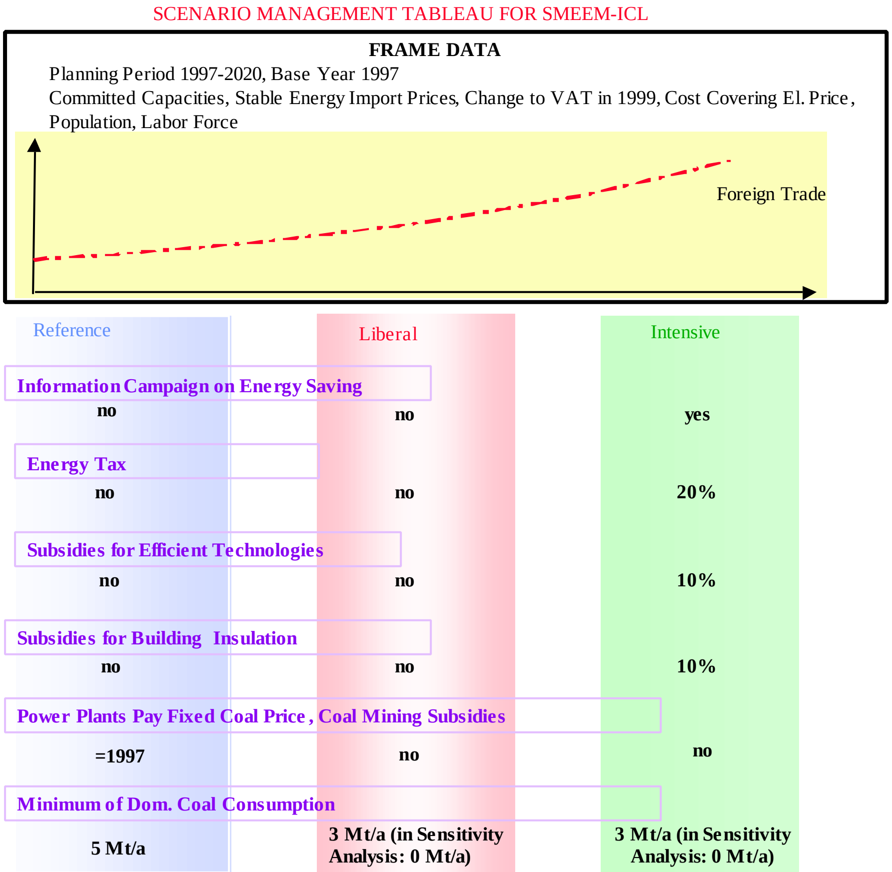

Figure 2: General Scenario Management Tableau of SMEEM-ICL study

6 Bibliography

Cimperman, F. et al. (1996), *Quarterly Econometric Model of Slovenian Economy*, Ljubljana.

Dougherty, Ch. (1992) *Introduction to Econometrics*, New York.

ETSU (1995) *Study on Energy Conservation Strategy in Slovenia*. Draft Final Report to Ministry of Economic Affairs ETSU REF/18614001.

Intriligator, M.D., R.G. Bodkin, Ch. Hsiao (1996) *Econometric Models, Techniques, and Applications*, 2nd ed., Upper Saddle River.

Kracun, D. (1997) *Short-Run Effects of stabilization Policies in Economies in Transition: A Model*, Working Paper, University of Maribor, School of Business and Economics, Institute for Economic Diagnosis and Prognoses.

Kuzmin, F., M. Simoncic (1995) *Model dolgorocnega gospodarskega razvoja in proucitev najbolj verjetnih scenarijev gospodarskega razvoja R slovenije*, Ljubljana.

Potocnik, J., B. Majcen (1996) *Possible Effects of Slovenian Integration to the EU - CGE Approach*, Ljubljana

Republika Slovenija Government (1994) *Strategy for the Efficient Energy Use and Supply of Slovenia* (Draft Translation of the Original Document in Slovene Language); Ljubljana.

Robinson, S. (1989) *Multisectoral Models* in: Chenery, H., T.N. Srinivarson (Ed.), Handbook of development Economics, Vol. II, Ch. 18, p. 885-947.

Verbundplan, IJS, IER (1997) *Integrated Resource Planning for the Rational Use of Energy in Slovenia*. PHARE program of the European Union. Final Report.

Wene, C.-O. (1996) "Energy-Economy Analysis: Linking the Macroeconomic and Systems Engineering Approaches" *Energy*, Vol. 21, No. 9, pp. 809-824.

7 Appendix: List of Variables

GDPR	Gross Domestic Product (Mill. SIT) in constant 1992 prices real GDP
M1R	Money in circulation M-1, with deposits in the Bank of Slovenia, Mill. SIT, deflated with consumer price index CPI real quantity of money M-1
M1RL4	M1R, lagged four quarters
SRDN	Nominal interest rate on one to three months deposits
UR	Unemployment rate
PROD	Labor productivity, defined as GDPR / number of employees
CPI	Consumer Price Index
RPI	Retail Price Index
AGWN	Average gross wage per employee, whole economy, SIT
E	Total electricity consumption (MWh) in Slovenia
OIL	Total oil consumption (t) in Slovenia
RPE	Price for electricity (SIT/KWh), deflated with retail price index relative price of electricity
RPO	Price for oil (SIT/t), deflated with retail price index relative price of oil
SEASON1	Seasonal dummy, 1 for the first quarter of each year, 0 in the other quarters
SEASON14	Seasonal dummy, 1 for the first and fourth quarter, 0 for the rest of the year
Δ	denotes the annual change of a variable
ln(var)	natural logarithm of series *var*