Optimal Monetary and Fiscal Policies for Slovenia after EU Accession

Reinhard Neck[1], **Klaus Weyerstrass**[2] **and Gottfried Haber**[3]

[1]Department of Economics, University of Klagenfurt, Klagenfurt, Austria
[2]Institute for Advanced Studies, Klagenfurt, Austria
[3]Ludwig Boltzmann Institute of Economic Policy Analysis, Vienna, Austria

Preliminary version, not to be quoted

Abstract

This paper analyzes the design of macroeconomic policies for Slovenia during the process of integration into the EU. For this purpose, we develop and use the model SLOPOL4, a macroeconometric model for Slovenia. We determine "optimal" monetary and fiscal policies for Slovenia as solutions of optimum control problems with a quadratic objective function and the model SLOPOL4 as constraint. Several optimization experiments under different assumptions about the set of economic policy instruments available under a fixed exchange rate, a flexible exchange rate, a crawling peg regime and a scenario approximating Slovenia's entry into the European Economic and Monetary Union (EMU) are carried out. We show that the best policy results are obtained when the average tax rate on labor is available as an active policy instrument. In this case, the optimization results do not differ significantly between the exchange rate regimes. If, on the other hand, the labor tax rate is held constant, the nature of the exchange rate system is more important for the policy design and outcomes.

JEL Classification: E5, E6, C5, O5.

Corresponding Author: Klaus Weyerstrass, Institute for Advanced Studies Carinthia, Domgasse 3, A-9020 Klagenfurt. Ph. +43-463-592-150-19; fax: +43-463-592-150-23;
email: weyerstrass@carinthia.his.ac.at

1. Introduction

On May 1, 2004, together with seven other Central and Eastern European countries (CEECs) (the Czech Republic, the Slovak Republic, Hungary, Poland, Estonia, Lithuania, Latvia) as well as Malta and Cyprus, Slovenia will join the European Union. From the first day of membership onward, these countries will participate in the European Economic and Monetary Union (EMU), albeit with a derogation. This means that the new entrants were not given the right not to join ("opt-out clause") as in the case of the UK and Denmark. However, being EMU members does not imply introducing the euro immediately. Before having the right to adopt the common currency, Slovenia, as the other acceding countries, is required to fulfil the criteria set out in the Maastricht treaty. In particular the choice of the exchange rate regime before adopting the euro will be an important issue. Currently, Slovenia pursues a managed float with respect to the euro.

In this paper, we consider several alternative policy designs for Slovenia for the next few years. Several optimization experiments are conducted, which differ with respect to the exchange rate regime for Slovenia and to the set of economic policy instruments assumed to be available to Slovenian policy-makers. First, we investigate whether a reduction of income taxes and social security contributions can help reducing unemployment without endangering other policy objectives, especially the goal of a balanced government budget. Furthermore, we address the question whether the policy objectives can be achieved equally well under flexible exchange rates, under crawling peg regimes and under fixed exchange rates. These scenarios shall highlight the importance of the availability of an independent monetary policy instrument, at least as long as the accession process is not completed. The optimization experiments are carried out using the optimum control algorithm OPTCON and SLOPOL4, a macroeconometric model of the Slovenian economy.

The paper is organized as follows: In Section 2, the econometric model SLOPOL4 is briefly described. Section 3 gives an overview of the optimum control algorithm OPTCON and details the optimization designs used. Section 4 addresses the optimization results obtained with the average "tax" rate available as an active policy instrument, for flexible exchange rates, two crawling peg regimes, and for fixed exchange rates. "Taxes" in this context include both income taxes and social security contributions. In Section 5, optimal policies are described that are obtained when the tax rate is exogenous. Section 6 concludes the paper. Details about the model and the optimization results can be found in the Appendices.

2. The SLOPOL4 Model

SLOPOL4 (SLOvenian economic POLicy model, version no. 4) is a medium-sized macroeconometric model of the small open economy of Slovenia. It consists of 45 equations: 15 behavioral equations and 30 identities. The former were estimated by ordinary least squares (OLS), using quarterly data for the period 1992:1 (where available; 1994:1 otherwise) until 2001:4.[1]

The model combines Keynesian and neoclassical elements. The former determine the short and medium run solutions in the sense that the model is demand driven and persistent

[1] Data for Slovenia were provided by the Slovenian Statistical Office, by the Institute of Macroeconomic Analyses and Development (IMAD), and by the Bank of Slovenia. Euro area data were taken from the EUROSTAT database, except for the short-term interest rate in the euro area, which was extracted from the database of the German Bundesbank.

disequilibria in the goods and labor markets are possible. The supply side incorporates neoclassical features. Most of the behavioral equations contain the lagged dependent variables, reflecting adaptive expectations and costs of adjustment. In this section, the behavioral equations are sketched very briefly. A more detailed description of an earlier version of the model can be found in Weyerstrass et al. (2001).

Consumption of private households is explained by a simple Keynesian consumption function, depending on current disposable income and on lagged consumption (in accordance with the habit persistence hypothesis). Capital formation is derived from profit maximization of firms. Real gross fixed investment is influenced by the change of total domestic demand (an accelerator hypothesis), the user cost of capital, approximated by the real interest rate, and by the capacity utilization rate, i.e. the ratio of actual to potential GDP. Real exports of goods and services are a function of the real exchange rate and of foreign demand for Slovenian goods and services. As the aggregate euro area is by far Slovenia's largest trading partner[2], the rest of the world is approximated by the euro area. Therefore, foreign demand is measured by euro zone real GDP, and we consider the exchange rate between the Slovenian tolar and the euro only. Slovenian real imports of goods and services depend on domestic final demand and on the real exchange rate.

Money demand depends on real GDP and the short-term interest rate. The long-term interest rate is linked to the short-term rate in a term structure equation. The exchange rate equation combines elements from the uncovered interest parity and the purchasing power parity theories. Thus, the nominal exchange rate between the Slovenian tolar and the euro depends on the interest differential and the price ratio between Slovenia and the euro area.

Labor demand (actual employment) is influenced by final demand for goods and services and by the real gross wage, while labor supply depends on the real net wage and on the size of the population. The wage rate is determined by the price level, by the difference between the actual unemployment rate and a proxy for the natural rate of unemployment (or the NAIRU), by labor productivity, and by the average labor tax rate, which is defined as the difference between the average gross and net wages as a percentage of the gross wage (hence "labor taxes" include income taxes and social security contributions). Consumer prices depend on domestic and international factors. The former comprise unit labor costs, the capacity utilization rate, and the nominal money stock. In addition, Slovenian prices depend on the oil price and on the nominal exchange rate. For Slovenia as a small open economy, import prices are important, and they rise when the domestic currency is devaluated (an increase of the exchange rate).

Total government expenditures are linked to government consumption and to transfer payments to households, total government revenues are linked to labor tax revenues. The budget deficit is given by the difference between total government expenditures and revenues. Potential output, which is determined by a Cobb-Douglas production function with constant returns to scale, depends on trend employment, the capital stock, and autonomous technical progress. Trend employment is defined as the labor force minus natural unemployment. The NAIRU is approximated by a four-quarter moving average of the actual unemployment rate.

In order to explore the implications of the exchange rate system, a regime of completely flexible exchange rates is compared to two crawling peg regimes and to a regime of fixed

[2] In 2001, according to balance of payments data, the euro area accounted for 60 percent of Slovenian foreign trade (Bank of Slovenia, 2002).

exchange rates. The first crawling peg is implemented as a nominal depreciation of the Slovenian tolar against the euro with a decreasing rate of depreciation. In particular, the depreciation rate is reduced by 0.5 percentage points per year from 2.5 percent in 2004 to 0.5 percent in 2008. The second crawling peg regime ("EMU regime") is meant to mimic Slovenia's membership in the ERM of the EMS-II until 2006 and its membership in the EMU from 2007 on. Here, the exchange rate is assumed to be 236 SIT/EUR in 2004, 238 in 2005, 239 in 2006, and 240 from 2007 on. For the optimization runs with fixed exchange rates, the Slovenian tolar is fixed at 230 SIT/EUR over the entire optimization period. This value is slightly higher than the actual exchange rate at the end of the year 2003. In the flexible exchange rate scenario, the short-term rate of interest is available as an active monetary policy instrument for internal stabilization purposes. In the other regimes, the interest rate and hence monetary policy have to be adjusted to stabilize the exchange rate and can therefore not be considered as an active policy instrument.

3. The Optimum Control Approach

We want to calculate time paths of macroeconomic policy instruments that are "optimal" according to an objective function of a hypothetical policy-maker for Slovenia. To obtain optimal economic policies, we apply the OPTCON algorithm, developed by Matulka and Neck (1992). OPTCON determines approximate solutions of optimum control problems with a quadratic objective function and a nonlinear multivariable model. The objective function has to be quadratic in the deviations of the state and control variables from their desired values. The objective function has the following form:

$$L = \frac{1}{2} \sum_{t=1}^{T} \begin{bmatrix} \boldsymbol{x}_t - \tilde{\boldsymbol{x}}_t \\ \boldsymbol{u}_t - \tilde{\boldsymbol{u}}_t \end{bmatrix}' \boldsymbol{W}_t \begin{bmatrix} \boldsymbol{x}_t - \tilde{\boldsymbol{x}}_t \\ \boldsymbol{u}_t - \tilde{\boldsymbol{u}}_t \end{bmatrix}, \tag{1}$$

$$\boldsymbol{W}_t = \alpha^{t-1} \ \boldsymbol{W} \ , \ t = 1, \ldots, \ T \tag{2}$$

where $\boldsymbol{x}_t$ denotes the vector of state variables, $\boldsymbol{u}_t$ denotes the vector of control variables, $\tilde{\boldsymbol{x}}_t$ and $\tilde{\boldsymbol{u}}_t$ are the desired values of the state and control variables, $\boldsymbol{W}_t$ is the matrix containing the weights given to the deviations of the state and control variables from their desired values, respectively, and *a* denotes the discount factor. The dynamic system has to be given in a state space representation. Although OPTCON can solve deterministic and stochastic optimum control problems, here we confine ourselves to deterministic optimizations only.

In the present paper, five "main" and several "minor" objectives are considered. The "main" objective variables cover the most important macroeconomic challenges Slovenian policy-makers will face in the medium-term future. With respect to the future Slovenian participation in the EU, catching-up with current EU members in terms of per-capita GDP is of high importance. In addition, reducing the rates of unemployment and of inflation are obvious goals for the next years. These objectives should be reached with a balanced government budget and at external equilibrium. Specifically, for the optimization experiments a desired real GDP growth rate of 4.5 percent p.a. is assumed. Optimizations are carried out for the period 2004 to 2009, but the final year is neglected to avoid terminal point effects, hence the period of interest is 2004 to 2008. The desired rate of unemployment is assumed to be reduced by one percentage point per year from 8 percent in 2004 to 4 percent in 2008. The desired rate of inflation declines gradually from 5 percent in 2004 to 2 percent in 2008. The

government budget and the current account (both in percent of nominal GDP) are assumed to be aimed at being balanced.

As "minor" objective variables, real GDP and its components (consumption of households, investment, government consumption, exports and imports) are considered. For these variables, ideal values consistent with the desired 4.5 percent growth rate of real GDP are specified. The introduction of "minor" objective variables shall reflect policy-makers' aim of obtaining smooth paths of the main macroeconomic aggregates, but serves also as substitute for introducing inequality constraints on state variables, which is not feasible in OPTCON. In addition, the policy instrument (control) variables are regarded as minor objective variables to reflect costs to the policy makers of changing instruments, but also due to formal requirements of the OPTCON algorithm and in order to prevent erratic fluctuations.

In the weight matrix of the objective function, all off-diagonal elements are set to zero. In addition, all endogenous variables of the model not mentioned get the weight zero, implying that they are not of direct relevance to policy-makers. The "main" variables are assigned the weight 10,000, whereas the "minor" objective variables are given a weight of 1, except for the control variables, which gets weights of 1,000 for the short-term interest rate, 10 for the tax rate, and 10 for the others. These weights reflect both the relative importance of the "main" and "minor" objective variables and their different orders of magnitude.

In the optimization experiments, different sets of policy variables are considered. Again, we distinguish between the four exchange rate regimes as discussed in Section 2. Therefore, we have one scenario with the short-term rate of interest as policy instrument (the flexible exchange rate case) and three scenarios without this instrument of monetary policy. Moreover, the question is addressed whether unemployment can be reduced significantly by cutting non-wage labor costs. For this purpose, in some optimization experiments the average labor tax rate, i.e. the difference between the average gross and net wages as a percentage of the gross wage, is introduced as a policy instrument. The results for this case are compared to those where this labor tax rate is fixed at a constant level over the entire optimization horizon.

As for the exogenous variables, it is assumed that EU real GDP grows by 1.7 percent in 2004 and 2.0 percent p.a. in the remaining period. EU CPI inflation is assumed to be 2 percent p.a. in each year. Over the entire optimization horizon, Slovenian population is constant at 1.99 million. The oil price is assumed to be constant at 27 USD per barrel over the period 2004 to 2008. Slightly rising values are assumed for the euro area interest rate EURIBOR (up to 4.7 in 2008).

4. Optimization Experiments with a Cut in Labor Taxes

In this section, we describe optimal fiscal and monetary policies resulting when the average labor tax rate is available as a policy instrument. The set of control variables thus consists of government consumption expenditures and government transfer payments to private households, both in nominal terms, and the average tax rate as defined in the previous section. With flexible exchange rates, the short-term interest rate can be used for discretionary policies in addition. The numerical results are summarized in Tables 2 to 5 in Appendix C.

In the *flexible exchange rates* scenario (Table 2), real GDP grows at the rate of 2.7 percent p.a. on average. The rate of unemployment rate and the rate of inflation are gradually reduced. The current account improves over the optimization horizon, turning from a marginal deficit in 2004 into a surplus in 2005 and the following years. During the entire period, the

government budget exhibits a moderate but slowly increasing deficit. From 2004 to 2008, the Slovenian currency depreciates by 11 percent in nominal terms, but the real exchange rate remains virtually constant, which is due to the lower inflation in the euro area, the representative foreign country block. The labor tax rate is distinctly lower than its last actual value of 37.5 percent; it is slightly increased between 2004 and 2008, with an average tax rate of 35.0 percent over the entire five-year period. Nominal government consumption increases more than transfer payments, implying a shift from redistributive to absorptive government expenditures.

With a *crawling peg regime* (Table 3), real GDP on average grows at the lower rate of 2.6 percent p.a. As compared to the flexible exchange rates regime, both the rate of unemployment and the rate of inflation are reduced more over the five-year period. As in the flexible exchange rates case, the current account improves over the optimization horizon, and the government budget has still lower deficits. The Slovenian tolar by design depreciates in nominal terms considerably less than in the flexible exchange rate case: over the entire optimization horizon, the domestic currency depreciates by around 5 percent in nominal terms, but retains essentially its real exchange rate. The labor tax rate is still lower, with an average value of 34.3 percent over the entire five-year period. Nominal government consumption and transfer payments to households show the same pattern as in the flexible exchange rate case, although both are lower now; also monetary policy is less expansionary in order to fulfill the exchange rate target. The task of expanding the economy is taken over by the tax rate from monetary policy, with favorable effects on the labor market.

With *fixed exchange rates* (Table 4), the nominal exchange rate is held constant over the five-year period. Now real GDP on average grows at the still lower rate of 2.1 percent p.a. The rate of unemployment is higher than in the other two scenarios, the rate of inflation is lower. The current account improves significantly over the optimization horizon. The government budget exhibits a less favorable development than in the other scenarios and deteriorates into a considerable (though still Maastricht-compatible) deficit between 2004 and 2008. The Slovenian tolar appreciates marginally in real terms. The labor tax rate is higher than in the two previous scenarios. Its average value over the entire five-year period is 35.4 percent. Nominal government consumption is increased by the highest amount, transfer payments to households by the lowest amount over the entire five-year period among all scenarios considered in this section. Monetary policy is considerably more restrictive in order to keep the nominal exchange rate fixed.

The scenario simulating the accession to the *EMU* (Table 5) gives results that are closest to the crawling peg scenario. Interestingly, both unemployment and inflation are reduced more than in every other scenario, the budget deficit remains below 2 percent of GDP, the current account improves, and the average growth rate of real GDP is 2.7 on average which is better than in the other scenarios except for the flexible exchange rate case. This favorable result is brought about mainly by low values of the labor tax rate, combined with only moderate increases of government consumption and transfers: both are lower than in the crawling peg case, while monetary policy is close to the latter.

The optimization experiments show that the trajectories of most objective variables do not vary significantly with the exchange rate regime if labor taxes and social security contributions, i.e. the difference between gross and net wages, are available as an active policy instrument. There are some differences in the objective variables inflation and unemployment. As is to be expected, the fastest reduction of inflation is brought about if the exchange rate is fixed to the currency of a low-inflation region, but the path into the EMU results in a similar (and even more sustainable) inflation path. In all cases where exchange

rates are not flexible, the loss of monetary policy as an instrument of stabilization policies resulting from fixing or pegging the exchange rate can be compensated for by cutting labor taxes once and (more or less) for all at the beginning of the optimization period. This policy, which has both favorable supply-side and demand-side effects, reduces the wedge between gross and net wages, thus lowering upward pressure on gross wages, thereby stimulating employment and reducing inflationary pressure at the same time.

5. Optimization Experiments without a Cut in Labor Taxes

In this section, we describe optimal macroeconomic policies that are obtained when the average "tax" rate, i.e. the difference between the average gross and net wages as a percentage of the gross wage, is not available as an active policy instrument. Only two fiscal policy instruments remain at the policy-maker's disposal, namely government consumption and transfer payments to households. In addition, in the flexible exchange rates scenario, monetary policy is also available for internal stabilization purposes, whereas in the crawling peg and the EMU cases and with fixed exchange rates, the money supply is determined endogenously by interventions of Slovenia's central bank in the foreign exchange market (or by the ECB in the EMU case). The numerical results can be found in tables 6 to 9 in Appendix C.

With *flexible exchange rates* (Table 6), real GDP on average grows at a rate of 2.7 percent p.a. over the period 2004 to 2008. The rate of unemployment is considerably higher than in the scenarios with a cut in labor taxes, especially in the last years; the rate of inflation is only marginally lower. The current account and the government budget surplus improve slightly as compared to the previous scenarios. The Slovenian tolar depreciates even more than in the respective scenario with the tax rate as an active policy instrument in nominal terms over the five-year period. In real terms, it again remains almost constant. Both government consumption and transfer payments to households are increased more strongly than in the previous scenarios. Monetary policy is expansionary, as before.

With a *crawling peg regime* (Table 7), real GDP on average grows at the marginally lower rate of 2.6 percent p.a. over the period 2004 to 2008. The unemployment rate remains fairly high, inflation decreases as in the scenarios of Section 4. Over the entire optimization horizon, the government runs a small but increasing budget deficit. The current account improves again to a higher surplus in the last year. As before, the exchange rate of the Slovenian tolar is fixed in such a way that it depreciates in nominal terms by around 5 percent over the entire optimization horizon; in real terms, the exchange rate again remains constant. Money supply rises less than before. This more restrictive monetary policy is due to interventions of Slovenia's central bank necessary to avoid greater nominal depreciation of the Slovenian tolar. This restrictive monetary policy is not counteracted by a more expansionary fiscal policy. Instead, government consumption behaves in a similar way as in the flexible exchange rate case, and transfers are rising even less than in the case of flexible exchange rates.

Fixing the exchange rate (Table 8) results again in a GDP growth rate of 2.4 percent p.a. on average. The rate of unemployment remains high again, and on average it is more than two percentage points higher than in the respective scenario with the lower tax rate. On the other hand, inflation is reduced faster by fixing the Slovenian exchange rate to the currency of the low inflation region. In nominal terms, the Slovenian exchange rate is held constant over the optimization horizon. There is a slight real appreciation of the tolar. As a result of low GDP growth and thus low imports, the current account improves over the five-year period, in the end reaching a remarkable surplus of more than 4.5 percent of GDP. The government budget

deteriorates again, but does not present a serious problem. With fixed exchange rates, the Slovenian central bank has to prevent depreciation by interventions in the foreign exchange market. Depreciation is caused by an excess demand for the foreign currency or, equivalently, an excess supply of the domestic currency. Therefore, the Slovenian central bank has to sell foreign and buy Slovenian currency, resulting in a relatively restrictive monetary policy. Such a policy might quickly exhaust Slovenia's foreign currency reserves. These results show that fixing the exchange rate may put strong pressure on national economic policies of a transition country like Slovenia. The restrictive monetary policy is only partly offset by an expansionary fiscal policy. Nominal government consumption is nearly doubled over the five years period. On the other hand, transfer payments to households are even decreased in nominal terms in this scenario, which may seem politically infeasible.

As in the corresponding scenario with an active policy instrument labor tax rate, the scenario emulating the access to the *EMU* (Table 9) gives result between those of the crawling peg and the fixed exchange rate: similar real GDP growth rates, similar (high) rates of unemployment and (low) of inflation, a considerable improvement of the current account, a rising government budget deficit, a negligible real appreciation and a strong shift from transfers (which remain approximately constant in nominal terms) to government consumption. Again, the performance of most objective variables is considerably worse than under the low-tax rate regime, showing the importance of this instrument in the Slovenian econometric model under consideration.

In contrast to the scenarios where the average labor tax rate is available as a control variable, the exchange rate regime makes more difference when the labor tax rate is held constant, i.e., when the number of policy instruments is reduced. The most striking result, however, can be seen from a comparison between any of the scenarios with the tax rate as an active instrument and the respective one without it. In each of these cases, nearly all objective variables show better results in the scenarios with the tax rate active. This is particularly true for the rate of unemployment, which can be very effectively and favorably influenced by a lower labor tax rate, without putting unduly pressure upon the government budget. Both among the cases with and without the active tax rate, the scenario leading to an EMU membership of Slovenia (which we consider to be the most likely) seems to yield a reasonable and acceptable compromise between too ambitious exchange rate targets (the fixed exchange rate case) and continuous depreciation (the flexible exchange rate case). Optimal policies require not only counter-cyclical demand-side reactions (either through automatic stabilizers or through discretionary policy) but also structural (supply-side) reforms, such as a shift of government expenditures from transfers to purchases and a reduction of the level of labor income taxation.

6. Concluding Remarks

In this paper we have shown how optimum control theory can be used to obtain insights into the design of economic policy decisions for a country on the way into EU membership. We have used the OPTCON algorithm and the simple model SLOPOL4, a medium-sized macroeconometric model of the Slovenian economy. Assuming that over the optimization horizon 2004 to 2008, Slovenian policy-makers aim at high GDP growth rates, low rates of inflation and unemployment, balanced budgets and balanced current accounts, we investigated the effects of variations in the set of available policy instruments on optimal economic policies and on the objective variables. It turned out that the differences between the exchange rate regimes are smaller when the average labor tax rate is available as an additional policy instrument. In this case, the loss of the monetary policy instrument resulting from adopting a fixed exchange rate regime can be more than compensated by a different mix

of the fiscal policy instruments, which can secure high GDP growth and a reduction in unemployment without endangering the aim of an almost balanced budget. If, on the other hand, the labor tax rate is held constant over the optimization horizon, considerably higher unemployment cannot be avoided.

It has to be stressed that factors like structural imbalances between labor supply and demand, which may be very important determinants of unemployment, cannot be captured with an aggregated model like SLOPOL4. In addition, only the variables contained in the objective function are taken into account in our analysis, while other measures of economic welfare, which are linked to the corporate ownership structure or the income distribution, for example, cannot be adequately considered within the framework of a highly aggregated macroeconomic model, which is used in this paper. Moreover, we have not touched upon the question of the Lucas critique, which represents a fundamental objection against the approach followed here. Incorporating changes in the public's expectation with the recognition of a new policy regime into the model will certainly be a major improvement, although the short time series available for Slovenian data makes an attempt at executing it still more difficult than for countries with a longer history without structural breaks.

7. Acknowledgements

The present research was supported by the Jubiläumsfonds of the Austrian Central Bank (project no. 9506) and by the Ludwig Boltzmann Institute for Economic Analyses, Vienna.

8. References

J. Matulka, R. Neck (1992), OPTCON: An Algorithm for the Optimal Control of Nonlinear Stochastic Models. *Annals of Operations Research* **37**, 375 – 401.

K. Weyerstrass, G. Haber, R. Neck (2001), SLOPOL1: A Macroeconomic Model for Slovenia. *International Advances in Economic Research* **7** (1), 20 – 37.

Appendix A: Variables of the Econometric Model SLOPOL4

Table 1. List of variables

Endogenous variables	
AGWN	Average gross wage rate per employee, nominal, SIT / quarter
AGWR	Average gross wage rate per employee, real
ANWN	Average net wage rate per employee, nominal, SIT / quarter
ANWR	Average net wage rate per employee, real
CAN	Current account, nominal
CAN%	Current account as percentage of nominal GDP
CAPR	Capital stock, real
CPI	Consumer price index
CR	Private consumption expenditures, real
DEFICITN	Budget deficit, nominal; *TGEN – TGRN*
DEF%	Budget deficit as percentage of nominal GDP
DEMAND	Total final demand, real; *GDPR + IMPR*
EMP	Employment; 1,000 persons
EXR	Exports, real
GDPDEF	GDP deflator
GDPN	Gross domestic product, nominal
GDPR	Gross domestic product, real
GR	Government consumption, real
GRCPI	Annual growth rate of CPI (rate of inflation)
GRGDPR	Annual growth rate of real GDP
GRM3N	Annual growth rate of money stock M3
IMPR	Imports, real
INTDIFF	Interest rate differential between Slovenia and the euro zone
INVR	Investment, real
LFORCE	Labor force; 1,000 persons
LTIRLN	Nominal long-term interest rate
LTIRLR	Real long-term interest rate
M3N	Money stock M3, nominal
M3R	Money stock M3, real
NAIRU	Natural (non-accelerating inflation) rate of unemployment
NETTAXR	Real net tax revenues
PRICERATIO	Ratio of Slovenia to euro zone CPI
PROD	Average labor productivity
SITEUR	Exchange rate between SIT and EUR, nominal
SITEURR	Exchange rate between SIT and EUR, real
TEMP	Trend, labor force
TGEN	Total government expenditures, nominal
TGRN	Total government revenues, nominal
TWEDGE	Government labor tax and social security revenues, nominal
UN	Number of unemployed persons
UR	Unemployment rate, % of the labor force
UTIL	Capacity utilization rate
WEDGE	Difference between average gross and net wage, SIT / quarter
YDR	Personal disposable income, real
YPOT	Potential GDP, real

Control variables	
GN	Government consumption, nominal
TAXRATE	Average labor tax rate
TRANSFER	Transfer payments to households, nominal
STIRLN	Short-term interest rate
Exogenous variables	
HICPEUR	Harmonized index of consumer prices in the euro area
D96	Dummy variable, 1 in 1996, 0 otherwise
DQ1	Dummy variable, 1 in 1st quarter, 0 otherwise
DQ2	Dummy variable, 1 in 2nd quarter, 0 otherwise
DQ3	Dummy variable, 1 in 3rd quarter, 0 otherwise
EURIBOR3M	EURIBOR, 3 months
GDPEUR	Euro zone GDP, real
OIL	Oil price in USD
POP	Population, 1,000 persons
TIME	Linear time trend

Appendix B: Model Equations

Behavioral Equations

R^2 is the adjusted coefficient of determination, p(LM) is the probability level of false rejection of the null hypothesis of no serial correlation up to lag 4, DW is the Durbin Watson statistic; t-statistics are given in parentheses below coefficients.

Consumption of private households

$$CR = \underset{(2.28)}{52.39} + \underset{(6.04)}{0.69}\, CR(-1) + \underset{(2.40)}{0.12}\, YDR - \underset{(5.04)}{19.49}\, DQ1 + \underset{(5.32)}{22.41}\, DQ2 - \underset{(1.62)}{9.63}\, DQ3$$

$R^2 = 0.94$ $p(\text{LM}) = 0.77$

Gross fixed capital formation

$$\log(INVR) = \underset{(2.25)}{1.31} + \underset{(8.73)}{0.62}\, \log(INVR(-4)) + \underset{(3.44)}{1.41}\, [\log(DEMAND) - \log(DEMAND(-4))]$$

$$+ \underset{(1.61)}{0.008}\, UTIL - \underset{(2.05)}{0.01}\, LTIRLR$$

$R^2 = 0.85$ $p(\text{LM}) = 0.89$

Exports of goods and services

$$\log(EXR) = \underset{(7.48)}{-25.66} + \underset{(4.57)}{1.73}\, \log(SITEURR) + \underset{(12.75)}{3.15}\, \log(GDPEUR12R)$$

$R^2 = 0.87$ $p(\text{LM}) = 0.03$ DW = 1.20

Imports of goods and services

$$\log(IMPR) = \underset{(2.34)}{-3.00} - \underset{(1.97)}{0.007}\, SITEURR + \underset{(12.60)}{1.44}\, \log(DEMAND)$$

$R^2 = 0.97$ $p(\text{LM}) = 0.01$ DW = 1.52

Real money supply

$$\log(M3R) = \underset{(0.31)}{-1.61} + \underset{(27.77)}{0.79}\, \log(M3R(-1)) + \underset{(0.94)}{0.49}\, \log(GDPR) - \underset{(0.21)}{0.002}\, STIRLN$$

$R^2 = 0.997$ $p(\text{LM}) = 0.12$

Long-term interest rate

$$LTIRLN = \underset{(9.37)}{2.20} + \underset{(3.68)}{0.007}\, LTIRLN(-4) + \underset{(82.12)}{0.95}\, STIRLN$$

$R^2 = 0.998$ $p(\text{LM}) = 0.59$

Exchange rate

$SITEUR = 7.47 + 0.57\ SITEUR(-1) + 59.20\ PRICERATIO - 0.10\ INTDIFF$
(1.15) (3.31) (2.81) (0.60)

$R^2 = 0.99$ $p(\text{LM}) = 0.08$

Labor supply

$\log(LFORCE) = -5.17 + 0.66 \log(LFORCE(-1)) + 0.98 \log(POP) + 0.02 \log(ANWR) - 0.01\ D96$
(1.83) (5.83) (2.26) (2.24) (2.66)

$R^2 = 0.81$ $p(\text{LM}) = 0.64$

Employment

$\log(EMP) = 1.00 + 0.82 \log(EMP(-1)) + 0.06 \log(DEMAND) - 0.04 \log(AGWR)$
(1.87) (9.71) (2.77) (1.36)

$R^2 = 0.90$ $p(\text{LM}) = 0.22$

Wages

$\log(AGWN) = -5.85 + 1.20 \log(CPI) + 0.003 \log(PROD) - 0.009\ (UR(-2) - NAIRU(-2))$
(3.03) (28.99) (2.26) (1.72)

$+ 1.66\ TAXRATE$
(2.99)

$R^2 = 0.997$ $p(\text{LM}) = 0.07$ DW = 1.54

Consumer price level

$\log(CPI) = 1.52 + 0.18 \log(AGWN/PROD) + 0.30 \log(M3N) + 0.001\ UTIL + 0.02 \log(OIL)$
(5.87) (1.91) (8.42) (1.12) (2.45)

$+ 0.126 \log(SITEUR)$
(1.85)

$R^2 = 0.998$ $p(\text{LM}) = 0.01$ DW = 1.03

GDP deflator

$\log(GDPDEF) = 0.04 + 0.29 \log(GDPDEF(-1)) + 0.70 \log(CPI)$
(1.03) (2.78) (6.44)

$R^2 = 0.998$ $p(\text{LM}) = 0.22$

Total government expenditures

$TGEN = -4.91 + 0.99\ GN + 1.45\ TRANSFERSN$
(0.21) (1.62) (2.20)

$R^2 = 0.91$ $p(\text{LM}) = 0.00$ DW = 2.51

Total government revenues

$TGRN = -27.58 + 2.86\ TWEDGE$
(2.05) (25.72)

$R^2 = 0.94$ $p(\text{LM}) = 0.00$ DW = 2.50

Potential GDP

$\log(YPOT) = -0.8182 + 0.2685 \cdot \log(CAPR) + (1-0.2685) \cdot \log(TEMP) + 0.0069 \cdot TIME$

Identities

GDPR	$= CR + GR + INVR + EXR - IMPR$
NETTAXR	$= (TGRN - TRANSFERSN)/CPI \cdot 100$
YDR	$= GDPR - NETTAXR$
DEMAND	$= GDPR + IMPR$
UTIL	$= GDPR/YPOT \cdot 100$
LTIRLR	$= LTIRLN - GRCPI$
SITEURR	$= SITEUR/PRICERATIO$
CAPR	$= CAPR(-1) \cdot 0.965 + INVR$
GR	$= GN/GDPDEF \cdot 100$
M3N	$= M3R \cdot CPI/100$
PRICERATIO	$= CPI/HICPEUR12$
INTDIFF	$= STIRLN - EUR3M$
UN	$= LFORCE - EMP$
UR	$= UN/LFORCE \cdot 100$
PROD	$= GDPR/EMP \cdot 100$
AGWR	$= AGWN/CPI \cdot 100$
ANWR	$= ANWN/CPI \cdot 100$
ANWN	$= AGWN - WEDGE$
GDPN	$= GDPR \cdot GDPDEF/100$
CAN	$= (EXR - IMPR) \cdot GDPDEF/100$
CAGDP	$= CAN / GDPN \cdot 100$
GRGDPR	$= GDPR/GDPR(-4) \cdot 100 - 100$
GRCPI	$= CPI/CPI(-4) \cdot 100 - 100$
GRM3N	$= M3N/M3N(-4) \cdot 100 - 100$
WEDGE	$= AGWN \cdot TAXRATE/100$
TWEDGE	$= WEDGE \cdot EMP/1000$
DEFICITN	$= TGEN - TGRN$
DEF%	$= DEFICITN/GDPN \cdot 100$
NAIRU	$= [UR(-1)+UR(-2)+UR(-3)+UR(-4)]/4$
TEMP	$= LFORCE \cdot (1 - NAIRU/100)$

Appendix C: Optimization Results

Table 2. Optimization results with labor tax rate as policy instrument; flexible exchange rate

	2004	**2005**	**2006**	**2007**	**2008**
GRGDPR	2.59	2.93	2.83	2.61	2.31
UR	9.49	8.98	8.16	7.23	6.48
GRCPI	5.53	5.21	4.88	4.44	4.40
CAN%	–0.34	0.17	0.71	1.42	2.01
DEF%	0.70	0.81	1.02	1.28	1.48
SITEUR	243.25	251.22	258.56	264.87	270.78
SITEURR	146.69	146.88	147.03	147.10	146.92
GN	1,129.44	1,216.95	1,318.14	1,442.16	1,624.54
TRANSFER	772.76	831.08	872.80	914.30	985.70
TAXRATE	35.15	35.09	34.87	34.77	35.13
M3N	3,487.19	3,967.10	4,492.86	5,029.19	5,563.52

Table 3. Optimization results with labor tax as policy instrument; crawling peg

	2004	**2005**	**2006**	**2007**	**2008**
GRGDPR	2.38	2.87	2.80	2.66	2.42
UR	7.31	7.06	6.61	6.01	5.41
GRCPI	4.19	4.04	3.57	3.05	2.65
CAN%	0.10	0.33	0.49	0.88	1.24
DEF%	0.68	0.76	0.84	0.98	1.14
SITEUR	238.47	243.24	246.88	249.35	250.60
SITEURR	147.42	147.42	147.36	147.34	147.14
GN	957.11	1,052.27	1,155.65	1,254.22	1,396.32
TRANSFER	710.98	771.29	840.12	900.54	963.60
TAXRATE	33.74	34.01	34.33	34.54	34.98
M3N	3,454.36	3,808.40	4,151.28	4,489.73	4,784.64

Table 4. Optimization results with labor tax rate as policy instrument; fixed exchange rate

	2004	**2005**	**2006**	**2007**	**2008**
GRGDPR	1.89	2.38	2.34	2.09	1.68
UR	8.07	8.18	7.89	7.45	7.39
GRCPI	2.05	2.03	2.08	2.21	2.49
CAN%	1.48	2.41	3.22	4.04	4.56
DEF%	1.36	1.79	2.24	2.60	2.67
SITEUR	230.00	230.00	230.00	230.00	230.00
SITEURR	147.40	147.36	147.24	146.94	146.24
GN	1,166.25	1,361.75	1,525.04	1,677.84	1,884.99
TRANSFER	602.48	589.48	568.37	576.17	665.46
TAXRATE	34.51	35.08	35.21	35.48	36.72
M3N	3,098.35	3,248.74	3,434.84	3,626.73	3,768.62

Table 5. Optimization results with labor tax rate as policy instrument; EMU

	2004	**2005**	**2006**	**2007**	**2008**
GRGDPR	2.41	2.89	2.85	2.76	2.49
UR	7.36	6.94	6.20	5.17	4.04
GRCPI	3.28	2.91	2.48	2.34	2.30
CAN%	0.85	1.36	1.63	2.09	2.27
DEF%	0.75	0.94	1.12	1.38	1.67
SITEUR	235.62	237.88	238.95	239.75	240.00
SITEURR	147.82	147.95	147.95	148.00	147.76
GN	954.44	1,050.53	1,146.00	1,236.81	1,371.14
TRANSFER	688.49	719.00	760.19	790.86	824.40
TAXRATE	33.65	33.72	33.79	33.64	33.73
M3N	3,353.61	3,628.59	3,891.28	4,184.38	4,464.28

Table 6. Optimization results with fixed labor tax rate; flexible exchange rate

	2004	**2005**	**2006**	**2007**	**2008**
GRGDPR	2.90	2.83	2.76	2.63	2.54
UR	12.56	12.03	11.35	10.60	9.80
GRCPI	5.41	5.26	4.90	4.45	4.33
CAN%	–0.21	0.15	0.71	1.41	2.06
DEF%	0.36	0.38	0.48	0.64	0.82
SITEUR	245.84	253.75	261.15	267.57	273.67
SITEURR	146.35	146.38	146.48	146.56	146.56
GN	1,275.39	1,372.31	1,492.15	1,633.87	1,793.36
TRANSFER	936.92	1,017.41	1,089.07	1,148.46	1,203.85
TAXRATE	37.50	37.50	37.50	37.50	37.50
M3N	3,394.81	3,855.19	4,346.83	4,855.55	5,410.23

Table 7. Optimization results with fixed labor tax rate; crawling peg

	2004	**2005**	**2006**	**2007**	**2008**
GRGDPR	2.31	2.75	2.72	2.58	2.54
UR	12.25	11.93	11.34	10.61	9.78
GRCPI	4.35	4.01	3.49	3.01	2.52
CAN%	1.38	1.92	2.52	3.24	3.93
DEF%	0.44	0.63	0.90	1.24	1.59
SITEUR	238.47	243.24	246.88	249.35	250.60
SITEURR	146.66	146.70	146.76	146.78	146.77
GN	1,220.28	1,338.45	1,476.45	1,627.18	1,798.42
TRANSFER	902.62	940.07	965.74	981.12	977.82
TAXRATE	37.50	37.50	37.50	37.50	37.50
M3N	3,178.67	3,513.05	3,840.93	4,158.27	4,455.38

Table 8. Optimization results with fixed labor tax rate; fixed exchange rate

	2004	**2005**	**2006**	**2007**	**2008**
GRGDPR	2.47	2.41	2.38	2.33	2.36
UR	12.46	11.94	11.26	10.49	9.64
GRCPI	1.86	2.12	2.09	2.11	2.12
CAN%	1.81	2.44	3.18	3.94	4.58
DEF%	1.11	1.51	1.91	2.29	2.62
SITEUR	230.00	230.00	230.00	230.00	230.00
SITEURR	146.98	146.81	146.69	146.53	146.35
GN	1,359.86	1,512.06	1,654.96	1,795.16	1,945.15
TRANSFER	751.38	729.43	717.75	712.36	703.41
TAXRATE	37.50	37.50	37.50	37.50	37.50
M3N	2,904.45	3,083.82	3,271.14	3,471.74	3,685.45

Table 9. Optimization results with fixed labor tax rate; EMU

	2004	**2005**	**2006**	**2007**	**2008**
GRGDPR	2.27	2.57	2.51	2.41	2.38
UR	12.13	11.81	11.23	10.52	9.70
GRCPI	3.51	2.93	2.45	2.39	2.21
CAN%	1.27	2.15	2.99	3.82	4.49
DEF%	0.84	1.18	1.57	1.99	2.37
SITEUR	235.62	237.88	238.95	239.75	240.00
SITEURR	146.78	146.86	146.86	146.80	146.65
GN	1,319.38	1,460.52	1,610.35	1,767.87	1,935.90
TRANSFER	824.70	826.81	821.95	816.58	803.86
TAXRATE	37.50	37.50	37.50	37.50	37.50
M3N	3,088.53	3,333.66	3,562.61	3,802.09	4,043.27