THE DYNAMIC EFFECTS OF FISCAL POLICY IN UKRAINE: A STRUCTURAL VAR APPROACH

by

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Abstract

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The Keynesian theory predicts that fiscal expansion has a positive effect on output. However, recently evidence was found in support of the opposite effect (*e.g.* Giavazzi, Jappelli, Pagano (1998)). Aslund (2002) and Fischer and Sahay (2000) argue that in the transition economies, due to specificity of the fiscal environment, these effects may prevail. In my thesis, I use the structural VAR model to test these conjecture, employing the data for Ukrainian economy. The identification is achieved using institutional information on Ukrainian fiscal system. I analyze the dynamic response of macroeconomic aggregates – output, consumption, and investment.

I find no evidence for the existence of the negative effect of government expenditures on output. Several tendencies that can also be observed from the Ukrainian data are as follows: First, consumption is following output patterns in its movements, while investment is influenced negatively, no matter which instrument of fiscal policy is used, government expenditures or government revenues. Second, sub-sample evolution of responses suggests that the economy becomes more responsive to fiscal shocks. Finally, analysis also shows that fiscal expansion has a positive effect on output when financed by borrowing, and the opposite effect is found when fiscal expansion is tax-financed.

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Chapter 1

INTRODUCTION

The sources of the recent years' growth, which Ukraine first experienced since its transition started 11 years ago, is debated in economic circles. "Ukraine has exhausted most of the potential for economic growth. Given lack of new stimuli growth may stop."[1] This is one of the major themes in the macroeconomic policy making in Ukraine. Among the proposed stimuli tax reform is mentioned most frequently, and much of the Parliament's attention is now devoted to it.[2]

Government policy, as a mean to intervene in a free market system is an object of debate for a long time. While any such intervention distorts the system of economic incentives the role of the government shouldn't be underestimated. Operating in the world of economic frictions[3], government may be able to implement a constrained optimum; furthermore its essential function is to solve social frictions. Of course specific implementation depends on the situation at hand, and, more importantly, on policy instruments available; therefore, the latter are of great interest to economists.

A government can choose between monetary or fiscal policy in its macroeconomic decisions. The effect of monetary policy is more rapid; however, in transition economies with underdeveloped financial structure it may be less effective than fiscal policy. Hence, the latter may be preferred as an economic tool in a transition economy.

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[1] INFOBANK News Service October 10, 2002

[2] Monthly Economic Monitor Ukraine, Institute for Economic Research and Policy Consulting, 11, 2002

[3] Positive transaction costs, externalities, market power, etc.

Keynesian theory is one of the theories that justifies using fiscal policy as a macroeconomic instrument. According to this macroeconomic approach, an increase in government expenditures leads to an expansion of output, and an increased price level. However, according to the classical approach increased spending of the government increases prices, but does not change output; and, on the other extreme, the new Keynesian approach suggests no change in the price level, but a significant output expansion. These are predictions taken from basic macroeconomics texts. The tree doctrines yield conflicting predictions about the effect of fiscal expansion.

The "standard wisdom"[4] is that increased government spending leads to output expansion, while the effect of taxes is the opposite. However, recently several episodes of non-Keynesian output effect of government expenditures were documented, so called "expansionary contraction" when GDP increases in response to a decrease in government expenditures. This puts under question the inferences based on the Keynesian-type theories, which predict the opposite outcome. Which is true is an important economic question, and is rather an empirical than theoretical in nature. An eight-year history of stable macroeconomic environment behind gives now econometric analysis a stronger grounding due to longer economic data time series available and increased impact of economic variables.

Recently, transition economies gained a lot of attention: they were a test for economic theory, showing how important market institutions are. The economic environment in these countries is different from that in the developed world; especially this is true for the Former Soviet Union. These economies were centrally planned, and more importantly, they never had an institution of private ownership, a market fundamental. Fiscal policy is totally new sphere to these

[4] Blanchard and Perotti (2002), p. 26

countries – the authority simply had to learn by trial and error their strategy to conduct this policy. The economic environment in transition countries has also all the requisites that are believed to lead to non-Keynesian effects in the developed world – large debt/GDP ratio, persistent and large fiscal impulses, etc. (Giavazzi, Jappelli, Pagano (1998)). In many studies (Fisher and Sahay (2000), Aslund (2002)) fiscal austerity was propagated as a mean of successful economic stabilization, and fiscal spending was associated with reduced growth and deterred transition. Thus, the question is, would one expect Ukraine, as a transition country, to be different from a developed world and, meaning that fiscal policy has non-Keynesian effects rather than conforms to "standard wisdom?"

Having available potentially powerful instruments to influence the economy, policy makers should realize all the consequences of their actions; after all while good macroeconomic policy is a prerequisite for a good economic performance, bad macroeconomic policies may stall the economy. Ukraine, having a high level of government intervention into the economy, poses an interesting case to investigate. In my thesis I want to analyze the patterns of the fiscal policy effect on macroeconomic aggregates in Ukraine. To answer the questions I use a structural vector autoregression model. This approach allows me exploiting the power of vector autoregression analysis, while preserving the structural interpretation of the estimation results. In this thesis I aim to investigate the dynamic behavior of the Ukrainian economy in response to exogenous changes in government spending and taxation. The contribution of my work is a thorough documentation of the dynamic response of the economy to shocks in government spending and taxation in Ukraine, a question which to the best of my knowledge has not been attempted yet.

The rest of the thesis is organized as follows. In the methodology section I provide an overview of the major theoretical and empirical works analyzing fiscal policy. In the Methodology section I set up the general framework for the analysis in my thesis. This section formulates the structural VAR model, describes the issues involved in estimation of the model, and provides solution to the latter. In the Data section I describe the data used in the empirical analysis. In the next section I analyze the estimation results. This section provides a description of the estimated model, evaluation of the impulse responses, and also tackles the issue of the robustness of the obtained results. The last section concludes.

Chapter 2

LITERATURE REVIEW

Government policy has always been an important issue for economists. Different economic schools have different attitudes toward fiscal policy, and derive different inferences about its impact on the functioning of the economy. Fiscal policy is often evaluated by its effect on investment, since investment is the most direct factor of economic growth. However, it is not well understood what the effect of fiscal policy on investment, and hence on output, is. One view is that government has no control over private consumption-investment decisions. However, as far back as almost four decades ago Phelps (1965, p.1-2) says that "in the contemporary capitalistic economies subject to ordinary fiscal and monetary controls, government has considerable influence over the investment rate."

To address the issue of the effect of fiscal policy on investment and growth of the economy Phelps (1965) classifies the approaches into three categories: classical, crude Keynesianism, and sophisticated Keynesianism. According to the classical approach an increase in government spending has an effect of decreased private investment and, consequently, slower economic growth. The argument is that interest rate adjusts automatically to equate aggregate demand with the full employment level.

On the contrary, according to "crude Keynesianism" the interest rate does not adjust enough to restore full employment. This is a result of the "speculative" nature of agents who in face of a decreased interest rate would increase their

"speculative" demand for money, unlike in the classical approach that assumes interest rate to be inelastic with respect to changes in money supply.

According to "sophisticated Keynesianism" (Phelps (1965)) there is a range of tax rates within which monetary policy is effective; so, the government has a choice of two instruments. However, alternative choices lead to alternative ends. On one hand, "easy money" policy and tight fiscal policy is considered to promote investment and growth. On the other hand, tight monetary and loose fiscal policy leads to mainly high consumption.

Miller (1988) refers to the above approaches as "old analytical framework". He criticizes it on the following grounds. First, it is static and therefore questions that can be answered in this analytical framework are static in nature. Although it was a common assumption in the past, simplifying the analysis considerably, it is now a common practice to set up the models, in which agents explicitly take into account future. Second, this framework is deterministic. This has two implications: one is that implied policy is "overly activist", and second is that there cannot be made a distinction between anticipated and unanticipated shocks. Third, it bases on the macro level assumptions about behavior of economic agents. Probably, the most important critique that applies here is the Lucas critique stating that economic behavior cannot remain irresponsive to the fiscal "experiments," or in other words, fiscal policy should be treated as endogenous.

In view of the above-said, Miller (1988) criticizes the work of Auerbach and Kottlikoff (1987). The latter is a deterministic overlapping generations model that includes fiscal sector. This model escapes all of the above problems except for being deterministic. Yet, as Miller points out, this modern framework lacks four ingredients. These are uncertainty as mentioned above, money, international trade, and private bequests. In Miller's view, a modern approach to the analysis of fiscal policy (and other macroeconomic issues) should be dynamic, stochastic,

general equilibrium, it should include money, and allow for private bequests. Thus, at this point I would like to conclude that these would be the basic ingredients for a model studying the effects of fiscal policy.

Going back to the old approach, Ashauer (1988) refers to it as the one that emphasizes the "first-order importance of the financial aspects of the public sector budgetary policy."[5] Similarly to Miller (1988), Ashauer argues that a dynamic approach, based on the optimizing behavior of agents, is needed. Ashauer's main insight is that the conventional approach does not allow for the type effects of fiscal policy implied in his model. Thus, the author argues that in studies based on the conventional approach the Ricardian equivalence was often spuriously rejected. The reason for the latter is that these studies failed to include future levels of government spending as determinants of contemporary level of consumption, a relation implied by the dynamic setup of the model. The solution to the latter is joint estimation of consumption and government spending equations, which allows the author to conclude that fiscal policy affects consumption to the extent it affects forecasts for future levels of the government spending.

Second, the author infers from his model that an increase tax rates decreases a lower net-of-taxes rate of return to capital, and lower output and consumption.[6] Third, the author finds that public investment crowds out private investment to a significant extent, while the effect of government consumption is smaller, and provides the empirical evidence that supports this hypothesis.

Barro (1990), similarly to Ashauer (1988), extends an endogenous growth model by including a tax financed government. Because of the externalities associated

[5] Ashauer (1988), p.41

[6] These are steady-state implications.

with public spending privately determined rates of investment are suboptimal, leaving a role for government. The author divides government spending into productive (affecting production function or directed at enforcement of private institutions) and unproductive (delivering consumption to government only) expenses and studies the effects of the latter under two scenarios: benevolent and self-interested government. In both cases productive efficiency is preserved and the optimal fraction of public revenues is invested. However, under both scenarios the size of the government is larger than the optimal – due to increased provision of public consumption services to agents or government itself. The author concludes with a discussion of the empirical evidence on public spending. While testing of a posed model is problematic due to the endogeneity of the fiscal sector, after controlling for the factors that could account for a cross-sectional variation of the public sector productivity, Barro concludes that the effect of the productive spending is positive, though statistically insignificant,[7] while the effect of unproductive spending is, as expected, negative, and is statistically significant, a result consistent with other studies.[8]

Most of the research on the effects of fiscal policy is based upon the U.S. case. This is natural since the structure of expenditures has undergone substantial changes in the post-war period, which stimulated new research concerning the optimal structure of public expenditures. The analysis of military expenditures, the share of which changed considerably over time, is interesting because using it one can easily distinguish between temporary and permanent fiscal expansion as was first done in Barro (1981). He documents that temporary increases in government expenditures (associated with wartime) lead to an increase in output twice as big as the increase in output after permanent shifts in government

[7] According to Barro's model (1990) this finding is consistent with a hypothesis that government tries to employ the volume of public expenditures that maximize its positive influence on the growth.

[8] Kormendi and Meguire 1985, Grier and Tullock (1987), and Landau (1983) are studies mentioned in Barro (1990), p.S122

expenditures. The author argues that the reason for this is intertemporal substitution that makes the effect of temporary shifts to outweigh the effect of permanent changes.

Continuing the issue of military expenses, Aschauer (1989) concludes on the basis of the U.S. data that from a productivity point of view, movements in non-military public capital stock are more important than movements in a flow of public expenditures, either military or non-military. The author uses an endogenous growth model with increasing returns to three production inputs – capital, labor, and government services. The implication derived from this model is that government spending is productive by making private investment more productive.

Government spending may have both positive and negative effect on output (output growth) as we saw above.[9] However, it is important to identify the channels through which these effects are propagated into economy. Gerson (1998) in his literature survey on the effects of fiscal policy on output growth points out that many studies often fail to define the channels, through which fiscal policy affects output. Human capital channel is one of the natural candidates, and it is generally accepted that education and health status in the country are important factors of output growth, but the empirical evidence is not conclusive about direct influence of this type of spending on output. On the other hand, investment in infrastructure is important for the output growth, so fiscal policy that targets the improvement of market supporting infrastructure as well as physical infrastructure, according to Gerson(1998), is worth detailed investigation.

[9] To refresh memory, in the above discussed work by Barro (1990) productive fiscal spending or fiscal investment had a positive effect on investment, unlike fiscal consumption, which had a negative effect.

Domenech and Garcia (2002) assume that the public sector affects productivity of private factors through two channels: first, increased public capital increases the productivity of private capital, and second, it increases the utility of private agents. Considering a general endogenous growth model setup, the authors calibrate their model and find a numerical solution that is consistent with the real performance of OECD economies. The authors also suggest on the basis of numerical exercises that deviations from the optimal structure of the government spending deteriorate the economy more than a departure from the optimal structure of taxes. Domenech and Garcia (2002) conclude that the choice of optimal level and structure of public expenditures are of primary importance, while the method of fiscal financing is considered to be of secondary importance. A similar conclusion is reached by Turnovsky (2001) who analyzes different ways of spending a budget surplus through the calibration of a growth model to the U.S. economy. The author suggests that it is better to invest a budget surplus into public capital or to decrease the capital taxation level, rather than to increase government consumption or to decrease the level of labor taxation.

Giavazzi, Jappelli, Pagano (1998) investigate the role of fiscal policy on the national savings in the panel of 18 OECD, and suggest the factors, which lead to opposite to conventional Keynesian predictions. (The authors bolster their argument with the examples of Denmark in 1983-1986, Ireland in 1987-1989 and Sweden in early 1990s.) Interestingly, that authors point out that even under the Keynesian setup, specific assumptions can reverse conclusion of a theoretical model; so assuming that government surplus affects interest rate, the authors find that consumption increases and national savings decreases after a surge in tax rate, as opposed to lower consumption and higher savings in a Keynesian model. This again emphasizes the dependence of the theoretical results on the specific assumptions made – even in a Keynesian model one can engineer a non-Keynesian one. The authors allege that existence of the "non-Keynesian" effect

depends directly on the size and persistence of fiscal impulses, and is rather attributed to changes in taxes than in government consumption. The "non-Keynesian" effect is also more likely to accompany fiscal contraction than expansion.

Auerbach (2002) analyzes fiscal policy from a point of view of countercyclical tool, as it was often used in USA. This research does not provide decisive evidence either for or against fiscal policy being a good countercyclical measure. As noted in this work, fiscal contraction does not necessarily lead to a decrease in output, but may also produce a "salutary effect on output." Auerbach (2002) concludes that automatic stabilizer mechanisms, e.g. embedded in the tax system, contributed to smoother cycle more than fiscal policy.

The effect of fiscal actions may also differ depending on the type of country. Fölster and Henrekson (2000) suggest distinguishing between rich and poor countries, when analyzing the relationship between government size and growth, because these type countries have a different composition of public expenditures. The econometric study of rich countries in the 1970-1995 show that indeed, in rich countries an increase of government spending leads to a decrease in the rate of output growth.

Hulten (1996), in its turn, studies the optimal structure of public expenditures. He argues that efficient usage of the public infrastructure, *i.e.* efficient allocation of public resources (or government spending) could be much more important than the magnitude of spending. The constructed infrastructure–effectiveness index, which is viewed as a proxy for total factor productivity, shows that one-quarter of the differentials in growth rate between countries of Africa and South Asia can be attributed to the difference in infrastructure.

The transition countries pose special case of fiscal policy use. Fischer and Sahay (2000) study the macroeconomic performance of transition economies. They suggest that the tight macroeconomic policy is beneficial to the growth recovery. However, since the fiscal surplus has opposite impact on the state and private sectors of the economy, the overall effect will depend on the magnitude of this impact in each sector and on the share of the sector in the economy.

As another point of view, Aslund (2002) in his work on Ukrainian economic growth, emphasizes that the attempts to cure real production with standard Keynesian methods by fiscal and monetary stimulation of demand had led to the destructive consequences. The author argues that the country needed supply regulation as opposed to demand stimulation, *i.e.* restrictive macroeconomic policy should have been used, imposing hard budget constraints on state enterprises and stimulating restructuring of the supply side of the economy. The author argues that the output growth began only after Ukraine exhausted its borrowing sources, both international and domestic.

Methodology

The question of the effect of the tax and spending shocks on the output is rather an empirical question as noted above. Hence, it is instructive to overview different empirical techniques that were used to evaluate these effects. The single equation econometric approach used in most of the above studies, while has its advantages, also neglects the interdependency of determinants. Therefore a more complex approach – the system of simultaneous equations – may be preferable. The latter is also better suited for a study of transition economies in which stable economic relations are less likely to be observed.[10]

[10] To complete the logical chain, it should be noted that analyzing a transitional economy does not entail inapplicability of the economic theory and its main results. Rather it is that in the early stages of the

The Harvard Institute for International Development (HIID) macro-econometric models of the Ukrainian economy in Sultan et al. (2000) and the Russian economy in Basdevant (2000) both use the simultaneous equations approach.

The Ukrainian model (Sultan et al. (2000)) describes the relationships between macroeconomic aggregates of the economy. The model makes it possible to estimate the multipliers of fiscal and monetary policies. Imposing a fiscal shock (an increase of government expenditures) leads to an increase of output (expressed in real terms) in smaller degree (0.6). A monetary shock leads to approximately one-to-one increase of the real output (1.0). It was also found that in the short run the effect of a fiscal shock in terms of output is approximately the same as the effect of a monetary shock. But an increase in money supply also leads to a significant increase in prices. Thus, the authors conclude that fiscal policy is more defensible than the monetary one.

Basdevant (2000) aims to account for structural changes in the economy. The author concludes from his study that public investment stimulates private investment rather than crowds it out. Therefore, fiscal revenues should be used to extend capital stock (broadly defined) when private sector fails to do so,[11] *i.e.* government investment is necessary for the economic recovery policy to be successful.

One possible drawback of such models is that they stress long-run relationships in economy, but do not take into account the dynamic effects of shocks (Lukyanenko (2003)). In transition economies, which are characterized by a

transition non-economic factors like social tension may play a more important role in shaping macroeconomic policy than economic factors. If this were true then an analysis of the interdependency between economic variables ignoring such factors could be misleading.

[11] When private investment is absent given high uncertainty on the early stages of transition, public investment may serve two purposes. First, neglecting the issue of the allocation efficiency of the government, public investment may fill the private investment gap. Second, it may signal rate of return and risk associated with undertaken investment.

highly unstable economic environment, and a highly volatile time path of macroeconomic aggregates, reliance on long-run relationship when analyzing short-run economic decisions may be risky.

Blanchard and Perotti (2002) suggest using a structural vector autoregressive approach in evaluating the dynamic effects of a government's macroeconomic policy. Studying the effects of the tax and spending shocks on output, the authors conclude that output increases in response to a positive spending shock, and decreases in response to a tax shock – a result "consistent with standard wisdom." However, they also find that the spending shock has positive effect on the private consumption and the private investment react negatively in response to both shocks, the results that is hardly in agreement with either theoretical approach to fiscal policy.

The methodology used in Blanchard and Perotti (2002) serves my approach. Structural VAR used in the latter has an important advantage over the previously discussed approaches. While allowing for the interdependency between the variables, in contrast to simple unrestricted VAR, it allows for a structural interpretation of the model estimate. Blanchard and Perotti (2002) use institutional information about the budget system and automatic responses of fiscal instruments to changes in output to achieve identification of the system. These restrictions do not predispose the model to any type of economic theories, which is its advantage.

While in a different context, Blanchard and Quah (1989) analyze the presence of several sources of disturbance in the model. They classify these disturbances into the one that has a long run effect on output and the one that does not, and interpret them as supply and demand disturbances respectively. Under the assumption that neither shock has a long run effect on the other endogenous variable (unemployment) the authors reach a conclusion that AD shocks have a

hump-shaped effect on the output, and estimate the range of contribution of the AD shock variation to the aggregate variation, which turns out to be in the range from 40% to over 95%.[12] Returning to the Ukrainian context, firstly, this result suggests that the type of response expected in this research should be hump-shaped. Secondly, abstracting from the disturbances having a long run effect on output may be a reasonable approximation of real, as the short run effect accounts for a significant (again, not less than 40%, and up to over 95%) part of the output variation.

The article by Perotti (2002) replicates the analysis of Blanchard and Perotti (2002) for 5 OECD countries. The important difference of the work is including of monetary variables – price level and short term interest rate, which allows investigating the interrelation between monetary and fiscal policy. Perotti (2002) finds that output response is positive in every country. However, after splitting the sample period into two sub-periods (before and after eighties) the author concludes that fiscal policy has recently become a weaker tool, as evaluated from the standpoint of its effect on the real sector. The author also documents a negative multiplier of government spending in several cases the post-eighties sub-sample period. The analysis of output components reveals a similar pattern: the effect of fiscal policy is weaker in the second half of the period, and a negative multiplier results in several cases. The price response is estimated to be negative or slightly positive, with estimates being highly dependent on the price elasticity of government spending.

To summarize, the literature reviewed makes clear that the views about the effects of the fiscal policy on the economy – output, output growth, investment, and other macroeconomic aggregates – differ. First, it is conceivable that

[12] As discussed further in the Methodology Section imposing long run restrictions on the behavior of the variables is one of the alternative ways to achieve identification of the model.

government spending has a positive effect on output as in Barro (1990), Ashauer (1989). On the other hand, under assumptions made by Giavazzi, Jappelli, Pagano (1998), Auerbach (2002), increased government spending may retard growth. Second, as argued by Gerson (1998) it is important to analyze the channels through which fiscal policy works While there is no evidence of a positive effect of spending on human capital, spending on infrastructure, broadly defined, has a positive effect on output and growth. Third, it is important to distinguish between the temporary and permanent shocks, as was first noted by Barro (1981). Fourth, as discussed in Blanchard and Perotti (2002), the effect of the fiscal policy can be efficiently analyzed in the context of the structural VAR model, and is preferred to single equation methods. Fifth, empirical studies also do not give a unanimous answer. Thus, while Blanchard and Perotti (2002) document a positive effect of government spending on output,[13] Giavazzi *et al.* (1999) find evidence for the contractive fiscal expansions. Sixth, studies and theories for the transition economies do not allow making decisive conclusions about the effects for fiscal policy. Though some empirical evidence, in particular for Ukrainian economy, was found about fiscal spending being positive determinant of output growth, there are claims that rather a negative effect is expected (Fischer and Sahay (2000), Aslund (2002)). So, in my thesis I aim to bring a new evidence for the ongoing debate, and to provide a thorough description of the dynamic effect of the tax and spending shocks on output. I also aim to analyze the effects of the two shocks on price level, consumption and investment.

[13] Blanchard and Perotti (2002), p.26 states that their finding of positive effect of the spending shock on output agrees with other studies.

Chapter 3

METHODOLOGY

Evaluation of the impact of fiscal policy on output and other macroeconomic variables until recently was primarily done using large-scale macroeconometric models (LSEM). These while allowing for a variety of interdependency between variables are relatively inflexible. Such models usually incorporate Keynesian assumptions about the economy, but as Blanchard and Perotti (2002) point out, recent empirical evidence is inconsistent with the Keynesian approach. They also point out that the results obtained from LSEM provide support for the Keynesian theory partly because it is imbedded in the model: *e.g.* positive effect of government expenditures on economy may be assumed in such model, and therefore any simulation result will have this property.

Among methods of empirical research on effects of fiscal policy, the simultaneous equation approach has been dominating for a long time. However, the LSEM estimated using this approach was unable to compete with atheoretic models like ARIMA and VAR, especially in the forecasting realm (Kennedy (1999)). On the other hand, a VAR model is only a reduced form, it reflects only a summary of the dynamics of variables, and its parameters and impulse response functions have no economic meaning.

In this research, I use the structural VAR approach (SVAR), which seems to overcome the deadlock indicated above. Lucas' critique was targeted on the problem of endogeneity of policy shocks in the econometric modeling. Assuming exogeneity of policy shocks, economists were able to make inferences about dynamics of variables with respect to these shocks. However, in reality these

shocks on their turn could reflect the response of fiscal variables to changes in variables under investigation.

The methodology I use was developed in Blanchard and Perotti (2002) and was used to study the dynamic effects of changes in fiscal policy on GDP and its elements. Though this method is widely used in analysis of monetary policy (see Bernanke and Mihov 1998; and Bilan 2002 for an analysis of the liquidity effect in Ukraine), the authors argue that this method is better suited for investigation of fiscal policy rather than of monetary policy. The rationale for this is the fact that fiscal policy is often aimed to achieve goals, other than output stabilization, so among fiscal shocks there are shocks, which are exogenous with respect to output. In addition, fiscal policy, as opposed to monetary policy, is less responsive to changes in economic conditions.

In the vector autoregressions approach all variables entering the system are treated to be endogenous. The structural relationship between variables can be written as the following system:

$$AY_t = C(L)Y_{t-1} + DZ_t + Be_t \qquad (1)$$

where Y_t is a vector of endogenous variables, Z_t is a vector of exogenous variables $C(L)$ is a matrix lag polynomial and e_t presents a vector of structural disturbances. Note, that matrix B allows structural shocks enter in more than one equation, or put it differently each endogenous variable can be affected by more than one shock.

Corresponding to (1) reduced vector autoregressive system (VAR in its standard view) is the following:

$$Y_t = A^{-1}C(L)Y_{t-1} + A^{-1}DZ_t + u_t \quad (2)$$

where u_t is VAR residual vector, normally independently distributed. Note that assumptions do not restrict cross-correlations of elements of u_t to be zero. The relationship between structural shocks and residuals from unrestricted VAR system is:

$$Au_t = Be_t \quad (3)$$

In this research vector Y_t includes three variables, $[G_t; T_t; X_t]$, which stand for taxes, government spending and output respectively. The vector u_t consists of $[g_t, t_t, x_t]$, which represents the residuals that correspond to the reduced form of each equation.

To determine lag structure of unrestricted VAR several criteria are used. According to the first criterion, number of lags should be such that resulting model has non-autocorrelated residuals (Charemza and Deadman (1997), pages 159-160). The second criterion emphasizes the importance of the information criteria in the choice of the lag structure, which means that a balance between goodness of fit and the parsimony of the specification should be sought. The third criterion that allows discriminating between different lag structures is the forecast potential of the model. Thus, the choice of criterion depends on the goal of the analysis. None of the specifications I tested revealed autocorrelations in its errors. The important factor also is that the number of observations (refer to Data description section for more information), which is available for the analysis, do not allow for large number of lags in the model. Thus, the main criteria I use to choose number of lags is Akaike and Schwarz information criteria.

After series of tests (see results in Table 1) the specification, which includes one lag and such deterministic variables as constant term and seasonal dummies for, first, second and third quarters (vector Z_t in (1)) was chosen.

For the purposes of this analysis, I need to estimate structural residuals e_t^t and e_t^g (elements of vector of structural residuals e_t) representing policy shocks. These will be used to investigate the effect of exogenous shocks to fiscal variables (*i.e.* government revenues – taxes, and government expenditures) on real economy using impulse response functions. However, before proceeding the identification problem must be solved first.

Identification

The relation between variance-covariance matrices of reduced and structural residuals is:

$$\hat{\Sigma} = A^{-1} B \, \mathrm{I} \, B' A^{-1} \qquad (4)$$

where $\hat{\Sigma}$ stand for variance-covariance matrix of reduced form residuals, and the assumption of orthonormality of structural shocks was used, which implies that variance-covariance matrix of structural form residuals is just the identity matrix I. With this assumption the maximum number parameters in matrices A and B to be identified is reduced to $n(n+1)/2$, which equals 6 in this case.

Several types of restriction on parameter matrices are discussed in the literature (*e.g.* Breitung (2001), Favero (2001)):

(i) the identification strategy, based on Choleski decomposition, *i.e.* the matrix A is assumed to be of lower triangular form with ones on the main diagonal, and matrix B have diagonal form;

(ii) contemporaneous restrictions on the elements of A and B matrix, using a priori information about relationship of variables, leading to non-recursive orthogonalization of errors of the system;

(iii) long-run restrictions on the behavior of shocks. [14]

Since the goal of VAR analysis and its advantage is often considered to be the ability to distinguish between alternative theories of economics, the assumptions imposed should be as objective as possible. The most independent from tested theories assumption is the first one, based on Choleski decomposition, which assumes only ordering in the estimation of structural shocks. But this identification procedure does not eliminate entirely the drawbacks of the VAR, *i.e.* it does not count for the endogeneity of policy shocks. The second identification scheme presumes that the identifying restrictions are independent from the theoretical predictions of the model which applicability to the real world is tested.

Finally, the restrictions on the long-run behaviour of shocks are usually those, compatible with wide range of economic model.

In this research, as in Blanchard and Perotti (2002), I use the type (ii) identification scheme. The following system is used to identify fiscal policy shocks:

[14] These restrictions are used in Blanchard and Quah (1989). However, I cannot rely on this type of the identification procedure for two reasons. First, the data I use is monthly data (see Data Description section); so, the relation I focus on cannot be of long term character. Second, it is unreasonable to talk about long term relations for a period covering only 7 years. Therefore, using long run restrictions to identify the system is not an option for this work.

$$
\begin{aligned}
g_t &= a_1 x_t + a_2 e_t^{\,t} + e_t^{\,g} \\
t_t &= b_1 x_t + b_2 e_t^{\,g} + e_t^{\,t} \\
x_t &= c_1 g_t + c_2 t_t + e_t^{\,x}
\end{aligned} \tag{5}
$$

As Perotti (2002) suggests the reduced form residuals for government revenues and expenditures reflect three types of shocks: the automatic response of taxes and outlays to unexpected movements in output, the discretionary response of policy-makers to changes in output, and the discretionary shocks to fiscal variables, which are exogenous with respect to changes in output. This relationship is represented in the system (5).

System (5) has the following matrix notation, where the matrices premultiplying the vector of the reduced form residuals and the vector of shocks are respectively matrices A and B from equation (3):

$$
\begin{pmatrix} 1 & 0 & -a_1 \\ 0 & 1 & -b_1 \\ -c_1 & -c_2 & 1 \end{pmatrix} \begin{pmatrix} g \\ t \\ x \end{pmatrix} = \begin{pmatrix} 1 & a_2 & 0 \\ b_2 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} e^g \\ e^t \\ e^x \end{pmatrix} \tag{6}
$$

To recover structural shocks $e^i{}_t$ from this system, Blanchard and Perotti (2002) suggest using institutional information on tax structure and budget system to estimate (5). First, using high frequency data implies that parameters a_1 and b_1 reflect responsiveness (elasticity) of taxes and government spending respectively to unexpected movements in output. Hence, in further analysis I can concentrate only on automatic response of fiscal system to these changes. Adjustments of fiscal policy can be neglected in this setting since these usually require more than a month to be implemented. Second, further identification of the system can be achieved using residuals adjusted for output changes. The latter allows refining residuals by separating the effect of unexpected movements in taxes and

government expenditures from the influence of output, and thus ensures that they are uncorrelated with output structural shocks:

$$g'_t = g_t - a_1 x_t = a_2 e^t_t + e^g_t$$
$$t'_t = t_t - b_1 x_t = b_2 e^g_t + e^t_t \qquad (7)$$

These additional residuals can be used as instruments in estimating of c_1 and c_2 coefficients in the equation for x_t. Coefficients a_2 and b_2 of the system (4) are elasticities of unexpected movements in the taxes and government expenditures to the policy shocks in the *vis-à-vis* variable (government expenditures and taxes respectively). The values of these parameters are dependent on the assumption about which decision about economy's fiscal policy takes place first: the change in the taxes $(a_2 \neq 0, b_2 = 0)$ or the change in the government expenditures $(a_2 = 0, b_2 \neq 0)$[15]. Rotov (1998) points out, that the process of budget planning in Ukraine goes in direction of searching revenues to meet targeted expenditures. So, the latter case, in which the expenditures decisions are made first, seems to be a more accurate description of Ukrainian fiscal policy-making. However, Granger causality test for pair government revenue – government expenditures (see Table A3 in the Appendix) do not allow to reject the null hypothesis that one variable does not Granger cause another. So, both assumptions should be tested.

To summarize, the identification procedure hinges on the following assumptions. First, I assume that adjustments in fiscal policy are very infrequent, and therefore take place in subsequent to shock periods. Second, the assumption that the effect of output shocks is fully represented in the seasonal pattern of fiscal variables

[15] As argued in Handbook of Econometrics (1994, p.2904-5) this assumption may be a reasonable one for high frequency data. These restrictions also constitute an example when matrix A is not assumed to be lower triangular (recursive model) as assumed in most econometric packages.

implies that it can be separated from the structural shocks in the tax and the expenditure variables. Third, I assume that only one (primary) fiscal instrument – taxes or government expenditure – is truly exogenous with respect to counterpart variable. Estimation of system (5) allows constructing structural residuals, which are exogenous to fiscal variables. These are later used to derive the impulse response functions for output.

Chapter 4

DATA DESCRIPTION

Data used are monthly and covers the period from August 1998 to March 2002. The main reason for using high frequency data is that it allows separating the automatic response of the fiscal system from discretionary fiscal adjustment. Using monthly data makes it possible since fiscal adjustments cannot be made within such a short span of time, and thus it serves identifying the fiscal shocks.

The period under investigation can be characterized as a period of a stable macroeconomic environment, and when the Ukrainian economy turned to positive economic growth. Macroeconomic stabilization was achieved in 1995 when inflation finally decreased to 8.7 %. In September 1996 the new Ukrainian currency, hryvnia, was introduced, allowing for independent monetary policy of the Central Bank. Concerning economic growth, Ukraine reached an "economic growth" through in 1995. The whole period is characterized by increasing growth rate, though it turned positive only in 2000. This brief discussion suggests that economic environment was stable during the period under investigation.

The source of data is the quarterly "Ukrainian Economic Trends" prepared by Ukrainian-European Policy and Legal Advise Centre (UEPLAC). UEPLAC edition often contains adjusted series which are published by the State Committee of Statistics only after some period. In this way I find using all the data from this source serving the consistency.

The main variables I analyze in this work are output, government expenditures, government revenues, price level, private consumption and private investment.

The GDP is calculated using the income method. The composition of the government revenues and expenditures are given respectively in Table 1 and 2.

Table 1. Government Revenues as a Share of GDP

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Value Added Tax	8.1	8.7	7.6	7.1	6.1	5.4
Enterprise Profit tax	7.0	6.5	6.7	5.6	5.3	4.6
Excise taxes	0.8	1.3	1.3	1.5	1.4	1.4
Chernobyl tax	1.9	2.0	1.5	0.2	0.1	0.0
Household income tax	3.4	3.8	3.8	3.7	4.1	4.6
Pension fund	8.9	11.2	9.8	9.5	9.3	9.5
Total Revenue	**38.6**	**42.4**	**39.8**	**37**	**40.4**	**38.2**

Table 1 reveals that inflows from the enterprise (profit) tax, and the value added taxes constitute the main part of the government revenue. Pension fund which is a target fund involved in redistribution of the largest share of revenues. As can be seen from the table above, the overall structure of the state revenues did not experience significant changes in its structure over the considered period and averaged 39.4% of GDP.

The present version of the value added tax code was implemented in 1997; the valued added tax of 20% rate now applies to virtually all sales in the economy. The code on excise tax was adopted in 1992. The excise tax applies to the wide range of the products, like alcohol, tobacco, petroleum, and similar products. The code on enterprise profit tax, in its present version, was introduced in 1997, and imposes a single rate of 30% on most of activities.[16] Finally, the household income tax was implemented in 1993, and is calculated according to a progressive scale.

[16] A 15% rate applies in special cases.

It should be noted that the tax legislation in Ukraine is highly unstable and the changes which occurred over the period of interest not always led to more efficient tax system. The tax system is characterized by high tax rates; many exemptions create more burden of taxes on those who pay them in full, so this leads to tax disloyalty. The main changes in the Ukrainian tax system that are thought to enhance the collection of revenues and lead to better of stimuli for economic activity are a reduction of direct taxes, and broadening of the tax base.

The structure of government expenditures is presented in Table 2.

Table 2. Government Expenditures as Percent of GDP

Year	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Economy and foreign trade	6.0	6.6	6.7	6.5	5.5	4.8
Education, health*[1], culture, science	10.5	11.7	9.7	8.3	8.8	9.4
Servicing of the foreign debt	2.7	2.3	0.8	1.5	1.9	1.3
Social transfers, and pensions	14.2	17.6	15.2	12.9	12.8	13.3
Police, justice, defense*[2]	4.5	5.1	4.5	4.2	5.6	5.8
Ecology and Chernobyl	2.0	2.0	1.6	1.3	1.3	1.1
Total expenditures	**43.2**	**49.6**	**41.9**	**38.4**	**39.2**	**37.6**

*[1] – includes expenditures on recreation
*[2] – includes state administration expenses

On the expenditure side, social transfers with pensions and expenditures on education, health, culture, and science by far exceed other items in the government's budget. Servicing of the external debt declined significantly in 1998, but recovered in 1999. However, due to relatively small importance of external debt servicing in the total expenditures this decline has no effect on the overall pattern. Financing of the fulfillment of the basic functions of government (health, education, and defense) during the period did not changed, at least as the share of GDP, though the total expenditures as the share of GDP experienced a decline.

As can be seen, the share of national income, which government institutions redistribute and use for conducting public policy is large and though was declining during transition years, still remains considerable.

In transition economies the issue of public sector is a new institution, since under centrally planned system the government was involved in each and every sphere of activity. It supported and governed all state enterprises through system of planning mechanisms. A lot of functions in the sphere of providing of social security was conducted through these state enterprises and now are new for the government. This list contains housing, medical care, kindergartens just to name. Also the important feature which was absent in the Soviet Ukraine and is of great importance now is the unemployment and the programs of social security. Before, the country assured the certain level of living standard for every member of society, either when young or when old. Now, in new conditions, when the old system is destroyed, these unprotected members of community require great expenses from the government. So, from one side the government share in output is driven down by the fact that now much less number of enterprises are staying in government ownership and require its financing. On the other side the government faced with new problem, requiring its firm actions in order to provide the stability and relax social stringencies in the country. Comparing to the developed countries structure of government expenditures, where it can be clearly split into expenditures into productive and non-productive activities, the transition countries differ a little bit. Facing great decrease in tax revenues but getting to its competition new functions of social security caring, government lacks the resources for even minimal financing of its functions. So, the structure of government expenditures in Ukraine is clearly skewed to the non-productive activity financing. The current expenditures have a priority over capital expenditures in the government finances. This should make difference in the influence of government spending on the output.

For the purposes of my analysis, first, I convert all the variables into real terms using GDP deflator (base year is 1990), second, I apply logarithmic transformation to the variables. [17] The time series analysis, however, requires data to be stationary. A usual choice is to apply the Hodrick-Prescott filter, which allows isolating the long run trend, but the time series I operate with are too short to consider a long term trend. So, I leave the data unchanged in this respect.

It is widely accepted that the price series is non-stationary (see Table A.2 for the unit root test for the price variable). To deal with this issue I use the series in first differences.[18]

Private investment series are unavailable,[19] however these may be recovered using the national income accountancy identity. To this end, I subtract merchandise trade and services balance, government expenditures and private consumption from output.

$$GDP_t = Consumtion_t + Investment_t + Government_t + Trade\ Balance_t \qquad (8)$$

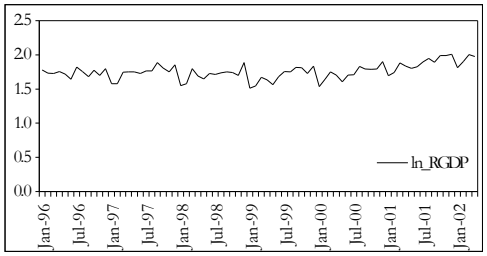
The descriptive statistics of the variables used in the analysis are provided in the Table A1 of the Appendix. The evolution of the variables over the period 1996:01-2002:04 is shown in Figure 1.

[17] Using logarithmic transformation does not have theoretical justification. However, this transformation "normalizes" data so that extreme observations do not get high weight in the estimate.

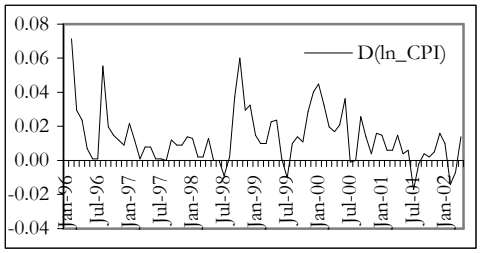
[18] A change in the log price level is inflation. Thus using differenced series is equivalent to using inflation.

Figure 1. Evolution of the Macroeconomic Aggregates, 01:1996 - 04:2002

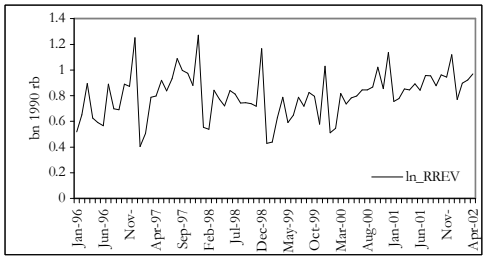
GDP



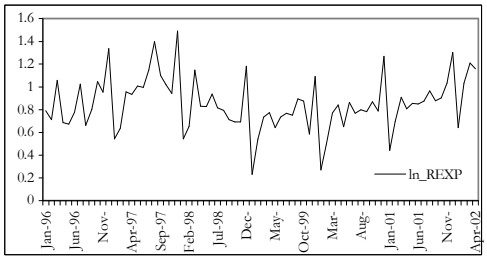
Inflation



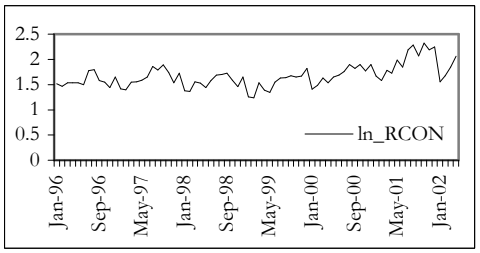
Government Revenues



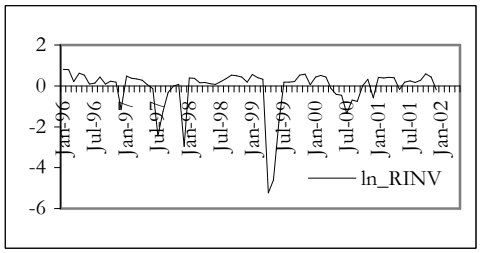
Government Expenditures



Private Consumption



Private Investment



[19] Though yearly data exist, private investment series on a monthly basis for the period of interest is unavailable.

Figure 1 reveals that variables do not present clear trend. However, as the period under investigation was critical for the economy of Ukraine, I split this period into two parts, to see weather there is any differences in dynamics of variables over these subsamples. Forestalling, each equation of the unrestricted VAR system was tested for structural break for a number of time points in the period. The results, given at the Figure 1 in the Appendix A reveal that the hypothesis of no structural break cannot be rejected for periods 1998-2000 for all of three variables.

Figure 1 also reveals a strong seasonal pattern of the fiscal spending and revenues series, *i.e.* the peaks in the collection of taxes and execution of the expenditure side of the budget in the end of each year. In the end of fiscal year strict measures are undertaken to fulfil the budget plan, which partly explain the irregular pattern of tax collection. A seasonal pattern can be also observed in government expenditures. One reason for this could be that in the end of fiscal year executive authorities try to spend 'excessive' resources, not to be in the inferior position when resources of a new budget are distributed. The other explanation could be that the government, like firms, pays all the bills at the end of the year (*e.g.* public sector wages).

To test for stationarity I use the unit roots test. First of all visual inspection of the series suggests that they are stationary in levels, *i.e.* represent integrated of order zero, I(0), series. Formal conclusion is based on the results of the Phillips-Perron test for unit root, which is less sensitive to lag length included in test equation, then the alternative augmented Dickey-Fuller test. Results, given in Table A.2 in the Appendix, suggest that the series are indeed stationary in levels.

Chapter 5

EMPIRICAL RESULTS

At first stage the following unrestricted form VAR system was estimated:

$$Y_t = A^{-1}C(1)Y_{t-1} + A^{-1}DZ_t + u_t \qquad (2A)$$

The results of the estimation of this three-variable model are given in Table B.2 in the Appendix. Since the parameters of the VAR specification do not reveal causality between variables (all the variables in the system are assumed to be endogenous), I cannot conclude about the direction and the magnitude of the effect of the fiscal shocks on output. The main output of this step is the residuals series from this reduced form VAR, which is used for recovering structural shocks. The VAR stability test suggests that the system (2A) is stable (*i.e.* no root lies outside the unit circle), and thus, the estimate of (2A) can be used in the rest of the procedure. If the residuals of the reduced VAR system were uncorrelated, I could make inferences about the effects of the policy shocks. But the latter have non-zero cross-correlation (see Table C1 in the Appendix), so policy shocks cannot be clearly exogenized while computing the impulse-responses.

The next step is estimating relationship between the structural shocks and the residuals from the reduced form model. This could be achieved using most of the econometric packages, which work with time series. However, the goal of the program (e.g. see E-views 4.1 User's Guide) is just to find matrices A and B which will ensure orthogonality of structural shocks. This is done by maximization of log-likelihood function, and the value found could be local maximum as well as global. Thus, first, this procedure may not give the true

values of the estimated parameters in the matrices A and B, and therefore can lead to spurious conclusions, and second, these values are fully arbitrary as opposed to the values constrained by economics argument. In view of this potential pitfall, the procedure as described in the Methodology section is more preferable.

Further analysis consists of the following steps. First, I estimate parameters in the matrices A and B and derive responses for the specification, which includes three variables – government expenditures, government revenues and total output. Second, I include prices in the model. Since the prices enter the model in differences, the effect of the fiscal policy shocks is treated as the effect on inflation level. Further, I add to this four variable specification consequently two output components: private consumption and private investment, which response to policy changes could be used to discriminate between alternative economic theories. This step-wise procedure, in fact, provides me with a sensitivity test of the model. The latter is to compare how the impulse response of the variables already included in the model change with the inclusion of new variables. I also verify the robustness of the results by calculating impulse response for different sample sub-periods. Finally, the model's sensitivity with respect to the price elasticity of the government expenditures and output elasticity of the government revenues was performed.

When new variables are added to the specification, we have to modify slightly the identification procedure in order to be able to recover fiscal shocks. For the four-variable specification (including the price variable), the relationship between reduced and structural residuals is, according to Perotti (2002)):

$$
\begin{aligned}
g_t &= a_1 x_t + a_3 p_t + a_2 e_t^{\ t} + e_t^{\ g} \\
t_t &= b_1 x_t + b_3 p_t + b_2 e_t^{\ g} + e_t^{\ t} \\
x_t &= c_1 g_t + c_2 t_t + e_t^{\ x} \\
p_t &= d_1 x_t + d_2 g_t + d_3 t_t + e_t^{\ p}
\end{aligned}
\tag{9}
$$

The last equation in the system accounts for the influence of the price level on the fiscal activity, and, in its turn, is subject to influence of fiscal and output shocks.

When the two output components, private consumption and investment, enter the model, the identification is achieved using the following relation between the structural and the reduced form residuals:

$$
\begin{aligned}
g_t &= a_1 x_t + a_3 p_t + a_2 e_t^{\ t} + e_t^{\ g} \\
t_t &= b_1 x_t + b_3 p_t + b_2 e_t^{\ g} + e_t^{\ t} \\
x_t &= c_1 g_t + c_2 t_t + e_t^{\ x} \\
x^i{}_t &= f_1 g_t + f_2 t_t + e_t^{\ x^i} \\
p_t &= d_1 x_t + d_2 g_t + d_3 t_t + e_t^{\ p}
\end{aligned}
\tag{10}
$$

where $x^i{}_t$ is a reduced form residual corresponding to equation for output component (i=Consumption, Investment), and as output is subject to the effect of the fiscal policy shocks. Note, that in this last scheme structural residuals $e^x{}_t$ and $e^{x^i}{}_t$ may be correlated, but this does not impede the analysis: here I aim to exogenize the government expenditures and the government revenues shocks only.

To begin with, I need to estimate the elasticity of government expenditures and revenues with respect to output and prices (i.e. a_1 and b_1 coefficients in (5) plus a_3 and b_3 in (6) and (7)). To achieve this, I estimate an auxiliary regression for

government revenues and government expenditures (see Tables D.1 and D.2 in the Appendix), which gives me the values of a_1, b_1, a_3 and b_3.

Zero value of a_1 (output elasticity of government spending) also can be justified by analytical considerations. This coefficient is non-zero in the presence of automatic stabilizers, which as their name suggest, automatically correct government spending when output changes. Concerning the revenue collection process, there are such automatic stabilizers, embedded in tax system. However, as government expenditures is a highly planned activity such stabilizers probably cannot exist in such a short period of time as a month, since any changes in government expenditures has to be approved by the Parliament of Ukraine. Therefore, I conclude that the assumption $a_1 = 0$ is not restrictive. Using high-frequency data is necessary for the validity of this assumption.

Following the described estimation procedure, I obtain the estimates of the parameters in the matrices A and B. Then, to verify sub-sample stability, I repeat procedure for two sub-samples: 1996:01-1999:12 and 1998:05-2002:04. The results of these exercises as well as the estimations for other specifications are presented in Table E.1 in the Appendix.

The estimates of the coefficients a_2 and b_2 were obtained for the two alternative assumptions. In the first government spending is assumed to be the primary policy, *i.e.* decisions about government spending are made; in the second, taxation is such. Estimated parameters of matrices A and B show contemporaneous relationship of variables. Thus, coefficients c_1 and c_2 give respectively the effect of the government expenditures and revenues shocks on GDP. Namely, it can be seen that increase in government expenditures leads to increase in GDP and increase in revenues leads to the inverse effect. The inflation rates are influenced negatively by any type of fiscal policy, but this effect turns out to be insignificant.

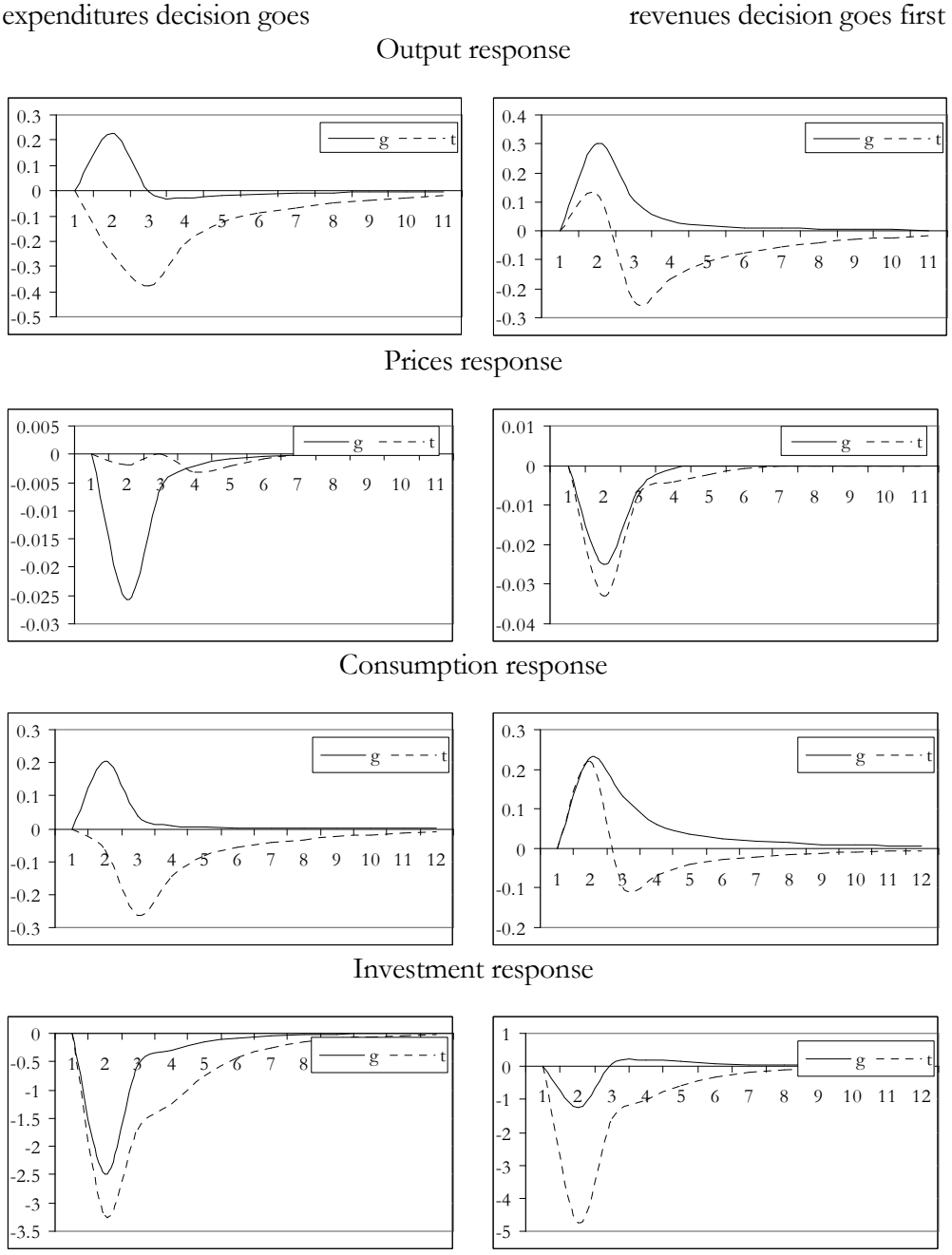
The consumption, in Specification 3, reacts positively to the increase in government expenditures, however, the contemporaneous effect of the revenue shock is insignificant. The contemporaneous response of investment to the fiscal policy shocks is opposite. It is significantly, both economically and statistically, influenced by revenue shock and the concurrent effect of expenditure shock is insignificant. In each sub-sample the effects of the fiscal shocks preserve the sign and are of comparable magnitude; and I may conclude that the results are robust to the chosen period.

Table E2 in the Appendix contains the contemporaneous effects evaluated at the mean points of the corresponding variables and expressed in monetary units. Thus, a one hryvnia positive government expenditures shock increases output by 0.98 hryvnia, which is given by c_1 coefficient. Similarly, a one hryvnia positive shock to government revenues decreases output by 0.87 hryvnia. The results for the sub-samples also suggest that output became less vulnerable contemporaneously to tax shocks in the last years (-0.25 hryvnia in the second sub-period versus -1.043 hryvnia in the first sub-period.) The effect of fiscal policy shocks on output components are: a 0.17 hryvnia increase in consumption due to the unitary increase in the government expenditures expansion and a 2.15 hryvnias decrease in the investment due to the unitary increase in the revenues. It also can be noted that adding new variables to the model change the contemporaneous effects of the variables already included in the model inconsequentially. Hence, the model is also robust to specification.

Structural residuals, obtained on this stage are uncorrelated by construction (Table C.1 in the Appendix confirms this); therefore, they present purely exogenized shocks, and the system can be disturbed by one shock, while holding other equal to zero. Impulse response functions derived using the estimated matrices A and B are presented in the Appendix in Table E.3 for the

expenditures shock and Table E.4 for the revenues shock, and Figure 2 visualizes the impulse responses.

Figure 2 Responses to fiscal shocks



The plots of impulse responses presented at the figure above reveal the following facts about dynamic effects of the expenditure and revenue shocks in Ukraine. An increase in the government spending leads to increase of output with a peak in the first period (0.23 % or equivalently 0.55 hryvnia in the Specification 1) [20]. This effect is the same across the specifications. An increase in the government revenues leads to output contraction with trough in the second period (-0.38 % or -0.96 hryvnia). When government revenues decision is assumed to be undertaken first, the above results change. Output initially increases in response to an increase in government revenues (0.12 % in the first period), and then returns back to conventional negative effect with a trough in the second period (-0.25 % or -0.63 hryvnia). This finding, a positive effect of the government expenditure shock and a negative effect of the tax shock on output, is in line with the "classical" Keynesian views. Hence I may conclude that the Ukrainian evidence does not provide support for the existence of "non-Keynesian" effects of fiscal policy. Rather, the results suggest existence of the positive effects of the fiscal expansion and conform to findings by other researches in this field.

The effect of the fiscal policy on consumption is similar to the effect on output – a positive government expenditure shock leads to an increase in consumption, while a positive shock in the government revenues leads to a decrease of this aggregate. The maximum of the consumption response to the government expenditures shock is achieved in the first period and is 0.21 % (0.14 hryvnias.) Consumption declines due to a government revenue shock and reaches a trough in the second period (-0.26 or -0.19 hryvnias.)

The effect of a positive fiscal policy shock on the investment is negative, no matter which policy instrument is used, expenditures or revenues. A response to

[20] Monetary analog of the response is recovered from the elasticity according to the following relation:

$$\frac{\partial y}{\partial x} = \varepsilon_{yx} \frac{y}{x}$$

the government expenditure is -2.48% (-1.20 hryvnias), and a response to the revenue shock is -3.22% (-1.65 hryvnias). These results are also sensitive to the assumption about ordering of fiscal decision – when taxes are assumed to be decided upon first the effect of the government expenditure is lower and the effect of the government revenue is greater in the absolute values.

The effect of the tax shock on the variables is also more prolonged than the effect of the expenditure shock.

The above analysis was about imposing the shock in one variable, leaving all the other variables unchanged; *i.e.* only one shock at time (the revenue or the expenditure shock) had a non-zero value. To experiment with the model I need further assumptions about how fiscal spending is financed: either the government borrows, or prints money, or increases taxes. So, when I allow for the unitary shock in the expenditure variable holding the tax shock zero, this means that government finances increase in its spending by borrowing, or by creating money or both, and increases budget deficit. The cumulative effect of such a policy experiment could be measured as the area under the impulse response function. Thus, the cumulative effect of the fiscal policy on output in the above scenario is positive and ranges from 0.31 to 0.60 hryvnia in different specifications. Notice that controlling for inflation in the Specification 2 eliminates also the possibility of inflationary budget financing; hence the cumulative effect in this specification is solely the effect of governments borrowing (0.48 hryvnias).

An increase in the revenues collection, keeping all other shocks to be zero, leads to a decrease of output in the range from 1.76 to 3.20 hryvnias. This impact is negative, as expected, since the government does take away a part of national income, but does not put it in a productive or even a non-productive activity.

Now let us consider a scenario, in which an increase in government expenditures is fully financed through an increase in the tax revenues. The cumulative effect for 10 periods is as follows. Since expenditures are decided upon first here, I use the impulse response estimations for the case where *a2=0*. The cumulative effect on output varies from -1.36 hryvnias to -2.89. The consumption and investment decrease in response to this policy scenario by 0.36 and 5.86 respectively. So, this suggests that the balanced budget fiscal expansion would decelerate output growth; moreover, this effect could be seen as undermining the future basis for growth through a decreased private investment, the most direct growth determinant. Similarly, I analyse the case when the government decide upon the revenue side first, the specification with $b_2=0$. In this case, the cumulative effect of output is ranged between -0.46 and 0.86 hryvnias, taking on a positive value in three specification out of four. The effect on consumption is positive (0.30 hryvnias), while the investment is crowded again out, -4.75 hryvnias.

To infer about the changes in the character of the dynamic response of output to fiscal shocks during the period under investigation, I compare impulse responses across sub-samples (Table E.5 in the Appendix.) It turns out that the influence of the expenditure shock in the first half of the period is smaller (maximum percentage response is 0.13 % or 0.31 hryvnia) than the influence in the second half (maximum is 0.36 % or 0.94 hryvnia.) The same conclusion is true for the tax shocks: in the first half of the period the output impulse response reaches a minimum of –0.31% (which is equivalent to a decrease in output by 0.78 hryvnias), while in the second half the minimum is –0.43 (-1.13 hryvnias). This suggests that during period of 1996-2002 the response from the economy became stronger, *e.g.* fewer enterprises stay in the shadow, more tax discipline, etc. So, fiscal policy may be now considered a true policy instrument.

Recalling that the identification procedure depends on the values of the elasticities that are estimated in the very beginning, it is important to check the sensitivity of the results with respect to these values, *i.e.* output and price elasticities. I use Specification 2, because it includes both price and output elasticities. For the test I use the benchmark values of elasticities from Tables D.1 and D.2 and change them by adding and subtracting 0.5 points. The exercise is conducted for the two assumptions, and the results for assumption of the government expenditures decision being ordered first are provided in Table F.2 in the Appendix; the second assumption leads to a similar pattern result and is not provided.

Analyzing the values of Table F1 the following inferences could be made. A change in the price elasticity of the government spending leads to no or negligible changes in the output and price impulse responses. At the same time, the changes in the output elasticity of revenues change impulse responses. Namely, the increase in absolute value of the output elasticity of revenues shifts down the impulse response. In the case of the revenue shock, a downward correction from 1.0 to 0.5 of value of elasticity leads to larger change of the impulse response than an upward correction of the same magnitude from 1.0 to 1.5. However, the main pattern is preserved in all specifications; so, the model may be regarded as insensitive to changes in the elasticity values.

Chapter 6

CONCLUSIONS

In this work, I analyzed the effects of fiscal policy on the dynamic behavior of the macroeconomic aggregates in Ukraine. The primary interest of my thesis lies in the description of the response of output and its components to fiscal policy: government expenditures and taxation.

I use structural VAR estimation technique, which has several important advantages in the given context. In particular, it allows both for interdependency of the variables, and for exogenous shocks. Furthermore, it is atheoretic, and thus can be used when theory does not yield a clear prediction, but its estimated parameters have structural interpretation and economic meaning.

Identification of the system is achieved incorporating contemporaneous restrictions in the model, which as I argue are preferable to otherwise arbitrary or technical identification assumptions. To be precise, I use high-frequency (monthly) data which allows me making assumption that automatic response of some fiscal variables to changes in output and other macroeconomic aggregates does not exist. Next, following Blanchard and Perotti (2002) I use the information on the budgetary system. In particular, I estimate output and price elasticity of fiscal variables with auxiliary regressions. Then, I assume the order in which fiscal decisions are made – whether government spending or taxation is decided upon first – and carry analysis for the two competing assumptions.

My key findings are as follows:

1. The expenditure shock alone leads to an increase in output and consumption, while investment decreases significantly; and the revenue shock has a negative effect on all of the studied aggregates, including investment. These findings conform to the findings in Blanchard and Perotti (2002) applying the same methodology to the USA.

   Comparing the responses of output and consumption, the responses of these in Ukraine are smaller in magnitude and persistence. The negative effect on investment is also larger in Ukraine. This could be explained in part by differences in composition of government expenditures and revenues, and their allocation, which could be less productive in Ukraine. Government spending in Ukraine may be largely thought of as government consumption, as in Barro (1990), rather than investment.

2. The estimation results suggest that in Ukraine the responsiveness of the economy to fiscal shocks has been increasing. This conclusion contrasts with the finding in Perotti (2002) studying the effect of fiscal policy in the OECD countries. This could be explained by strengthening of fiscal policy institutions in Ukraine and improved confidence in the government policies as the economy experienced significant growth in the last years.

3. Analysis of the alternative scenarios of fiscal financing suggests that borrowing lead to a positive effect on output, while the effect of a tax-financed fiscal expansion depend on the specific assumption about the order in which fiscal decisions are made. When the government spending decision is taken before the decision about the tax level, a tax-financed increase in government spending has a negative overall effect on output;

when the order of the decisions is reversed, the effect becomes positive, and the magnitude of the increase is larger than in the case a debt-financed (or inflationary) fiscal expansion. This finding has an economic interpretation. The effect of fiscal expansion is positive whenever revenues decisions are made first, *i.e.* government spending has a real financial source and does not search for the resources when an unexpected need emerges. This suggests that a budget system has to be designed so that there is no possibility of discretionary fiscal expansion.

The fact that is difficult to agree with is a negative effect on investment under all scenarios. However, this finding agrees with findings in previous studies on fiscal policy, *e.g.* Blanchard and Perotti (2002), Perotti (2000).

4. As presented in my thesis, fiscal expansion in transition is often thought to have a negative effect on the economy. Aslund (2002) (see also Fischer and Sahay (2000)), claims that in the years of transition government should seek supply side remedies, and should not attempt demand side stimulating of the economy as was done in Ukraine, and as is prescribed by the Keynesian theory. However, I find no support for the existence of the non-Keynesian effect for the Ukrainian economy in my thesis. On the contrary, Ukraine reveals a pattern of the fiscal policy effects that are similar, in all major respects, to those found for developed economies. This suggests that although the Ukrainian economic environment is perceived to be different this does not imply that the economic policy prescriptions from the developed world do not apply to Ukraine.

5. To understand fully the working mechanisms of fiscal policy additional research are needed. In particular, it is necessary to understand the channels of the fiscal policy. For example one may want to study the

effects of fiscal policy on the term structure of the interest rates in Ukraine.

In conclusion I would like to say that the findings of this thesis are generally optimistic. The effects of the fiscal policy are of the same direction as those in the developed countries, which I interpret as a possibility to take over the experience of the developed world and evidence that Ukraine evolves in the right direction.

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APPENDIX A DATA DESCRIPTIVE STATISTICS

Table A.1. Descriptive statistics of variables used in the analysis

	LN_REXP	LN_RREV	LN_RGDP	LN_CON	LN_RINV	D(LN_CPI)
Mean	0.845070	0.799234	1.748919	0.502720	-0.098251	11.85255
Median	0.821837	0.804775	1.748447	0.497736	0.201274	11.83849
Maximum	1.490922	1.270858	2.008319	0.842844	0.808430	12.29584
Minimum	0.233110	0.403894	1.512334	0.215111	-5.226983	11.30775
Std. Dev.	0.232804	0.186072	0.108129	0.132852	1.061508	0.298254
Skewness	0.235356	0.138919	0.066983	0.511230	-3.157620	0.128741
Kurtosis	3.791334	3.057156	3.089909	3.314604	13.73393	1.647560
Jarque-Bera	2.543338	0.241381	0.078092	3.433195	465.2986	5.686173
Probability	0.280363	0.886308	0.961706	0.179676	0.000000	0.058246
Observations	72	72	72	72	72	72

Table A.2. Phillips-Perron Test for Unit Root

Variables used in VAR analysis	Phillips-Perron statistic	
	levels	differences
LN_REXP	-7.895208	-
LN_RREV	-7.399900	-
LN_RGDP	-4.550388	-
LN_CON	-3.520158	-
LN_RINV	-4.735518	-
LN_CPI	-1.638035	-6.044539
MacKinnon 1 % critical value for rejection of hypothesis of a unit root is -3.5188		

Table A.3 Coefficients of Correlation between Variables.

	LN_REXP	LN_RREV	LN_RGDP	LN_CON	LN_RINV	D_LN_CPI
LN_REXP	1.000000	0.881063	0.680487	0.496865	-0.255656	-0.257745
LN_RREV	0.881063	1.000000	0.781708	0.668604	-0.226660	-0.194679
LN_RGDP	0.680487	0.781708	1.000000	0.881935	0.092090	-0.187285
LN_CON	0.496865	0.668604	0.881935	1.000000	0.057096	-0.247596
LN_RINV	-0.255656	-0.226660	0.092090	0.057096	1.000000	0.066252
D_LN_CPI	-0.257745	-0.194679	-0.187285	-0.247596	0.066252	1.000000

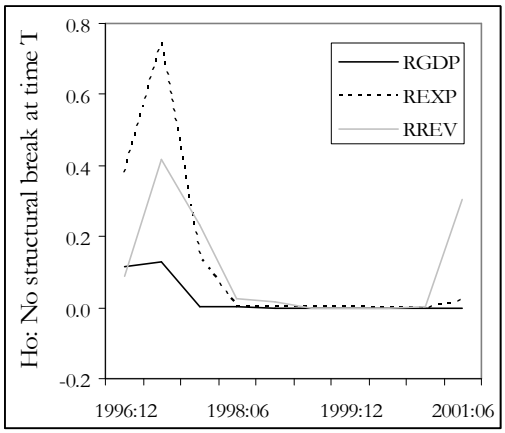
Table A.4. Pairwise Granger Causality Tests

Pairwise Granger Causality Tests			
Date: 02/21/03 Time: 13:09			
Sample: 1996:01 2002:04			
Lags: 12			
Null Hypothesis:	Obs	F-Statistic	Probability
LN_RREV does not Granger Cause LN_RGDP	64	3.26285	0.00252
LN_RGDP does not Granger Cause LN_RREV		0.75548	0.69003
LN_REXP does not Granger Cause LN_RGDP	64	2.32647	0.02331
LN_RGDP does not Granger Cause LN_REXP		0.87334	0.57942
LN_REXP does not Granger Cause LN_RREV	64	0.63560	0.79886
LN_RREV does not Granger Cause LN_REXP		1.64842	0.11793

Figure A.1 The Chow Breakpoint Test

Null hypothesis: there is no structural break at a point of time T (horizontal axis).

(P-values on the vertical axis.)



APPENDIX B UNRESTRICTED VAR ESTIMATION

Table B.1 Choice of the Lag Structure

Statistic	1 lag	1 lag, dummies	3 lags, dummies	5 lags, dummies	11 lags, dummies
AIC	-5.052856	-5.121891	-5.148422	-5.037141	-3.478417
SC	-4.682058	-4.472995	-3.924752	-3.220624	0.234767
MSE					
REXP	0.05495	0.06021	0.06882	0.02627	0.29245
RREV	0.02558	0.02863	0.02334	0.01871	0.02870
RGDP	0.18609	0.04048	0.02957	0.00893	0.00322
Adj. R^2					
REXP	0.027161	0.203722	0.381788	0.524596	0.633964
RREV	0.058250	0.307085	0.420607	0.525962	0.636867
RGDP	0.354548	0.439996	0.623057	0.728208	0.753819

Table B.2 Vector Autoregression (VAR) Estimation Output

Vector Autoregression Estimates			
Date: 04/09/03 Time: 01:38			
Sample(adjusted): 1996:02 2002:04			
Included observations: 75 after adjusting endpoints			
Standard errors in ( ) & t-statistics in [ ]			
	LN_REXP	LN_RREV	LN_RGDP
LN_REXP(-1)	0.448079	0.093002	-0.068990
	(0.21688)	(0.15484)	(0.08775)
	[2.06603]	[0.60065]	[-0.78617]
LN_RREV(-1)	-0.742051	-0.212650	-0.231442
	(0.30084)	(0.21477)	(0.12172)
	[-2.46663]	[-0.99011]	[-1.90136]
LN_RGDP(-1)	0.254695	0.381911	0.829061
	(0.34357)	(0.24528)	(0.13902)
	[0.74132]	[1.55701]	[5.96376]
C	0.786189	0.368322	0.589525

	(0.50835)	(0.36293)	(0.20569)
	[1.54654]	[1.01486]	[2.86607]
D_I	-0.302861	-0.261360	-0.088265
	(0.07125)	(0.05087)	(0.02883)
	[-4.25082]	[-5.13824]	[-3.06176]
D_II	-0.201049	-0.179500	-0.068104
	(0.07279)	(0.05197)	(0.02945)
	[-2.76201]	[-3.45409]	[-2.31232]
D_III	-0.136053	-0.100680	-0.007864
	(0.07195)	(0.05136)	(0.02911)
	[-1.89102]	[-1.96009]	[-0.27014]
R-squared	0.268285	0.363267	0.485402
Adj. R-squared	0.203722	0.307085	0.439996
Sum sq. resids	3.034298	1.546557	0.496773
S.E. equation	0.211239	0.150809	0.085472
F-statistic	4.155392	6.465865	10.69033
Log likelihood	13.86116	39.13424	81.72126
Akaike AIC	-0.182964	-0.856913	-1.992567
Schwarz SC	0.033335	-0.640614	-1.776268
Mean dependent	0.854660	0.807832	1.757785
S.D. dependent	0.236724	0.181171	0.114217
Determinant Residual Covariance		6.84E-07	
Log Likelihood (d.f. adjusted)		213.0709	
Akaike Information Criteria		-5.121891	
Schwarz Criteria		-4.472995	

APPENDIX C. COMPARISON BETWEEN THE REDUCED AND THE STRUCTURAL RESIDUALS

Table C.1. Correlation Matrices

for the Structural and the Reduced Form Residuals

	Reduced			Structural		
	LN_REXP	LN_RREV	LN_RGDP	LN_REXP	LN_RREV	LN_RGDP
LN_REXP	1.000000	0.874150	0.763240	1.000000	-1.04E-13	3.20E-15
LN_RREV	0.874150	1.000000	0.746095	-1.04E-13	1.000000	5.15E-15
LN_RGDP	0.763240	0.746095	1.000000	3.20E-15	5.15E-15	1.000000

APPENDIX D. ESIMATION OF ELASTICITIES

Table D.1. Elasticity of Government Revenues
with respect to Output and Prices

Dependent Variable: LN_RREV				
Method: Least Squares				
Date: 05/12/03 Time: 04:09				
Sample(adjusted): 1996:08 2001:12				
Included observations: 65 after adjusting endpoints				
Newey-West HAC Standard Errors & Covariance (lag truncation=3)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.340718	0.478268	-2.803278	0.0068
LN_RGDP	1.073192	0.278184	3.857846	0.0003
D(LN_CPI)	0.390194	0.864779	0.451206	0.6535
LN_RSAL	0.374516	0.141007	2.656007	0.0101
LN_RWAR	0.095857	0.051176	1.873087	0.0659
R-squared	0.715877	Mean dependent var		0.812406
Adjusted R-squared	0.696935	S.D. dependent var		0.185483
S.E. of regression	0.102111	Akaike info criterion		-1.651714
Sum squared resid	0.625596	Schwarz criterion		-1.484453
Log likelihood	58.68070	F-statistic		37.79397
Durbin-Watson stat	1.563806	Prob(F-statistic)		0.000000

Table D.2. Elasticity of the Government Spending
with respect to Output and Prices

Dependent Variable: LN_REXP				
Method: Least Squares				
Date: 05/12/03 Time: 04:13				
Sample(adjusted): 1996:08 2002:03				
Included observations: 68 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.025304	0.273680	-0.092460	0.9266
D(LN_CPI)	-2.001746	0.971869	-2.059687	0.0435
LN_RREV	1.138074	0.120491	9.445273	0.0000
LN_RGDP	-0.013608	0.192384	-0.070736	0.9438
R-squared	0.789343	Mean dependent var		0.853098
Adjusted R-squared	0.779468	S.D. dependent var		0.241162
S.E. of regression	0.113251	Akaike info criterion		-1.461389
Sum squared resid	0.820858	Schwarz criterion		-1.330830
Log likelihood	53.68723	F-statistic		79.93706
Durbin-Watson stat	1.436219	Prob(F-statistic)		0.000000

APPENDIX E. IMPULSE RESPONSES

Table E.1 Contemporaneous Response to the Shocks (elasticities)

	a_1	b_1	a_2	b_2	c_1	c_2	a_3	b_3	f_1	f_2	d_1	d_2	d_3
Specification 1													
1996:01 2002:04	0	1.073	1.241	0.292	0.407	-0.337	-	-	-	-	-	-	-
1996:01 1999:12	0	1.245	1.342	0.445	0.381	-0.409	-	-	-	-	-	-	-
1998:05 2002:04	0	0.589	1.262	0.382	0.420	-0.094	-	-	-	-	-	-	-
Specification 2	0	1.073	1.238	0.354	0.382	-0.283	-2.001	0	-	-	*-0.048*	*-0.004*	*-0.016*
Specification 3	0	1.073	1.239	0.354	0.381	-0.280	-2.001	0	0.243	*-0.083*	*-0.053*	*-0.004*	*-0.015*
Specification 4	0	1.073	1.221	0.387	0.377	-0.279	-2.001	0	*0.116*	-4.167	*-0.046*	*-0.002*	*-0.017*

Table E.2 Contemporaneous Responses to the Shocks (monetary units)

	a_1	b_1	a_2	b_2	c_1	c_2	a_3	b_3	f_1	f_2	d_1	d_2	d_3
Specification 1													
1996:01 2002:04	0	0.417	1.167	0.274	0.984	-0.865	-	-	-	-	-	-	-
1996:01 1999:12	0	0.489	1.477	0.405	0.883	-1.043	-	-	-	-	-	-	-
1998:05 2002:04	0	0.226	1.280	0.377	1.082	-0.246	-	-	-	-	-	-	-
Specification 2	0	0.417	1.164	0.333	0.923	-0.727	-4.767	0	-	-	*-0.008*	*-0.001*	*-0.007*
Specification 3	0	0.417	1.165	0.333	0.921	-0.719	-4.767	0	0.168	*-0.061*	*-0.009*	*-0.001*	*-0.006*
Specification 4	0	0.417	1.148	0.364	0.911	-0.716	-4.767	0	*0.056*	-2.146	*-0.007*	*-0.001*	*-0.007*

Note: values in italic are not significant at 5% level of significance.

Table E.3 Ten-Period Response to the Spending Shock

		1	2	3	4	5	6	7	8	9	10
Specification 1											
output	$a_2=0$	0.226	-0.005	-0.026	-0.020	-0.014	-0.010	-0.008	-0.006	-0.004	-0.003
	$b_2=0$	0.299	0.104	0.034	0.016	0.011	0.008	0.006	0.004	0.003	0.002
Specification 2											
output	$a_2=0$	0.231	0.004	-0.012	-0.007	-0.005	-0.003	-0.002	-0.002	-0.001	-0.001
	$b_2=0$	0.307	0.125	0.039	0.015	0.009	0.007	0.005	0.003	0.002	0.002
prices	$a_2=0$	-0.025	-0.005	-0.001	-0.000	-0.000	-0.000	-0.000	--0.000	-0.000	-0.000
	$b_2=0$	-0.024	-0.006	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
Specification 3											
output	$a_2=0$	0.232	0.018	-0.001	0.000	0.001	0.001	0.000	0.000	0.000	0.000
	$b_2=0$	0.309	0.145	0.052	0.025	0.017	0.013	0.010	0.007	0.005	0.004
consumption	$a_2=0$	0.205	0.038	0.010	0.005	0.003	0.002	0.001	0.001	0.000	0.000
	$b_2=0$	0.228	0.131	0.061	0.034	0.024	0.017	0.013	0.009	0.007	0.005
prices	$a_2=0$	-0.026	-0.005	-0.001	-0.000	0.000	0.000	0.000	0.000	0.000	0.000
	$b_2=0$	-0.026	-0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Specification 4											
output	$a_2=0$	0.220	-0.025	-0.015	-0.006	-0.003	-0.002	-0.001	-0.000	-0.000	-0.000
	$b_2=0$	0.325	0.113	0.033	0.011	0.004	0.001	0.000	0.000	0.000	0.000
investment	$a_2=0$	-2.480	-0.565	-0.293	-0.159	-0.082	-0.043	-0.023	-0.012	-0.007	-0.004
	$b_2=0$	-1.235	0.089	0.192	0.135	0.086	0.053	0.033	0.021	0.014	0.009
prices	$a_2=0$	-0.023	-0.008	-0.003	-0.001	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	$b_2=0$	-0.021	-0.009	-0.003	-0.001	-0.000	0.000	0.000	0.000	0.000	0.000

Table E.4 Ten-period Response to the Tax Shock

		1	2	3	4	5	6	7	8	9	10
Specification 1											
output	$a_2=0$	-0.247	-0.375	-0.211	-0.128	-0.089	-0.065	-0.049	-0.036	-0.027	-0.020
	$b_2=0$	0.124	-0.245	-0.167	-0.107	-0.075	-0.055	-0.041	-0.030	-0.023	-0.017
Specification 2											
output	$a_2=0$	-0.216	-0.341	-0.146	-0.067	-0.042	-0.031	-0.023	-0.017	-0.012	-0.009
	$b_2=0$	0.165	-0.186	-0.097	-0.047	-0.030	-0.022	-0.016	-0.012	-0.009	-0.006
prices	$a_2=0$	-0.001	0.000	-0.003	-0.002	-0.000	-0.000	-0.000	0.000	0.000	0.000
	$b_2=0$	-0.032	-0.007	-0.004	-0.002	-0.000	-0.000	-0.000	0.000	0.000	0.000
Specification 3											
output	$a_2=0$	-0.215	-0.358	-0.153	-0.072	-0.047	-0.035	-0.026	-0.020	-0.015	-0.011
	$b_2=0$	0.168	-0.178	-0.088	-0.040	-0.025	-0.018	-0.014	-0.010	-0.008	-0.006
consumption	$a_2=0$	-0.064	-0.263	-0.144	-0.084	-0.059	-0.044	-0.033	-0.025	-0.019	-0.014
	$b_2=0$	0.219	-0.100	-0.068	-0.040	-0.029	-0.022	-0.017	-0.013	-0.010	-0.007
prices	$a_2=0$	0.000	-0.001	-0.004	-0.002	-0.001	0.000	0.000	0.000	0.000	0.000
	$b_2=0$	-0.034	-0.007	-0.004	-0.002	-0.001	0.000	0.000	0.000	0.000	0.000
Specification 4											
output	$a_2=0$	-0.212	-0.252	-0.102	-0.049	-0.028	-0.017	-0.011	-0.007	-0.005	-0.003
	$b_2=0$	0.158	-0.164	-0.073	-0.034	-0.019	-0.012	-0.008	-0.005	-0.003	-0.002
investment	$a_2=0$	-3.215	-1.687	-1.252	-0.761	-0.435	-0.249	-0.145	-0.087	-0.054	-0.034
	$b_2=0$	-4.724	-1.579	-1.017	-0.595	-0.330	-0.183	-0.104	-0.061	-0.037	-0.023
prices	$a_2=0$	-0.003	0.003	-0.000	-0.002	-0.001	-0.001	-0.000	-0.000	-0.000	-0.000
	$b_2=0$	-0.030	-0.008	-0.004	-0.003	-0.002	-0.001	-0.000	-0.000	-0.000	-0.000

Table E.5 Sub-Sample Evolution

		1	2	3	4	5	6	7	8	9	10
Expenditure shock											
output	1996:01 2002:04	0.226	-0.005	-0.026	-0.020	-0.014	-0.010	-0.008	-0.006	-0.004	-0.003
	1996:01 1999:12	0.132	0.072	-0.001	-0.005	0.000	0.001	0.000	0.000	0.000	0.000
	1998:05 2002:04	0.364	0.020	0.058	0.046	0.037	0.030	0.024	0.019	0.015	0.012
Revenue shock											
output	1996:01 2002:04	-0.247	-0.375	-0.211	-0.128	-0.089	-0.065	-0.049	-0.036	-0.027	-0.020
	1996:01 1999:12	-0.271	-0.307	0.009	0.033	0.004	-0.002	0.000	0.000	0.000	0.000
	1998:05 2002:04	-0.089	-0.433	-0.212	-0.169	-0.135	-0.108	-0.087	-0.070	-0.056	-0.045

APPENDIX F SENSITIVITY ANALYSIS

Table F.1 Sensitivity with respect to Elasticity Values

		1	2	3	4	5	6	7	8	9	10
expenditure shock											
output	a_3=-1.5	0.225	-0.003	-0.018	-0.011	-0.007	-0.005	-0.004	-0.003	-0.002	-0.001
	$\underline{a_3}$=-2.0	0.231	0.004	-0.012	-0.007	-0.005	-0.003	-0.002	-0.002	-0.001	-0.001
	a_3=-2.5	0.237	0.012	-0.007	-0.004	-0.002	-0.002	-0.001	-0.001	-0.000	-0.000
	b_1=0.5	0.293	0.034	0.012	0.011	0.009	0.007	0.005	0.003	0.002	0.002
	$\underline{b_1}$=1.0	0.231	0.004	-0.012	-0.007	-0.005	-0.003	-0.002	-0.002	-0.001	-0.001
	b_1=1.5	0.194	-0.009	-0.029	-0.023	-0.016	-0.012	-0.009	-0.006	-0.004	-0.003
prices	a_3=-1.5	-0.023	-0.004	-0.001	-0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000
	$\underline{a_3}$=-2.0	-0.025	-0.005	-0.001	-0.000	-0.000	-0.000	-0.000	--0.000	-0.000	-0.000
	a_3=-2.5	-0.027	-0.006	-0.002	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000
	b_1=0.5	-0.023	-0.004	-0.001	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	$\underline{b_1}$=1.0	-0.025	-0.005	-0.001	-0.000	-0.000	-0.000	-0.000	--0.000	-0.000	-0.000
	b_1=1.5	-0.024	-0.005	-0.001	-0.000	-0.000	-0.000	0.000	0.000	0.000	0.000
revenue shock											
output	a_3=-1.5	-0.220	-0.346	-0.150	-0.070	-0.044	-0.032	-0.024	-0.018	-0.013	-0.009
	$\underline{a_3}$=-2.0	-0.216	-0.341	-0.146	-0.067	-0.042	-0.031	-0.023	-0.017	-0.012	-0.009
	a_3=-2.5	-0.210	-0.335	-0.140	-0.063	-0.039	-0.029	-0.021	-0.016	-0.012	-0.008
	b_1=0.5	-0.000	-0.159	0.006	0.046	0.040	0.028	0.020	0.014	0.010	0.007
	$\underline{b_1}$=1.0	-0.216	-0.341	-0.146	-0.067	-0.042	-0.031	-0.023	-0.017	-0.012	-0.009
	b_1=1.5	-0.240	-0.360	-0.175	-0.092	-0.061	-0.044	-0.032	-0.024	-0.017	-0.013
prices	a_3=-1.5	-0.000	0.000	-0.002	-0.002	-0.000	-0.000	-0.000	0.000	0.000	0.000
	$\underline{a_3}$=-2.0	-0.001	0.000	-0.003	-0.002	-0.000	-0.000	-0.000	0.000	0.000	0.000
	a_3=-2.5	-0.003	-0.000	-0.003	-0.002	-0.000	-0.000	-0.000	0.000	0.000	0.000
	b_1=0.5	-0.028	-0.011	-0.008	-0.004	-0 .001	-0.000	-0.000	-0.000	-0.000	-0.000
	$\underline{b_1}$=1.0	-0.001	0.000	-0.003	-0.002	-0.000	-0.000	-0.000	0.000	0.000	0.000
	b_1=1.5	0.010	0.005	-0.000	-0.001	-0.000	-0.000	0.000	0.000	0.000	0.000

Note: underlined are the benchmark specification values of elasticities coefficients, which where diverged by ± 0.5