THE BUCHAREST ACADEMY OF ECONOMIC STUDIES
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Transmission of fiscal policy shocks into Romania's economy

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Aims of the thesis

- To provide evidence on the effects of fiscal policy actions using a DSGE model with a notable degree of disaggregation, both on the government revenue and expenditure side.
- Also, using fiscal feedback rules, I would like to estimate the feedback parameters that capture the automatic stabilizing effects.
- To assess the effects of different fiscal policy measures on the most important macroeconomic variables.

Brief literature review

- **Baksa, Benk and Jakab** (2010) who estimated a DSGE model for the Hungarian economy with a disaggregated fiscal policy block.
- **Thomassi Stahler** (2011) presents in his paper a model, jointly developed by Banco de España and Deutsche Bundesbank staff, used for fiscal policy simulations.
- **Forni, Gerali and Pisani** (2010) created a model for Italian economy.
- **Stork** (2011) developed Hubert, a simple DSGE model for the Czech Republic.
- **Kliem and Kriwoluzky** (2010), **Iwata** (2009), **Zubairy** (2009)

Model features

- I used the model created by Baksa, Benk and Jakab (2010). This model is an extended version of the DSGE model presented in Smets and Wouters (2003) an it incorporates rigidities like:
- - habit consumption
- - investment adjustment cost
- - capital utilization rate
- - price and wage settings as in Calvo (1983)
- - the agents can learn the inflation trend gradually by applying an adaptive algorithm.
- - the fiscal policy is modeled explicitly by introducing **three types of tax rates** (personal income tax rates, social contribution rate paid by employers and VAT) and **two types of expenditures** (social transfers and Government expenditure)

The model

- The model describes the behavior of four categories of players:

- Households
- Firms
- Government (represented by central bank and fiscal authority)
- External market

Households

- Two types of households: Ricardian and Liquidity constrained.
- Gain utility from consumption and leisure.

$$\sum_{t=0}^{\infty} \beta^{t} E_0 \left(\left(1+\eta_t^c\right) \left[\frac{\left(C_t^o(j) - hC_{t-1}^o(j)\right)^{1-\sigma}}{1-\sigma} \right] - \left(1+\eta_t^l\right) \left[\frac{L_t^{1+\varphi}(j)}{1+\varphi} \right] \right)$$

- Capital motion law is:

$$K_t = (1-\delta)K_{t-1} + \left[1 - S\left(\frac{(1+\eta^I{}_t)I_t(j)}{I_{t-1}(j)}\right)\right] I_t(j)$$

Households' budget constraint

- Ricardian households: - maximize their lifetime utilities deciding on consumption, labor supply, domestic and foreign bond holding, investment, capital stock and capital utilization rate.

$$(1+\tau_t^c)P_t c_t^o(j) + P_t I_t(j) + \frac{B_t(j)}{1+i_t} + \frac{B_t^s(j)}{1+i_t^*}$$
$$= B_{t-1}(j) + B_{t-1}^s(j) + \left(1-\tau_t^l\right)W_t(j)L_t(j)$$
$$+ P_t r_t^k u_t(j) k_{t-1}(j) - \Psi(u_t(j))P_t k_{t-1}(j) + Div_t - OT_t$$

- Liquidity-constrained households: - spend their entire current disposable income (wages and transfers) on consumption.
- $(1+\tau_t^c)P_t C_t^{no}(j) = \left(1-\tau_t^l\right)W_t(j)L_t(j) + \frac{TR_t}{1-\varpi}$

Wage setting

- Following Calvo (1983), households can re-optimize their wage at a given date with probability $1-\gamma_w$
- If a household cannot re-optimize its wage, then it will adjust its wage with the perceived trend of inflation:

$$(1+\overline{\pi_t}) = (1+\overline{\pi_{t-1}})^{\rho\pi}\left(\frac{(1+\pi_t)}{(1+\overline{\pi_{t-1}})}\right)^{g}$$

- The log-linear wage Phillips curve is given by:

$$\widetilde{\pi_t^w} = \frac{(1-\gamma_w)(1-\beta\gamma_w)}{\gamma_w(1+\theta_w\varphi)(1+\beta\vartheta_w)}\left\{\varphi L_t - w_t + \eta_t^l + \frac{\sigma}{1-h}\left(\tilde{c}_t^l - h\tilde{c}_{t-1}^l\right) + \frac{\tau^c}{1+\tau^c}\tau_t^c + \frac{\tau^l}{1+\tau^l}\tau_t^l + \xi_t^w\right\}$$
$$+ \frac{\beta}{(1+\beta\vartheta_w)}E_t\widetilde{\pi_{t+1}^w} + \frac{\vartheta_w}{(1+\beta\vartheta_w)}\widetilde{\pi_{t-1}^w}$$

Firms I

- In the first stage, a homogenous intermediate good is created in a perfectly competitive industry using labor and imports as inputs.

$$z_t = \left\{ a^{\frac{1}{\rho_z}} \left[\left(1+\phi_1\right)^{-1} L_t \right]^{\frac{\rho_z - 1}{\rho_z}} + (1-a)^{\frac{1}{\rho_z}} \left[\left(1+\phi_2\right)^{-1} m_t \right]^{\frac{\rho_z - 1}{\rho_z}} \right\}^{\frac{\rho_z}{\rho_z - 1}}$$

- In the second phase, the intermediate good is sold to the final good producers who combine it with the capital supplied by households and produce differentiated goods in a monopolistically competitive industry.

$$y_t(i) = \left(1+\eta_t^A\right) \left\{ \alpha^{\frac{1}{\rho}} \left[K_t(i) \right]^{\frac{\rho-1}{\rho}} + (1-\alpha)^{\frac{1}{\rho}} \left[z_t \right]^{\frac{\rho-1}{\rho}} \right\}^{\frac{\rho}{\rho-1}} - \bar{\mathrm{f}}$$

Price setting

- As in Calvo's model (1983), we assume that prices are sticky.
- If the firm can re-optimize its price, it solves the profit maximization problem.
- The log-linear inflation Phillips curve is given by:

$$\widehat{\pi_t} = \frac{(1-\gamma_d)(1-\beta\gamma_d)}{\gamma_d(1+\beta\vartheta_d)}\{mc_t + \xi_t^d\} + \frac{\beta}{(1+\beta\vartheta_d)}E_t\widehat{\pi_{t+1}} + \frac{\vartheta_d}{(1+\beta\vartheta_d)}\widehat{\pi_{t-1}}$$

- The exporters set their prices in a similar way as the producers of final goods do.

Monetary policy and Government

- The central bank sets nominal interest rates following a Taylor type rule:

$$1 + i_t = (1 + i_{t-1})^{\zeta_i}(1 + \pi_t)^{\zeta_\pi} e_t^{\zeta_e} gdp_t^{\zeta_{gdp}}$$

- Government budget constraint:

$$rev_t = exp_t + t_t - \left(\frac{1 + i_t}{1 + \pi_t} - 1\right) b_{t-1}$$

- where $rev_t = pit_t + sc_t + vat_t + ot_t$

$vat_t = \tau_t^c c_t$, $pit_t = \tau_t^l w_t L_t$, $sc_t = \tau_t^s w_t L_t$ and $ot_t = \rho_{ot} ot_{t-1} + \varepsilon_{ot_t}$

- and $exp_t = g_t + tr_t + oe_t$ $\qquad oe_t = \rho_{oe} oe_{t-1} + \varepsilon_{oe_t}$
- Government debt:

$$b_t = b_{t-1} + t_t$$

Fiscal rules

- Tax rates are modeled to allow a positive response to an increase in deficit to output ratio:

$$\hat{\tau}_t^i = \rho^{\tau^i}\hat{\tau}_{t-1}^i + \left(1-\rho^{\tau^i}\right)\left(f_{\tau^i}^g\widehat{\overline{gdp}_t} - f_{\tau^i}^t\hat{t}_{t-1}\right) + \varepsilon_i$$

- where i={c, s, l}, ρ^{τ^i} denotes the degree of tax rate smoothing, $f_{\tau^i}^g$, $f_{\tau^i}^t$ are reaction parameters.

- These tax rates can be considered as effective tax rates.

- The government expenditure and financial transfers are assumed to follow a rule that negatively respond to an increase in deficit to output ratio:

$$\hat{\chi}_t^i = \rho^{\chi^i}\hat{\chi}_{t-1}^i + \left(1-\rho^{\chi^i}\right)\left(-f_{\chi^i}^g\widehat{\overline{gdp}_t} + f_{\chi^i}^t\hat{t}_{t-1}\right) + \varepsilon_i$$

- where χ={G, TR}, ρ^{χ^i} denotes the degree of expenditure item smoothing, $f_{\chi^i}^g$, $f_{\chi^i}^t$ are reaction parameters.

Data:

- The model parameters were estimated using quarterly data of the Romanian economy which cover the period 2000:Q1 - 2011:Q4.

- The set of eighteen variables, considered as observables, includes:

- - Ordinary series used in literature: GDP, households' consumption, investment, export, import, wage.
- - Fiscal data as: public debt, budget revenues, budget expenditure, VAT, personal income tax, Social contributions paid by employees and employers, transfers and government consumption.
- - Employment, nominal interest rate and CPI.

- These data are seasonally adjusted, logged and de-trended with HP filter.

Calibrated parameters

Table 1:	Calibrated parameters	value
β	discount factor	0.97
δ	depreciation rate	0.03
σ	Intertemporal elasticity of consumption	2
φ	intertemporal elasticity of labor	5
ϖ	share of ricardian households	0.75
ρ	elasticity of substitution between capital and composite input	1.05
ρ_z	elasticity of substitution between labor and imports	0.8
fix	fix cost	0.25
θ	home price elasticity	6
θ_w	elasticity of labor	3
ϕ_i	investment adjustment cost	13
ψ	parameter of capital utilization	0.2
ϕ_l	labor input adjustment cost	3
ϕ_m	import input adjustment cost	3
υ	debt elasticity of financial premium	0.01

Table 2.	**Steady state – implied ratios**	**values**
τ_t^c	VAT	0.24
τ_t^l	Labor tax rate+social contribution tax rate (paid by employees)	0.325
τ_t^s	Social contribution tax rate (paid by employers)	0.315
D/GDP	Ratio of debt to GDP	-0.2686
T/GDP	Ratio of deficit to GDP	-0.0358
G/GDP	Share of gov. consum. to GDP	0.171
C/GDP	Share of households consumption to GDP	0.67
m/GDP	Share of imports to GDP	0.4292
x/GDP	Share of exports to GDP	0.3457
tr/GDP	Ratio of transfers to GDP	0.13
rev/gdp	Ratio of budgetary revenues to GDP	0.341
expn/gdp	Ratio of budgetary expenditure to GDP	0.3768
pit/gdp	Ratio of Pit to GDP	0.066
vat/gdp	Ratio of vat to GDP	0.075
sc/gdp	Ratio of social contributions to GDP	0.068
oe/gdp	Ratio of other expenditure to GDP	0.0758
i_ss	Nominal interest rate	0.0309
rk_ss	Rental fee	0.0609
a	Share of labor used in production	0.2987
α	Share of capital used in production	0.3929

Prior distributions of parameters:

Symbol	Description	Prior distribution	Mean	Standard error
Utility function parameters				
h_c	habit formation	beta	0.7	0.05
Prices and wage settings parameters				
γ_x	Calvo export prices	beta	0.5	0.03
γ_w	Calvo wages	beta	0.7	0.01
γ_d	Calvo domestic prices	beta	0.5	0.03
γ_n	Calvo employment	beta	0.5	0.03
ϑ_w	indexation rate wages	beta	0.5	0.1
ϑx	indexation rate export prices	beta	0.5	0.1
ϑ_d	indexation rate domestic prices	beta	0.5	0.1
Interest rate coefficients				
ζ_i	interest smooth	norm	0.7	0.05
ζ_π	inflation policy rule	norm	1.5	0.05
ζ_e	exchange rate	norm	0.01	0.01
ζ_{gdp}	GDP	norm	0.5	0.05
Inflation learning				
ρ_π	trend inflation persistence	beta	0.9	0.05
g	Gain	beta	0.2	0.05

Symbol	Description	Prior distribution	Mean	Standard error
Export				
h_x	export smoothing	beta	0.8	0.01
θ_{xs}	Elasticity	beta	0.3	0.05
Autoregressive parameters		beta	0.7	0.05
Autoregressive parameters of fiscal elements				
Reaction function parameters				
$f^t_{\tau^c}$	VAT to deficit	invg	0.05	0.1
$f^g_{\tau^c}$	VAT to GDP	norm	0	0.2
$f^t_{\tau^l}$	PIT to deficit	invg	0.05	0.1
$f^g_{\tau^l}$	PIT to GDP	norm	0	0.2
$f^t_{\tau^s}$	SC to deficit	invg	0.05	0.1
$f^g_{\tau^s}$	SC to GDP	norm	0	0.2
f^t_{rt}	TR to deficit	invg	0.05	0.1
f^g_{tr}	TR to GDP	norm	0	0.2
f^t_g	G to deficit	invg	0.05	0.1
f^g_g	G to GDP	norm	0	0.2

Estimation results

Symbol	Description	Posterior mean	Conf. Interval	
Utility function parameters				
h_c	habit formation	0.8803	0.849	0.9118
Prices and wage settings parameters				
γ_x	Calvo export prices	0.4935	0.4439	0.5462
γ_w	Calvo wages	0.6763	0.6608	0.6924
γ_d	Calvo domestic prices	0.5112	0.4961	0.5289
γ_n	Calvo employment	0.4211	0.3735	0.4705
ϑ_w	indexation rate wages	0.1173	0.0714	0.1666
ϑx	indexation rate export prices	0.4965	0.4086	0.5894
ϑ_d	indexation rate domestic prices	0.5775	0.5016	0.6626
Interest rate coefficients				
ζ_i	interest smooth	0.4944	0.4342	0.5531
ζ_π	inflation policy rule	1.3795	1.2974	1.4561
ζ_e	exchange rate	0.0017	0	0.0035
ζ_{gdp}	GDP	0.6092	0.5348	0.6854

Symbol	Description	Posterior mean	Conf. Interval	
Inflation learning				
ρ_π	trend inflation persistence	0.7994	0.6936	0.9064
g	Gain	0.0596	0.0312	0.0868
Export				
h_x	export smoothing	0.8074	0.7903	0.8231
θ_{xs}	Elasticity	0.3627	0.3159	0.4098
Autoregressive parameters		range from 0.6 to 0.75		
Autoregressive parameters of fiscal elements				
ρ_{τ_c}	VAT	0.6975	0.6161	0.78
ρ_{τ_l}	PIT	0.6946	0.6157	0.7776
ρ_{τ_s}	SC	0.6965	0.6194	0.7805
ρ_g	government expenditure	0.6965	0.6073	0.7804
ρ_{tr}	Transfers	0.7008	0.6272	0.7819
ρ_{ot}	Lump sum tax	0.6942	0.6049	0.7753
ρ_{oe}	other expenditures	0.692	0.6062	0.7695

Estimated parameters for fiscal rules

Symbol	Description	Posterior mean	Conf. Interval	
Reaction function parameters				
$f^t_{\tau^c}$	VAT to deficit	0.0526	0.0143	0.0996
$f^g_{\tau^c}$	VAT to GDP	0.0302	-0.2877	0.3518
$f^t_{\tau^l}$	PIT to deficit	0.0402	0.012	0.0721
$f^g_{\tau^l}$	PIT to GDP	-0.0053	-0.3171	0.3039
$f^t_{\tau^s}$	SC to deficit	0.0364	0.0143	0.058
$f^g_{\tau^s}$	SC to GDP	-0.0132	-0.3535	0.3386
f^t_{rt}	TR to deficit	0.036	0.0131	0.0572
f^g_{tr}	TR to GDP	-0.0015	-0.3262	0.3234
f^t_g	G to deficit	0.0328	0.0139	0.0508
f^g_g	G to GDP	-0.0998	-0.4052	0.2199

- These results suggest that taxation of consumption and labor played an important role in stabilizing the fiscal deficit during the sample period.
- The estimated fiscal response parameters to output gap seem to indicate a pro-cyclical fiscal policy, the automatic stabilizers being too weak or insufficient to stabilize the economy.

Irf interpretation

Figure 1: Impulse response functions to a one percent increase in the VAT rate.

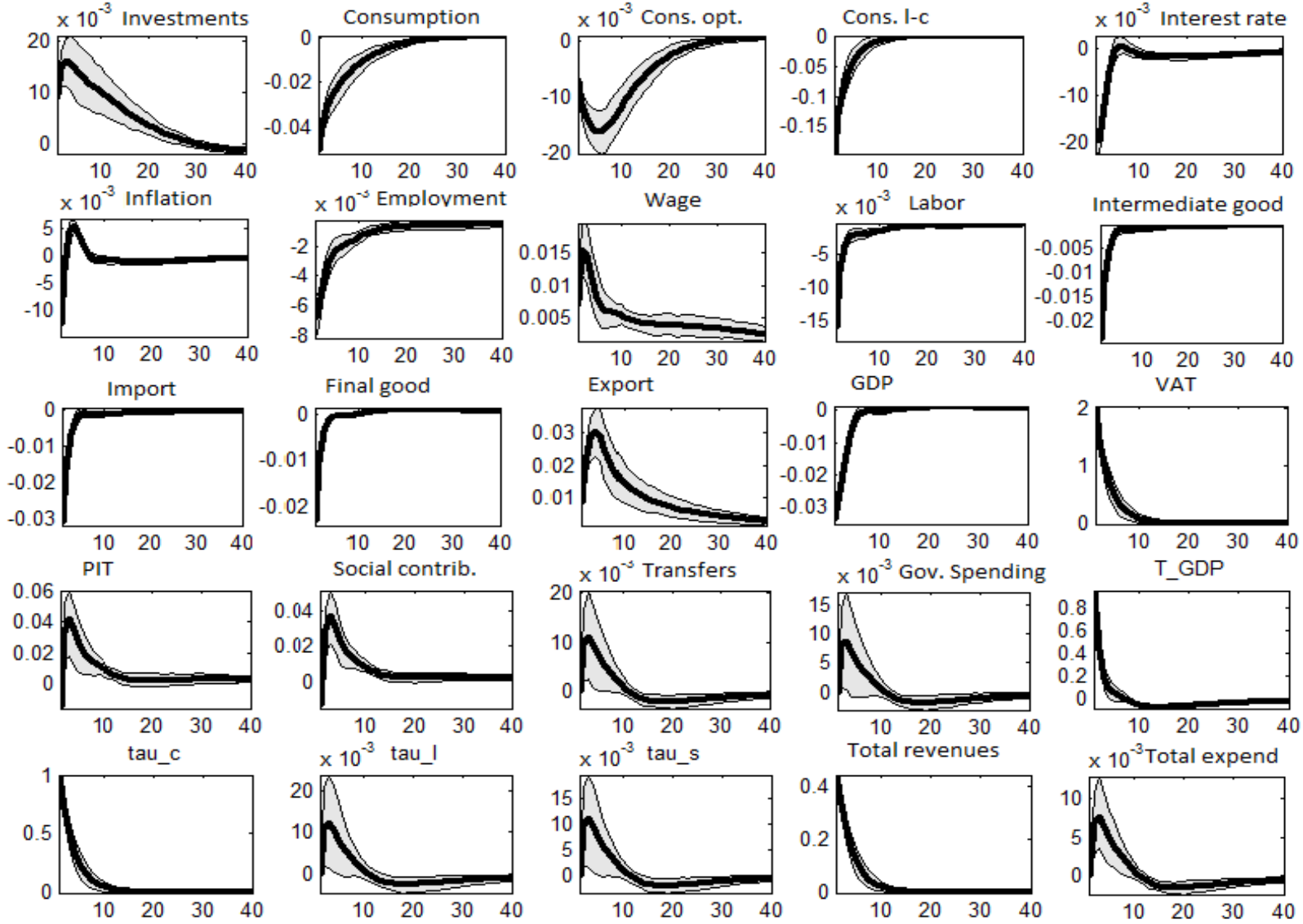


Figure 2: Impulse response functions to a one percent increase in the PIT rate.

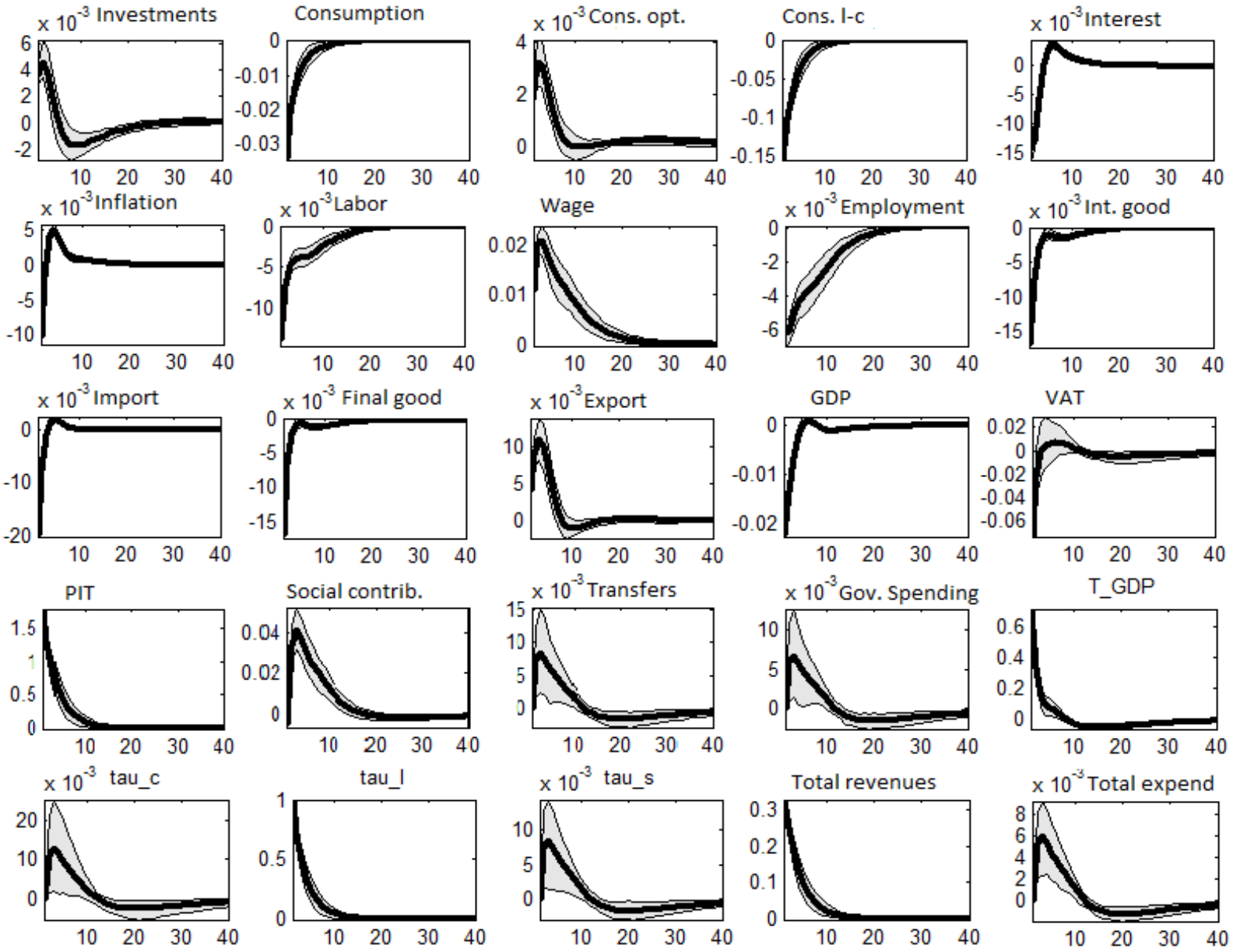


Figure 3: Impulse response functions to a one percent increase in the Social Contrib. rate.

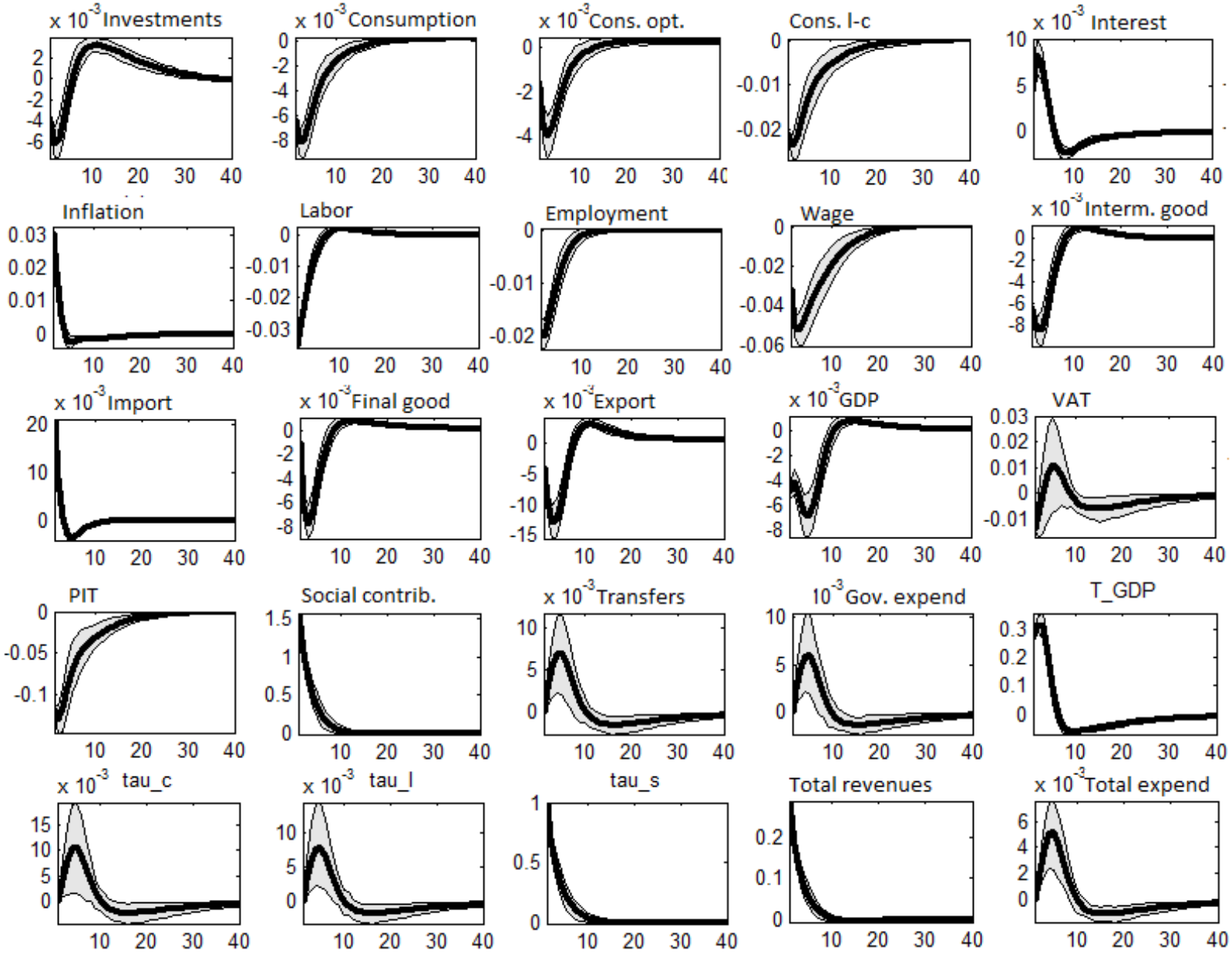


Figure 4: Impulse response functions to a one percent increase in transfers.

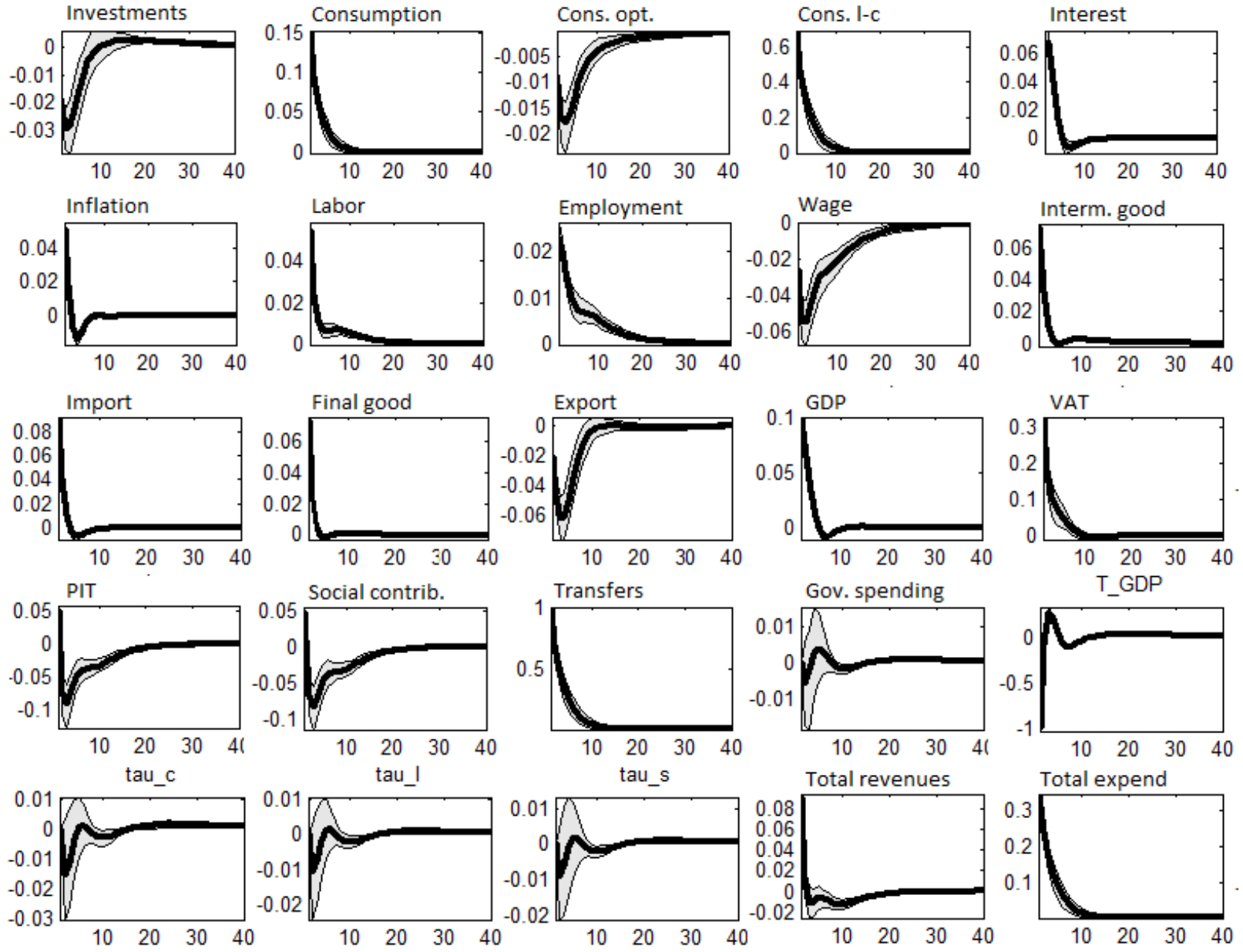
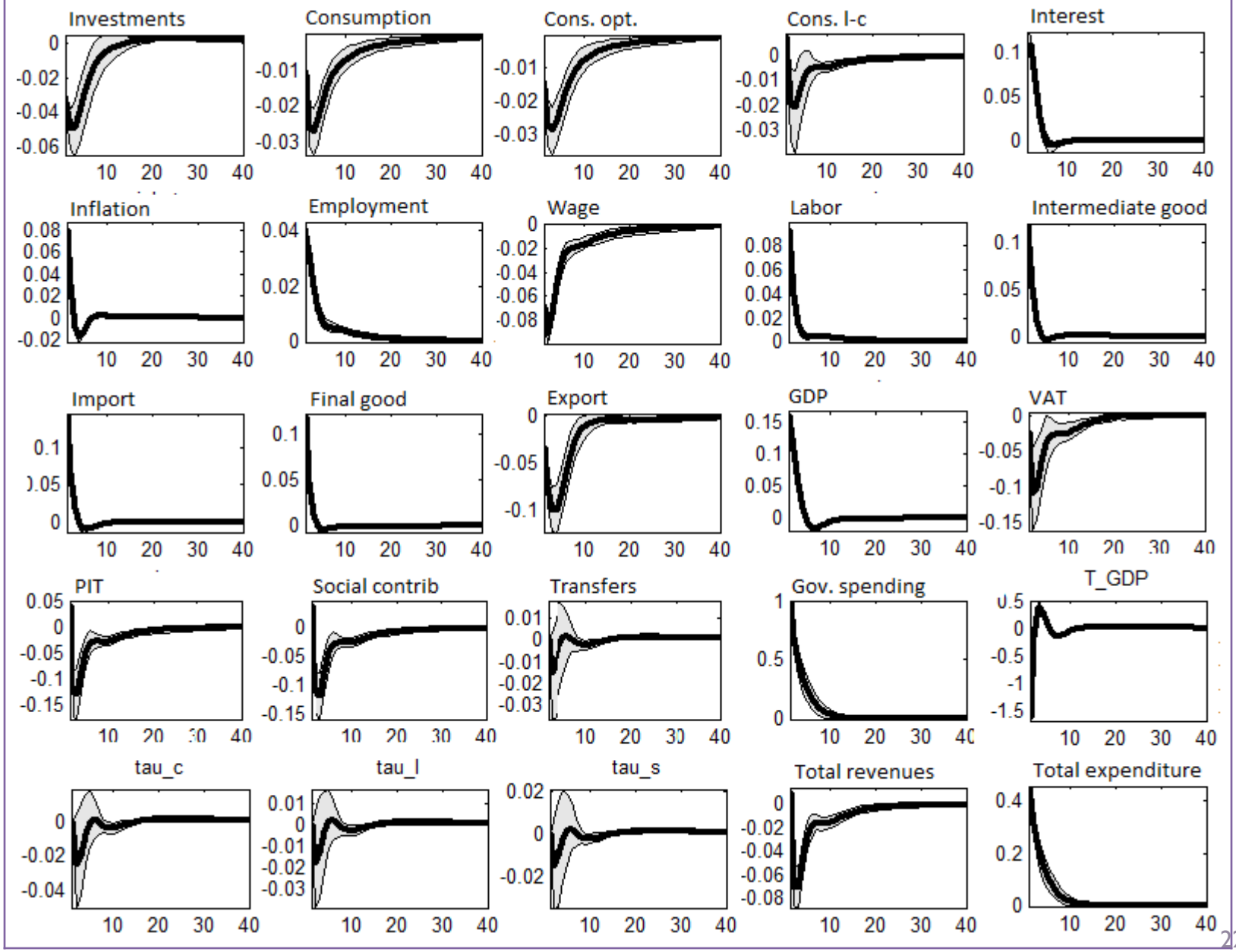


Figure 5: Impulse response functions to a one percent increase in government spending.



Conclusions

- Taxation of consumption and labor played an important role in stabilizing the fiscal deficit during the sample period.
- The estimated fiscal response parameters to output gap seem to indicate a pro-cyclical fiscal policy.
- A shock in VAT rate has negative effects on total consumption, mainly due to a sharply fall in consumption of liquidity constrained households
- Surprisingly, an increase in labor tax rate also causes an increase in wages and this can be explained due to efforts to renegotiate work contracts.
- Increasing transfers has a strongly positive effect on non-optimizers households' consumption. After an increase in transfers, one can see strong crowding out effects on investments.
- Also, the model is not in agreement with specific literature (for example, Blanchard and Perotti (2002)) which argues a positive effect on consumption and wages as a result of an increase in government expenditures.
- The fiscal policy block should provide a better disaggregation on the fiscal expenditure side (including some components like public investment, public purchases of goods and services or public sector wage bill).
- The model could serve in variance decomposition analysis and also, the model can be used in forecasting observable variables.

Thank you!

References:

- Adolfson, M., Laseen, S., Linde, J. and Villani, M. (2005), 'Bayesian estimation of an open economy DSGE model with incomplete pass-through', *Sveriges Riksbank Working Paper Series* (179).
- Baksa, D., S. Benk, M. Z. Jakab (2010), *„Does "The" Fiscal Multiplier Exist? Fiscal and Monetary Reactions, Credibility and Fiscal Multipliers in Hungary"* , published by Office of the Fiscal Council.
- Blanchard, O and R., (1999),. "*An Empirical Characterization of the Dynamic Effects of Changes in Government Spending and Taxes on Output*," NBER Working Papers 7269, National Bureau of Economic Research, Inc.
- Calvo, G. A. (1983), *'Staggered prices in a utility-maximizing framework'*, *Journal of Monetary Economics* **12**(3), 383 – 398.
- Christiano, L. J., M. Eichenbaum and C. Evans (2005), *"Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy"*, Journal of Political Economy, 113 (1), 1–45.
- Forni L., A. Gerali, M. Pisani (2010), *"The macroeconomics of fiscal consolidations in a monetary union: the case of Italy"*, Banca D'Italia.
- Gali, J. and Monacelli, T. (2002), "*Monetary Policy and Exchange Rate Volatility in a Small Open Economy*", Working Paper 8905, National Bureau of Economic Research.
- Iwata Y. (2009), *„Fiscal Policy in an Estimated DSGE Model of the Japanese Economy: Do Non Ricardian Household explain all?",* ESRI Discussion Paper Series No.216
- Jakab Z., B. Vilagi (2009, *"An estimated DSGE model of the Hungarian economy",* MNB Working Papers 2008/9.
- Kliem, M and A. Kriwoluzky (2011), „*Toward a Taylor rule for fiscal policy*", Deutsche Bundesbank, Discussion paper Series 1: Economic Studies No 26/2010.
- Smets, F. and R. Wouters (2003), "*An Estimated Dynamic Stochastic General Equilibrium Model of the Euro Area*," Journal of the European Economic Association, MIT Press, vol. 1(5), pages 1123-1175, 09.
- Stork Z. (2011), *„A DSGE model of the Czech economy: a Ministry of Finance approach",* Ministry of Finance, Czech Republic.