Dynamic Elasticities of Tax Revenue: Evidence from the Czech Republic

Tomáš Havránek, Zuzana Iršová, Jiří Schwarz
CNB, 16.5.2016

Motivation

- Elasticities of tax revenues important for analysis and forecasting of public finances not only for MF, but also for CNB:
  - Tax revenue forecasts based on macro predictions
  - Cyclical adjustment of public budget balances (both EC & ESCB method)
  - Tax multipliers also need correct estimates of elasticities
- Despite their importance often only calibrated, especially for emerging and transition economies.
- Why not estimated?
  - Need to have long time series of tax revenue …
  - adjusted for the effects of tax reforms and tax policy changes.

Tax revenue adjustment

- The 2008 stabilization fiscal package (Ambriško et al., 2012):
  - Increase of VAT reduced rate from 5% to 9%;
  - Replacement of four-bracketed PIT (12%, 19%, 25%, 32%) with the flat rate of 15%;
  - Decrease of CIT rate from 24% to 21%;
  - Broader CIT base and a couple of other minor changes;
  - Introduction of a limit on social security contributions assessment base;
  - Reduction of sickness insurance rate for employers from 3.3% to 2.3%.

➢ 2008: -2.2 bn.; 2009: -25.4 bn.; 2010: -48.3; 2011: -52 bn. CZK

1. Derivation of elasticities from the tax code (ratio of the marginal to the average tax rate)
   - No need to adjust the data for tax reform effects and deal with technical estimation issues.
   - Tax evasion, existence of multiple tax brackets, various tax exemptions, allowances, and deductibles constitute an important drawback.
2. Estimation of elasticities using tax revenues and an aggregate base, such as nominal GDP
   - Macroeconomic aggregates updated timely and regularly.
   - High level of aggregation limits precision.

3. Estimation of elasticities using tax revenues and more adequate less aggregated bases: sum of wages and salaries for wage tax & social security contributions, a measure of corporate profits for profit tax, and private consumption statistics for indirect tax
   - Need to take into account the effects of tax reforms and tax policy changes.
- Best practice: compute short- and long-run elasticities simultaneously using adjusted tax revenue data.
  - The dynamics of adjustment to tax base shocks may be crucial for policy applications.
  - Problem: Short time series and unavailability of adjustment data.

Existing estimates

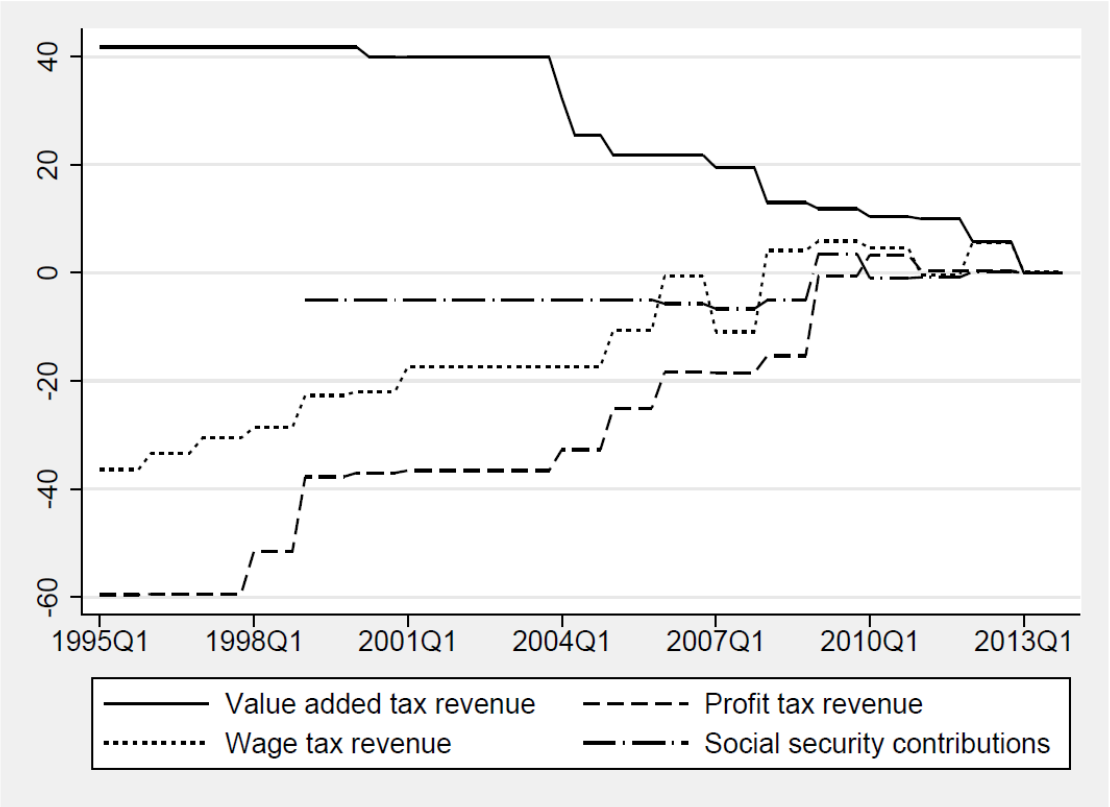
- Wage tax (PIT):
  - Czechia: 1.7, 2.2, 1.2, 2.23, 1.08; **Our: 1.4**
  - Netherlands: 0.8-1.6; Germany: 1.75; LA: 0.9-3.0
- Profit tax (CIT):
  - Czechia: 1, 0.8, 1.2-1.5, 1.29-1.11; **Our: 1.7**
  - Netherlands: 1; Germany: 0.77; LA: 1.3-3.8
- VAT:
  - Czechia: 1, 0.95, 1, 0.8, 0.96-1.32; **Our: 0.9**
  - Netherlands: 0.9-1.0; Germany: 0.79; LA: 1.4-2.6
- Social security contributions:
  - Czechia: 1.1, 0.99; **Our: 1**

Data

- Quarterly revenue data 1995Q1-2013Q4 (CIT & social security since 1999Q1): MF & CZSO; quarterly tax bases data from national accounts: CZSO.
- Wage-related tax (PIT):
  - Revenue categories: excluded tax paid by self-employed individuals on the basis of a yearly tax return
  - Base: wages and salaries
- Profit-related tax (CIT):
  - Revenue categories: complete CIT revenue
  - Base: net operating surplus (= gross operating surplus – gross mixed income – consumption of fixed capital)
- VAT
  - Revenue categories: complete VAT revenue
  - Base: household consumption & private investment in dwellings
- Social security
  - Revenue categories: complete social security revenue
  - Base: wages and salaries

Tax revenue adjustment

Figure 2: The cumulative effects of tax reforms in % of adjusted revenues



- Proportional adjustment method (Prest, 1962): E.g. a VAT reform in 2004 caused a permanent increase in revenue = we increase all preceding periods proportionally with the corresponding tax revenue.
- Data: CNB; mostly *ex ante* predictions from publicly available explanatory memoranda of legislative measures sent to the Parliament

- Error correction model based on Koester and Priesmeier (2012):

$$\log revenue_t^i = \beta_0^i + \beta_1^i \log base_t^i + \sum_{l=-j}^{j} \gamma_l^i \Delta \log base_{t+l}^i + \delta^i reform_t + \sum_{k=1}^{3} \varphi_k^i quarter_k (1 + \phi^i break_t^i) + \epsilon_t^i,$$

$$\Delta \log revenue_t^i = \alpha_0^i + \alpha_1^i \Delta \log base_t^i + \alpha_2^i \Delta \log revenue_{t-1} + \alpha_3^i \hat{\epsilon}_{t-1}^i + \lambda^i reform_t + \sum_{k=1}^{3} \eta_k^i quarter_k (1 + \theta^i break_t^i) + u_t^i,$$

- Tax revenues and tax bases cointegrated of order one, saving the error term from the long-run and using it as the error correction term in the short-run equation.
- Newey-West standard errors (robust to autocorrelation and heteroskedasticity), bootstrap to compute confidence intervals.

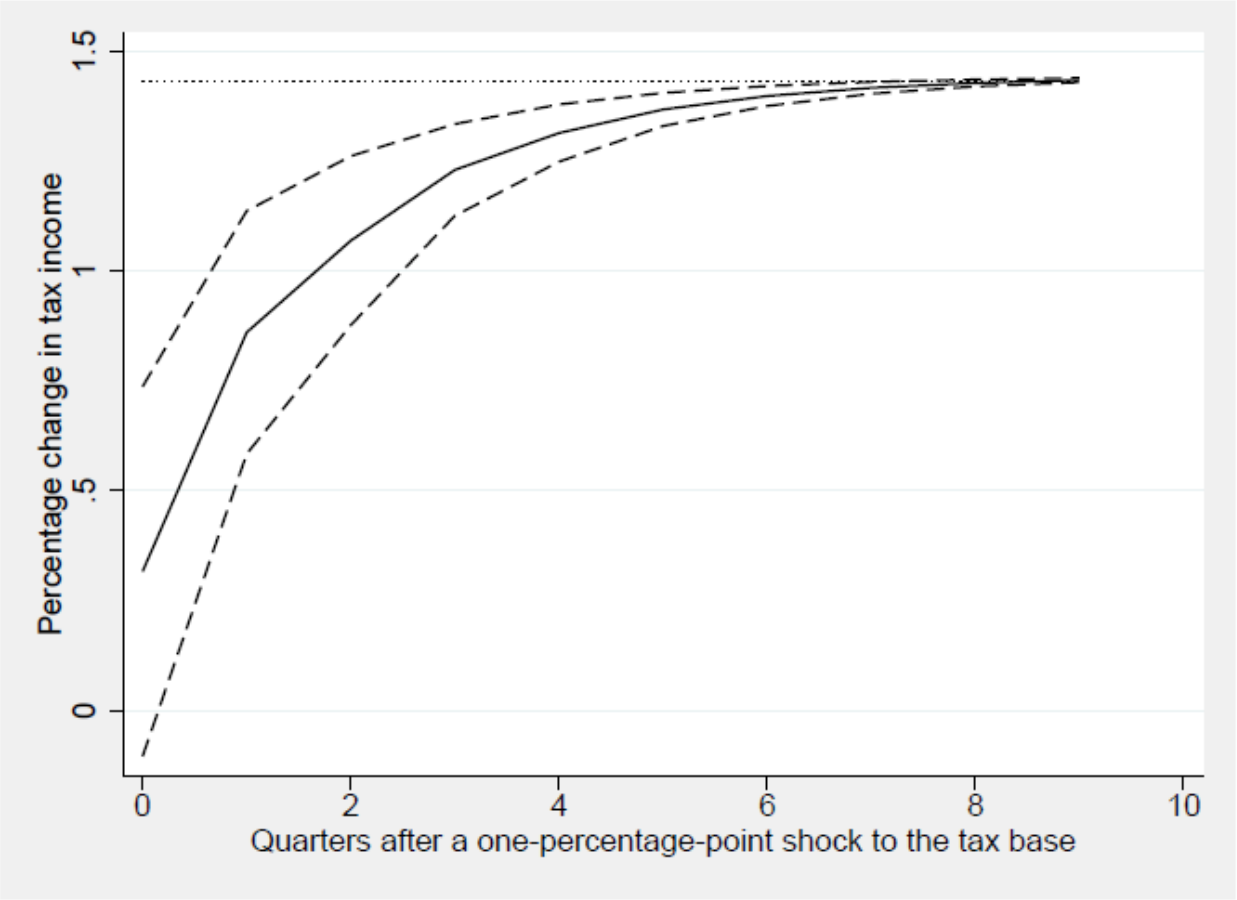
Table 1: The adjustment of tax revenue to shocks to the tax base (baseline estimation)

	Wage tax	Valued added tax	Profit tax	Social security
Long run				
base (LR elasticity)	1.445***	0.867***	1.687***	1.016***
	(0.0493)	(0.0472)	(0.169)	(0.0150)
	[0.0566]	[0.0518]	[0.141]	[0.00969]
2008 reform	-0.0724***	-0.0384**	0.0212	-0.000671
	(0.0240)	(0.0180)	(0.0680)	(0.00845)
	[0.0299]	[0.0140]	[0.0623]	[0.00722]
Short run				
Δbase (SR elasticity)	0.316*	0.453	0.587	1.189***
	(0.165)	(0.757)	(0.411)	(0.242)
	[0.192]	[0.729]	[0.316]	[0.281]
Δrevenue$_{t-1}$	-0.191*	0.147	-0.157	-0.0804
	(0.102)	(0.121)	(0.133)	(0.125)
	[0.0677]	[0.105]	[0.129]	[0.167]
residual_LR$_{t-1}$ (adjustment)	-0.536***	-1.109***	-0.903***	-0.960***
	(0.110)	(0.178)	(0.193)	(0.172)
	[0.0612]	[0.186]	[0.186]	[0.218]
2008 reform	-0.0241**	-0.0241	-0.0511	0.00156
	(0.00916)	(0.0234)	(0.0546)	(0.00768)
	[0.00720]	[0.0234]	[0.0389]	[0.00969]
Autocorrelation (χ^2)	0.101	0.648	0.719	0.835
Observations	73	73	57	58

Notes: The response variable is tax revenue for the long-run estimation and growth of tax revenue for the short-run estimation. The long-run specification is estimated by dynamic OLS; the additional controls (lags and leads of the tax base) are not reported for ease of exposition. Standard errors computed using the Newey-West correction (heteroscedasticity and autocorrelation-robust up to lag 4) are shown in round brackets; standard errors clustered at the year level are reported in square brackets. We do not report the constant, which is included in both the short- and long-run estimation. The regressions for value added tax additionally include unreported interactions of quarterly dummies and a dummy variable *break*, which equals one for all observations occurring after the last quarter of 2003 (a major change in reporting value added tax revenue in the Czech Republic). The short-run specification is estimated with OLS, and we report the χ^2 statistic for Durbin's alternative test of autocorrelation in this specification (in all cases we do not reject the null hypothesis of no autocorrelation). *Residual_LR* denotes residuals from the long-run equation. *Reform* denotes a dummy variable that equals one for observations occurring after the last quarter of 2007 (the implementation of a major tax reform in the Czech Republic).

Wage tax revenue elasticity

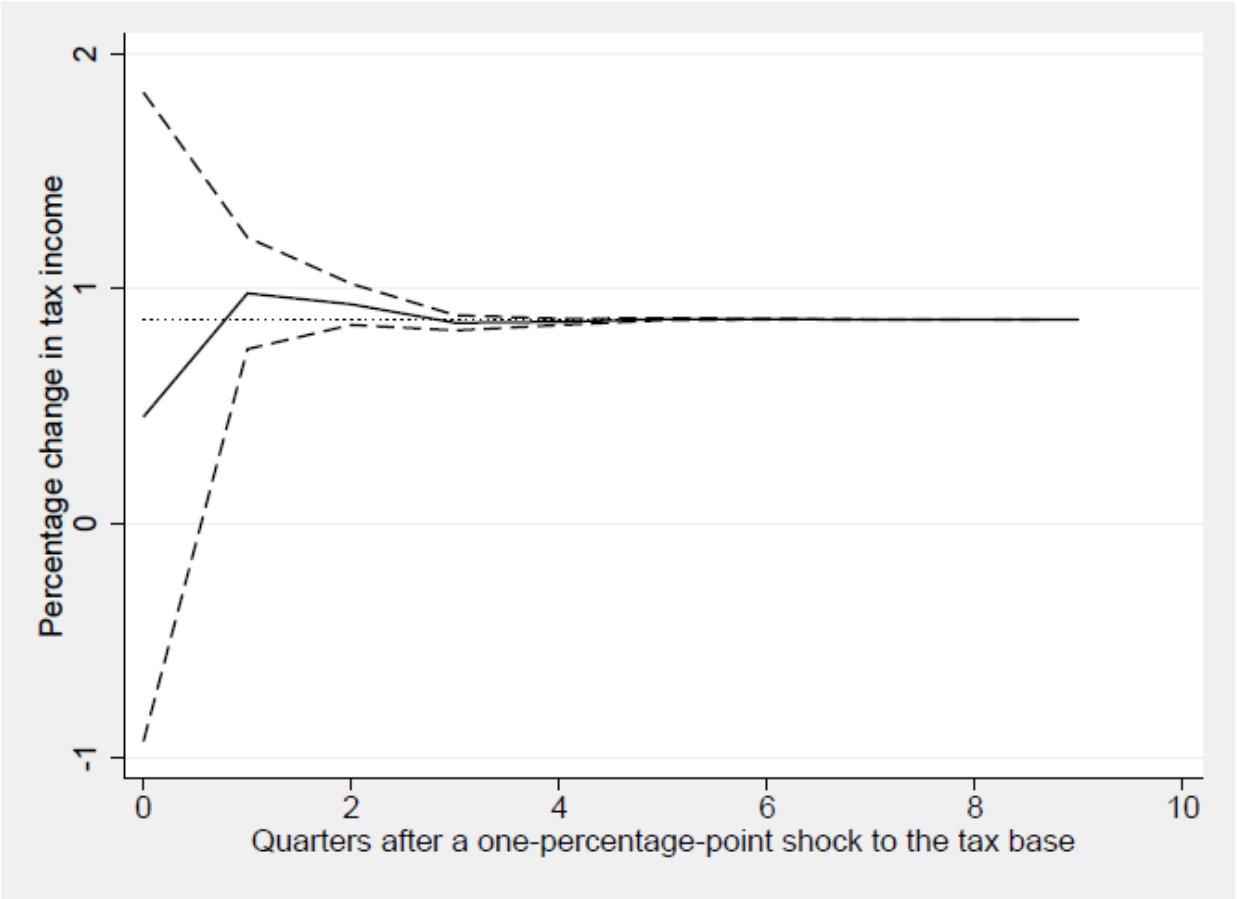
Figure 4: The impulse response of wage tax revenue



Notes: The solid line shows the impulse response of wage tax revenue to a one-percentage-point increase in the corresponding tax base. The bounds of the 95% confidence interval (denoted by dashed lines) are bootstrapped using 10,000 iterations. The dotted line represents the long-run elasticity.

Value added tax revenue elasticity

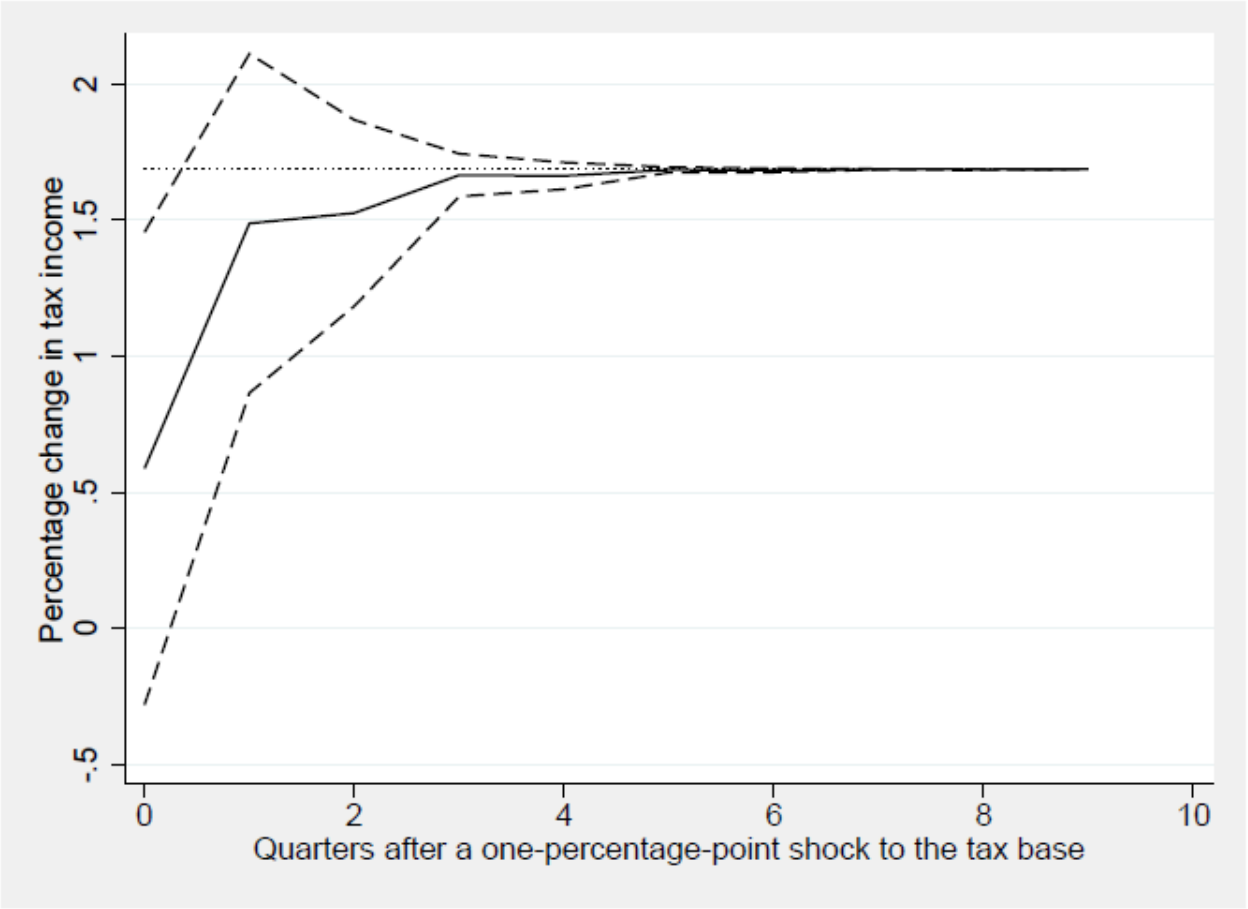
Figure 5: The impulse response of value added tax revenue



Notes: The solid line shows the impulse response of value added tax revenue to a one-percentage-point increase in the corresponding tax base. The bounds of the 95% confidence interval (denoted by dashed lines) are bootstrapped using 10,000 iterations. The dotted line represents the long-run elasticity.

Profit tax revenue elasticity

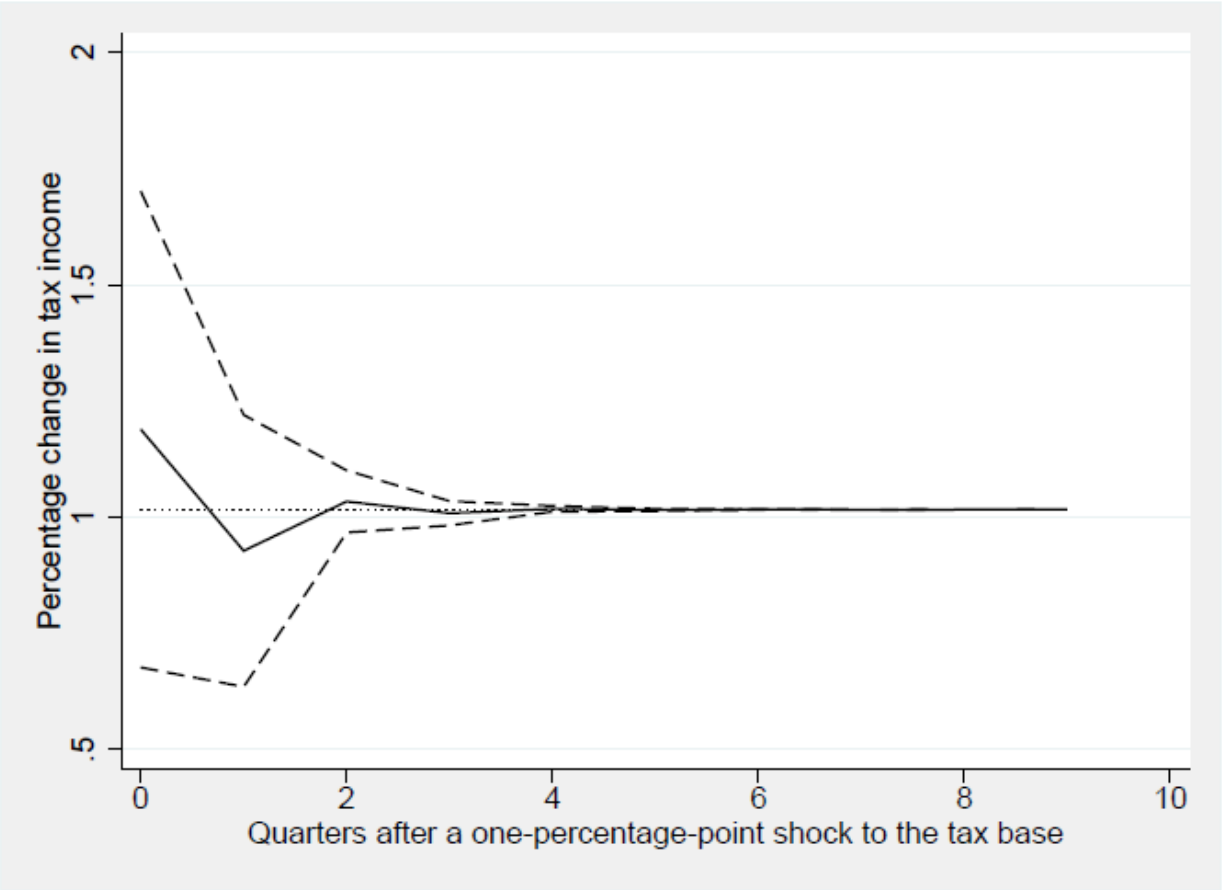
Figure 6: The impulse response of profit tax revenue



Notes: The solid line shows the impulse response of profit tax revenue to a one-percentage-point increase in the corresponding tax base. The bounds of the 95% confidence interval (denoted by dashed lines) are bootstrapped using 10,000 iterations. The dotted line represents the long-run elasticity.

Social security contributions elasticity

Figure 7: The impulse response of social security contributions



Notes: The solid line shows the impulse response of social security contributions to a one-percentage-point increase in the corresponding tax base. The bounds of the 95% confidence interval (denoted by dashed lines) are bootstrapped using 10,000 iterations. The dotted line represents the long-run elasticity.

Conclusions

- We use an error correction model to estimate short- and long-run tax revenue elasticities with respect to the corresponding tax bases.
- We introduce a framework for using quarterly data adjusted for the effects of tax reforms and policy changes.
- **Value added tax: 0.9**; share of housing-related expenditure subject to reduced rate doubled since 1995; tax evasion.
- **Wage tax: 1.4** (0.3 in short run); important dynamics.
- **Profit tax: 1.7**; possibility of fiscal drag; cash-based revenue data (but tax liability settled with a long lag).
- **Social security contributions: 1**
- **Important:** Usability for monetary & fiscal policy!

References

- Ambrisko, R., V. Augusta, D. Hajkova, P. Kral, P. Netusilova, M. Rikovsky, & P. Soukup (2012): "Fiscal Discretion in the Czech Republic in 2001-2011: Has It Been Stabilizing?" *Research and Policy Notes 2012/01*, Czech National Bank, Research Department.

- Koester, G. B. & C. Priesmeier (2012): "Estimating dynamic tax revenue elasticities for Germany." *Discussion Papers 23/2012*, Deutsche Bundesbank, Research Centre.

- Prest, A. R. (1962): "The Sensitivity of the Yield of Personal Income Tax in the United Kingdom." *The Economic Journal* 72(287): pp. 576-596.