The design of the funding scheme of social security systems and its role in macroeconomic stabilization

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(work in progress)

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Overview

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Motivation and contribution

- If prices and wages are flexible, the tax incidence of payroll taxation is fully determined by the elasticity of demand and supply.

  $\Rightarrow$ The split of the collection of payroll taxes between firms and workers is meaningless for the real allocation.

- **But**: In a stochastic setup with nominal rigidity, the split of collection is important for the means of a social system to function as automatic stabilizer.
- Contribution: Adding this new aspect to the literature on social security systems and macro stabilization.

Social security systems, 2012

	Social security contributions, % of GDP	Workers' share in %
Austria	14.5	40
Belgium	14.2	30
Czech Republic	15.4	20
Denmark	1.0	95
Estonia	11.9	7
Finland	12.6	22
France	16.7	24
Germany	14.2	44
Greece	10.6	39
Hungary	12.9	60
Ireland	4.6	23
Italy	13.4	18
Luxembourg	11.0	46
Netherlands	14.8	43
Norway	9.5	33
Poland	11.4	40
Portugal	9.3	39
Slovak Republic	12.3	24
Spain	12.1	16
Sweden	10.1	26
United Kingdom	6.7	40

Paper in a nutshell

- Starting point: Burda and Weder (2014) report counter cyclical fluctuations in social contribution rates in many OECD countries.
- Balanced budget assumption links exogenous shocks to (unanticipated) changes in SCR.
- Under nominal rigidity, changes in the SCR temporarily suspend the long-run tax incidence.
- The split of collection determines if the tax incidence shifts towards firms or towards workers.
- Hence, it influences the resulting nominal adjustment.
- In general equilibrium, collecting payroll taxes from workers lowers the volatility of prices and wages.

  $\Rightarrow$ This reduces price and wage dispersion in the economy. Efficiency costs due to stochastic fluctuations are reduced.

References

- Social security systems as automatic stabilizer:
  Kaldor (1936), Clement (1960), Eilbott (1966), Darby and Melitz (2008), Furceri (2010), Dolls et al. (2012)
  and many more.
- Counter cyclical social contribution rates:
  Burda and Weder (2014).

The model

Standard closed-economy DSGE model with the following features:

- Price- and wage rigidity à la Calvo
- Social security system with constant expenditures and a balanced budget
- Government with stochastic spending (demand disturbances)
- Productivity disturbances

Households

- All households j maximize discounted lifetime utility:

$$U_t = \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \left\{ \frac{\left(c_{t+k}\right)^{1-\gamma}}{1-\gamma} - \frac{\left(n_{t+k}\right)^{1+\phi}}{1+\phi} \right\}$$

- Budget constraint:

$$P_t c_t + q_t b_t \leq b_{t-1} + (1-\tau_t^w) \underbrace{w_t(j) \int_0^1 n_t(j,i)\, di}_{\text{pre-tax labor income}} + ssb - tax_t + \Pi_t$$

  - ssb: Social security benefits
  - tax_t: Lump-sum taxes levied by the government
  - Π_t: Nominal profits

$\Rightarrow$ Problem yields standard Euler equation

Wage setting (1/2)

Sticky wages à la Erceg, Henderson and Levin (2000):

- Each household j supplies its own type of labor. A type-specific labor union sets wages on his/her behalf.
- As different types are imperfect substitutes in the production technology of firms, workers have market power and real wages exceed the MRS.

Wage setting (2/2)

- Objective of the labor union for type-j labor:

$$\max_{w_t(j)} \mathbb{E}_t \left\{ \sum_{k=0}^{\infty} (\beta\theta_w)^k \, U\left(c_{t+k|t}(j), n_{t+k|t}(j)\right) \right\}$$

- FOC for wage setting:

$$\mathbb{E}_t \sum_{k=0}^{\infty} (\beta\theta)^k \, MU_{t+k|t} n_{t+k|t} \left[\frac{\left(1-\tau^w_{t+k}\right) w^*_t}{P_{t+k}} - \frac{\epsilon_w}{(\epsilon_w - 1)} MRS_{t+k|t} \right] = 0$$

$\Rightarrow$ Nominal wage $w^\star_t$ is set such that:

The weighted average future after-tax real wage is a markup over the weighted average future MRS.

Firms / price setting (1/2)

- All firms i has a linear production technology

$$y_t(i) = A_t n_t(i)$$

with $\log A_t = \rho^A \log A_{t-1} + \epsilon_t^A$ and $\epsilon_t^A \sim N\left(0, \sigma^A\right)$.

- The input is a bundle of all differentiated types of labor supplied by households j:

$$n_t(i) \equiv \left\{ \int_0^1 n_t(i,j)^{1-\frac{1}{\epsilon_w}} \, dj \right\}^{\frac{\epsilon_w}{\epsilon_w - 1}}$$

Firms / price setting (2/2)

- Objective of a firm i in setting its price:

$$\max_{p_t(i)} \mathbb{E}_t \sum_{k=0}^{\infty} Q_{t,t+k} \theta^k \left\{ y_{t+k|t}(i)\, p_t(i) - \Psi_{t+k}\left(y_{t+k|t}(i)\right) \right\}$$

- The cost function are after-tax production costs:

$$\Psi_{t+k}\left(y_{t+k|t}(i)\right) = \left(1+\tau^f_{t+k}\right) W_{t+k} n_{t+k|t}(i) = \left(1+\tau^f_{t+k}\right) W_{t+k} \frac{y_{t+k|t}(i)}{A_{t+k}}$$

$\Rightarrow$ Yields a standard NKPC.

Fiscal and monetary policy

- The only role of the government is to allow for demand disturbances. Spending is exogenous and stochastic:

$$G_t = \left(1 - \rho^G\right) \bar{G} + \rho^G G_{t-1} + \epsilon_t^G$$

  with $\epsilon_t^G \sim N\left(0, \sigma^G\right)$.

- The government has a balanced budget and levies lump-sum taxes, $tax_t = G_t$.

- Monetary policy follows a standard Taylor rule

$$i_t = \beta^{-1} + \alpha^\pi \left(\pi_t - 1\right)$$

Social system

- Revenues: Payroll taxes are subtracted from workers' wages (τ^w) and/or added to wage bills of firms (τ^f).
- Following Burda and Weder (2014), the social security system has a balanced budget,

$$\text{scr}_t \ * \ \text{total labor compensation}_t = \text{ssb}$$

- Size of the system *ssb* is assumed to be constant.

$\Rightarrow$ This gives rise to the cyclical behavior of the SCR:

Since the tax base of the payroll tax declines during a recession, the SCR has to increase to hold revenues (=benefits) constant.

Resource constraint

- The resource constraint has to account for inefficiencies arising from wage- and price dispersion.
- In the lines of Schmitt-Grohé and Uribe (2007), aggregate labor N_t is given by

$$N_t = \int_0^1 \int_0^1 n_t(i,j)\, didj$$

- It can be shown that aggregation yields

$$N_t = s_t^p s_t^w \frac{c_t}{A_t}$$

where $s_t^p = \int_0^1 \left(\frac{p_t(i)}{p_t}\right)^{-\epsilon} di$ and $s_t^w = \int_0^1 \left(\frac{w_t(j)}{w_t}\right)^{-\epsilon_w} dj$ are price- and wage dispersion terms.

Parameter choices

Parameter		Value	Motivation
Structural parameters			
β	Discount factor	0.99	Annual risk-free rate of 4%
γ	Relative risk aversion	1	Log-utility
ϕ^{-1}	Frisch elasticity of labour supply	1	Kimball and Shapiro (2008)
ϵ	Elast. of subs. goods variations	10	11% price mark-up, Basu and Kimball (1997
ϵ_w	Elast. of subs. types of labor	7.4	15% wage mark-up, Chari et al. (2002)
θ	Calvo probability firms	3/4	Average life time one year
θ_w	Calvo probability unions	3/4	Average life time one year
α^π	Inflation coefficient in Taylor rule	1.5	Standard
$\bar{G}$	Steady state gov't Spending	0.2	Evers (2012)
ssb	Social security expenditures	0.13	14% of steady state GDP
Exogenous processes			
ρ^A	persistence technology shock	0.95	Chari et al. (2002)
ρ^G	persistence gov't spending shock	0.66	Matches std(G)/std(gdp) in data
σ^A	Std innovations of technology	0.0036	Matches std(gdp) in the data
σ^G	Std innovations of gov't spending	0.0013	Matches std(G) in the data

stylized account of the mechanism (1/3)

- For all splits of payroll tax collection, prices and wages adjust towards establishing one unique elasticity-determined ratio between profits and labor income.
  $\Rightarrow$ Allocation in determ. St.St. independent of split

How does the locus of payroll tax collection affect the allocation?

- If pries and wages are rigid, unanticipated changes in the SCR temporarily suspend this unique profit share because nominal variables do not adjust instantaneously.
- The split of taxation determines how a given SCR change affects the profit share.

$\Rightarrow$ Hence, it determines whether the subsequent nominal adjustment occurs mainly via price adjustments or via wage adjustments.

stylized account of the mechanism (2/3)

$$\begin{array}{c}\text{after-tax}\\ \text{real profits}\end{array} = Y - \left(1+\tau^{f}\right)\frac{W}{P}N \qquad \begin{array}{c}\text{after-tax}\\ \text{real labor}\\ \text{income}\end{array} = (1-\tau^{w})\frac{W}{P}N$$

- In the deterministic St.St., (W/P) has adjusted to establish the unique long-run ratio between profits and labor income.
- In this situation, consider an unanticipated decline in the SCR:
  - If firms are taxed: $\tau^{f}\downarrow$ increases after-tax profits.
    $\Rightarrow$ Adjustment: MC$\downarrow$ causes prices to decline via NKPC.
    Rising real wages restore initial profit share.
  - If workers are taxed: $\tau^{w}\downarrow$ increases after-tax labor income.
    $\Rightarrow$ Adjustment: For given expected future MRS, nominal wages decline to stabilize after-tax real wages. Declining real wages restore initial profit share.

$\Rightarrow$ Split of collection affects nominal adjustment caused by SCR$\downarrow$.

stylized account of the mechanism (3/3)

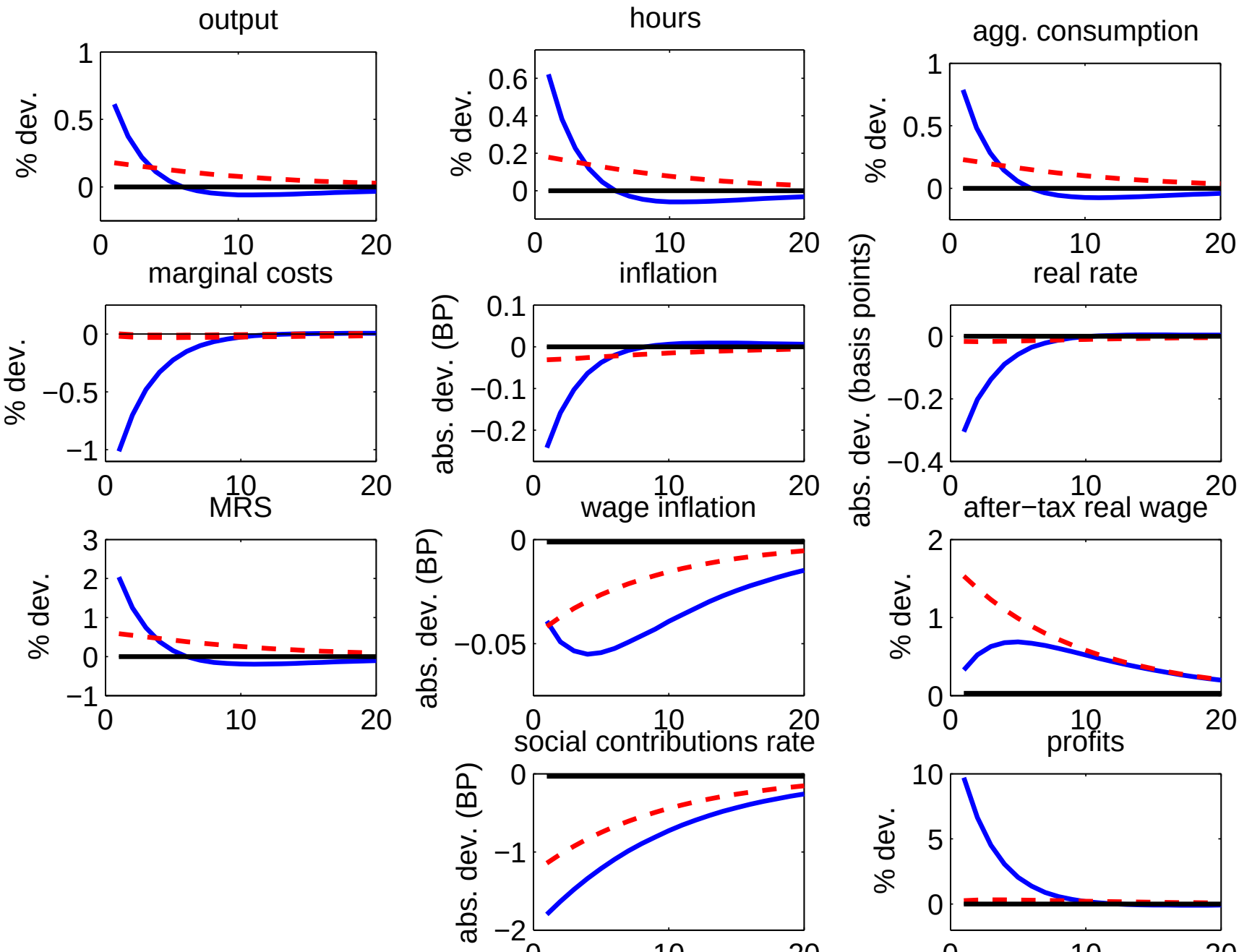
- Under the balanced budget assumption, fluctuations in total labor compensation (the tax base of payroll taxes) translate into fluctuations in the SCR.
  $\Rightarrow$ This links exogenous disturbances to unanticipated changes in the SCR.

- Before we look the whole picture, we analyze an isolated shock in the SCR itself.

Next slide: IRF of the adjustment to an unanticipated reduction in social contribution revenues by 1% GDP.

Shock: 1% reduction of social security contributions

Solid blue lines: Firms taxed. Dashed red lines: Workers taxed



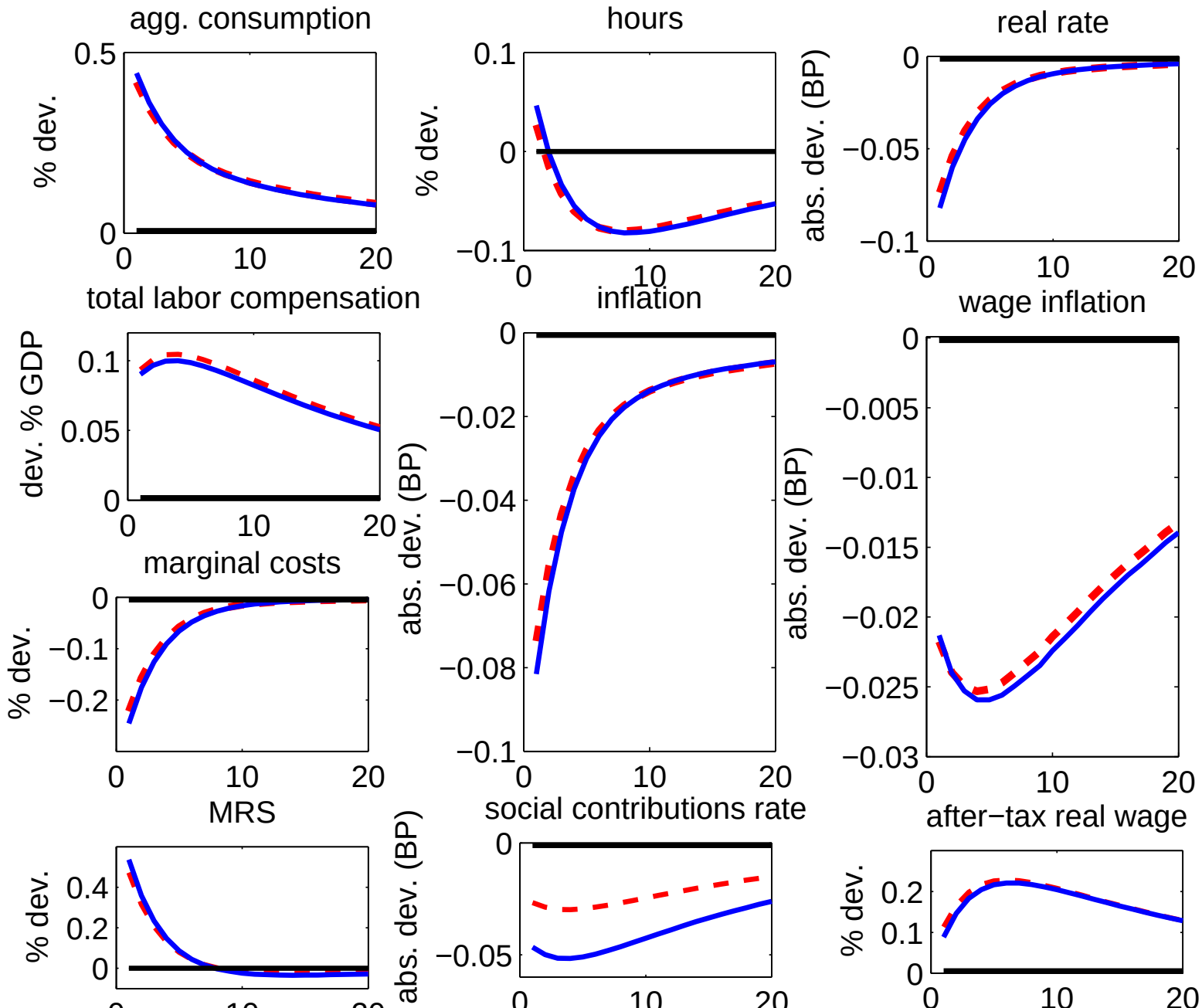
Impulse responses

- Summing up the adjustment to an isolated reduction in social security revenues: The decline in prices and wages is stronger if social contributions are collected from firms.

Next slide: Adjustment to an exogenous 1 STD - increase in productivity

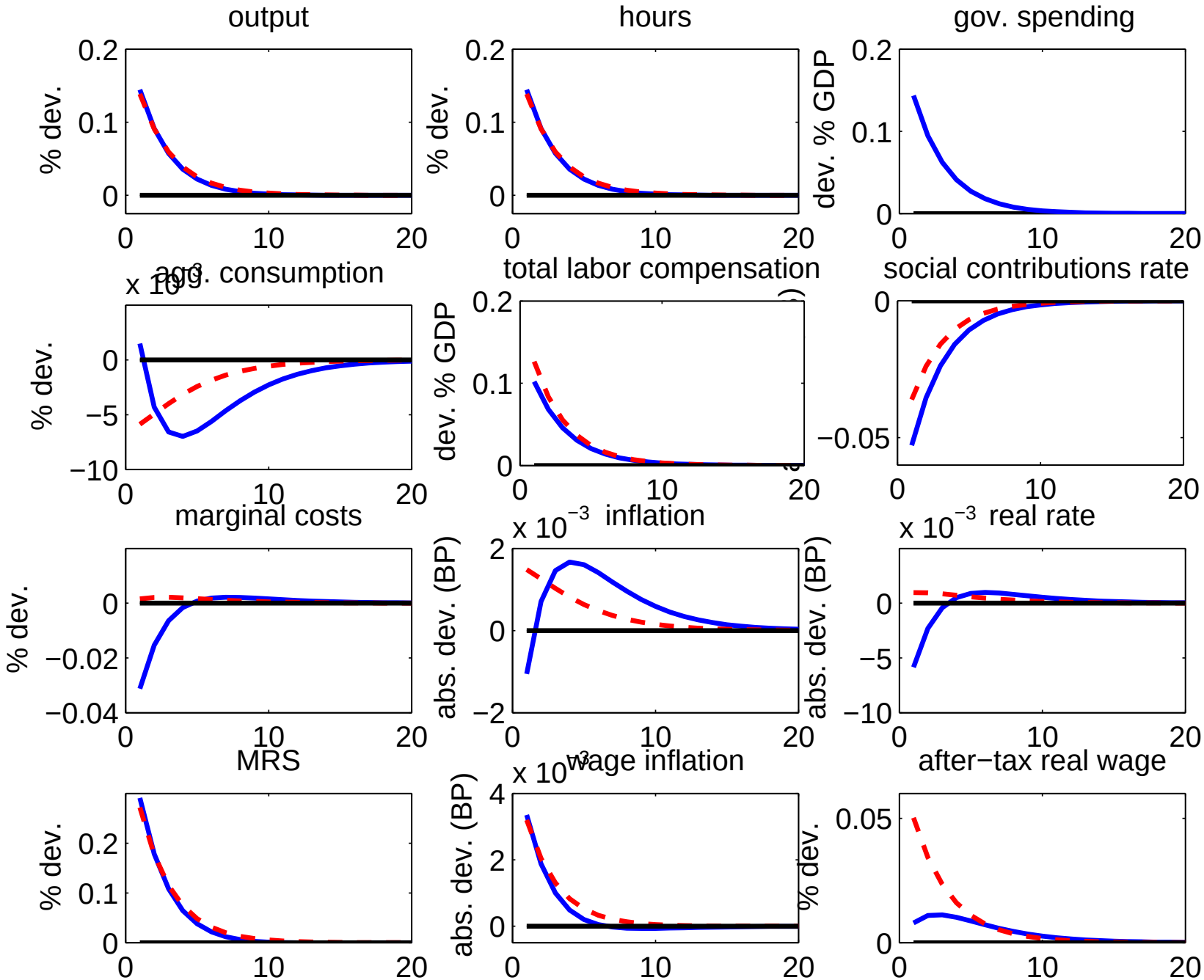
Shock: 1 STD increase in productivity.

Solid blue lines: Firms taxed. Red dashed lines: Workers taxed.



Shock: 1 STD increase in government spending

Solid blue lines: Firms taxed. Red dashed lines: Workers taxed.



Welfare Analysis

- Welfare costs of Business Cycle fluctuations are measured as 'consumption compensation'.
- For a split A, welfare is measured as the percentage value ν^A for which the following holds: The agent is equally well off in the ergodic distribution of the model and in the the deterministic steady state if consumption is reduced by ν^A percent.

$$\mathbb{E}\sum_{t=0}^{\infty}\beta^t U\left(c_t^A, n_t^A\right) = \sum_{t=0}^{\infty}\beta^t U\left(\left(1+\nu^A\right)\bar{c}, \bar{n}\right).$$

- I follow Evers (2013) in approximating this consumption compensation by a function of first- and second moments of consumption and labor.
- Unconditional moments of the ergodic distribution are calculated analytically using the nonlinear moving-average method by Alex and Hong (2013).

	Productivity shocks			Demand shocks		
	Workers	Firms	%-diff.	Workers	Firms	%-diff.
Total Wefare	-0.0466	-0.0513	-10.01	-0.0002	-0.0002	-4.16
Decomposition:						
mean cons.:	-0.0699	-0.0751	-11.16	-0.0002	-0.0003	-4.68
mean hours:	0.0300	0.0307	1.49	0.0002	0.0002	1.68
volatility cons.:	-0.0062	-0.0063	-0.31	-0.0000	-0.0000	-0.09
volaility hours:	-0.0006	-0.0006	-0.03	-0.0001	-0.0001	-1.08
Moments						
Mean output*	0.9171	0.9171	-0.03	0.9177	0.9176	-0.00
Std. output	0.0080	0.0080	1.14	0.0017	0.0017	0.87
Mean hours*	0.9173	0.9173	-0.01	0.9177	0.9177	-0.00
Mean consumption*	0.7172	0.7171	-0.05	0.7177	0.7177	-0.00
Std. consumption	0.0080	0.0080	1.14	0.0001	0.0001	25.74
Std. marginal costs	0.0034	0.0036	6.46	0.0000	0.0002	384.45
Std. MRS.	0.0058	0.0061	3.66	0.0011	0.0012	2.29
Std. inflation	0.0019	0.0020	5.19	0.0000	0.0000	31.32
Std. wage inflation	0.0012	0.0012	2.25	0.0000	0.0000	0.01
Mean price dispersion^{X}	0.2146	0.2374	10.61	0.0000	0.0001	72.44
Mean wage dispersion^{X}	0.0678	0.0709	4.53	0.0001	0.0001	0.02

*Changes are reported in units per mil.

^{X}Dispersion terms are reported as deviations from one in units per mil.

Welfare and moments in the full stochastic setup

	Workers	Firms	%-diff.
Total Wefare	-0.0469	-0.0515	-9.98
Decomposition:			
mean cons.:	-0.0702	-0.0754	-11.13
mean hours:	0.0302	0.0309	1.49
volatility cons.:	-0.0062	-0.0063	-0.31
volaility hours:	-0.0007	-0.0007	-0.04
Moments			
Mean output*	0.9171	0.9171	-0.03
Std. output	0.0081	0.0082	1.13
Mean hours*	0.9173	0.9173	-0.01
Mean consumption*	0.7172	0.7171	-0.05
Std. consumption	0.0080	0.0080	1.14
Std. marginal costs	0.0034	0.0036	6.59
Std. MRS.	0.0060	0.0062	3.61
Std. inflation	0.0019	0.0020	5.19
Std. wage inflation	0.0012	0.0012	2.25
Mean price dispersion^{X}	0.2146	0.2374	10.62
Mean wage dispersion^{X}	0.0679	0.0710	4.53

*Changes are reported in units per mil.

^{X}Dispersion terms are reported as deviations from one in units per mil.

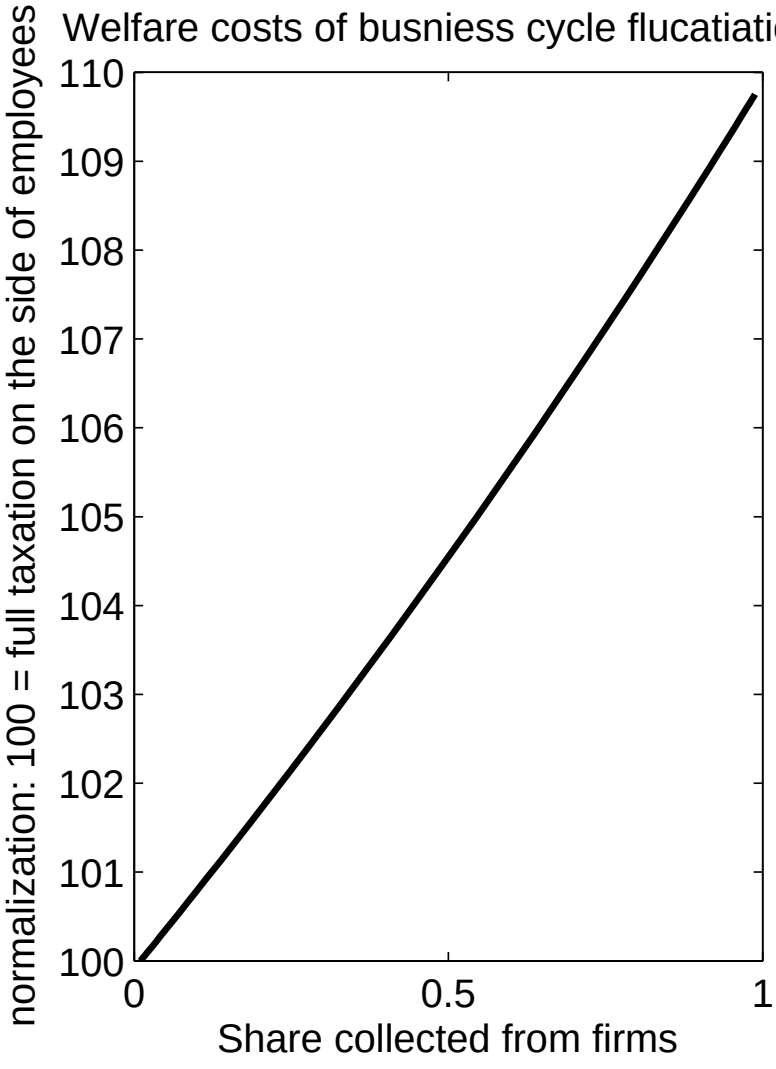
Welfare Analysis

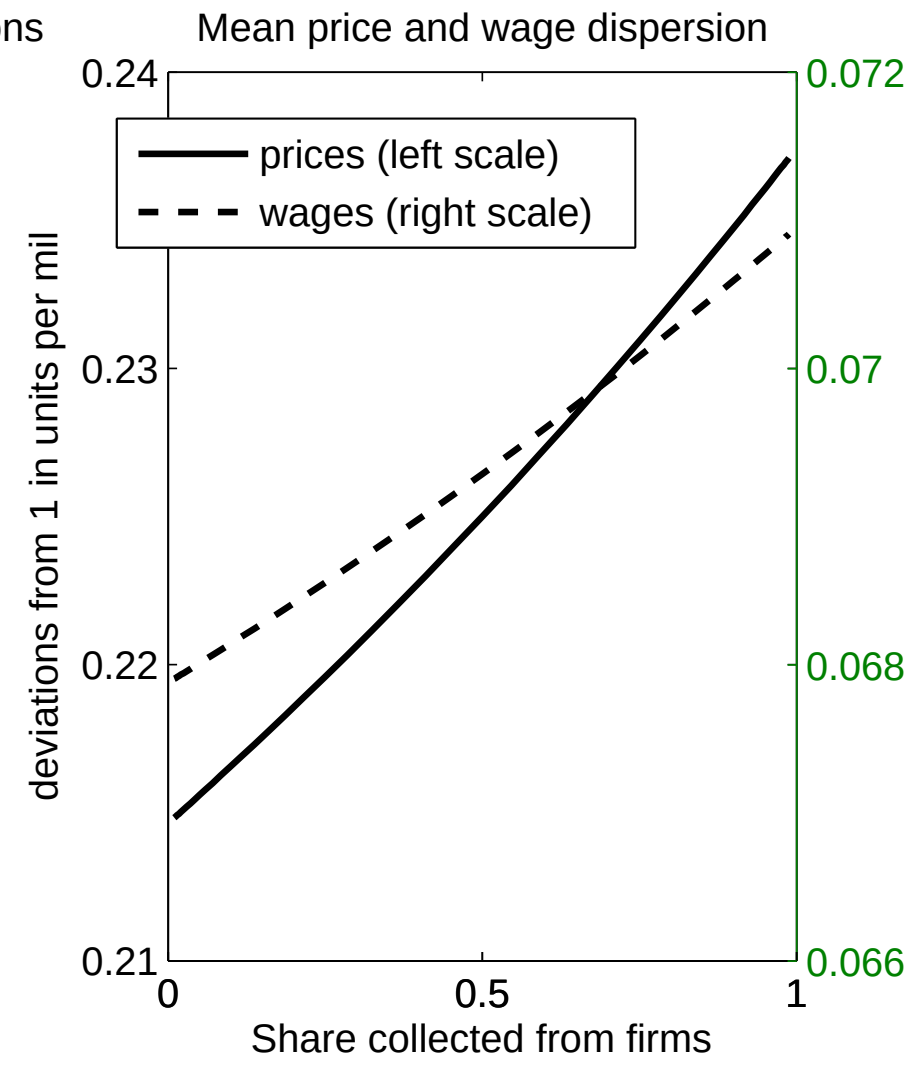
- Collection from workers instead of firms reduces the STD of inflation and wage inflation by 5.2% and 2.25% respectively.
- This reduces the mean price dispersion and wage dispersion by 10.6% and 4.53% respectively

$\Rightarrow$ Gain in efficiency, which reduces the welfare costs of business cycle fluctuations by 9.9%.

- Changing the collection in an existing social system does not entail any long-run redistribution.
- No public funds need to be disposed: Gain in productivity at no costs.

Welfare Analysis





Stickiness by Druant et al. (2009)

- Recent study on the Euro Area:
  Lifetime of prices and wages of 9.6 and 12.5 months respectively (excluding the outliner Italy).
- Findings are matched by the Cavlo parameters $\theta = 0.6875$ for prices and $\theta^w = 0.76$ for wages.

	Welfare decomposition					Unconditional means			
	Total	Mean Cons.	Mean Hours	Vola. Cons.	Vola. Hours	Output	Hours	Price Disp.	Wag Disp
Workers	-0.0451	-0.0773	0.0390	-0.0060	-0.0008	0.9170	0.9172	0.1616	0.079
Firms	-0.0503	-0.0836	0.0404	-0.0061	-0.0009	0.9170	0.9172	0.1835	0.084
% diff.	-11.52	-14.03	2.92	-0.32	-0.09	-0.04	-0.02	13.57	5.3

Relaxing balanced budget assumption

- A quarterly adjustment of the SCR to maintain a balanced budget does not seem too realistic.
- Relaxation: The system can run deficits and surpluses.
  A given deficit / surplus is reduced by half after one year of time.

	Welfare decomposition					Unconditional means			
	Total	Mean Cons.	Mean Hours	Vola. Cons.	Vola. Hours	Output	Hours	Price Disp.	Wag Disp
Workers	-0.0463	-0.0693	0.0299	-0.0062	-0.0007	0.9171	0.9173	0.2122	0.067
Firms	-0.0496	-0.0731	0.0306	-0.0065	-0.0007	0.9171	0.9173	0.2244	0.069
% diff.	-7.01	-8.13	1.58	-0.48	0.02	-0.02	-0.01	5.76	2.9

EMU setup for core country (1/2)

- The calibration of the model matches European countries with sizable social security systems. These countries are part of the EMU and therefore have no independent monetary authority.
- Bayoumi and Eichengreen (1994) report a high correlation of supply shocks for Germany, France, Austria, Belgium and the Netherlands. This set covers more than half of the population of the European Union and has a joint HICP weight of 60.2%. A given deficit / surplus is reduced by half after one year of time.

EMU setup for core country (2/2)

A joint productivity disturbance enters the monetary policy's objective with a weight of 60.2%. Hence, a country belonging to this set faces the following monetary policy stance:

$$i_t = \beta^{-1} + \pi_t + 0.5 \left[0.602 \left(\pi_t^{set} - 1 \right) + 0,398 \left(\pi_t^{others} - 1 \right) \right]$$

	Welfare decomposition					Unconditional means			
	Total	Mean Cons.	Mean Hours	Vola. Cons.	Vola. Hours	Output	Hours	Price Disp.	Wag Disp
Workers	-0.0463	-0.0693	0.0299	-0.0062	-0.0007	0.9171	0.9173	0.2122	0.067
Firms	-0.0496	-0.0731	0.0306	-0.0065	-0.0007	0.9171	0.9173	0.2244	0.069
% diff.	-7.01	-8.13	1.58	-0.48	0.02	-0.02	-0.01	5.76	2.9

Thank you for your time