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Why the split of payroll taxation between firms and workers matters for macroeconomic stability

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Why the split of payroll taxation between firms and workers matters for macroeconomic stability

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Why the split of payroll taxation between firms and workers matters for macroeconomic stability

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Abstract

Conventional wisdom states that the statutory split of payroll taxation between firms and workers is of no macroeconomic relevance, because the tax incidence is fully determined by the market structure. This paper breaks with this view by establishing a theoretical link between the statutory split and the average volatility of prices and wages. It is shown that shifting taxation towards workers significantly reduces the volatility in nominal variables without entailing long-run redistribution. The gain in stability of prices and wages reduces inefficiencies in the equilibrium allocation of the stochastic model and thereby reduces welfare costs of business cycle fluctuations. In a standard DSGE model, welfare costs under the full taxation of firms are 11.25% larger than under the full taxation of workers.

JEL classification: H55, H21, E30, E32, E60.

Keywords: Payroll taxes, social security, business cycles, automatic stabilizers, optimal taxation.

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1 Introduction

This paper contributes to the literature on the nexus of social security systems and macroeconomic stabilization. It is the first to establish a theoretical link between the statutory split of payroll taxation between firms and workers and the degree of macroeconomic fluctuations in the economy. Most of the existing literature in this field focuses on the role of social security systems as automatic stabilizer and studies how taxes and transfers cushion disposable income over the cycle. Given that social security systems govern a substantial share of the total redistribution conducted by rich-world governments,¹ it is not surprising that this property of social welfare received substantial attention in the literature (see Furceri (2010) for a recent overview).

Regarding its general focus the study at hand seeks to contribute to this literature, but with the statutory split of taxation, it addresses a design aspect of social security systems that has never been related to macroeconomic stability. It is shown that under taxation of workers, volatility in nominal variables is lower than under the taxation of firms. The reason is straightforward. In accordance with the classic result on tax incidence, shifting the statutory taxation towards workers leads to a rise in pre-tax real wages.² In the aggregate, this translates into a higher (gross) total labor compensation, which constitutes the tax base of payroll taxes. This implies that in order to raise tax revenues by e.g. 1 mio Euro, the tax rate has to be increased by less. Therefore, a given volatility in revenues translates into a smaller volatility in the payroll tax rate if taxes are levied on the side of workers. Since changes in the payroll tax rate move after-tax real wages (on the side of workers) and effective marginal costs (on the side of firms), they trigger nominal adjustments. Hence, increasing the tax base by shifting the statutory taxation towards workers lowers the magnitude of nominal adjustments caused by given fluctuations in tax revenues.

Reducing the volatility in nominal variables is welfare improving. The reason is that inflation in prices and wages is accompanied by dispersion among the latter. Price and wage dispersion in turn lowers the efficiency of the equilibrium allocation, resulting in a loss in production efficiency. Shifting the statutory taxation towards workers therefore reduces the efficiency loss caused by the volatility in nominal variables originating from a given volatility

The result of this paper is more general than resting on volatility in payroll tax revenues only. It also emerges if the tax rate is adjusted in the face of fluctuations in the tax base to keep revenues constant, since a given deviations in the tax base requires a smaller offsetting adjustment in the tax rate if the tax base

¹Table 7 in the appendix shows the size of the social security system as a share of GDP for several European countries. This figure ranges from 4.6 percent in Ireland to 16.7 percent in France. The bulk of these funds are used to fund retirement benefits and to provide public health and unemployment insurance.

²Under flexible prices and wages, the well-known neutrality result on tax incidence holds in the context of the statutory split of payroll taxation. That is, the market structure uniquely determines the ratio between after-tax real wages and profits, while the significance of the statutory split is limited to the nominal sphere: For each split, prices and wages adjust such that this unique proportion between labor and profit income prevails.

is larger. Both driving forces can be summarized as volatility in a conceptual 'funding gap' between the amount of revenues scheduled by the government and the amount of revenues generated for the given tax base, which is at all times closed by adjustments the tax rate. As a first assessment of the empirical plausibility of variance in the statutory payroll tax rate, the following graph shows the evolution of the statutory social contributions rate in Germany. The mean deviation from the HP-filtered series amounts to 0.34%³, which is shown to be sufficient to generate significant welfare implications of the statutory split of taxation.

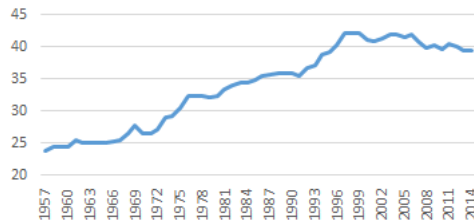


Figure 1: German statutory social contributions rate

Besides the plain volatility of the 'funding gap', the fact that it is likely to be systemically linked to the business cycle proves also to be relevant for this analysis. Since outflows are likely to move counter cyclical due to the expenses of the unemployment insurance while the tax base (total labor compensation) moves cyclical, the conceptual 'funding gap' is expected to fluctuate counter cyclical as well. This implies that adjustments in the payroll tax rate are systematically linked to the business cycle in a counter cyclical manner. It follows that the nominal adjustment going along with a given business cycle disturbance is likely to occur at the same time as the nominal adjustment to the counter cyclical movement of the payroll tax rate. The analysis shows that the two sources of movement in nominal variables are rectified, i.e. they complement each other with respect to their effect on nominal variables. This implies that the strength of the correlation between output fluctuations and tax rate adjustments is relevant for the analysis at hand: The higher the degree of synchronization, the higher is the reduction in total volatility of nominal variables that can be achieved by reducing the magnitude of fluctuations in the tax rate.⁴ This consideration is taken into account by following Burda and Weder (2014) in assuming that the welfare system runs a balanced budget. Under this assumption, the model endogenously generates a counter cyclical dynamic of the

³The smoothing parameter $\lambda = 6.25$ was applied as in Burda and Weder (2014). Data source: The German Council of Economic Experts.

⁴If the effect on nominal variables originating from business cycle fluctuations and from tax rate changes are not perfectly synchronous, it occurs with a positive probability that both effects are directed in opposed directions and therefore offset each other. This limits the reduction in total nominal volatility that can be achieved by reducing the nominal volatility stemming from tax rate fluctuations.

payroll tax rate that is well in line with the empirical findings of the authors.⁵

The mechanism presented in this paper is disconnected from the well understood Keynesian-type stabilization provided by social security systems. As the statutory breakdown between firms and workers does not affect the amount of revenues generated, it is detached from the general financial stance of the system and thereby from its means to stabilize income over the cycle. In other words, the statutory split constitutes a political control variable that is disconnected from any macroeconomic properties of the welfare system. The focus of this paper does not lie on the classic workings of a welfare system to provide stabilization – which has been extensively studied – but on the novel aspect of the statutory split. For this reason, the social welfare system is modeled as a redistribution device that fully abstracts from Keynesian features. This is admissible due to the disconnect of the statutory split from the latter, and allows to study the implications of the statutory split in isolation, i.e. without being overlaid by Keynesian properties of the system.

It should be emphasized that the statutory split has, in line with the classic result on tax incidence, no long-run implications for the average ratio between profits and labor income. That is, it does not entail any long-run redistribution between different groups in the economy. Given that a one-time shift of the statutory tax burden towards workers is anticipated in wage negotiations and accompanied by a nominal wage increase in equal magnitude, this change in the tax structure induces a Pareto improvement. Only then it is desirable from the perspective of the author.

The baseline calibration of the standard DSGE model employed in this study seeks to match a typical European country with a sizable welfare system. In this setup, welfare costs of business cycle fluctuations are by 11.25% larger under the full taxation of firms than they are under the full taxation of workers. From the arguments made above, a reduction in the inefficiencies stemming from business cycle fluctuations can be achieved without impeding existing automatic stabilizers or affecting the income distribution in the economy. Since the statutory share of workers is below 50% in vast majority of OECD countries, the findings are of potential relevance for many governments.⁶

Section 2 lays out the model and discusses the calibration. Section 3 and 4 explain the findings in detail. Welfare results and robustness checks are reported in section 5, while the paper concludes with section 6.

2 The model

This paper employs a standard closed-economy New Keynesian DSGE model. The economy is populated by a continuum of firms and of infinitely-lived house-

⁵Table 7 in the appendix is taken from Burda and Weder (2014) and shows the correlation between deviations of the SCR and of GDP for OECD countries. The authors find significant counter cyclical dynamics for Germany, France, Finland, Japan, Belgium, Austria, Australia, Canada, South Korea and Spain.

⁶Table 7 in the appendix reports the statutory split for 21 OECD countries. From this sample, 19 countries have a statutory share of workers of below 50%.

holds. Firms produce differentiated intermediate goods which are aggregated into a final good bundle consumed by households. Likewise, households supply differentiated types of labor which enter the production function subject to aggregation into a composite of labor services. Price and wage setting is staggered by Calvo mechanisms. The model features a social security system which is financed by payroll taxes levied from firms and/or workers. Revenues are reimbursed as lump-sum transfers to households. There is a government with public consumption modeled as an exogenous process and defined as plain waste. Its expenditures are fully financed by lump-sum taxes in every period. Monetary policy is governed by a standard Taylor rule. There are two sources of uncertainty in the economy: Productivity shocks entering the production technology and demand shocks entering government spending. The remainder of this section presents the different building blocks of the model as well as its calibration.

2.1 Households

Each household on the continuum is indexed by $j \in [0, 1]$, but the index is suppressed in this section for ease of notation. Households choose consumption as to maximize their expected live-time utility. Hours worked are determined by labor demand because households reduce their labor supply below the competitive level to make use of their market power.

Live-time utility is given by:

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

where n_{t+k} are hours worked in period $t+k$ and c_{t+k} is the consumption of the final goods aggregate in that period. The maximization is subject to a series of period budget constraints given by

$$P_t c_t + (1/i_t) b_t \leq b_{t-1} + (1 - \tau_t^w) w_t \int_0^1 n_t(i) di + ssb_t - tax_t + \Pi_t \quad . \quad (1)$$

P_t is the economy's price index defined below and i_t is the nominal interest rate on the one-period riskless bond b_t assumed to mature at the beginning of period $t+1$. The payroll tax rate for workers τ_t^w is deducted from nominal labor income $w_t \int_0^1 n_t(i) di$, where the integral constitutes the total remuneration the household receives from renting its differentiated type of labor to all firms on the continuum. ssb_t are social security benefits, tax_t are lump-sum taxes levied by the government and Π_t denotes nominal profits from the ownership of firms. The problem leads to a standard consumption Euler equation given by

$$q_t = \beta \mathbb{E}_t \left\{ \left(\frac{c_t}{c_{t+k}} \right)^\gamma \frac{P_t}{P_{t+1}} \right\}.$$

The Dixit-Stiglitz aggregate c_t consumed by households consists all varieties $c_t(i)$ produced by firms, each indexed by $i \in [0, 1]$. Aggregation into final goods

c_t can be thought of as being conducted by a competitive final-goods firm with technology

$$c_t \equiv \left(\int_0^1 c_t(i)^{1-\frac{1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}. \quad (2)$$

Cost-efficient composition of variations implies the following demand schedule for the variation produced by firm i , where $p_t(i)$ denotes its price:

$$c_t(i) = \left(\frac{p_t(i)}{P_t} \right)^{-\epsilon} c_t. \quad (3)$$

The economy's aggregate price index is defined as

$$P_t \equiv \left[\int_0^1 p_t(i)^{1-\epsilon} di \right]^{\frac{1}{1-\epsilon}}. \quad (4)$$

2.2 Firms and inflation dynamics

Since variations produced by different firms are imperfect substitutes in aggregator (2), firms possess market power which they use to extract profits. Assuming price stickiness à la Calvo (1983), only a random share θ of firms is allowed to re-optimize prices in each period. Firms' production technologies are linear in a composite of all differentiated labor services supplied by households.

A firm i produces its good variation $y_t(i)$ with the linear production function

$$y_t(i) = A_t n_t(i) \quad (5)$$

where productivity is governed by $\log A_t = \rho^A \log A_{t-1} + \epsilon_t^A$ with $\epsilon_t^A \sim N(0, \sigma^A)$ allowing for aggregate productivity shocks. Firm i 's labor composite $n_t(i)$ contains labor-variations $n_t(i, j)$ supplied by all households on the continuum:

$$n_t(i) \equiv \left\{ \int_0^1 n_t(i, j)^{1-\frac{1}{\epsilon_w}} dj \right\}^{\frac{\epsilon_w}{\epsilon_w-1}}. \quad (6)$$

Analog to demand equation (3), the cost-minimizing composition of different types of labor implies the following demand schedule for type- j labor:

$$n_t(i, j) = \left(\frac{w_t(j)}{W_t} \right)^{-\epsilon_w} n_t(i) \quad (7)$$

where $w_t(j)$ is the wage charged by household j for its labor service and W_t is the aggregate wage index defined by

$$W_t \equiv \left\{ \int_0^1 w_t(j)^{1-\epsilon_w} dj \right\}^{\frac{1}{1-\epsilon_w}}. \quad (8)$$

Using (7) and (8), firm i 's total wage bill can be expressed as

$$\int_0^1 (1 + \tau_t^f) w_t(j) n_t(i, j) dj = (1 + \tau_t^f) W_t n_t(i) \quad (9)$$

where τ_t^f is the payroll tax rate levied on the side of firms.

Since the government is assumed consume the same final good aggregate as households, total demand for the variety produced by firm i is given by

$$y_t(i) = \left(\frac{p_t(i)}{P_t} \right)^{-\epsilon} [C_t + G_t] \quad (10)$$

where $C_t = \int_0^1 c_t(j) dj$ is aggregate private consumption and G_t government consumption.

The price setting problem of a firm i allowed to re-optimize the price for its good variation $p_t(i)$ reads as

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

where $y_{t+k|t}(i)$ is the firm's period $t+k$ output given that the price set today remains valid up to this period, which occurs in a Calvo setup with probability θ^k . $Q_{t,t+k} \equiv \beta^k (c_{t+k}/c_t)^{-\gamma} (P_t/P_{t+k})$ is the stochastic discount factor. The cost function $\Psi_t(\cdot)$ represents the firm's total wage bill (9), which can under the use of (5) be written as

$$\Psi_{t+k}(y_{t+k|t}(i)) = \left(1 + \tau_{t+k}^f \right) W_{t+k} \frac{y_{t+k|t}(i)}{A_{t+k}} \quad .$$

Optimal price setting subject to demand schedule (10) is governed by the FOC

$$\mathbb{E}_t \sum_{k=0}^{\infty} Q_{t,t+k} \theta^k y_{t+k|t} \left\{ p_t^* - \frac{\epsilon}{(\epsilon-1)} \left(1 + \tau_{t+k}^f \right) W_{t+k} A_{t+k}^{-1} \right\} = 0 \quad (11)$$

where p_t^* is the price set by all firms allowed to re-optimize in the current period. Combining this FOC with the definition of the aggregate price level (4) yields a standard New Keynesian Phillips Curve.

2.3 Wage setting

Nominal wage rigidity is introduced by using the apparatus of Erceg et al. (2000), which closely resembles the structure of the goods market. Households exert market power on the labor market because labor services supplied by different households are imperfect substitutes in aggregator (6). Each household is assumed to be represented by its own labor union which sets the household-specific wage rate subject to a Calvo-constraint, i.e. only a random share θ_w of unions is allowed to adjust wages in each period.

The labor union operating on behalf of household j chooses this household's wage rate $w_t(j)$ as to maximize its expected present value of utility:

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

where $c_{t+k|t}(j)$ and $n_{t+k|t}(j)$ are period $t+k$ consumption and hours given that the newly set wage is in place up to that period. It can be shown that the optimal wage w_t^* satisfies the following FOC:

$$\mathbb{E}_t \sum_{k=0}^{\infty} (\beta\theta)^k MU_{t+k|t} n_{t+k|t} \left[\frac{(1 - \tau_{t+k}^w) w_t^*}{P_{t+k}} - \frac{\epsilon_w}{(\epsilon_w - 1)} MRS_{t+k|t} \right] = 0 \quad (12)$$

where $n_{t+k|t} = (w_t^*/W_{t+k})^{-\epsilon_w} (N_{t+k}/s_{t+k}^w)$ is period $t+k$ total demand for type- j labor, given that the wage rate is w_t^* .⁷ $MU_{t+k|t}$ and $MRS_{t+k|t}$ denote household j 's marginal utility and marginal rate of substitution in period $t+k$ under the same condition. Combined with the definition of the aggregate wage index (8), this FOC governs the evolution of aggregate wages. It implies that nominal wages are set such that the weighted average of future after-tax real wages is, in expectations, a mark-up over the weighted average of future marginal rates of substitution.

2.4 Social security

The social security system is modeled as a simple redistribution device. Social contributions are levied as payroll taxes from firms and/or workers, in a breakdown that is varied across different scenarios under consideration. Revenues are reimbursed to households as lump-sum transfers. The system's budget reads as follows:

$$scr_t * \text{total labor compensation}_t = ssb_t \quad (13)$$

where scr_t is the effective payroll tax rate (social contributions rate SCR from now on), which is the sum of the rate levied on the side of firms τ_t^f and on the workers side τ_t^w . The system's outflows ssb_t (social security benefits) enter the household's budget (1) as lump-sum transfer.

To see why this specification is suitable for the analysis, note that this paper abstracts from Keynesian-type stabilization provided by the social security system. The reason is that the statutory split is of no consequence for the macroeconomic properties of the system itself. The implications of the split identified by this paper are therefore detached from the latter and take effect in addition to Keynesian-type stabilization. In other words, the statutory split constitutes a degree of freedom that is not related to the general properties of the social system. This disconnect makes it admissible to abstract from the latter, which has the advantage that one can study the implications of the statutory split in isolation, i.e. without being overlaid by other sources of stabilization. Shutting down the effects of the system's outflows, the only purpose of the social system is to model fluctuations in the 'funding gap' between revenues scheduled by the

⁷ N_t is the aggregate employment index and s_t^w a wage dispersion term, both introduced below. To obtain this demand schedule, notice that a household charges the same wage to all firms renting its labor service, so (7) implies that total demand for type- j labor is given by $n_t(j) = \int_0^1 n_t(i, j) di = \left(\frac{w_t(j)}{W_t}\right)^{-\epsilon_w} \int_0^1 n_t(i) di$. Substituting the corollary $\int_0^1 n_t(i) di = \frac{N_t}{s_t^w}$ (see derivation of (14) in the appendix) yields the equation.

government (i.e. ssb_t) and actual revenues generated for the given tax base and SCR – i.e. to model the driving force of this paper’s findings.

I abstract from Keynesian-type stabilization by following Burda and Weder (2014) in assuming that the system runs a balanced budget. As all revenues are instantaneously reimbursed as lump-sum transfers, the redistribution conducted by the system is neutral to the income of households.⁸ It follows that the effect of fluctuations in the size of the system ssb_t , i.e. in the amount of money it redistributes, are limited to the funding side of the system.⁹ In particular, a balanced budget implies that the SCR adjusts in every period to close the funding gap. Since the magnitude of the SCR adjustment required to close one unit of the gap depends on the size of the tax base, this specification of the system constitutes an otherwise irrelevant device to introduce the driving force of the findings of this paper.¹⁰

Regarding the dynamics of the SCR, the balanced budget implies that it moves for given outflows opposed to total labor compensation. As the latter is cyclical, counter cyclical dynamics of the SCR arise endogenously. Therefore, the assumption made in the baseline model that ssb_t fluctuates exogenously is sufficient to generate empirically plausible counter cyclical SCR dynamics. Assuming that the mean deviation of ssb_t amounts to half a percent of its steady state value, the model yields under equal taxation of both sides a standard deviation in the SCR of 0.35% and a correlation with output of -0.4. Both moments are well in line with the results of Burda and Weder (2014) (see table 5 and 6 in the appendix, table 6 reporting my own but analog calculations).

Assuming that ssb_t fluctuates exogenously in a given magnitude pins down a specific dynamic of the funding gap. In the course of the welfare analysis, this paper considers a broad set of dynamics of the latter. Different dynamics in the gap are induced by linking ssb_t systematically to output fluctuations, which is admissible since fluctuations in ssb_t are in the model otherwise irrelevant.

2.5 Government and monetary policy

As widely done in the literature, exogenous disturbances in aggregate demand are modeled by introducing stochastic government spending in addition to the social security system. The government is assumed to consume the same final-good aggregate as households. Its consumption G_t is defined as plain waste and exogenously determined by

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

with $\epsilon_t^G \sim N(0, \sigma^G)$.¹¹ I assume that expenditures are fully financed by lump-sum taxes in every period, so $G_t = tax_t$. Note that one could equally well

⁸In a representative agent framework there is also no redistribution between households, since profit and labor income as well as lump-sum transfers are equally distributed across households.

⁹Variations in the degree of distortions in the economy are neglected.

¹⁰As this is the only purpose of the social system, it would be pointless for the analysis to allow for deficits/surpluses, i.e. to generalize the balanced budget assumption.

¹¹This specification of government spending is also found in Evers (2012).

combine government consumption and social security into one entity without changing of the model.

Monetary policy is governed by the following standard Taylor rule:

$$i_t = \beta^{-1} + \alpha^\pi (\pi_{t+1} - 1).$$

In a robustness check, the Taylor Rule is altered as to account for the monetary policy stance faced by a single member state of a monetary union.

2.6 Resource constraint

The resource constraint of the model economy has to account for resource costs resulting from inefficiencies in the equilibrium allocation that arise in the presence of price and wage dispersion. Closely to Schmitt-Grohé and Uribe (2007), the relation between output of the final consumption good and the required amount of labor is established by defining aggregate employment N_t as total labor performed by all households j in all firms i :

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

as shown in the appendix of this paper, it follows that

$$N_t = s_t^p s_t^w \frac{C_t + G_t}{A_t} \tag{14}$$

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 dispersion terms which are equal to their lower bound of one in the absence of dispersion.

2.7 Calibration

The table below presents the parametrization of the baseline version of the model. It is calibrated for a typical member country of the European Union with a sizable welfare system. The Calvo probabilities for price and wage rigidity are chosen to match the empirical findings of Druant et al. (2009). In their recent study on the Euro Area, the authors report an average lifetime of prices and wages of 9.6 and 12.5 months respectively (excluding the outlier Italy). The elasticity of substitution between different variations of goods and types of labor match the respective mark-ups estimated in Basu and Kimball (1997) and Chari et al. (2002). Steady state government spending of $\bar{G} = 0.2$ is also used in Evers (2012). The steady state size of the social security system $\bar{s}\bar{b}$ of 14.2% steady state GDP is the lowest of the figures observed in the set of Germany, France, Belgium, Austria, the Czech Republic and the Netherlands. Both figures combined imply a public spending ratio of 36%.

Apart from the standard value of 0.95 for the persistence of technology shocks, the parameters governing the processes of technology and government

spending are calibrated to match the moments of output and government spending reported for the Euro Area by Evers (2012).¹² The resulting parameters are roughly in line with the ones used in his study which employs a related model.

The volatility of the size of the social system, i.e. of outflows ssb_t , is used to target a standard deviation of the SCR of 0.35% as observed for the statutory rate in Germany (see introduction). Again note that fluctuations in the size of the system have no effect in the model apart from influencing the SCR.

Table 1: Baseline calibration

Parameter	Value	Motivation / Target
Model 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 Elasticity of substitution goods variations	10	11% price mark-up, Basu and Kimball (1997)
ϵ_w Elasticity of substitution types of labor	7.4	15% wage mark-up, Chari et al. (2002)
θ Calvo probability firms	0.6875	Avg. lifetime 9.6 months, Druant et al. (2009)
θ_w Calvo probability unions	0.76	Avg. lifetime 12.5 months, Druant et al. (2009)
α^π Inflation coefficient in Taylor rule	1.5	Standard
\bar{G} Steady state government Spending	0.2	Evers (2012)
\bar{ssb} Steady state social security expenditures	0.13	14.2% of steady state GDP
σ^{ssb} SD of social security expenditures	0.0007	$\sigma(scr_t) = 0.35\%$
Shock 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 the data
σ^A Std innovations of technology process	0.0044	Matches std(gdp) in the data
σ^G Std innovations of gov't spending process	0.0013	Matches std(G) in the data

3 Nominal volatility and the statutory split

This section establishes why the statutory split of payroll taxation has no long-run implications for the distribution of income and why it nevertheless matters for volatility in nominal variables. The welfare implications of the split are addressed in the subsequent section.

It is well known that the tax incidence from taxing a transaction is under price flexibility independent of the statutory split of the burden between buyer and seller. The allocation of the real tax burden is determined by demand and supply elasticities, while the statutory split of the burden pins down a price for

¹²His sample covers nine European countries (Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal and Spain) over the sample period 1999Q1 to 2007Q4. The author applied an HP filter with smoothing parameter 1600 on the data in logs. He reports standard deviations of output and government spending of 0.87 and 0.83 percent respectively.

which this unique tax incidence prevails. In the DSGE model employed in this study, this result manifests in the context of payroll taxes. Prices and wages adjust such that the real allocation of the burden between production costs and labor income is independent of the statutory breakdown of payroll taxes (i.e. social contributions) between firms and workers.¹³ To see how this result emerges in the model at hand, consider a stylized account in which after tax real profits and after-tax real labor income are governed by

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

where Y denotes output, N total employment and W/P the real wage.

The result is best illustrated by an example. Consider an initial steady state in which prices and wages have fully adjusted such that the ratio between after-tax real profits and after-tax real labor income is on its long-run value, which is determined by the market structure. In this situation, let statutory taxation be surprisingly shifted towards workers, i.e. $\tau^w \uparrow$ and $\tau^f \downarrow$. This change in the tax structure instantaneously increases profits and reduces labor income, because prices and wages do not adjust in real time due to nominal rigidity. Rather, nominal variables start to gradually re-adjust with a decline in prices and an increase in wages.¹⁴ This adjustment raises pre-tax real wages (W/P) which lowers profits and increases labor income, thereby revoking the immediate redistribution towards profit income caused by the shift in the tax structure. This adjustment continues until the initial ratio between profits and labor income is restored. Note that the transitory fluctuations in the labor share are irrelevant in a representative agent framework.

The reason why the statutory split is relevant for the volatility of nominal variables rests on a corollary of this neutrality result. As demonstrated in the example, the shift of statutory taxation towards workers implies an increase in pre-tax real wages. In the aggregate, this corresponds to a rise in gross total labor compensation, which constitutes the tax base of payroll taxes. A higher tax base in turn implies that the adjustment in the SCR required to close a given gap between revenues generated for a given tax base and revenues scheduled by the government – the system’s outflows under a balanced budget – is smaller. This can easily be shown by splitting the variables in the budget into steady state components (denoted by a bar) and deviations (denoted by a delta). The budget (13) then reads as

$$(\bar{s}cr + \Delta scr) * (\bar{t}b + \Delta tb) = \bar{s}sb + \Delta ssb$$

where tb abbreviates tax base. Defining the fluctuating gap as the overhang of fluctuations in outflows over fluctuations in revenues for a given SCR ($gap \equiv$

¹³In the deterministic steady state of the model, real variables including after tax wages and profits are virtually independent of the split of payroll tax collection.

¹⁴Prices decline because $\tau^f \downarrow$ enters marginal costs and therefore reduces the optimal price in FOC (11). Wages increase because optimal wage setting (12) schedules a stabilization of after-tax real wages, implying nominal wages to rise in compensation for $\tau^w \uparrow$.

$\Delta_{ssb} - \bar{s}cr * \Delta tb$) and subtracting the steady state relationship $\bar{s}cr * \bar{t}b = \bar{s}sb$ yields

$$\Delta_{scr} = gap * (\bar{t}b + \Delta tb)^{-1} .$$

Which shows that the adjustment in the SCR required to close a given gap is declining in the steady state tax base.¹⁵ This implies that a given volatility in the gap translates into a smaller volatility in the SCR if the steady state tax base is larger, i.e. if steady state pre-tax real wages are higher.

The account presented so far neglects two aspects in the relationship between the statutory split and nominal volatility that need to be addressed in a general equilibrium analysis. The first is that under nominal rigidity, the short-run impact of a given change in the SCR depends on the statutory split, since the neutrality result is conditional on the adjustment of nominal variables. The second is the systematic dependency of SCR adjustments on business cycle fluctuations. Since shocks driving the business cycle and resulting SCR adjustments exhibit some synchronization – in a degree varied in the welfare analysis – one has to account for how they interfere in general equilibrium. The following subsection provides the full picture of the implications of the statutory split for nominal volatility.

General equilibrium analysis

This subsection contains three exercises. Each contrasts the adjustment to an exogenous shock under the full statutory taxation of workers with the adjustment under the full taxation of firms. The first exercise is a reduction in social security revenues in the magnitude of 1% GDP. The purpose is to illustrate how the magnitude of the required SCR adjustment depends on the statutory split, as well as to account for the difference in the impact on the economy under nominal rigidity. The second and the third exercise show the adjustment to a productivity and a demand shock. As the SCR endogenously adjusts to fluctuations in the tax base, the analysis accounts for its empirically documented counter cyclical dynamic. The description of all exercises focuses on the fluctuations in nominal variables, since the dependency of nominal volatility on the statutory split is shown to be driving the welfare results presented in the next section.

Exogenous change in social security revenues

The figure below shows the adjustment to an exogenous reduction of social security revenues in the magnitude of 1% GDP if these are fully collected from firms (solid lines) respectively from workers (lines marked by circles).¹⁶

¹⁵Taking the derivative w.r.t. $\bar{t}b$ yields $(\delta\Delta_{scr}) / (\delta\bar{t}b) = -gap * (\bar{t}b + \Delta tb)^{-2} < 0$.

¹⁶The change in the size of the social system is modeled as AR(1) with $\rho = 0.9$ to be roughly as persistent as the structural shocks under consideration.

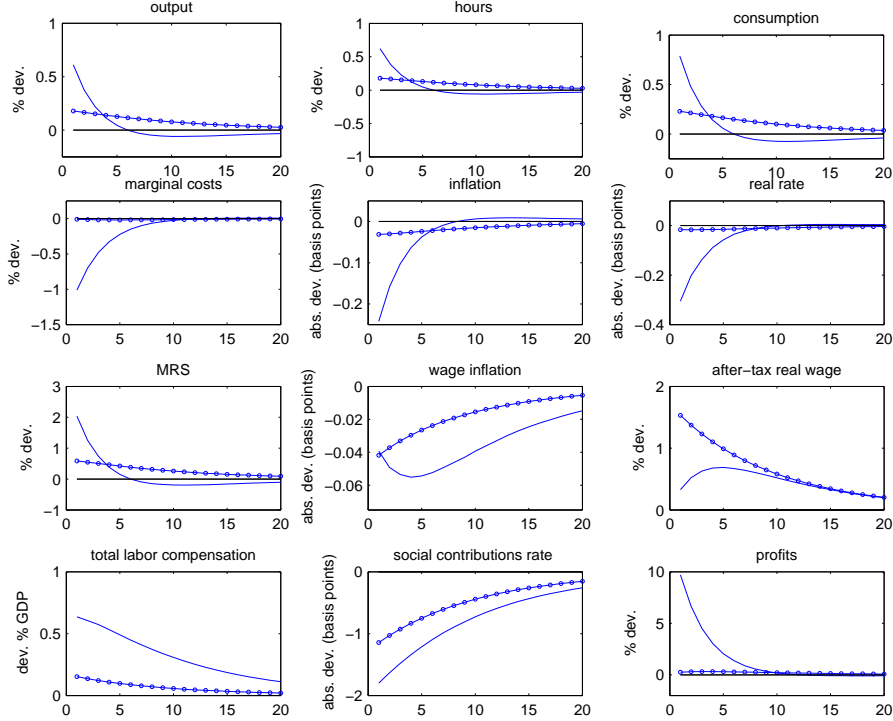


Figure 2: Reduction of social security revenues in the magnitude of 1% GDP. Solid lines: taxing firms vs. marked lines: taxing workers.

Before turning to the differences in the adjustment in both scenarios, notice that for the reason outlined above, the decline in the SCR required to lower revenues by 1% GDP is substantially weaker if they are collected from workers. We begin by examining the scenario of full taxation of firms (no markers). The reduction of the SCR directly reduces effective marginal costs, which leads firms to reduce prices and the central bank to respond by implementing a negative deviation of the real interest rate. Consumption and output surge as a result. Regarding the evolution of wages, we observe a decline in wage inflation but an increase in after-tax real wages. To understand this adjustment, recall that labor unions' FOC (12) schedules a stabilization of future after-tax real wages around a mark-up over future marginal rates of substitution. Since the strong decline in prices elevates after-tax real wages on a level above the one which is optimal for the equilibrium path of the MRS, labor unions reduce nominal wages. The adjustment of wage inflation has a hump-shaped form because this downward pressure on wages is at the beginning of the adjustment compensated by the initial jump of the MRS, in turn resulting from the surge in hours.

Turning to the adjustment under full taxation of workers (marked lines),

we observe that the surge in output and hours is roughly one third of the magnitude as in the opposed scenario. This is because the reduction in the real rate is considerably weaker, due to the fact that real marginal costs and prices do not decline nearly as much as in the adjustment under the collection from firms. This is for two reasons. The first is that a given decline in the SCR has a weaker effect on marginal costs if taxes are collected from workers. In this case, the reduction in the SCR does not directly enter marginal costs – as it is the case in under the collection from firms – but only affects marginal costs indirectly via slowly adjusting nominal wages. The second reason is that the magnitude of the decline in the SCR is smaller, from the reasoning outlined at the beginning of this section.

Concerning the adjustment of wages, we again observe a decline in newly set nominal wages but a rise in after-tax real wages. The explanation is similar to the one in the scenario of taxing firms: The reduction of payroll taxes (instead of a reduction of prices) pushes after-tax wages on a level exceeding the optimal one for the given path of the MRS. As a result, newly set wages are reduced to compensate for the reduction in the SCR.

Since the dependency of nominal volatility on the statutory split drives the welfare results, it is useful to conclude by comparing the adjustment of prices and wages under both scenarios. The decline in price inflation is many times stronger if they are collected from firms because the reduction of the SCR then enters marginal costs directly, and because the reduction in the SCR itself is stronger. Concerning wage inflation, we also observe a larger negative deviation if taxes are collected from firms, although the difference between both scenarios is not nearly as great as for price inflation.¹⁷ The explanation why the decline in wage inflation is stronger under the collection from firms lies in the equilibrium path of the MRS. Only in this scenario it deviates negatively in the medium run, leading labor unions to adjust nominal wages downwards.¹⁸

Productivity disturbances

The next figure shows the adjustment to a positive productivity shock in the magnitude of one standard deviation. Plain lines (lines marked by circles) depict

¹⁷Accordingly, the implications of the statutory split for mean price dispersion are more important in the welfare analysis than its implications for mean wage dispersion.

¹⁸In explaining this path of the MRS, we start with the observation that price inflation deviates positively from period 7 on. This inflation leads the central bank to raise the real interest rate and thereby to lower consumption and output, which drags the MRS below its steady state value during the late phase of the adjustment.

The positive deviation of inflation from period 7 has to be due to an increase in marginal costs (barely visible in the plot), which constitute pre-tax real wages since the firm pays no taxes in this scenario. The reason why we only observe a sustained increase in pre-tax real wages under the collection of taxes from firm is the strong initial deflationary impulse occurring in this case. This short-lived impulse pushing up real wages has a sustained impact because nominal wages do only adjust sluggishly. Hence, in the late stage of the adjustment, the remaining positive deviation of real wages is dismantled by negative wage inflation and positive price inflation. In the opposed scenario, the deflationary impulse is comparably negligible while the initial decline in the SCR pushing up the after-tax real wage has no direct effect on marginal costs.

the adjustment if payroll taxes are fully collected from firms (workers).

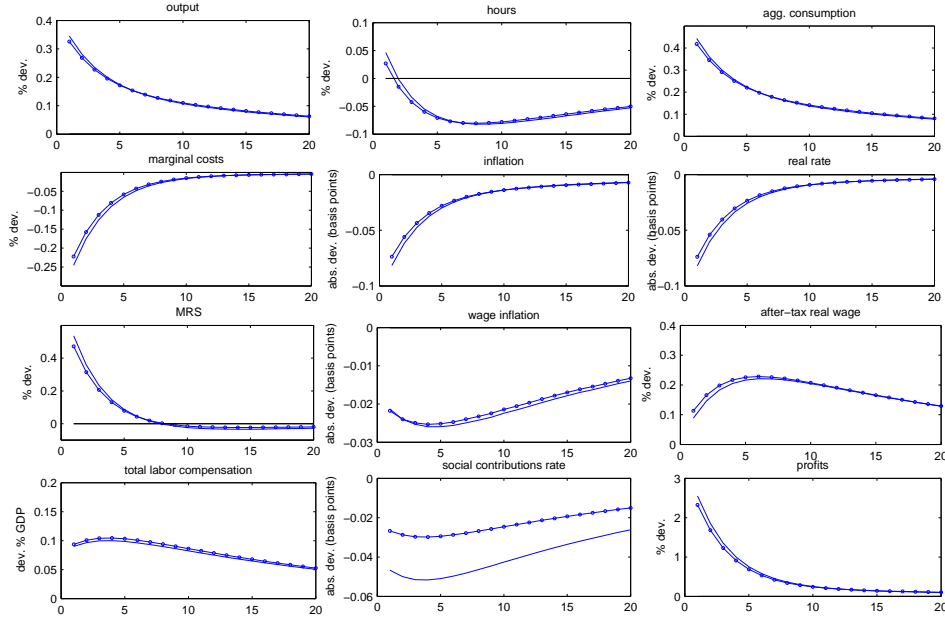


Figure 3: Positive one STD productivity shock.
Solid lines: taxing firms vs. marked lines: taxing workers.

Before we turn to the implications of the split of collection, we briefly discuss the economy's general adjustment to the shock. The reduction in marginal costs from the gain in productivity leads firms to lower prices, which in turn causes the central bank to implement a decline in the real interest rate. This causes households to increase consumption. Regarding output and hours, we observe that labor demand, and with it hours, decline despite the surge in production because the gain in productivity reduces the amount of hours required per unit of output. The MRS deviates positively for about 1.5 years because the decline in marginal utility overcompensates the decline in the disutility of labor. In their decision on newly set wages, labor unions take into account this increase in the MRS as well as the decline in consumer prices. As the latter dominates, we observe a decline in wage inflation. Regarding real wages, the drop in prices overcompensates the gradual decline of nominal wages, implying a positive deviation.

With increasing total labor compensation, the SCR has to decline to maintain a balanced budget for constant outflows of security program. In line with the explanation at the beginning of the section, holding revenues constant requires the SCR to drop by more under the taxation of firms, because the steady state tax base is smaller. Notice that the positive productivity disturbance

lowers prices and nominal wages, and at the same time triggers a downward adjustment of the SCR in compensation for the rise in the tax base. The latter does, in line with the previous IRF, also exert downward pressure on nominal variables. Hence, the effect on nominal variables originating from the productivity shock and from the resulting adjustment in the SCR have the same sign, i.e. they complement each other.

Demand disturbances

The next figure shows the adjustment to a positive government spending shock in the magnitude of one standard deviation. Regarding the general adjustment, we observe that the bulk of additional government consumption is covered by a surge in output, which implies a very mild consumption crowding out. This is due to wage rigidity: As nominal wages slowly adjust to the increment in disutility of labor, the rise in output only causes a moderate hike in marginal costs. This limits the induced inflation and thereby reduces the strength of the resulting contractionary monetary policy stance, i.e. of driving force of consumption crowding out. The output expansion implies an increase in total labor compensation which requires a downward adjustment of the SCR.

Under taxation of workers (marked by circles), marginal costs are only affected by the growth in nominal wages resulting from the surge in disutility of labor. The emerging inflationary pressure leads the central bank to implement a rise in the real rate, causing consumption to decline. The adjustment of real marginal costs is substantially different if social contributions are collected from firms (no circles). In this case, the reduction in the SCR overcompensates the rise in nominal wages at the beginning of the adjustment, leading to the hump-shaped path of inflation. The resulting monetary policy causes consumption to decline in a hump-shaped manner as well.

In the context of demand disturbances, no clear-cut picture arises on whether the statutory taxation of firms or workers is more favorable in terms of nominal volatility. The examination of the ergodic distribution in the context of the welfare analysis shows that the collection from workers slightly reduces the volatility of price and wage inflation, but to an insignificant magnitude.

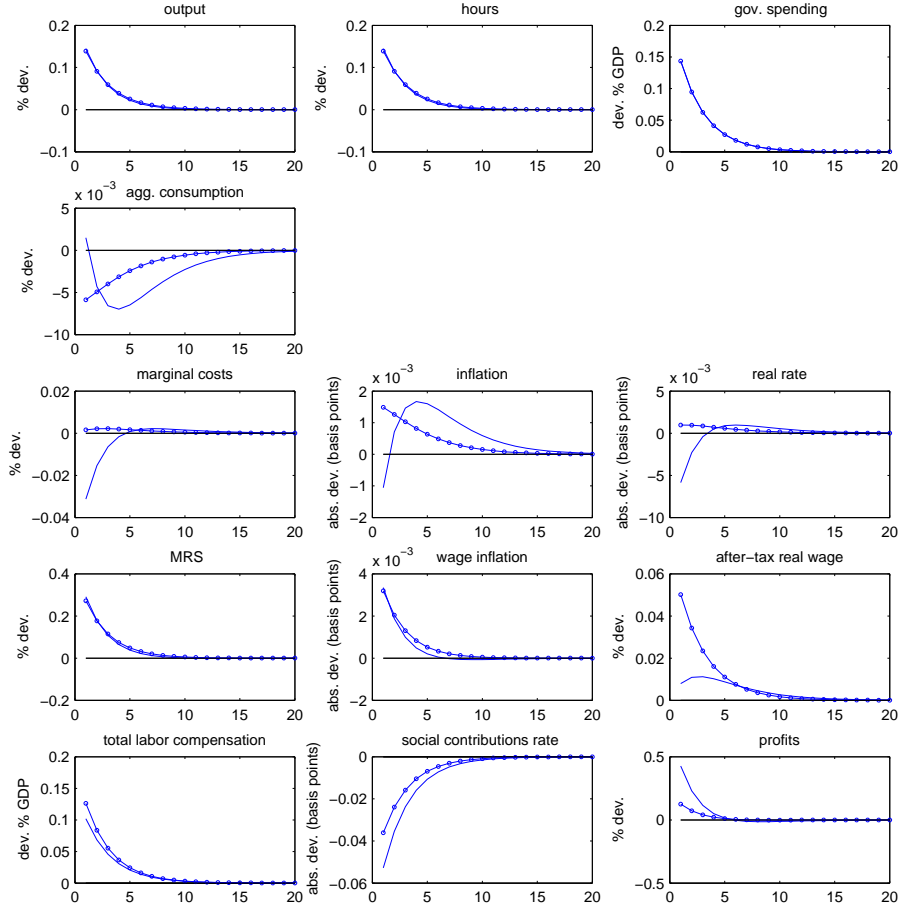


Figure 4: Positive one STD government spending shock.
Solid lines: taxing firms vs. marked lines: taxing workers.

4 Welfare analysis

This section first elaborates on the technical details of the welfare analysis and subsequently presents the results for the baseline model, as well as for a generalization of the dynamics in the size of the social system. The metric employed to compare welfare under different splits of payroll tax collection is consumption compensation for business cycle fluctuations. For some split A , I compute the percentage value ν^A for which it holds that the agent is equally well off in the

ergodic distribution of the model as in the deterministic steady state, given that consumption is reduced by ν^A percent. This commonly applied measure goes back to Lucas (1987) and Lucas (2003). Welfare is defined as the discounted sum of future and present flow utility, so it holds for the welfare compensation of some split A that

$$\mathbb{E} \sum_{t=0}^{\infty} \beta^t U(c_t^A, n_t^A) = \sum_{t=0}^{\infty} \beta^t U((1 + \nu^A) \bar{c}, \bar{n}) \quad . \quad (15)$$

That is, the unconditional expectation of the agent's welfare in the ergodic distribution of the model equals his/her welfare in the deterministic steady state of the model, given that consumption is scaled by ν^A .

Following Evers (2012), Taylor-Approximations are applied on both sides to express ν^A as a function of first and second moments of the ergodic distribution. This allows to decompose the total welfare loss arising from the stochastics into its components, i.e. into the contributions of the volatility of consumption and hours and the deviations of their unconditional expectations from their deterministic steady state values.¹⁹ A flawless welfare analysis requires very precise figures of second-order accurate first and second moments of the ergodic distribution. To obtain perfectly precise figures, the equilibrium conditions are not linearized but written in a recursive form as in Schmitt-Grohé and Uribe (2007). Then, Dynare is used to employ a second-order accurate perturbation method.²⁰ The moments are obtained analytically under the use of the nonlinear moving average method developed by Lan and Meyer-Gohde (2013).²¹

In the following, this section computes the welfare costs of fluctuations under variation of the statutory split of social security revenues. Using this method to evaluate the welfare implications of the statutory split is only admissible because the real allocation in the deterministic steady state, and thereby the right hand side of (15), is independent of the split.²² This makes the welfare costs computed under different statutory splits comparable because they have a joint reference point.

4.1 Welfare results for the baseline model

This subsection reports welfare results for the baseline model in which outflows are assumed to fluctuate exogenously. The table shows welfare costs of fluctuations as well as moments of selected macro aggregates in dependency of the

¹⁹The functions and details on their derivation are provided in the appendix.

²⁰Kim and Kim (2003) show that welfare analysis based on first-order accurate second moments are prone to yield spurious results.

²¹The Dynare add-on provided by the authors does not directly report variances around deterministic steady state values, as required to compute consumption compensations. The required statistics can easily be recovered from the output of the software. Details are available upon request.

²²The flexible-price allocation holds in the deterministic steady state. As the neutrality result of tax incidence applies for the latter, the statutory split is of no consequence for real after-tax variables and therefore of no consequence for the welfare of the agent.

statutory split. Columns labeled 'workers' ('firms') report figures arising under the full statutory taxation of workers (firms). In addition to the full stochastic setup, the results are also reported for productivity and demand disturbances in isolation. Note that a negative welfare loss implies that the agent suffers from the stochastics, i.e. consumption in the deterministic steady state has to be reduced to make him/her as well off as in the stochastic setup.

Table 2: Welfare costs of fluctuations, baseline model

	Both shocks			Only productivity shocks			Only Demand shocks		
	Workers	Firms	%-diff.	Workers	Firms	%-diff.	Workers	Firms	%-diff.
Welfare loss of fluctuations	-0.0800	-0.0890	-11.25	-0.0797	-0.0887	-11.29	-0.0009	-0.0025	-171.10
Decomposition:									
mean cons.:	-0.1458	-0.1582	-15.58	-0.1455	-0.1580	-15.64	-0.0016	-0.0039	-246.70
mean hours:	0.0735	0.0770	4.31	0.0734	0.0768	4.35	0.0010	0.0017	71.07
volatility cons.:	-0.0061	-0.0061	0.02	-0.0061	-0.0061	0.03	-0.0001	-0.0001	2.53
volatility hours:	-0.0016	-0.0016	-0.01	-0.0015	-0.0015	-0.02	-0.0002	-0.0002	1.99
Moments									
Mean output*	0.9165	0.9164	-0.08	0.9165	0.9164	-0.08	0.9176	0.9176	-0.02
Mean consumption*	0.7166	0.7165	-0.12	0.7166	0.7165	-0.12	0.7176	0.7176	-0.02
Mean hours*	0.9169	0.9168	-0.04	0.9169	0.9168	-0.04	0.9176	0.9176	-0.01
Std. dev. consumption	0.0079	0.0078	-0.32	0.0079	0.0078	-0.32	0.0010	0.0008	-13.54
Std. dev. hours	0.0056	0.0056	2.26	0.0053	0.0054	4.60	0.0020	0.0019	-48.77
Std. dev. SCR	0.0031	0.0041	35.78	0.0030	0.0041	35.88	0.0029	0.0039	35.57
Std. dev. inflation	0.0028	0.0029	5.99	0.0028	0.0029	5.98	0.0001	0.0005	264.66
Std. dev. wage inflation	0.0017	0.0018	2.87	0.0017	0.0018	2.87	0.0001	0.0002	66.00
Mean disp. good variations ^X	0.2720	0.3054	12.29	0.2720	0.3053	12.27	0.0008	0.0100	1229.78
Mean disp. labor types ^X	0.1453	0.1537	5.78	0.1452	0.1536	5.79	0.0011	0.0031	175.54

*Changes are reported in units per mill.

^XDispersion terms are reported as deviations from one in units per mill.

Before turning to the differences in the outcomes under both sides of taxation, it is useful to discuss some general implications of the stochastics in the model. The first is that with regard to the induced welfare losses, volatility of consumption and hours are of negligible importance compared to the deviations of their unconditional means from deterministic steady state values.²³ This allows us to focus on the latter.

Differences between unconditional expectations of the ergodic distribution and deterministic steady state values arise because production efficiency is lower in the stochastic setup. In the face of a decline in productivity, households work fewer hours (increasing welfare) and consume less (reducing welfare), resulting in a reduction in overall welfare. The productivity loss can be traced back to inefficiencies in the equilibrium allocation of the model, which are ultimately driven by the willingness of firms and labor unions to adjust prices and wages.

²³In the full stochastic setup and averaging over the outcomes under both sides of taxation, the total loss from volatility in consumption and hours sums up to roughly 0.008, while the total loss due to changes in means amounts to 0.076.

This willingness does not only lead to price and wage inflation, but also to the emergence of dispersion across prices (wages) charged by different firms (unions). The reason is that only a random share of entities is allowed to reset nominal variables in a given period. While price dispersion causes households to consume differing quantities of different good variations, wage dispersion leads firms to employ varying amounts of different types of labor. As a result, Jensen’s Inequality applies for aggregators (2) and (6). This efficiency loss – the amount of goods (labor) required for one unit of the final good (labor composite) increases – manifests in the emergence of resource costs in the aggregate resource constraint (14).

The second general property is that the welfare costs arising from demand disturbances are negligible compared to the welfare costs due to productivity shocks.²⁴ The reason is that, line with the IRFs presented in the last section, this type of shock induces a much smaller volatility in nominal variables.

Turning to the welfare implications of the statutory split, we observe that the welfare loss of business cycle fluctuations under the full taxation of firms is by 11.25% larger than under the taxation of workers. In understanding this result, the two general properties allow us to focus on the implications of the statutory split for the expected production efficiency in the context of productivity disturbances. The explanation rests on the insights of section 3: The volatility in the funding gap (originating from fluctuations in the tax base caused by productivity shocks as well as from the independent fluctuations in outflows) translates into a smaller volatility of the SCR if workers are taxed. That is, $\sigma(\text{scr}_t)$ is by 35% larger under the taxation of firms than under the taxation of workers. A reduction in the volatility of the SCR has the effect of reducing the expected magnitude of price and wage dispersion, implying a reduction of inefficiencies and thereby of the welfare loss. The reason is that fluctuations in the SCR translate into fluctuations in after-tax real wages (if workers are taxed) and gross marginal costs (if firms are taxed). Hence, they give rise to the willingness of firms (labor unions) to re-adjust prices (wages), which is the driving force of dispersion as explained above. This can be seen in the reported moments. Under taxation of firms, the standard deviation of inflation (wage inflation) is by 5.99% (2.87%) larger than under taxation of firms, implying that expected price (wage) dispersion is by 12.29% (5.78%) larger. This in turn implies that production efficiency is lower under the taxation of firms, which leads the households to work less and consume less, reducing overall welfare.

So far, we only compared the outcomes under the full taxation of either firms or workers. The following plot shows the functional form the dependency of the welfare loss on the statutory split. The analysis shows that it is almost perfectly linear.

²⁴Averaging over the outcomes under both sides of taxation, productivity shocks cause a loss of 0.0842, while the figure for demand shocks is 0.0017.

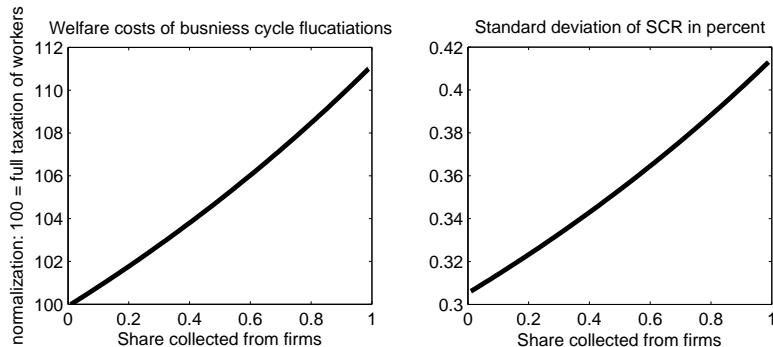


Figure 5: Functional form of the dependency of welfare costs and $\sigma(scr)$.

4.2 Generalizing the dynamics of the financing needs

In the baseline calibration, the system's outflows ssb_t fluctuate exogenously with a std. dev. of 0.5% of their steady state value. This pins down one specific dynamic of the funding gap between scheduled revenues and actual revenues generated for the given tax base and SCR. For this dynamic, holding the gap closed by adjusting the SCR yields empirically plausible moments of $\sigma(scr_t) = 0.35\%$ and $\rho(scr_t, gdp_t) = -0.4$. In this subsection, the analysis is extended by generalizing the dynamics of the gap.

A dynamic of the funding gap is characterized by the resulting dynamic in the SCR, i.e. by the dynamic in the SCR implied by the requirement that it adjusts to close the gap in every period. In particular, the dynamic of a gap is summarized by $\sigma(scr_t)$ and $\rho(scr_t, gdp_t)$ as they arise under equal statutory taxation of both sides. To see why it is suitable to report welfare results not in dependency on statistics of the gap but in dependency on statistics on the statutory SCR, two remarks are in order.

The first is that adjusting the statutory SCR constitutes the discretionary policy decision of a government to affect the budgetary position of a social welfare program. As such, it summarizes a multiple of factors relevant to the government, including the budgetary stance of the system and the degree of the adherence to the balanced budget principle. That is, an adjustment in the statutory SCR compresses the complex decision taking of a government into the one aspect relevant for this finding of paper, i.e. into the decision to affect the financial position of the system by a given amount. Hence, observed dynamics in the statutory SCR constitute a valid empirical counterpart to assess the relevance of the findings. The second remark is that modeling fluctuations in the funding gap constitutes, as explained in section 2.4, nothing more than an otherwise neutral way to introduce volatility in the decision of a government to influence the financial stance of the system. This implies that it is admissible to use ad-hoc assumptions on the dynamics of the funding gap to target dynamics in the statutory SCR. The reason is that an ad-hoc assumptions on the behavior

of the gap does – due to the neutrality – not introduce any unfounded economic behavior of agents.

Turning to the technical details, different dynamics in the gap are generated by abandoning the assumption of independent outflows ssb_t . Instead, ssb_t is linked to output in an ad-hoc fashion that allows to target $\sigma(scr_t)$ and $\rho(scr_t, gdp_t)$ of the the SCR adjusting to close the gap at all times. The dynamics of ssb_t can be used to target these two moments for the following reason: As apparent in the budget (13), changes in outflows ssb_t cause the SCR to move in the same direction for a given tax base. Since output and total labor compensation closely move together, adjusting the magnitude of independent fluctuations in ssb_t , as well as the strength of its alignment to output, allows to target the resulting moments $\sigma(scr_t)$ and $\rho(scr_t, gdp_t)$.²⁵ To achieve e.g. independent fluctuations of the SCR, the alignment of ssb_t to output is chosen such that ssb_t moves in a way to compensate in the system’s budget (13) for movements in total labor compensation – which is possible since the latter is systemically linked to output. In this case, the cyclicity arising from the balanced budget rule would be deactivated, and movements in the SCR originate solely from its independent component.

The following graph shows the results. For its construction, ad-hoc dynamics of ssb_t are used to target tuples of $\sigma(scr_t)$ and $\rho(scr_t, gdp_t)$ as they arise for the specific dynamic of the gap under equal taxation of firms and workers. The grid of target values spans empirically plausible values.²⁶ For each gridpoint, the main exercise – comparing welfare costs under the full taxation of firms respective workers – is repeated.

²⁵In order to be able to adjust the portion of independent fluctuations of ssb_t as well as the strength of its link to output, outflows are governed by $ssb_t = \bar{ssb} + fluc_t$ with \bar{ssb} being constant and

$$fluc_t = 0.95 * fluc_{t-1} + \alpha \epsilon_t^{ssb} + \beta \epsilon_t^A .$$

While ϵ_t^{ssb} are independent innovations, ϵ_t^A is the same shock as in the technology process entering the production function (5). Since technology fluctuations are the predominant driver of output fluctuations, parameters α and β govern not only the magnitude of volatility in ssb_t but also the strength of its alignment to output. Hence, α and β lend themselves to target $\sigma(scr_t)$ and $\rho(scr_t, gdp_t)$, which are influenced by ssb_t in the budget equation.

²⁶Positive correlations between SCR and output are not considered because they are of minor empirical relevance according to the findings of Burda and Weder (2014) (see table 7), as well as from the classic argument that expenses of unemployment insurance schemes rise during recession.

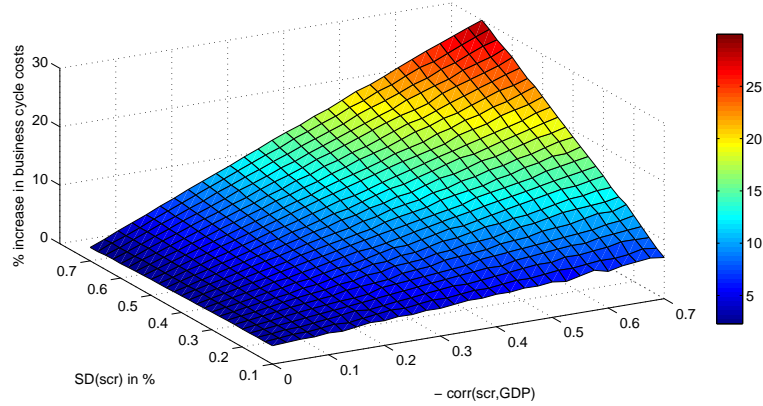


Figure 6: %-increase in welfare costs of business cycle fluctuations from full shift of taxation from workers towards firms.

The welfare loss from shifting the statutory taxation from workers to firms increases in $\sigma(scr_t)$, i.e. in the volatility of the underlying funding gap. The slope of this dependency increases in the strength of the negative correlation between SCR and GDP.²⁷ The first observation, that the welfare loss increases along the $\sigma(scr_t)$ -axis, is straightforward to explain. If the financial requirements of the welfare system are more unstable (i.e. if fluctuations in the funding gap are stronger), the volatility in nominal variables brought about by the associated SCR adjustments is larger. Hence, inducing a proportionate reduction of this nominal volatility by shifting the taxation from firms to workers implies a stronger decline of overall nominal volatility and thereby a stronger reduction of welfare costs.

To understand why the slope in $\sigma(scr_t)$ -direction increases along the axis of $-\rho(scr_t, gdp_t)$, it is useful to distinguish between the following two sources of volatility in nominal variables: While most of the movement is driven by exogenous disturbances (predominantly productivity shocks), another portion of movement in prices and wages is due to the adjustment of the SCR. Now consider how the movements originating from the two sources are related, by revisiting the IRFs presented in section 3. Figure 3 shows that productivity disturbances push output in the opposed direction than prices and wages,²⁸ while figure 2 shows that movements in the SCR pull prices and wages in the same direction (with the magnitude depending on the statutory split). This implies for the limiting case of $\rho(scr_t, gsp_t) = -1$ that e.g. a positive productivity shock, exerting downward pressure on nominal variables, is always accompanied by

²⁷The welfare gain also increases at the left border of the graph, i.e. for $\rho(scr_t, gdp_t) = 0$. Due to the scaling on the graph, the slope is not visible.

²⁸In figure 3, the balanced budget assumption holds for generating the IRF, implying that the adjustment to the shock is overlain by an adjustment in the SCR. However, since the SCR adjustment has a small influence on the IRF relative to the productivity shock, we can learn from it that the shock drives prices and wages in the opposed direction than output.

a downward adjustment in the SCR which has a rectified effect on prices and wages. More generally, $\rho(\text{scr}_t, \text{gdp}_t) < 0$ implies that the dynamics of the funding gap tend to trigger adjustments in the SCR which move nominal variables in the same direction as productivity shocks.

In a simplified perspective, one can interpret the overall movement of nominal variables as the sum of two random variables, each representing the movement originating from one of the two sources of nominal volatility. In this interpretation, a higher magnitude of $-\rho(\text{scr}_t, \text{gdp}_t)$ translates into a stronger positive correlation between the two random variables, since it synchronizes the rectified effect on nominal variables originating from both sources. This explains why the slope of the reduction in welfare costs along the $\sigma(\text{scr}_t)$ -axis increases for stronger negative correlations: Denoting changes in nominal variables caused by productivity shocks as a random variable A and changes caused by SCR adjustments by B, total variance in nominal variables is governed by $\sigma(A)^2 + \sigma(B)^2 + 2\rho(A, B)\sigma(A)\sigma(B)$. It follows that a marginal reduction in $\sigma(B)$ (i.e. in the volatility in nominal variables stemming from SCR adjustments) lowers total nominal variance by $2\sigma(B) + 2\rho(A, B)\sigma(A)$. Hence, reducing $\sigma(B)$ by shifting the statutory taxation from firms towards workers implies a stronger decline in total nominal volatility – and thereby in welfare costs – if $\rho(A, B)$ is larger, which is the case for a higher value of $-\rho(\text{scr}_t, \text{gdp}_t)$.

The intuition is best explained by considering the limiting in which movements in nominal variables originating from productivity shocks and SCR changes are uncorrelated. In this case, movements from both sources are as likely to cancel each other out as they are likely to complement each other. Limiting the movements from one source does therefore also reduce the magnitude of neutralization if both movement occur to be directed in opposed directions. Hence, reducing the volatility in nominal variables originating from SCR changes has the undesirable side effect of limiting the degree of this neutralization. In the other limiting case of perfect positive correlation between the movements in nominal variables from both sources (i.e. the case of $\rho(\text{scr}_t, \text{gsp}_t) = -1$), neutralization between both movements has a probability of zero. Hence, reducing the volatility stemming from one source does not entail a reduction in the magnitude of possible neutralization, implying that its impact on total nominal volatility is stronger.

In the light of the empirical findings for $\sigma(\text{scr}_t)$ and $\rho(\text{scr}_t, \text{gdp}_t)$ reported in table 5 and 6, the analysis suggests that there is room for substantial welfare improvements in many OECD countries.²⁹ Given the current split of payroll

²⁹There is a drawback in using the results from table 7 and 7 to assess the quantitative results of this paper. These figures are reported for a measure of the SCR which is constructed as the ratio of social security revenues to total labor compensation ('effective SCR'). Therefore it is possible that a portion of the volatility in this measure is due to caps to social security contributions: Since total labor compensation varies over the cycle, the share of contracts for which the caps are binding is also cyclical. This dynamic affects total revenues and thereby the 'effective SCR' employed in calculating the descriptive statistics.

The theoretical argument made in this paper rests on movements in the statutory SCR mirroring fluctuations in the 'funding gap' of the system. The portion of volatility in the 'effective SCR' that is due to caps can not directly be related to fluctuations in the funding

taxation found in table 7, the feasible reduction of business cycle costs in Germany, France, Belgium and Austria amount to roughly 7%, 6%, 8% and 5% respectively.

5 Robustness analysis

This section examines the sensibility of the results to parameter choices. While table A replicates the results from the baseline calibration depicted in figure 6 above, the remaining tables report the results for modifications of the model.

Table 3: Robustness exercises

		Baseline calibration									A: Avg. lifetime prices and wages of one year								
		SD(scr_t)	0.1	0.2	0.3	0.4	0.5	0.6	0.7			SD(scr_t)	0.1	0.2	0.3	0.4	0.5	0.6	0.7
-corr(scr_t, GDP_t)	0.1		3.7	4.2	4.7	5.2	5.6	6.0	6.3	-corr(scr_t, GDP_t)	0.1		3.2	3.8	4.4	4.8	5.4	5.6	6.2
	0.2		4.2	5.2	6.7	7.5	8.5	9.5	10.4		0.2		3.7	4.6	6.2	7.0	8.2	9.0	10.2
	0.3		4.7	6.2	8.3	9.9	11.5	12.9	14.5		0.3		4.2	6.5	7.6	9.4	10.9	12.4	13.9
	0.4		4.6	7.9	9.5	11.6	14.3	16.5	18.1		0.4		5.3	7.3	9.7	12.0	13.7	15.8	17.9
	0.5		6.3	8.8	11.6	14.0	16.9	19.6	22.5		0.5		5.2	8.2	11.0	14.2	16.2	18.8	21.7
	0.6		6.3	9.8	12.9	16.4	20.1	22.8	25.9		0.6		6.3	9.7	12.8	16.2	19.3	21.9	25.6
	0.7		7.3	11.3	15.4	18.5	22.4	26.5	28.9		0.7		6.2	11.2	14.1	18.3	21.5	25.6	27.1
		B: Less responsive monetary policy									C: Smaller social security system								
		SD(scr_t)	0.1	0.2	0.3	0.4	0.5	0.6	0.7			SD(scr_t)	0.1	0.2	0.3	0.4	0.5	0.6	0.7
-corr(scr_t, GDP_t)	0.1		3.8	4.3	4.7	5.0	5.3	5.6	5.8	-corr(scr_t, GDP_t)	0.1		3.2	3.7	4.1	4.6	4.9	5.4	5.7
	0.2		4.2	4.8	6.0	6.5	7.4	8.1	8.8		0.2		3.6	4.6	5.7	6.9	8.0	9.0	9.6
	0.3		4.6	6.2	7.0	8.3	9.4	10.5	11.7		0.3		4.1	5.5	7.5	9.2	10.9	12.5	13.3
	0.4		5.4	6.8	8.5	10.1	11.4	13.0	14.5		0.4		4.6	7.1	9.5	11.6	14.1	15.9	17.5
	0.5		5.3	7.5	9.4	11.7	13.7	15.5	17.1		0.5		5.1	8.6	11.4	13.7	16.5	19.8	22.2
	0.6		6.1	8.6	10.8	13.2	15.3	17.7	19.9		0.6		5.6	9.5	12.5	16.5	19.5	22.8	26.6
	0.7		6.0	8.8	12.1	15.1	17.4	19.7	19.7		0.7		6.1	11.5	14.3	18.5	22.3	25.0	25.0

Exercise A: Avg. lifetime of prices and wages of one year

Calvo-Probabilities of price and wage adjustments are set to $\theta = \theta_w = 0.75$, implying an average lifetime of prices and wages of one year. Relative to the baseline calibration prices are more sticky, whereas wage rigidity is almost identical. The welfare difference between the outcomes under the taxation of firms and workers shrinks to a small extent, not qualitatively changing the results. The reason is that the difference whether changes in the SCR enter marginal costs directly (if firms are taxed) or via slowly adjusting wages (if workers are taxed) matters less for the volatility of inflation if prices are more sticky.

gap, and is therefore not informative about the empirical relevance of the finding of this paper.

However, the example of Germany suggests that movements due to caps are not necessarily of major relevance. Figure 7 in the appendix contrasts trend deviations of the statutory SCR (not picking up the effect of caps) with deviations of the 'effective' SCR (picking up the effects of caps). Both series move closely together, with a correlation coefficient of 0.74.

Exercise B: Less active monetary policy

The assumption of independent monetary policy maintained in the baseline version of the model is odd in the context of countries belonging to the European Monetary Union. While a thorough analysis requires an open-economy setup – which is a promising direction for further research – this robustness exercise seeks to draw near this analysis by reducing the responsiveness of monetary policy. In this exercise the model represents a country of the EMU core region defined as Germany, France, Austria, Belgium and the Netherlands. As the size of the social system exceeds 14% GDP in all of these countries (see table 7 in the appendix), they well match the calibration for sizable welfare states. With a total population of 183.12 million, this set covers more than half of the population in the Eurozone and has, according to the ECB’s 2014 HICP country weights, a weight of 60.2% in the average inflation measure.

From the perspective of an individual Eurozone country, the responsiveness of monetary policy to the domestic macroeconomic environment does not only depend on the size of this country, but also on the synchronization between this country’s and other Eurozone countries’ business cycles.³⁰ A large majority of the studies on European business cycle synchronization (surveyed e.g. by de Haan (2008) and Jones et al. (2012)) find a high degree of synchronization across the EMU core counties, which in all studies include Germany, France and Austria. This is in line with the classic study of Bayoumi and Eichengreen (1994), who found that the set defined as EMU core in this exercise is a suitable candidate for a currency area because of the high correlation of supply shocks across these countries. On the background of these empirical findings, this robustness exercise treats the EMU core as one country entering the measure of union-wide inflation with a weight of 60.2%.³¹ The adjustment in this exercise consists of adapting the active portion of monetary policy (i.e. the change of the nominal interest rate exceeding the inflation rate) to the weight of the EMU core. Given that the baseline calibration features the standard inflation coefficient of 1.5, the responsiveness of monetary policy to inflation in the EMU core amounts to $\alpha_{core}^{\pi} = 1 + 0.5 * 0.602 = 1.301$.

Panel C shows that the results implications of the statutory split become slightly weaker in a monetary union, but do not change qualitatively. However, these results are only a rough approximation of a monetary union setup, as the latter has to be modeled as open economy.

Exercise C: Smaller social security system

Reducing the steady-state size of the social security system to 10% GDP (i.e. $\bar{s}b = 0.09$) only causes a slight reduction of the relevance of the split of payroll tax collection. This result is due to the nature of the exercise which holds the

³⁰In the limiting case of perfect synchronization between all member countries, a union-wide monetary policy could not be distinguished from the individual conduct of monetary policy in all member countries.

³¹Equivalently, one can think of the model to represent one country belonging to the set under the assumption of perfect correlation of inflation rates.

dynamics of the SCR constant over the different robustness checks, and thereby effectively decouples them from the size of the system. This finding confirms the insight that only SCR dynamics drive, not the size of the system itself, the results of this paper.

6 Conclusion

The paper uses a standard DSGE model to establish a theoretical link between the statutory split of payroll taxation between firms and workers and the volatility in nominal variables caused by productivity and demand fluctuations. In a model calibrated to a typical Euro Area country with a sizable social security system featuring counter cyclical SCR dynamic as reported in Burda and Weder (2014), the full taxation of firms increases the welfare costs of business cycle fluctuations by 11.25% relative to the figure under the full taxation of workers. Improving the design of a social system along this dimension constitutes a Pareto improvement, given that the one-time tax shift is fully anticipated. From the perspective of a policymaker, this result is of high relevance since the implementation of the Pareto improvement does not require to dispose public funds, and does not interfere with the property of social systems to provide stabilization in a Keynesian fashion.

With regard to real-world applicability, the findings of this study have to be taken with a grain of salt. While the structure of the model is sufficiently rich to allow for the mechanism that gives rise to the macroeconomic relevance of the statutory split, it is hardly encompassing enough to provide a realistic account of European economies. There are several modeling dimensions which are presumably relevant for the results, and therefore constitute a promising direction for further research. Introducing credit constrained Rule-of-Thumb consumers who do not earn profit income as in Galí et al. (2004) would allow to account for short-term redistribution in the course of unanticipated SCR changes. This would affect aggregate demand via the different propensities to consume between both groups. Further extensions of potential interest are the inclusion of capital, as well as allowing for trade in an open economy setup. The latter generalization is especially interesting if the model represents a member country of a monetary union. Since the literature on optimal currency areas identifies price stickiness as the root for the costs of belonging to a union, the split of collection with its impact on price setting is of potential relevance in this context.

7 Appendix

Derivation of (14):

Starting with

$$N_t = \int_0^1 \int_0^1 n_t(i, j) di dj = \int_0^1 \int_0^1 \frac{n_t(i, j)}{n_t(i)} n_t(i) di dj$$

one can use (7) to substitute for the fraction:

$$= \int_0^1 \int_0^1 \left(\frac{w_t(j)}{W_t} \right)^{-\epsilon_w} n_t(i) di dj = \int_0^1 \left(\frac{w_t(j)}{W_t} \right)^{-\epsilon_w} \int_0^1 n_t(i) di dj$$

since the inner integral is constant in j ,

$$= \int_0^1 \left(\frac{w_t(j)}{W_t} \right)^{-\epsilon_w} dj \int_0^1 n_t(i) di = s_t^w \int_0^1 n_t(i) di.$$

Equating the production function (5) with firm-specific total demand (10) to evoke market clearing on the firm level, one obtains $n_t(i) = \left(\frac{p_t(i)}{P_t} \right)^{-\epsilon} \frac{C_t + G_t}{A_t}$. Substituting yields

$$= s_t^w \int_0^1 \left(\frac{p_t(i)}{P_t} \right)^{-\epsilon} di \frac{C_t + G_t}{A_t} = s_t^w s_t^p \frac{C_t + G_t}{A_t}.$$

Derivation of Welfare Functions:

The sum on the LHS of equation (15) comprises unconditional expectations of utility on the ergodic distribution, while the sum on the RHS comprises utility in the deterministic steady state. As neither quantity depends on time and are therefore constant in the sum, (15) can be written as

$$\frac{1}{1-\beta} \mathbb{E} U(c_t^A, n_t^A) = \frac{1}{1-\beta} U((1+\nu^A) \bar{c}, \bar{n})$$

$$\mathbb{E} [U(c_t^A, n_t^A)] = U((1+\nu^A) \bar{c}, \bar{n})$$

On the LHS, applying a second-order Taylor approximation in c_t^A and n_t^A around the deterministic steady state yields

$$\bar{U} + \bar{U}_C \mathbb{E} [c_t^A - \bar{c}] + \frac{\bar{U}_{CC}}{2} \mathbb{E} [c_t^A - \bar{c}]^2 + \bar{U}_N \mathbb{E} [n_t^A - \bar{n}] + \frac{\bar{U}_{NN}}{2} \mathbb{E} [n_t^A - \bar{n}]^2$$

where the bar denotes variables of the deterministic steady state and the cross term is neglected as commonly done in the literature. On the RHS, applying a first-order Taylor approximation in ν^A around the deterministic steady state yields

$$\bar{U} + \frac{\delta \bar{U}_C}{\delta \nu^A} \nu^A \quad .$$

It follows that the total consumption compensation for business cycle fluctuations is a sum of the following sources of welfare losses:

$$\begin{aligned}\nu_{\text{mean C}}^A &= (\delta \bar{U}_C / \delta \nu^A)^{-1} \bar{U}_C \mathbb{E} [c_t^A - \bar{c}] \\ \nu_{\text{mean N}}^A &= (\delta \bar{U}_C / \delta \nu^A)^{-1} \bar{U}_N \mathbb{E} [n_t^A - \bar{n}] \\ \nu_{\text{volatility C}}^A &= (\delta \bar{U}_C / \delta \nu^A)^{-1} 0.5 \bar{U}_{CC} \mathbb{E} [c_t^A - \bar{c}]^2 \\ \nu_{\text{volatility N}}^A &= (\delta \bar{U}_C / \delta \nu^A)^{-1} 0.5 \bar{U}_{NN} \mathbb{E} [n_t^A - \bar{n}]^2\end{aligned}$$

Tables:

Table 4: Social security systems in the EU, 2012

	Social security contributions, % of GDP	Employee's 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

Source: OECD Revenue Statistics 2012

Table 5: Payroll taxes overt time, correlation between SCR and GDP

	Ratio of payroll taxes to total compensation		Correlation of annual payroll payroll tax rate with GDP*		
	1970-89	1990-2012	1970-1989	1990-2012	1970-2012
Germany	0.28	0.34	-0.48	-0.56	-0.51
Sweden	0.24	0.29	-0.56	0.41	0.13
France	0.37	0.41	-0.19	-0.34	-0.28
Netherlands	0.31	0.29	-0.47	0.19	-0.01
UK	0.22	0.26	0.29	0.12	0.22
Denmark	0.09	0.16	-0.04	0.20	0.15
Finland	0.14	0.15	-0.47	-0.15	-0.22
Japan	0.17	0.25	-0.45	-0.05	-0.24
Belgium	0.32	0.39	-0.69	-0.57	-0.63
Italy	0.36	0.38	-0.30	-0.04	-0.10
Austria	0.30	0.35	-0.41	-0.58	-0.50
Australia	0.01	0.01	-0.34	0.04	-0.23
Norway	0.23	0.21	0.21	-0.07	0.14
Canada	0.07	0.09	-0.30	-0.33	-0.32
New Zealand		0.10		0.33	0.25
South Korea	0.10	0.18	-0.44	-0.43	-0.39
Spain	0.25	0.30	-0.65	-0.24	-0.38
US	0.10	0.12	0.29	-0.48	-0.02

Source: Burda and Weder (2014), data from OECD.

*Tax rates and log real GDP are HP-filtered with a smoothing parameter $\lambda = 6.25$.

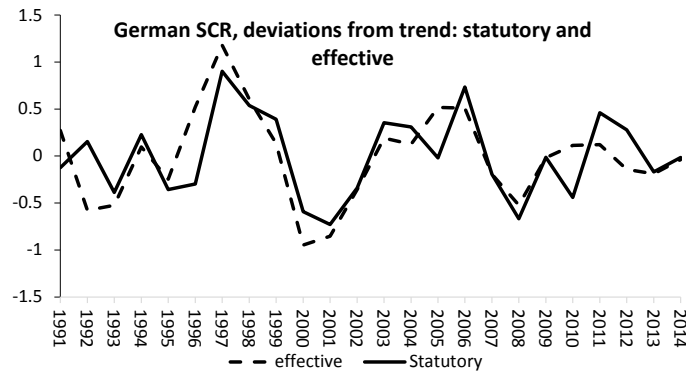


Figure 7: German SCR, statutory and 'effective' as computed in Burda and Weder (2014), deviations from trend.

Table 6: Volatility of social contributions rate

Country	Std. dev. SCR in %	Sample
Austria	0.21	76-13
Belgium	0.19	95-13
Cyprus	0.42	95-13
Germany	0.38	91-13
Estonia	0.46	95-14
Spain	0.13	95-13
Finland	0.73	75-13
France	0.32	74-14
Greece	0.75	00-13
Italy	0.65	92-14
Luxembourg	0.24	85-14
Latvia	0.86	92-13
Malta	0.16	95-13
Netherlands	0.83	71-13
Portugal	0.22	95-13
Slovenia	0.20	91-13
Slovakia	1.19	95-14

SCR constructed as social contributions divided by compensation of employees. Std. dev. reports the expected deviation from HP-filtered series ($\lambda = 6.25$). The approach is analog to Burda and Weder (2014).

Source: Eurostat government statistics.

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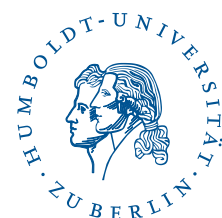
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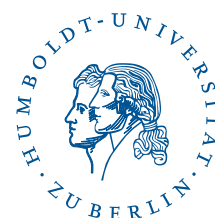
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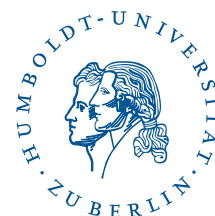
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