Who Benefits From Using Property Taxes To Finance A Labor Tax Wedge Reduction?

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Abstract

We use a New Keynesian DSGE model with a rental housing market to evaluate how financing a labor tax wedge reduction through higher property taxation affects the real economy and welfare. We find that a labor tax wedge reduction generates favorable macroeconomic effects independent of the financing instrument used. Even though it negatively affects the housing market, property acquisition taxation outperforms all other instruments as the financing instrument in terms of welfare. This finding is the result of allowing households to decide whether to buy or to rent housing services and of the fact that, in this situation, they shift from purchasing to renting more housing services. Abandoning tax credit on mortgage interest payments effectively harms borrowers.

Keywords: Housing and Rental Markets, Property Taxation, Labor Tax Wedge, General Equilibrium (JEL: E51, E6, R31, K34)

1. Introduction

High labor income taxation is said to be detrimental to growth and employment (an overview of the discussion can be found in Arnold et al., 2011). Therefore, budget-neutral labor tax wedge reductions to foster economic performance and international competitiveness rank high on the agenda in many euro area economies (see European Commission, 2013, 2014, 2015, 2016). Following much discussion in the literature, which we will review below, shifting the tax burden away from direct labor to less distortive indirect consumption taxation has been suggested as a politically viable option to reap the economic benefits of labor tax wedge reductions.

Another option that has recently gained some attention is the shift towards higher property taxation (inter alia OECD, 2012, 2015, and IMF, 2014, provide an overview of the debate). The arguments in favor of such a shift are based on findings in the literature on optimal tax policy, which show that it is most efficient to tax objects with a rather immobile base and where tax-induced distortions are kept at minimum – conditions that are apparently fulfilled for property goods (see, among others, Mankiw et

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al., 2009, Feldstein, 2006, Slemrod, 1990, or Diamond and Mirrlees, 1971). Bielecki and Stähler (2018) show in a recent paper that property taxation can indeed marginally outperform consumption taxation as the financing instrument to finance a labor tax wedge reduction.

As is discussed by Surico and Trezzi (2015) as well as Paetzold and Tiefenbacher (2016) in microeconomic simulation studies for Italy and Germany, respectively, it is very likely that a change in property tax legislation will create winners and losers. Different types of property-related taxes, such as recurrent property taxes, property acquisition taxes, tax credits on mortgage interest or taxes on rental income from providing housing services, may affect different groups in the economy, such as homeowners with and without mortgages or renters, quite differently. Given that everyone needs housing, property tax legislation is therefore an important issue, also for the general public. Hence, it would appear crucial to identify who gains and who loses under which circumstances and to what extent from using property taxes to finance a labor tax wedge reduction.

Our paper contributes to this discussion by means of a New Keynesian two-country monetary union DSGE model characterized by a comprehensive fiscal block that includes a wide range of taxes and disaggregation of government spending as well as a complex housing market structure that takes account of the households' decision whether to buy or rent housing services. The model is calibrated to core and periphery Europe. Some households are liquidity-constrained and face a borrowing limit. There are three different types of housing-related taxes: a property acquisition tax on house purchases, a recurrent property tax on the housing stock and a tax on rental income from providing housing rental services. In addition, we also allow for a tax credit on mortgage interest payments in line with the legislation of most European economies and for tax credits related to property tax payments. Furthermore, a frictional labor market to capture the labor market effects of a labor tax wedge reduction is included.

As expected, we find that a reduction in the labor tax wedge has positive employment, demand and output effects. Also, international competitiveness increases via the marginal cost channel and the aggregate demand for housing services rises as a result of the increase in net labor income. When using higher consumption taxation as the financing instrument, this indeed dampens these positive effects due to the policy-induced price increase for consumption goods. However, they are not overturned because taxing consumption is less distortive than taxing labor. This has been extensively discussed in the literature, which we discuss below.

Using property taxation to finance a labor tax wedge reduction has similar positive effects from an overall macroeconomic perspective. Not surprisingly, however, housing and/or rental markets are negatively affected, which generates changes in tenure status, changes in the composition of GDP and the redistribution of consumption and housing between household types. Aggregate labor market effects are still very similar independent of the property tax instrument used. What changes is the employment composition across sectors (regular versus housing goods). Because of a lack of policy-induced price increase for regular consumption goods, both household types are able to increase private consumption more compared to a situation in which consumption taxes finance the labor tax wedge reduction (albeit to different degrees). However, not only does it become less attractive for borrowers to become homeowners (except for the simulation in which taxes on rental income disproportionately increase rental prices) but also borrowers tend to rent fewer housing services (except for the simulation in which property acquisition taxes are raised). Hence, the utility borrowers obtain from housing falls. Savers tend to benefit in all simulated scenarios.

In terms of welfare, we find that, in all but one scenario, the increase in private consumption utility prevails over the loss in housing utility for borrowers. By contrast, welfare gains clearly depend on the exact instrument used. Property acquisition taxes outperform all other instruments as the financing instrument. This stems from the fact that we allow households to purchase or rent housing services. Even though home ownership for borrowers falls, they rent more housing services such that housing utility does not fall disproportionately. In the welfare ranking, the use of recurrent property and consumption taxes closely follows the use of property acquisition taxes. Increasing rental income taxation is the least favorable tax instrument, and abandoning tax credit on mortgage interest payments effectively harms borrowers because of the relatively high increase in mortgage costs. Overall, our simulations suggest that the use of property taxation can outperform the use of consumption taxation to finance budget-neutral labor tax wedge reductions.

1.1. Related literature

Our analysis relates to the literature on labor tax wedge reductions and "fiscal devaluations" as well as the literature on modeling housing taxation in modern dynamic macroeconomics.[1] Related to the former, Prescott (2004) finds that the differences in aggregated hours of work between Europe and the United States are primarily driven by discrepancies in marginal effective tax rates, which is confirmed by, among others, Coenen et al. (2008, 2012) in a more complex DSGE model and by Ohanian et al. (2008) in a neoclassical growth model.[2] Budget-neutral labor tax wedge reductions, also termed

[1] In a strict sense, fiscal devaluation is defined as an intended nominal devaluation that is replicated by altering labor income and consumption taxes to generate a sequence of taxes that replicates a sequence of nominal exchange rates (see Farhi et al., 2014, and Kaufmann, 2016). The literature, which we discuss below, however, tends to define a permanent shift from labor income to consumption taxes as fiscal devaluation, too. We use this definition in the paper.

[2] The papers just mentioned use a Walrasian labor market framework (households decide on the amount of hours they want to supply). A labor tax reduction increases "benefits" from working and, thus, households switch from not wanting to work to wanting to work (more). In the search and matching labor market framework used below, we abstract from an endogenous labor market participation decision. Hence, all workers want to work, but only a fraction of them find a job. Thus, the resulting effects of reduced labor taxation are primarily labor demand-driven (even though, as we will see, workers also accept lower gross wages in the bargaining process, which is also true in a Walrasian labor market). Still, aggregate labor market effects are comparable in both frameworks, while a non-Walrasian one seems more appropriate to depict European economies (see Maffezzoli, 2001, for a discussion). Further-

fiscal devaluation in the literature, have been analyzed in a prominent paper by Farhi and Werning (2014), who find that lower labor income taxes financed by higher VAT can replicate a nominal devaluation and may be economically beneficial. In terms of improving economic performance, a similarly beneficial finding of a permanent shift from labor income to consumption taxation is supported by Boscà et al. (2009, 2013), Gadatsch et al. (2016b), Gomes et al. (2016), Jacquinot et al. (2018), Langot et al. (2014), Lipinska and von Thadden (2009, 2013) and Stähler and Thomas (2012) in DSGE models calibrated to France, Germany, Portugal or Spain. Engler et al. (2017) show that tax wedge reductions on the employers' side are more beneficial compared to reductions on the employees' side which, at least for the short run, is confirmed in an analysis by Burgert and Roeger (2014). Attinasi et al. (2018) show that using other financing instruments such as lower public purchases or public employment may also be beneficial. Positive effects of a permanent fiscal devaluation are also present in other modeling frameworks (see, among others, de Mooij and Keen, 2013, Koske, 2013, or Vuksic and Holzner, 2016).

Alpanda and Zubairy (2016) and Mora-Sanguinetti and Rubio (2014) discuss the impact of taxation in the housing market.[3] Both papers include a housing rental market, partly following Ortega et al. (2011). They find that increasing property taxation in terms of recurrent property tax rates, transaction tax rates and reductions in mortgage interest deductions have negative macroeconomic effects overall. Considering the effects of higher property taxation by themselves, the results of our paper are in line with these findings. We also confirm the findings of Alpanda and Zubairy (2017) that higher property taxation can play a part in lowering private-sector indebtedness. However, Alpanda and Zubairy (2016, 2017) and Mora-Sanguinetti and Rubio (2014) are not concerned with using property taxation to finance a labor tax wedge reduction and lower non-distortive transfers to compensate households for the property tax increase. We can show that, when reducing labor taxes, the overall effect of a property tax hike may actually be beneficial. Furthermore, the search labor market in our framework and the two-country structure allows us to assess the different effects on unemployment and international competitiveness.

To our knowledge, the first paper that addresses the use of property taxation to finance a reduction in the labor tax wedge is provided by Bielecki and Stähler (2018). They model a housing sector characterized by search frictions and compare the effects of using consumption taxation as the financing instrument to those resulting from using recurrent property or property transaction taxes.[4] They find that the use of property

more, note that introducing a labor market participation decision in our framework would not alter the results qualitatively (as is discussed in, for example, Gadatsch et al., 2016b, who analyze the shift from labor to consumption taxation in Germany during the early 2000s).

[3]Using different modeling frameworks, earlier contributions include Porterba (1990, 1992) or, dating back even further, Bickerdike (1902). Gervais (2002) and Summer and Sullivan (2018) present an OLG model with income heterogeneity to address the effects of property taxation.

[4]Models with search frictions on the housing market can also be found in Wheaton (1990), Krainer

transaction taxation fares worse than the use of consumption taxation. The primary reason for this is that, in their model, households are "forced" to purchase housing. In our framework, they can decide to own or rent housing. The negative macroeconomic effects of higher property acquisition taxes per se are similar in both frameworks, especially for housing market transactions. But the fact that households rent more housing services after an increase in the property transaction tax rate in our framework affects the housing-utility loss much less. This result shows that it can be important to include a household choice between renting and buying.

The rest of the paper is structured as follows. In Section 2, we describe the model, while the analysis, including a welfare assessment, is undertaken in Section 3. Section 4 concludes.

2. The model

We build a New Keynesian two-region monetary union model, where the two regions of the model depict the core and periphery of the euro area. The economies are characterized by frictional labor markets and a fiscal block that includes a wide range of taxes and disaggregation of government spending, following Stähler and Thomas (2012). In addition, we introduce savers and borrowers as well as housing along the lines of Kiyotaki and Moore (1997) and Iacoviello (2005). Borrowers are less patient than savers and need housing collateral to obtain loans. There are two production sectors, one for housing and one for consumption/investment goods in line with Iacoviello and Neri (2010). Furthermore, we assume that houses can be either bought or rented as in Ortega et al. (2011) and Mora-Sanguinetti and Rubio (2014). Hence, households, firms, policymakers and the external sector interact in each period by trading final goods, housing, financial assets and production factors. In what follows, we use the term "country" in the model sense and use the words "home"/"foreign" and "core"/"periphery" interchangeably. Normalizing total union-wide population to one, a share $\omega \in (0,1)$ lives in the core, while the remaining share $(1-\omega)$ lives in the periphery. We will only describe the model setup in the core country. The structure of the foreign economy is identical up to potentially different parameter values. If we need to show variables and parameters of the periphery, they will be indicated by an asterisk. In what follows, we will now describe the model in more detail.

2.1. Households

Following Kiyotaki and Moore (1997) and Iacoviello (2005), we assume that each country is populated by a share $\mu \in [0,1)$ of impatient households (borrowers) and a remaining share $(1-\mu)$ of patient households (savers). Savers are characterized by a

(2001), Novy-Marx (2009), Burnside et al. (2016), Head et al. (2014), and Ngai and Tenreyro (2014), to mention a few. These papers, however, are more concerned with the cyclical aspects of housing markets and do not include structural (tax) issues.

higher subjective discount rate, $\beta^s > \beta^b$, where the superscript $i = b, s$ indicates borrowers and savers, respectively. This implies savers give future consumption a higher utility value. The welfare function of each type of representative household at time t is given by

$$E_t \left\{ \sum_{t=0}^{\infty} \left(\beta^i\right)^t \cdot \left(\underbrace{\frac{\left(c_t^i - hab \cdot c_{t-1}^i\right)^{1-\sigma_c}}{1-\sigma_c} + \zeta^h \cdot \frac{\left(\tilde{h}_t^i\right)^{1-\sigma_h}}{1-\sigma_h}}_{=U\left(c_t^i, \tilde{h}_t^i\right)} \right) \right\}, \tag{1}$$

where E_t is the expectations operator conditional on time-t information, c_t^i denotes consumption of final goods and hab is the degree of habit formation in final goods consumption. Households also obtain utility from housing services, $\tilde{h}_t^i$, where ζ^h is the weight of housing services relative to the consumption of final goods, and $\sigma_c, \sigma_h > 0$ are the inverse of the intertemporal elasticity of substitution. Following Ortega et al. (2011) and Mora-Sanguinetti and Rubio (2014), we assume that borrowers either rent or live in their own houses. Here,

$$\tilde{h}_t^b = \left[\left(\omega^h\right)^{1/\epsilon^h} \left(h_t^b\right)^{(\epsilon_h - 1)/\epsilon_h} + \left(1-\omega^h\right)^{1/\epsilon^h} Z_t^{(\epsilon_h-1)/\epsilon_h} \right]^{\epsilon_h(\epsilon_h - 1)} \tag{2}$$

is a composite of housing services consisting of borrowers' owner-occupied housing stock, h_t^b, and rental services, Z_t.[5] In contrast, savers are assumed to not demand rental services. Hence, their composite of housing services is given by $\tilde{h}_t^s = h_t^s$ (see Mora-Sanguinetti and Rubio, 2014, for a detailed discussion of this – at first sight – seemingly restrictive assumption). But savers use a certain part of their housing stock, which we denote by h_t^z, to produce rental services $Z_t = \epsilon^z \cdot h_t^z$, where ϵ^z measures efficiency of the rental market. The aggregate housing stock of the economy is given by $h_t^{tot} = (1-\mu) \cdot (h_t^s + h_t^z) + \mu \cdot h_t^b$.

Inside each household, its members may be employed in the public sector (denoted by $n_t^{g,i}$), in the final goods sector (denoted by $n_t^{p,i}$), in the construction sector (denoted by $n_t^{h,i}$), or be unemployed (denoted by u_t^i).[6] It holds that $1 = n_t^{g,i} + n_t^{p,i} + n_t^{h,i} + u_t^i$. We assume full consumption insurance within each household as in Andolfatto (1996) or Merz (1995).

Households in both countries trade final consumption and investment goods as well as international nominal bonds. Following the literature on liquidity-constrained con-

[5] In contrast to Alpanda and Zubairy (2016), we do not model renters as a fixed share of 'rule-of-thumb' households. Our choice allows renters to endogenously become owners depending on, among other things, tax policies. We believe that this is a plausible choice.

[6] Having public employment in the model and targeting the steady-state wage premium of public employees turns out to be useful in matching a realistic relationship between sector-specific wages, which will become clear in the calibration section.

sumers (among others, Galí et al., 2007), we assume that borrowers only invest in housing (which they need as collateral) and not in physical capital or international bonds. The consumption and investment baskets, c_t^i and $I_t^{s,f}$, respectively, of a household of type i in the home country are given by

$$x_t^i = \left(\frac{x_{At}^i}{\omega+\psi}\right)^{\omega+\psi} \left(\frac{x_{Bt}^i}{1-\omega-\psi}\right)^{1-\omega-\psi},$$

with $x_t^i = \left\{c_t^i, I_t^{s,f}\right\}$, where c_{At}^i, $I_{At}^{s,f}$ and c_{Bt}^i, $I_{Bt}^{s,f}$ represent consumption/investment demand of goods produced in the core (country A) and the periphery (region B), respectively, and ψ is a parameter capturing the degree of home bias in consumption. $f = p, h$ indicates capital investment in the consumption/investment goods and in the construction sector, respectively.

From now onwards, let $p_{Bt} \equiv P_{Bt}/P_{At}$ denote the *terms of trade*, where P_{At} and P_{Bt} are the *producer price indices* (PPI) in countries A and B, respectively. Cost minimization by the household then implies $x_{At}^i/x_{Bt}^i = (\omega+\psi)\,/\,(1-\omega-\psi)\cdot p_{Bt}$. Nominal expenditure in consumption and investment goods equal $P_{At}x_{At}^i + P_{Bt}x_{Bt}^i = P_t x_t^i$, where $P_t = (P_{At})^{\omega+\psi}(P_{Bt})^{1-\omega-\psi}$ is the corresponding *consumer price index* (CPI). Notice that $P_t = P_{At}\cdot p_{Bt}^{1-\omega-\psi}$. Therefore, CPI inflation, $\pi_t \equiv P_t/P_{t-1}$, evolves according to $\pi_t = \pi_{At}\left(p_{Bt}/p_{Bt-1}\right)^{1-\omega-\psi}$, where $\pi_{At} \equiv P_{At}/P_{At-1}$ is PPI inflation in the core.

To allow for a different degree of home bias in the foreign country, the consumption and investment baskets there are defined as

$$x_t^{i*} = \left(\frac{x_{At}^{i*}}{\omega-\psi^*}\right)^{\omega-\psi^*} \left(\frac{x_{Bt}^{i*}}{1-\omega+\psi^*}\right)^{1-\omega+\psi^*},$$

where ψ^* captures the degree of home bias in foreign households' preferences. The corresponding consumer price index in the periphery (which is used as numeraire by households and firms in that country) is given by $P_t^* = P_{At}^{\omega-\psi^*}P_{Bt}^{1-\omega+\psi^*} = P_{Bt}\left(1/p_{Bt}\right)^{\omega-\psi^*}$. Analogously to the home country, we can then calculate the foreign country's consumer price inflation and the corresponding producer price index/inflation.

Each household's real labor income (gross of taxes) is given by $w_t^p n_t^{p,i} + w_t^h n_t^{h,i} + w_t^g n_t^{g,i}$, where w_t^p and w_t^h are the real wages paid in the consumption/investment goods and the construction sector (to be derived later) and w_t^g is the pre-determined real wage of the government sector. The labor income tax rate is denoted by τ_t^w. Household members who are unemployed receive unemployment benefits κ^B. τ_t^c denotes the consumption tax rate, TR_t^i stands for subsidies and T_t^i represents lump-sum taxes.

Only savers invest in physical capital and trade international and national government bonds. But savers and borrowers trade a nominal domestic bond B_t^i which pays nominal (gross) interest R_t. Investments in physical capital k_t^f, with $f = p, h$, earn a real rental rate $r_t^{k,f}$, while the capital depreciates at rate $\delta^{k,f}$. Returns on physical capital net of depreciation allowances are taxed at rate τ_t^k. Nominal government bonds B_t^G pay a gross nominal interest rate R_t^G. Finally, D_t^s denotes holdings of international nominal bonds, which pay the gross nominal interest rate R_t^{ecb}.[7] Π_t^s is nominal per capita profits generated by firms net of vacancy posting costs. We assume that all firms are owned by the optimizing households and that profits are redistributed in a lump-sum manner.

Housing depreciates at rate δ^h (for simplicity, we do not differentiate between different depreciation rates for owner-occupied and rented housing). Hence, the household-type-specific housing stock evolves according to $h_t^m = (1-\delta^h)h_{t-1}^m + I_t^m$, with $m = s, b, z$. Following Alpanda and Zubairy (2016), we assume that the value of the housing stock is subject to a recurrent property tax at rate τ_t^p, which may be deductible from (labor) income taxation. An indicator function $\iota^p = 1$ indicates when this is the case. It is zero otherwise. Rental housing income is taxed at rate τ_t^z. As in Mora-Sanguinetti and Rubio (2014), we assume that house purchases are taxed at rate τ_t^{pa} to proxy a property acquisition tax. Summarizing, the savers' budget constraint in CPI-deflated real terms (divided by P_t) is given by

$$
\begin{aligned}
&(1+\tau_t^c)c_t^s + (1+\tau_t^{pa})\tilde{q}_t^h \sum_{m=s,z} I_t^m + \tau_t^p \tilde{q}_t^h \sum_{m=s,z} h_t^m + \sum_{f=p,h} I_t^{s,f} + \frac{B_t^s + B_t^{G,s} + D_t^s}{P_t} + T_t^s \\
&= \frac{\Pi_t^s}{P_t} + TR_t^s + \frac{R_{t-1}B_{t-1}^s + R_{t-1}^G B_{t-1}^G + R_{t-1}^{ecb} D_{t-1}^s}{P_t} - \frac{\psi_d \left(D_t^s/P_t - \bar{D}^s/\bar{P}\right)^2}{2} \\
&+ \sum_{f=p,h} \left((1-\tau_t^k) r_t^{k,f} + \tau_t^k \delta^{k,f}\right) k_{t-1}^{s,f} + (1-\tau_t^w) \sum_{f=p,h,g} w_t^f n_t^{f,s} + \iota^p \tau_t^w \tau_t^p \tilde{q}_t^h \left(h_t^s + h_t^z\right) \\
&+ u_t^s \kappa^B + (1-\tau_t^z) q_t^z \epsilon^z h_t^z, \qquad (3)
\end{aligned}
$$

where $\tilde{q}_t^h$ is the CPI-deflated price of housing (i.e. the nominal price of houses divided by P_t) and q_t^z represents the CPI-deflated price of rental services provided to borrowers competitively. The law of motion of physical capital is given by

$$
k_t^{o,f} = (1-\delta^{k,f})k_{t-1}^{o,f} + \left[1 - S\left(I_t^{o,f}/I_{t-1}^{o,f}\right)\right] I_t^{o,f}, \qquad (4)
$$

where $S\left(I_t^{o,f}/I_{t-1}^{o,f}\right) = \frac{\kappa_I}{2}\left(I_t^{o,f}/I_{t-1}^{o,f} - 1\right)^2$ represents investment adjustment costs (see Christiano et al., 2005, for discussion). Maximizing (1) subject to equations (3) and (4) yields standard first-order conditions for optimizing households (see also Mora-

[7] In order to ensure stationarity of international bond holdings, we follow Schmitt-Grohé and Uribe (2003) and assume that there exist portfolio adjustment costs of the form $\psi_d/2\left(D_t/P_t - \bar{D}/\bar{P}\right)^2$, with $\psi_d > 0$ and the bar indicating steady-state values. We assume for simplicity that trading in bonds is not taxed.

Sanguinetti and Rubio, 2014).

The borrowers' budget constraint reads

$$\begin{aligned}&(1+\tau_t^c)\,c_t^b + (1+\tau_t^{pa})\,\tilde{q}_t^h\,I_t^b + \tau_t^p\,\tilde{q}_t^h\,h_t^b + q_t^z\,Z_t + \frac{R_{t-1}B_{t-1}^b}{P_t}\\&= \frac{B_t^b}{P_t} + (1-\tau_t^w)\sum_{f=p,h,g} w_t^f n_t^{f,b} + \iota^p\tau_t^w\tau_t^p\,\tilde{q}_t^h h_t^b + \iota^{\varrho}\,\tilde{\tau}\min\left\{\frac{(R_{t-1}-1)B_{t-1}^b}{P_t}, cap\right\}\\&+u_t^b\kappa^B + TR_t^b, \qquad (5)\end{aligned}$$

where the government grants a tax credit on mortgage interest payments whenever $\iota^{\varrho}=1$. The tax credit is calculated as $\tilde{\tau}\cdot\min\{(R_{t-1}-1)B_{t-1}^b/P_t, cap\}$, where $cap\in(0,\infty)$ is a potential upper limit for the tax credit per household. If present, it only applies whenever tax liabilities of the household are positive, which is the case in our representative agent economy. Borrowers are also subject to a collateral constraint which limits the amount of borrowing (gross of interest payments) to a fraction ϱ^b of the expected resale value their houses,

$$\frac{B_t^b}{P_t} \leq \frac{\varrho^b}{R_t}E_t\left\{\pi_{t+1}\cdot q_{t+1}^h\cdot h_{t+1}^b\right\}. \qquad (6)$$

First-order conditions are given by maximizing (1) subject to equations (5) and (6) and are standard, too.

Given the above description, domestic per capita consumption in the home country equals the weighted average of consumption for each household type, i.e. $C_t = (1-\mu)\cdot c_t^s + \mu\cdot c_t^b$. Per capita domestic demand for home and foreign goods, C_{At} and C_{Bt}, are analogously aggregated. Given the economy-wide housing stock h_t^{tot}, total housing investment is given by $IH_t = h_t^{tot} - (1-\delta^h)h_{t-1}^{tot}$. For quantity variables that exclusively concern savers, economy-wide per capita amounts are simply given by $X_t = (1-\mu)X_t^s$, where $X_t \in \{k_t^p, k_t^h, B_t^G, I_t^h, I_t^p, D_t, I_{At}^h, I_{Bt}^h, I_{At}^p, I_{Bt}^p\}$ and $X_t^s \in \{k_t^{s,p}, k_t^{s,h}, B_t^{G,s}, I_t^{s,h}, I_t^{s,p}, D_t^s, I_{At}^{s,h}, I_{Bt}^{s,h}, I_{At}^{s,p}, I_{Bt}^{s,p}\}$. Furthermore, it must hold that loan demand of borrowers equals credit supply by savers, i.e. $(1-\mu)B_t^s + \mu B_t^b = 0$. Employment aggregation will be described in the labor market section below.

2.2. Production

The construction sector is modeled in line with Iacoviello and Neri (2010), while the final and intermediate goods sectors of the economy are similar to Smets and Wouters (2003, 2007) or Christiano et al. (2005). Following Stähler and Thomas (2012), we assume that labor services are not hired directly from the households but from a sector of firms that produce homogeneous labor services in the manner of Boscá et al. (2011), Christoffel at al. (2009) or de Walque et al. (2009). In this subsection, we focus on the final and intermediate goods sectors as well as on the construction sector, postponing the description of the labor market until the next subsection.

2.2.1. Final goods producer

There is a measure-ω continuum of firms in the final goods sector, in which firms purchase a variety of differentiated intermediate goods and bundle these into a final good. This is then sold under perfect competition. Assuming that the law of one price holds within the union, the price of the home country's final good is the same in both countries, equal to P_{At}. The problem of the representative retail firm reads

$$\max_{\{\tilde{y}_t(j):j\in[0,\omega]\}} P_{At}Y_t - \int_0^{\omega} P_{At}(j)\tilde{y}_t(j)dj, \tag{7}$$

where $Y_t = \left(\int_0^{\omega}\left(\frac{1}{\omega}\right)^{1/\epsilon}\tilde{y}_t(j)^{(\epsilon-1)/\epsilon}dj\right)^{\epsilon/(\epsilon-1)}$ with $\epsilon > 1$ is the retailer's production function, $\tilde{y}_t(j)$ is the retailer's demand for each differentiated input $j \in [0,\omega]$, and $P_{At}(j)$ is the nominal price of each input. The standard first-order condition for the problem is given by $\tilde{y}_t(j) = (P_{At}(j)/P_{At})^{-\epsilon}\frac{Y_t}{\omega}$. Combining the latter with (7) and the zero profit condition, we obtain that the producer price index in the home country must equal $P_{At} = \left(\int_0^{\omega}\frac{1}{\omega}P_{At}(j)^{1-\epsilon}dj\right)^{1/(1-\epsilon)}$. Total demand for each intermediate input equals

$$\omega\tilde{y}_t(j) \equiv y_t(j) = \left(\frac{P_{At}(j)}{P_{At}}\right)^{-\epsilon} Y_t. \tag{8}$$

as there are ω retail firms.

2.2.2. Intermediate goods

Each intermediate goods producer $j \in [0,\omega]$ faces the technology

$$y_t(j) = \epsilon^p \cdot \left[\tilde{k}^p_{t-1}(j)\right]^{\alpha} \cdot \left[lab^p_t(j)\right]^{(1-\alpha)}, \tag{9}$$

where $\alpha \in [0,1]$ is the elasticity of output with respect to capital, $lab^p_t(j)$ denotes the demand for labor services and $\tilde{k}^p_t(j) = \left[(\alpha_k^{1/v_k}k^p_t(j)^{(v_k-1)/v_k} + (1-\alpha_k)^{1/v_k}(k^g_t)^{(v_k-1)/v_k}\right]^{v_k/(v_k-1)}$ is a CES composite of private and public capital in line with Coenen et al. (2013), where $v_k > 0$ denotes the elasticity of substitution between private and public capital and $\alpha_k \in (0,1]$ is a share parameter. ϵ^p represents total factor productivity. By modeling private and public capital as a composite good, we implicitly assume the public capital stock to be productivity-enhancing while, at the same time, allowing the private sector to be able to at least partly substitute for public capital (see Baxter and King, 1993, Leeper et al., 2010, and Coenen et al., 2013, for discussion). Intermediate goods firms acquire labor and private capital services in perfectly competitive factor markets at real (CPI-deflated) prices x^p_t and $r^{k,p}_t$, respectively. Cost minimization subject to (9) implies the factor demand conditions for labor and capital $x^p_t = mc_t \cdot (1-\alpha)\cdot y_t(j)/lab^p_t(j)$ and

$r_t^{k,p} = mc_t \cdot \alpha \cdot y_t(j)/\tilde{k}_{t-1}^p(j) \cdot \left(\partial\tilde{k}_{t-1}^p(j)/\partial k_{t-1}^p(j)\right)$, where mc_t is the real (CPI-deflated) marginal cost common to all intermediate good producers. $r_t^{k,p}$ and x_t^p and, therefore, factor inputs are equalized across firms because of constant returns to scale in private capital and labor and perfectly competitive input prices.

As is standard in the literature, intermediate goods firms set nominal prices à la Calvo (1983). This implies that a randomly chosen fraction $\theta_P \in [0,1)$ of firms cannot re-optimize their price in each period. A firm that has the chance to re-optimize its price in period t chooses the nominal price $P_{At}(j)$ that maximizes

$$E_t \sum_{z=0}^{\infty} (\beta\theta_P)^z \frac{\lambda_{t+z}^o}{\lambda_t^o} \left[\frac{P_{At}(j)}{P_{t+z}} - mc_{t+z}\right] y_{t+z}(j), \tag{10}$$

subject to $y_{t+z}(j) = \left(P_{At}(j)/P_{At+z}\right)^{-\epsilon} Y_{t+z}$. The first-order condition is standard implying the law of motion of the price level $1 = \theta_P \left(1/\pi_{At}\right)^{1-\epsilon} + (1-\theta_P)\tilde{p}_t^{1-\epsilon}$, where $\tilde{p}_t \equiv \tilde{P}_{At}/P_{At}$ is the relative (PPI-deflated) optimal price and $\tilde{P}_{At}$ is the optimal price chosen by all period-t price setters.

2.2.3. Construction sector

Similar to the intermediate goods sector, producers in the construction sector $j \in [0,\omega]$ face an analogous technology

$$IH_t(j) = \epsilon^h \cdot \left[\tilde{k}_{t-1}^h(j)\right]^{\alpha^h} \cdot \left[lab_t^h(j)\right]^{(1-\alpha^h)}. \tag{11}$$

As already mentioned, houses are sold in a perfectly competitive market at a CPI-deflated relative price $\tilde{q}_t^h$. Hence, firms in the production sector maximize (11) times $\tilde{q}_t^h$ subject to capital and labor. This yields $x_t^h = \tilde{q}_t^h \cdot (1-\alpha^h) \cdot IH_t(j)/lab_t^h(j)$ and $r_t^{k,h} = \tilde{q}_t^h \cdot \alpha^h \cdot IH_t(j)/\tilde{k}_{t-1}^h(j) \cdot \left(\partial\tilde{k}_{t-1}^h(j)/\partial k_{t-1}^h(j)\right)$, which are again equalized across firms.

2.3. The labor market

Following Christoffel et al. (2009) or de Walque et al. (2009), we assume that labor firms hire workers from the household sector in order to produce homogeneous labor services, which they sell to intermediate goods producers at the perfectly competitive price x_t^f, with $f = p, h$. The production function of each labor firm is linear in labor. With N_t^f being the fraction of the total labor force employed in sector f, the total per capita supply of labor services is given by $Lab_t^f = N_t^f$. Equilibrium in the market for labor services requires that $Lab_t^f = \int_0^\omega lab_t^f(j)dj$.

Using equations (8) and (9) and the fact that the capital-labor ratio is equalized across intermediate goods firms, this yields $Y_t D_t = \epsilon^a (\tilde{k}_{t-1}^p)^\alpha (N_t^p)^{1-\alpha}$, where $D_t \equiv \int_0^\omega \omega^{-1} \left(P_{At}(j)/P_{At}\right)^{-\epsilon} dj$ is a measure of price dispersion. Analogously, it holds for the construction sector that $IH_t = \epsilon^h (\tilde{k}_{t-1}^h)^{\alpha^h} (N_t^h)^{1-\alpha^h}$. In what follows, we will specify the matching process, flows in the labor market, private-sector vacancy creation and the corresponding wage determination. Government wages and employment are autonomously chosen by the fiscal authority (described in Section 2.4).

2.3.1. Matching process and labor market flows

A household member can be in one of four states: (i) employed in the public sector, (ii) employed in the consumption/investment goods sector, (iii) employed in the construction sector, or (iv) unemployed. Unemployment is the residual state in the sense that a worker whose employment relationship ends flows back into unemployment. All unemployed workers look for job opportunities. We assume that searchers are randomly matched to an employment sector.[8]

Denoting total sector-specific per capita employment in period t by $N_t^f = (1 - \mu) n_t^{f,o} + \mu n_t^{f,r}$, where $f = p, h, g$, the total economy-wide employment rate is given by $N_t^{tot} = N_t^p + N_t^h + N_t^g$, while the aggregate unemployment rate is given by $U_t = 1 - N_t^{tot}$. Following Blanchard and Galí (2010), we assume that the hiring round takes place at the beginning of each period, and that new hires start producing immediately. We also assume that workers dismissed at the end of period $t-1$ start searching for a new job at the beginning of period t. Therefore, the pool of searching workers at the beginning of period t is given by

$$\tilde{U}_t = U_{t-1} + s^p N_{t-1}^p + s^h N_{t-1}^h + s^g N_{t-1}^g = 1 - (1 - s^p) N_{t-1}^p - (1 - s^h) N_{t-1}^h - (1 - s^g) N_{t-1}^g,$$

where s^f represents the constant separation rate in the consumption/investment goods (p), the construction (h) and the public (g) sector. The matching process is governed by a standard Cobb-Douglas aggregate matching function for each sector f,

$$M_t^f = \kappa_e^f \cdot \left(\tilde{U}_t\right)^{\varphi^f} \cdot \left(v_t^f\right)^{(1-\varphi^f)}, \tag{12}$$

where $\kappa_e^f > 0$ is the sector-specific matching efficiency parameter, $\varphi^f \in (0, 1)$ the sector-specific matching elasticity and M_t^f the number of new matches formed in period t resulting from the total number of searchers and the number of sector-specific vacancies

[8]Here, it is worth highlighting that, due to this assumption, a worker who loses his/her job in the construction sector, for example, may subsequently find a job in a different sector without suffering a loss in productivity. This is assumed for simplification but can certainly be seen as a caveat of our setup (which may result in overestimating the positive employment and the resulting macroeconomic effects of the tax shift analyzed below). In order to take such productivity effects into account, however, we would need a heterogeneous agent model allowing us to track employment histories of individuals, which goes beyond the scope of this paper. Therefore, our results should be considered as a first step towards analyzing the effects of financing labor tax wedge reductions through higher property taxation. Further research should certainly test how important these productivity losses may be for the results.

v_t^f. The probability of an unemployed worker finding a job in sector f can thus be stated as $p_t^f = M_t^f / \tilde{U}_t$, while the probability of filling a vacancy is given by $q_t^f = M_t^f / v_t^f$. The law of motion for sector and household-type-specific employment rates is therefore given by

$$n_t^{f,i} = \left(1 - s^f\right) \cdot n_{t-1}^{f,i} + p_t^f \cdot \left(u_{t-1}^i + s^p n_{t-1}^{p,i} + s^h n_{t-1}^{h,i} + s^g n_{t-1}^{g,i}\right). \tag{13}$$

Employment in sector f today is given by yesterday's employment that has not been destroyed plus newly created matches in that sector.

2.3.2. Asset value of jobs, wage bargaining and job creation

As is standard in the literature, we assume that firms and workers Nash bargain about their share of the overall match surplus to determine wages. Following Boscá et al. (2011), we assume that sector-specific unions for the consumption/investment goods and the construction sectors, which take into account utility of savers and borrowers, undertake the bargaining. Furthermore, we assume staggered bargaining of nominal wages similar to Gertler et al. (2008). This implies that, in each period, a randomly chosen fraction θ_w of continuing firms cannot renegotiate wages, while a fraction θ_w^n of newly created firms do not negotiate wages and simply pay the average nominal wage of the previous period. Denoting the value of employment for firms in sector $f = p, h$ that are allowed to negotiate wages by $J_t^f\left(\tilde{W}_t^f\right)$ and the value of the union by $\Omega_t^f \equiv (1-\mu) H_t^{s,f}\left(\tilde{W}_t^f\right) + \mu H_t^{b,f}\left(\tilde{W}_t^f\right)$, where $H_t^{i,f}\left(\tilde{W}_t^f\right)$ is the corresponding household type-i utility, the Nash problem is given by

$$\max_{\tilde{W}_t^f} \quad \left[\Omega_t^f\right]^{\xi^f} \left[J_t^f\left(\tilde{W}_t^f\right)\right]^{1-\xi^f}, \tag{14}$$

where $\xi^f \in [0, 1)$ is the sector-specific bargaining power of the union and $\tilde{W}_t^f$ denotes the nominal wage negotiated in period t. The value function of a firm that renegotiates in that period is given by

$$\begin{aligned} J_t^f\left(\tilde{W}_t^f\right) \quad = \quad & E_t \sum_{z=0}^{\infty} \left\{ \left[\beta^s \cdot (1 - s^f) \cdot \theta_w\right]^z \cdot \frac{\lambda_{t+z}^s}{\lambda_t^s} \cdot \left[x_{t+z}^f - (1 + \tau_{t+z}^{sc}) \cdot \frac{\tilde{W}_t^f}{P_{t+z}}\right] \right\} \\ & + (1 - \theta_w) \cdot E_t \sum_{z=1}^{\infty} \left\{ \left[\beta^s \cdot (1 - s^f)\right]^z \cdot \theta_w^{z-1} \cdot \frac{\lambda_{t+z}^s}{\lambda_t^s} \cdot J_{t+z}^f\left(\tilde{W}_{t+z}^f\right) \right\}, \end{aligned} \tag{15}$$

where τ_t^{sc} is the social security contribution rate. Remember that firms belong to savers, which is the reason why they discount future profit flows by the corresponding discount factor, where λ_t^s denotes the savers' marginal utility of consumption. Hence, the value of the firm is the discounted profit flow in those future states in which it is not allowed to renegotiate plus its continuation value should it have the chance to re-optimize in the next period (see also Stähler and Thomas, 2012, for more details). Whenever the firm and worker do not have the chance to renegotiate, the nominal wage equals last period's average nominal wage, W_{t-1}^{f}, and the value of the job equals

$$J_t^f\left(W_{t-1}^f\right) = J_t^f\left(\tilde{W}_t^f\right) - E_t\sum_{z=0}^{\infty}\left\{\left[\beta^s\cdot(1-s^f)\cdot\theta_w\right]^z\cdot\frac{\lambda_{t+z}^s}{\lambda_t^s}\cdot(1+\tau_{t+z}^{sc})\cdot\frac{W_{t-1}^f-\tilde{W}_t^f}{P_{t+z}}\right\}.$$

Analogously, we can derive how workers value a match. Since different household types use different discount factors, we must distinguish between the surplus for savers and borrowers. For a worker belonging to a type-i household, with $i = s, b$, the surplus value of a job in a renegotiating firm in sector $f = p, h$ is given by

$$\begin{aligned} H_t^{i,f}\left(\tilde{W}_t^f\right) &= E_t\sum_{z=0}^{\infty}\left\{\left[\beta^i\cdot(1-s^f)\cdot\theta_w\right]^z\cdot\frac{\lambda_{t+z}^i}{\lambda_t^i}\cdot\left[(1-\tau_{t+z}^w)\cdot\frac{\tilde{W}_t^f}{P_{t+z}}-\Xi_{t+z}^{i,f}\right]\right\} \\ &\quad +(1-\theta_w)\cdot E_t\sum_{z=1}^{\infty}\left\{\left[\beta^i\cdot(1-s^f)\right]^z\cdot\theta_w^{z-1}\cdot\frac{\lambda_{t+z}^i}{\lambda_t^i}\cdot H_{t+z}^{i,f}(\tilde{W}_{t+z}^f)\right\}, \end{aligned} \tag{16}$$

where

$$\begin{aligned} \Xi_t^{i,f} &\equiv \kappa^B + \beta^i(1-s^f)E_t\frac{\lambda_{t+1}^i}{\lambda_t^i}\left\{p_{t+1}^p\left[(1-\theta_w^n)H_{t+1}^{i,p}\left(\tilde{W}_{t+1}^p\right)+\theta_w^n H_{t+1}^{i,p}\left(W_t^p\right)\right]\right. \\ &\quad \left. +p_{t+1}^h\left[(1-\theta_w^n)H_{t+1}^{i,h}\left(\tilde{W}_{t+1}^h\right)+\theta_w^n H_{t+1}^{i,h}\left(W_t^h\right)\right]+p_{t+1}^g H_{t+1}^{i,g}\right\}, \end{aligned}$$

represents the outside option of a type-i worker employed in sector $f = p, h, g$ at time t. The latter is the sum of unemployment benefits, κ^B, and the expected value of searching for a job in the following period.[9] In new jobs in sectors $f = p, h$ where the wage is not optimally negotiated, the surplus value enjoyed by type-i workers is given by

$$H_t^{i,f}\left(W_{t-1}^f\right) = H_t^{i,f}\left(\tilde{W}_t^f\right) + E_t\sum_{z=0}^{\infty}\left\{\left[\beta^i\cdot(1-s^f)\cdot\theta_w\right]^z\cdot\frac{\lambda_{t+z}^i}{\lambda_t^i}\cdot(1-\tau_{t+z}^w)\cdot\frac{W_{t-1}^f-\tilde{W}_t^f}{P_{t+z}}\right\}.$$

Note that $H_t^{i,g}$ denotes the surplus value of a government job for a type-i worker. As wages there are autonomously set by the fiscal authority, the asset value function is

[9] Notice that we have to take into account that, conditional on landing on a private-sector job ($f = p, h$), the surplus value for the worker is contingent on whether the firm is allowed to bargain (in which case the worker receives $\tilde{W}_{t+1}^f$) or not (in which case he/she receives today's average wage, W_t^f).

simplified to

$$H_t^{i,g} = (1-\tau_t^w)w_t^g - \Xi_t^{i,g} + \beta^i(1-s^g)E_t\left\{\frac{\lambda_{t+1}^i}{\lambda_t^i}\cdot H_{t+1}^{i,g}\right\}, \tag{17}$$

where w_t^g is the real wage paid by the government. Given the asset value functions of firms and workers, equations (15) to (17), we are now in a position to solve the wage bargaining game (14). The resulting sharing rule is given by

$$\Omega_t^f = \frac{\xi^f}{1-\xi^f}\cdot\frac{(1-\mu)Aux_t^{worker,s} + \mu\, Aux_t^{worker,b}}{Aux_t^{firm}}\cdot J_t^f\left(\tilde{W}_t^f\right), \tag{18}$$

where

$$Aux_t^{worker,i} = E_t\sum_{z=0}^{\infty}\left\{\frac{\lambda_{t+z}^i}{\lambda_t^i}\left[\beta^i(1-s^f)\theta_w\right]^z\frac{(1-\tau_{t+z)}^w)}{P_{t+z}}\right\}$$

and

$$Aux_t^{firm} = E_t\sum_{z=0}^{\infty}\left\{\frac{\lambda_{t+z}^s}{\lambda_t^s}\left[\beta^s(1-s^f)\theta_w\right]^z\frac{(1+\tau_{t+z)}^{sc})}{P_{t+z}}\right\}.$$

Solving equation (18) for $\tilde{W}_t^f$ by using the corresponding asset value functions gives the optimal wage bargained in period t. The average real wage in the private sector, $w_t^f \equiv W_t^f/P_t$, hence evolves according to

$$w_t^f = \frac{(1-s^f)N_{t-1}^f}{N_t^f}\left[(1-\theta_w)\tilde{w}_t^f + \theta_w\cdot\frac{w_{t-1}^f}{\pi_t}\right] + \frac{M_t^f}{N_t^f}\left[(1-\theta_w^n)\tilde{w}_t^f + \theta_w^n\cdot\frac{w_{t-1}^f}{\pi_t}\right], \tag{19}$$

where $\tilde{w}_t^f \equiv \tilde{W}_t^f/P_t$ is the optimally bargained real wage and $w_{t-1}^f/\pi_t = W_{t-1}^f/P_t$ is the real value of yesterday's average nominal wage at today's prices. We have also taken into account the fact that new and continuing jobs pay the optimally bargained wage with probabilities $1-\theta_w^n$ and $1-\theta_w$, respectively.

How jobs are created remains to be determined. As is standard in the literature, we assume that opening a vacancy has a real (CPI-deflated) flow cost of κ_v^f. Following Pissarides (2009), we further assume that free entry into the vacancy posting market drives the expected value of a vacancy to zero. Under our assumption of instantaneous hiring, real vacancy posting costs, κ_v^f, must equal the time-t vacancy filling probability, q_t^f, times the expected value of a filled job in period t. This condition can be expressed as

$$\frac{\kappa_v^f}{q_t^f} = (1-\theta_w^n)\cdot J_t^f\left(\tilde{W}_t^f\right) + \theta_w^n\cdot J_t^f\left(W_{t-1}^f\right), \tag{20}$$

where we take into account that the wage of the newly created job may be optimally bargained with probability $1-\theta_w^n$.

2.4. Fiscal authorities

Defining the (CPI-deflated) per capita value of end-of-period government debt as $b_t^g \equiv B_t^G/P_t$, we can state that it evolves according to a standard debt accumulation equation,

$$b_t^g = \frac{R_{t-1}}{\pi_t} b_{t-1}^g + PD_t,$$

where PD_t denotes real (CPI-deflated) per capita primary deficit. The latter is given by per capita fiscal expenditures minus per capita fiscal revenues,

$$\begin{aligned} PD_t \;=\; & \left[\left(C_t^g + I_t^g\right) p_{Bt}^{-(1-\omega-\psi)} + (1+\tau_t^{sc}) w_t^g N_t^g + \kappa^B U_t + (1-\mu) TR_t^s + \mu TR_t^b + \kappa_v^g v_t^g\right] \\ & - \left[\tau_t^c C_t + (\tau_t^{sc} + \tau_t^w) \sum_{f=p,h,g} w_t^f N_t^f + \tau_t^p \left(1 - \iota^p \tau_t^w\right) \tilde{q}_t^h h_t^{tot} - \iota^{\varrho} \tau_t^w \frac{(R_{t-1}-1) b_{t-1}^b}{\pi_t} \right. \\ & \left. + \tau_t^{pa} \tilde{q}_t^h IH_t + \tau_t^z q_t^z \epsilon^z h_t^z + \tau_t^k \sum_{f=p,h} \left(r_t^{k,j} - \delta^{k,f}\right) k_{t-1}^j + (1-\mu) T_t^s \right], \end{aligned}$$

where C_t^g and I_t^g denote per capita public purchases and investments expressed in PPI terms (hence the correction for the CPI-to-PPI ratio, $P_t/P_{At} = p_{Bt}^{1-\omega-\psi}$) and $b_t^b \equiv B_t^b/P_t$. Given public investment, the stock of public physical capital evolves as follows,

$$k_t^g = (1-\delta^g) k_{t-1}^g + I_t^g, \tag{21}$$

where we assume that the public capital stock depreciates at rate δ^g. To guarantee stationarity of public debt, for *at least* one fiscal instrument $X \in \{\tau^w, \tau^{sc}, \tau^p, \tau^{pa}, \tau^z, \tau^c, \tau^k, C^g, I^g, w^g, N^g, TR^s, TR^b, T^s\}$, the government must follow a fiscal rule of the form

$$X_t = \bar{X} + \rho_X \left(X_{t-1} - \bar{X}\right) + (1-\rho_X)\, \phi_X \cdot \left(\frac{b_{t-1}}{Y_{t-1}^{tot}} p_{Bt-1}^{1-\omega-\psi} - \omega^b\right) + \epsilon_t^X, \tag{22}$$

in which the coefficient ϕ_X, i.e. fiscal policy's stance on debt deviations from target, is non-zero (positive for revenue instruments, negative for expenditure instruments). ρ_X is a smoothing parameter.

Following Coenen et al. (2013), we assume that transfers between savers and borrowers are distributed according to $(1-\bar{\mu})(TR_t^s/\bar{TR}^s - 1) = \bar{\mu}(TR_t^b/\bar{TR}^b - 1)$, where $\bar{\mu} \in [0,1]$ and $\bar{TR}^i$, with $i = s, b$, is the steady-state transfer received by household of type i. We assume the latter to be such that, in the initial steady state, savers and borrowers consume the same amount of private goods and services, i.e. $\bar{c}^s = \bar{c}^b$. For $\bar{\mu} = 0$, any change in the aggregate level of transfers $TR_t = (1-\mu) TR_t^s + \mu TR_t^b$ will affect borrowers only (in this case, $TR_t^s = \bar{TR}^s \forall t$). For $\mu = 1$, only savers will be affected (in this case, $TR^b = \bar{TR}^b \forall t$). Savers and borrowers are equally affected by a change in transfers when $\bar{\mu} = 0.5$. Hence, the larger $\bar{\mu}$, the more a change in aggregate transfers affects savers.

2.5. International linkages and union-wide monetary policy

International linkages between the two countries are given by trade in goods and services as well as in international bonds. The home country's net foreign asset position, expressed in terms of PPI, evolves according to

$$d_t = \frac{R_{t-1}^{ecb} \cdot d_{t-1}}{\pi_{At}} + \frac{1-\omega}{\omega} \left(C_{At}^* + I_{At}^{p*} + I_{At}^{h*} \right) - p_{Bt} \left(C_{Bt} + I_{Bt}^p + I_{Bt}^h \right), \tag{23}$$

where $(1-\omega) \left(C_{At}^* + I_{At}^{p*} + I_{At}^{h*} \right) / \omega$ are real per capita exports and $p_{Bt} \left(C_{Bt} + I_{Bt}^p + I_{Bt}^h \right)$ are real per capita imports. Zero net supply of international bonds implies $\omega d_t + (1-\omega)\, p_t^B d_t^* = 0$. Terms of trade $p_{Bt} = P_{Bt}/P_{At}$ evolve according to $p_{Bt} = (\pi_{Bt}/\pi_{At})\, p_{Bt-1}$.

We assume that the area-wide monetary authority has its nominal interest rate, R_t^{ecb}, respond to deviations of area-wide inflation from its long-run target, $\bar{\pi}$, and to area-wide GDP growth, according to a simple Taylor rule,

$$\frac{R_t^{ecb}}{\bar{R}^{ecb}} = \left(\frac{R_{t-1}^{ecb}}{\bar{R}^{ecb}} \right)^{\rho_R} \left\{ \left[\left(\frac{\pi_t}{\bar{\pi}} \right)^{\omega} \left(\frac{\pi_t^*}{\bar{\pi}^*} \right)^{1-\omega} \right]^{\phi_\pi} \left[\left(\frac{GDP_t}{G\bar{D}P} \right)^{\omega} \left(\frac{GDP_t^*}{G\bar{D}P*} \right)^{1-\omega} \right]^{\phi_y} \right\}^{(1-\rho_R)},$$

where ρ_R is a smoothing parameter, and ϕ_π and ϕ_y are the monetary policy's stance on inflation and output growth, respectively.

2.6. Market clearing and GDP

Market clearing implies that private per capita production in the home and foreign country, Y_t and Y_t^* respectively, is used for private and public consumption as well as private and public investment demand,

$$Y_t = C_{At} + I_{At}^p + I_{At}^h + C_t^g + I_t^g + \frac{1-\omega}{\omega} \left(C_{At}^* + I_{At}^{p*} + I_{At}^{h*} \right) + \left(\kappa_v^p v_t^p + \kappa_v^h v_t^h \right) p_{Bt}^{1-\omega-\psi}. \tag{24}$$

Market clearing in the foreign country is analogous. Furthermore, housing market clearing implies that

$$\begin{aligned} IH_t &= h_t^{tot} - (1-\delta^h) h_{t-1}^{tot} \\ &= (1-\mu) \left(h_t^s + h_t^z - (1-\delta^h)(h_{t-1}^s + h_{t-1}^z) \right) + \mu \left(h_t^b - (1-\delta^h) h_{t-1}^b \right). \end{aligned} \tag{25}$$

Consistent with national accounting and in line with Stähler and Thomas (2012), each country's GDP is the sum of private-sector production, government production of goods and services and, in this model, housing production. Government production is measured at input costs, that is, by the gross government wage bill. Hence, (PPI-deflated) per capita GDP is given by

$$GDP_t = Y_t + \left(\tilde{q}_t^h \, IH_t + (1+\tau_t^{sc}) w_t^g N_t^g\right) p_{Bt}^{1-\omega-\psi}. \tag{26}$$

Again, it is analogous in the foreign country. This completes the model description. We now turn to the model calibration.

2.7. Calibration

We calibrate our model to quarterly frequency, where the home country (A) represents the core and the foreign country (B) is the periphery of Europe. We adopt the following split of the original 12 euro area countries: Greece, Ireland, Italy, Portugal and Spain comprise the periphery, while Austria, Belgium, Finland, France, Germany, Luxembourg and the Netherlands comprise the core. Hence, the size of the home country is set to $\omega = 0.6$.

Our calibration strategy consists of (i) matching steady-state values of selected model variables with the corresponding data averages (mainly fiscal and labor market variables) and of (ii) carefully choosing the remaining free parameters values in line with the existing literature. Most of the data we use are based on a large data set for the euro area containing a rich set of quarterly fiscal variables, described in more detail in Gadatsch et al. (2016a). The primary sources for the various variables are the European System of Accounts (ESA) for the main aggregates and the European Commission for fiscal and some housing-market-related variables. The majority of labor market variables come from OECD data. Furthermore, we normalize the core's per capita GDP, PPI inflation and the terms of trade to one and set the net foreign asset position to zero in the initial steady state. Together with targeting a GDP-weighted average of domestic expenditure shares of 85% in line with Balta and Delgado (2009), this allows us to derive the corresponding home bias parameters endogenously. Furthermore, we set the per capita GDP of the periphery relative to core's per capita GDP to 0.875 in line with Moyen et al. (2016).

Table 1: Targeted values

Target	Symbol	Value Core	Periphery
Relative population share	$\omega; (1-\omega)$	0.600	0.400
GDP	$\bar{Y}^{tot}$	1.000	0.875
Share of borrowers	μ	0.261	0.437
Import shares	$(\bar{C}_B + \bar{I}_B))/GDP$	0.150	n.a.
PPI inflation	$\bar{\pi}_A = \bar{\pi}_B$	1.000	

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Target	Symbol	Value	
		Core	Periphery
Net foreign assets	$\bar{d} = \bar{d}^*$	0.000	
Terms of trade	$\bar{p}^B$	1.000	
Labor income tax rate	$\bar{\tau}^w$	0.275	0.233
Consumption rate	$\bar{\tau}^c$	0.205	0.165
Social security contribution rate	$\bar{\tau}^{sc}$	0.190	0.230
Capital tax rate	$\bar{\tau}^k = \bar{\tau}^z$	0.320	0.287
Property tax rate	$\bar{\tau}^p \bar{q}^h \bar{h}^{tot} / (4G\bar{D}P)$	0.01	0.01
Property transfer tax rate	$\bar{\tau}^{pa} \bar{q}^h I\bar{H}^{tot} / (4G\bar{D}P)$	0.005	0.005
Gov. SS purchases	$\omega^{Cg} = \bar{C}^g / G\bar{D}P$	0.077	0.080
Gov. SS investment	$\omega^{Ig} = \bar{I}^g / G\bar{D}P$	0.030	0.034
Gov. SS public-sector wage bill	$\omega^G = \bar{w}^G \bar{N}^G / G\bar{D}P$	0.102	0.107
Gov. SS transfers	$\omega^{TR} = T\bar{R} / GDP$	0.193	0.183
SS public debt-to-annual-GDP ratio	$\omega^b = \bar{b}^g / (4G\bar{D}P)$	0.700	0.885
SS private debt-to-annual-GDP ratio	$\mu \bar{b}^b / (4G\bar{D}P)$	0.520	0.700
Unemployment rate	$\bar{U}$	0.084	0.127
Unemployment benefit replacement ratio	$\kappa^B / ((1 - \bar{\tau}^w)\bar{\tilde{w}})$	0.725	0.523
Fraction of public employment	$\bar{N}^g / (1 - \bar{U})$	0.165	0.177
Fraction of employment in construction	$\bar{N}^h / (1 - \bar{U})$	0.080	0.101
Public-sector wage premium in SS	$\bar{w}^g / \bar{w}^p$	1.040	1.140
Construction-sector wage premium in SS	$\bar{w}^h / \bar{w}^p$	0.990	1.060
Vacancy filling rate (private)†	$\bar{q}^p = \bar{q}^h$	0.70	
Vacancy filling rate (public)†	$\bar{q}^g$	0.80	
Total housing stock	$\bar{h}^{tot}$	1.000	1.000
Share of housing with mortgage	$\mu \, \bar{h}^b$	0.385	0.261
Housing rental share	$(1 - \mu) \, \bar{h}^z$	0.347	0.262
Rent over house price	$\bar{q}^z / \bar{\bar{q}}^h$	0.038	0.048

Source: Target values as described in the main text. Data sources are the European System of Accounts (ESA), the European Commission and the OECD. Labor market targets marked with an † are from Christoffel et al. (2009), who estimate a matching model using European data. We drop the ∗ for convenience.

We normalize the stock of housing in each region to one. In line with Eurostat data,[10] the share of housing with mortgages in our set of core countries amounts to 38.54%, while the share of tenants is 34.66%. The remaining housing stock is owner-occupied without mortgages. For the periphery countries, these shares are 26.06% and 26.2%, respectively. Following Bielecki et al. (2017), we assume that the private debt to annual GDP ratios in core and periphery Europe amount to 0.52 and 0.70, respectively. Furthermore, the house over rental price ratio is 3.8% and 4.8% in the two regions.

[10]See http://ec.europa.eu/eurostat/statistics-explained/index.php/Housing_ statistics.

Table 2: Baseline parameter calibration

Parameter	Symbol	Value Core	Value (common)	Value Periphery
<u>Preferences</u>				
Discount rate savers	β^s		0.992	
Discount rate borrowers	β^b		0.972	
Intertemporal elasticity of substitution	$\sigma_c = \sigma_h$		1.000	
Habits in consumption	h		0.600	
Relative utility weight of housing^e	ζ^h	0.817		2.283
Housing composite weight^e	ω^h	0.268		0.132
Home bias^e	ψ	0.342		0.489
<u>Production</u>				
Capital depreciation	$\delta^{k,j} = \delta^g$		0.025	
Housing depreciation	δ^h		0.010	
Intermediate-sector capital share in prod.	α^p		0.333	
Construction-sector capital share in prod.	α^h		0.220	
Public-sector capital share in priv. prod.	α_k		0.900	
Elasticity of substitution priv./pub. cap.	v_k		0.840	
Invstment adjustment cost parameter	κ_I		4.93	
TFP scaling parameter intermediate goods^e	ϵ^a	0.563		0.510
TFP scaling parameter construction goods^e	ϵ^h	0.084		0.059
<u>Price & wage stickiness</u>				
Calvo parameter (prices)	θ_P		0.750	
Market power (markup)	ϵ		6.000	
Calvo parameter (wages of existing jobs)	θ_w		0.830	
Calvo parameter (wages of newly created jobs)	θ_w^n		0.830	
<u>Monetary policy</u>				
Interest rate smoothing	ρ_R		0.850	
Stance on inflation	ϕ_π		1.500	
Stance on output gap	ϕ_y		0.125	
<u>Trade in internat. bonds</u>				
Risk premium parameter	ψ_d		0.01	
<u>Labor market</u>				
Matching elasticity (private sector)	$\varphi^p = \varphi^p$		0.500	
Matching elasticity (public sector)	φ^g		0.300	
Separation rate (public sector)	s^g		0.020	
Separation rate (intermediate goods sector)	s^p		0.040	
Separation rate (construction sector)	s^h		0.050	
Bargaining power intermediate goods^e	ξ^p	0.676		0.455
Bargaining power construction goods^e	ξ^h	0.116		0.114
Intermediate-sector matching efficiency^e	κ_e^p	0.407		0.332
Construction-sector matching efficiency^e	κ_e^h	0.141		0.139
Public-sector sector matching efficiency^e	κ_e^g	0.285		0.262
Vacancy posting costs (intermed. and public)^e	$\kappa_v^p = \kappa_v^g$	0.167		0.723
Vacancy posting costs (construction)^e	κ_v^h	2.397		6.759
<u>Financial frictions</u>				
Loan-to-value ratio^e	ϱ^b		0.750	
<u>Fiscal policy</u>				
Smoothing	ρ_T		0.750	
Stance on debt	ϕ_T		0.005	
Transfer distribution	$\bar{\mu}$		0.500	

Source: Parameter values primarily based on Christoffel et al. (2009) unless indicated differently in the main text. Those marked with an *e* are derived endogenously to match the steady-state targets of Table 1. We drop the $*$ for convenience.

Targeting property tax and property acquisition tax revenues over GDP to be 0.01 and 0.005 for both regions in line with Eurostat data, we get the corresponding tax rates. In line with legislation in most European countries, we assume that the tax rate on rental income is equal to the tax rate on capital interest. In order to meet these targets, and given a loan to value ratio of 0.75, which is a standard value in the literature, we have to calculate the amount of borrowers and the housing utility parameters (including ω^h in the composite good) endogenously. Parameter values are summarized in Table 2.

Regarding the labor market, the elasticity of the matching function in the private sector, $\varphi^p = \varphi^h$, is set to 0.6 in line with Christoffel et al. (2009), who estimate a model with a search and matching labor market to European data. The value in the public sector, φ^g, is set a bit lower to 0.4 in line with Afonso and Gomes (2014). The quarterly separation rate in the private sector is set to 0.04. Again, it is somewhat lower in the public sector but slightly higher in the construction sector. In line with Moyen et al. (2016), the unemployment rate in core is 8.4%, while it is 12.7% in the periphery. Of all employed people, 16.5% (17.7%) work in the public sector and 7.3% (20.1%) work in the construction sector in the core (periphery). The steady-state public-sector wage markup relative to the private consumption/investment goods sector in the core (periphery) amounts to 1.04 (1.14), while it is 0.99 (1.06) for those workers working in the construction sector (see also Giordano et al., 2011). The steady-state replacement rate of the unemployment insurance amounts to 72.5% in the core and 52.3% in the periphery following Moyen et al (2016). In order to match the wage relations between the public, consumption/investment goods and construction goods sectors, we derive the sector-specific bargaining powers. We also need to endogenously derive the efficiency of the matching functions as well as vacancy posting costs to meet the matched unemployment rates and vacancy filling probabilities of Table 1.

On the household side, the discount factors are set to $\beta^s = 0.992$ and $\beta^b = 0.972$, which are standard values. The intertemporal elasticities of substitution $\sigma_c = \sigma_h = 1$ as well as habits $h = 0.6$ are set close to the mode estimates in Smets and Wouters (2003). Capital depreciation rates are set to a standard value of $\delta^{k,j} = \delta^g = 0.025$, with $j = p, h$, and $\delta^h = 0.01$, the latter in line with Mora-Sanguinetti and Rubio (2014). The capital share in intermediate goods production is set to one third (Cooley and Prescott, 1995). The capital share in the construction sector is lower, $\alpha^h = 0.2$, following Iacoviello and Neri (2010). In calibrating the CES aggregator for private and public capital, we rely on Coenen et al. (2013). who estimate such an aggregator to the euro area. Due to the lack of data, we assume values to be equal across sectors. Investment adjustment costs are set to a standard value close to five. Matching steady-state GDP and private-sector output, then, requires us to derive sector-specific TFP productivity ϵ^p and ϵ^h endogenously.

Price stickiness and the markup as well as parameters for the monetary policy rule are assumed to take standard values (see Cristoffel et al., 2008, for a discussion). For nominal wage rigidities, Christoffel et al. (2009), Cocliago et al. (2008) and de Walque et al. (2009) find a rather high degree of stickiness. We opt for a middle value of these studies and set it to 0.83 for newly created and existing jobs. According to Schmitt-Grohé and Uribe (2003), it is sufficient to chose a rather small value for the risk premium parameter on international bonds in order to generate a stable equilibrium. So we opt for $\psi_d = \psi_d^* = 0.01$.

As regards fiscal policy, tax rates are implicit rates calculated from national accounts, as are the different government spending-to-GDP ratios by category. The data is described in detail in Gadatsch et al. (2016a). We assume that debt stabilization along the transition is taken care of by lump-sum taxes in order to avoid other distortions. There exists a tax credit on mortgage interest, $\iota^{\varrho} = 1$, and deductability of property taxes from labor taxation, $\iota^{p} = 1$, in the initial steady state, and we assume that cap amounts to 10% of steady-state interest payments.

3. Analysis

In this section, we compare the effects of a permanent decrease in the labor tax wedge financed by an increase in (i) the property tax rate, (ii) the property acquisition tax rate, (iii) the tax rate on rental income and (iv) the consumption tax rate.[11] Along the transition, debt is stabilized using lump-sum taxes to avoid distortions.

In order to make things comparable, we assume that, in all scenarios, the labor tax wedge is decreased such that it generates an increase in the primary deficit-to-GDP ratio by 1 percentage point ex ante. In our model, the labor tax wedge can be reduced by two instruments: social security contributions on the employers' side or personal income tax rate reductions on the employees' side. A reduction in the social security contribution rate τ^{sc} yields somewhat more favorable effects in terms of aggregate macroeconomic effects, which is generally also the case in the literature (see the literature review above as well as an extensive discussion in Attinasi et al., 2018). Thus, we focus on using the social security contribution rate to reduce the labor tax wedge in the main body of this paper. However, we discuss the differences in the transmission mechanism when using the personal income tax rate τ^{w} and show according simulation results in the appendix.

Given the average economy-wide wage, $\bar{w} = \bar{N}^{p}/\bar{N}^{tot}\,\bar{w}^{p} + \bar{N}^{h}/\bar{N}^{tot}\,\bar{w}^{h} + \bar{N}^{g}/\bar{N}^{tot}\,\bar{w}^{g}$, the change in the social security contribution rate is calculated as

$$d\left(\bar{\tau}^{sc}\right) = -0.01 \cdot \left(\frac{\bar{p}_B^{1-\omega-\psi}\bar{N}^{tot}\bar{w}}{GDP}\right)^{-1}.$$

As a result, the social security contribution rate can be decreased by close to 2 percentage points. The necessary change in the other tax rates to finance reduced labor taxation ex

[11] We also simulate abandoning tax credits on mortgage interest payments (by setting $\iota^{\varrho} = 0$) and the deductability of property taxes from gross labor income (by setting $\iota^{p} = 0$). However, these measures by themselves are not sufficient to finance a labor tax wedge reduction that generates an increase in the ex ante primary deficit-to-GDP ratio by 1 percentage point (see the description of the simulation design in the main text). Therefore, in those simulations, we assume that, first, the "financing" instrument is increased and, then, calculate the resulting decrease in the labor tax rate ex post. In order to compare these measures to those described in the main text, we take the resulting labor tax rate reduction (instead of the one generating an ex ante decrease in the primary deficit-to-GDP ratio by 1 percentage point) and re-do the corresponding simulations. To save space, we relegate the simulation results to the appendix but briefly discuss them at the end of this section.

post are as follows: the consumption tax rate must be increased by 0.3, the property tax rate by only 0.03, the property acquisition tax rate by 1.66 and the tax rate on rental income by 1.44 percentage points.

For simplicity, we assume that, at the time of the fiscal change, the economy is in its initial steady state, that the changes are unanticipated and that there are no future shocks in the economy after the change in tax policy. This allows us to isolate the effects of changes in property taxation from other shocks. Simulations are performed in a non-linear manner under perfect foresight. Results for the transitional dynamics are summarized in Figures 1 to 3 and the long-run effects are shown in Table 3. In the main body of the text, we focus on on the policy change conducted in the core. Macroeconomic effects for conducting the policy change in the periphery are analogous but, because it is calibrated to be somewhat less efficient (see previous section), they are slightly less favorable overall. The simulation results are relegated to the appendix, too.

3.1. Macroeconomic effects of a labor tax wedge reduction financed by property taxes

In this section, we describe the macroeconomic effects of a labor tax wedge reduction financed by one of the different property tax instruments. These are compared to financing the tax wedge reduction through higher consumption taxation.

A lower social security contribution rate immediately decreases labor costs and fosters job creation. At the same time, firms can reduce prices via the marginal cost channel, which slightly augments international competitiveness. Because of higher job creation, gross wages start rising as they are, in the end, a share of firms' profits. This is a result of the bargaining game. Higher gross wages do not overcompensate for the reduction in the policy-induced labor cost cut such that unemployment falls in the long run. This holds in all sectors in which wages are negotiated and increases the average net wage income of all households. From an aggregate labor market perspective, these effects are present independent of the financing instrument used.

As a result of higher labor income, households demand more consumption/investment goods and also housing services. The latter increase the relative price of housing. This also spills over to housing rents because borrowers can shift part of the increase in investment costs to renters. In the medium term, higher house prices and rental costs reduce borrowers' demand for both rented and owner-occupied housing. Because house prices have increased, they need quantitatively less housing collateral to finance their desired increase in private consumption, which they partly do by increasing demand for loans.

Using *consumption taxes* to finance the labor tax reduction generates a policy-induced increase in consumption costs. This dampens the increase in demand for regular consumption goods which, as we can see in Table 3 and Figure 3, is smallest when using this instrument, whereas the increase in housing demand is highest. However, as has extensively been discussed in the literature (see Section 1.1), the increase in net labor income is stronger than the increase in consumption costs such that the positive income and demand effects of lower labor taxation are not overturned by higher consumption taxes, which is also a result of the fact that consumption taxation is less distortionary than labor income taxation.

While the aggregated labor market effects are basically identical independent of the financing instrument used (see Figure 1), it does not come as a surprise that using property-related tax instruments to finance the labor tax wedge reduction dampens the positive spillovers to the housing market (see Figure 2), which again spills over to general macro developments (see Figure 3) and back to the labor market, at least from a disaggregated perspective (Figure 1).

More precisely, an increase in the *recurrent property tax rate* augments the operating costs of holding housing and, thus, makes housing less attractive. Aggregate housing investment and the housing stock fall, which also reduces house prices. In addition, the increase in operating costs diminishes the attractiveness of housing rental investments for savers. As they are able to shift part of these higher operating costs to renters, housing rental prices increase. Together with falling house prices, this induces borrowers to rent less and purchase more housing services ceteris paribus. However, this effect is not strong enough to compensate for higher operating costs when owning a house. Hence, borrowers demand less housing overall. While the higher operating costs kick in immediately, it takes time for the rental price to adjust. Therefore, borrowers rent more and buy less on impact until rental prices have risen. Lower house prices and less housing demand diminishes the demand for loans. Private consumption increases for both, savers and borrowers. The rise in aggregate private consumption is larger relative to the previous scenario due to the lack of the policy-induced increase in consumption costs (through a higher consumption tax rate). These developments benefit the consumption/investment goods sector, while they hurt the construction sector, which analogously holds for sector-specific capital investment. Higher consumption decreases the marginal utility of consumption and, thus, makes holding additional housing relatively more attractive. For savers, this effect and the reduced house price compensate for the higher operating costs such that they increase housing demand. Given the weaker increase in consumption for borrowers, this is not the case for them.

The effects of using *property acquisition taxes* as the financing instrument are qualitatively similar. Now, the attractiveness of investing in housing falls because of a policy-induced increase in the gross purchasing price. This price increase cannot be turned around by the fact that net house prices actually fall. Again, savers can partly pass on the higher purchasing price of housing investment to borrowers through higher rental prices. But, given that the purchasing price of new housing has actually increased in this policy scenario, too, borrowers now still prefer to rent more and own less housing. Less housing at a lower net price also reduces their collateral and, thus, loans. They now spend relatively more of their additional labor income on private consumption goods. In terms of quantity, the negative spillovers on the housing market are largest in this scenario. In terms of macro developments, this also holds for aggregate GDP because the positive effects in the consumption/investment goods sector are not able to compensate for this. Due to the relatively large shift towards private consumption, which is also spent on foreign goods, spillovers to the periphery are larger relative to the two scenarios previously discussed.

Table 3: Long-run effects of policy change

Variable	Policy measure			
	$\Delta\tau^{p}$	$\Delta\tau^{pa}$	$\Delta\tau^{z}$	$\Delta\tau^{c}$
GDP/Output (core)	0.53	0.51	0.54	0.55
...in consumption/investment goods sector	0.66	0.71	0.62	0.58
...in construction sector	-0.26	-1.08	0.44	1.03
Consumption (aggregate)	0.76	0.83	0.70	0.65
...of savers	1.17	1.16	0.92	1.19
...of borrowers	0.46	0.58	0.54	0.26
Housing stock (aggregate)	-0.05	-0.22	0.09	0.21
...of savers (owner-occupied)	0.62	1.01	1.04	1.23
...of borrowers (owner-occupied)	-0.11	-1.84	1.77	-0.16
...of savers (tenement)	-0.51	0.62	-2.51	-0.16
House prices (net)	-0.21	-0.86	0.35	0.82
House prices (gross)	-0.21	0.77	0.35	0.82
Rental prices	1.13	0.74	2.53	0.82
Unemployment	-0.45	-0.44	-0.45	-0.45
...employment consumption/investment goods sector	0.50	0.54	0.47	0.44
...employment construction sector	-0.05	-0.09	-0.02	0.02
Competitiveness (core)	0.70	0.75	0.65	0.61
GDP/Output (periphery)	0.09	0.10	0.08	0.08

Note: Table shows long-run changes of selected variables relative to initial steady-state values in percent (percentage points for rates and ratios).

Figure 1: Medium-term effects of policy change on labor market variables

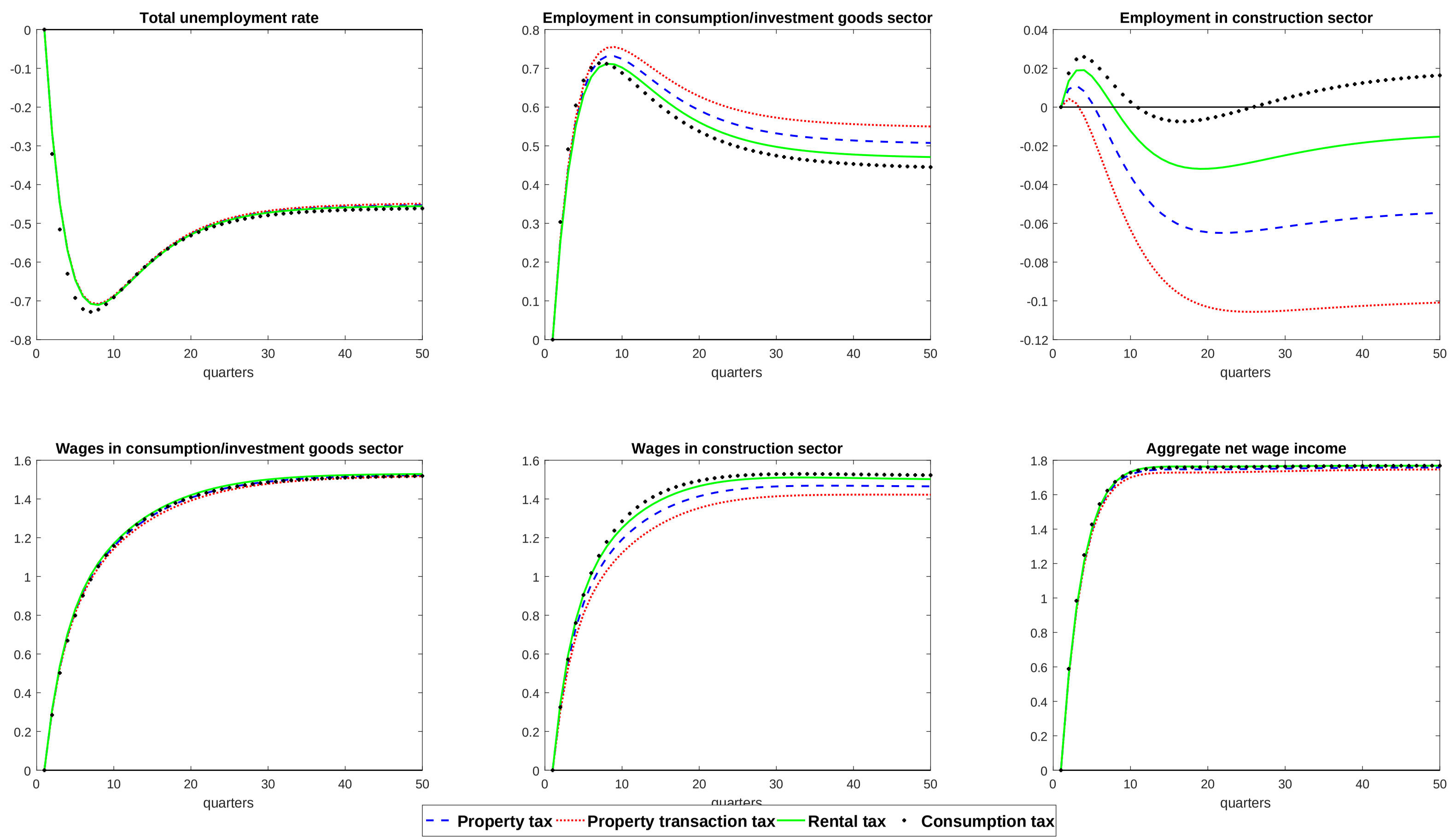


Figure 2: Medium-term effects of policy change on key housing variables

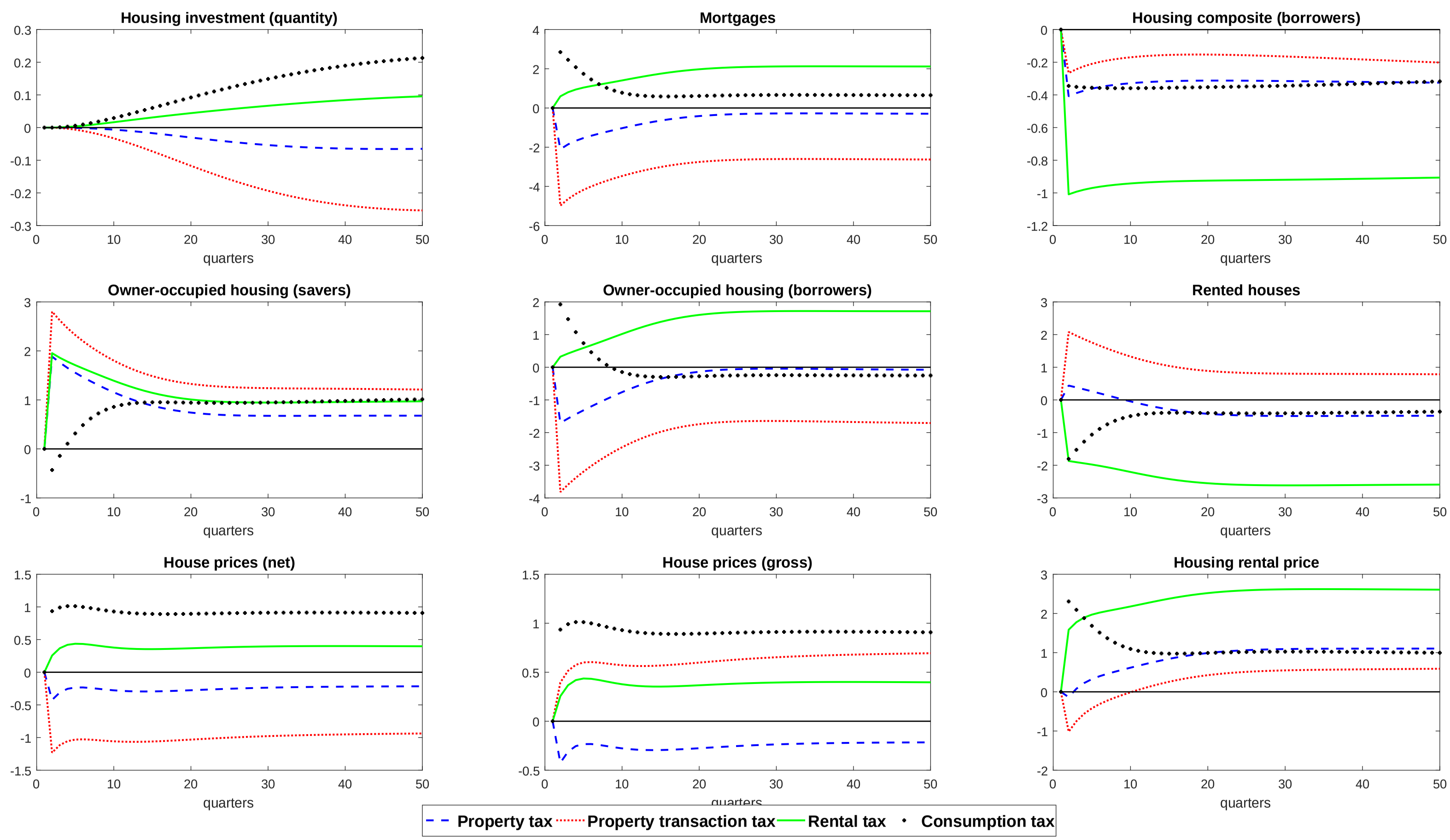
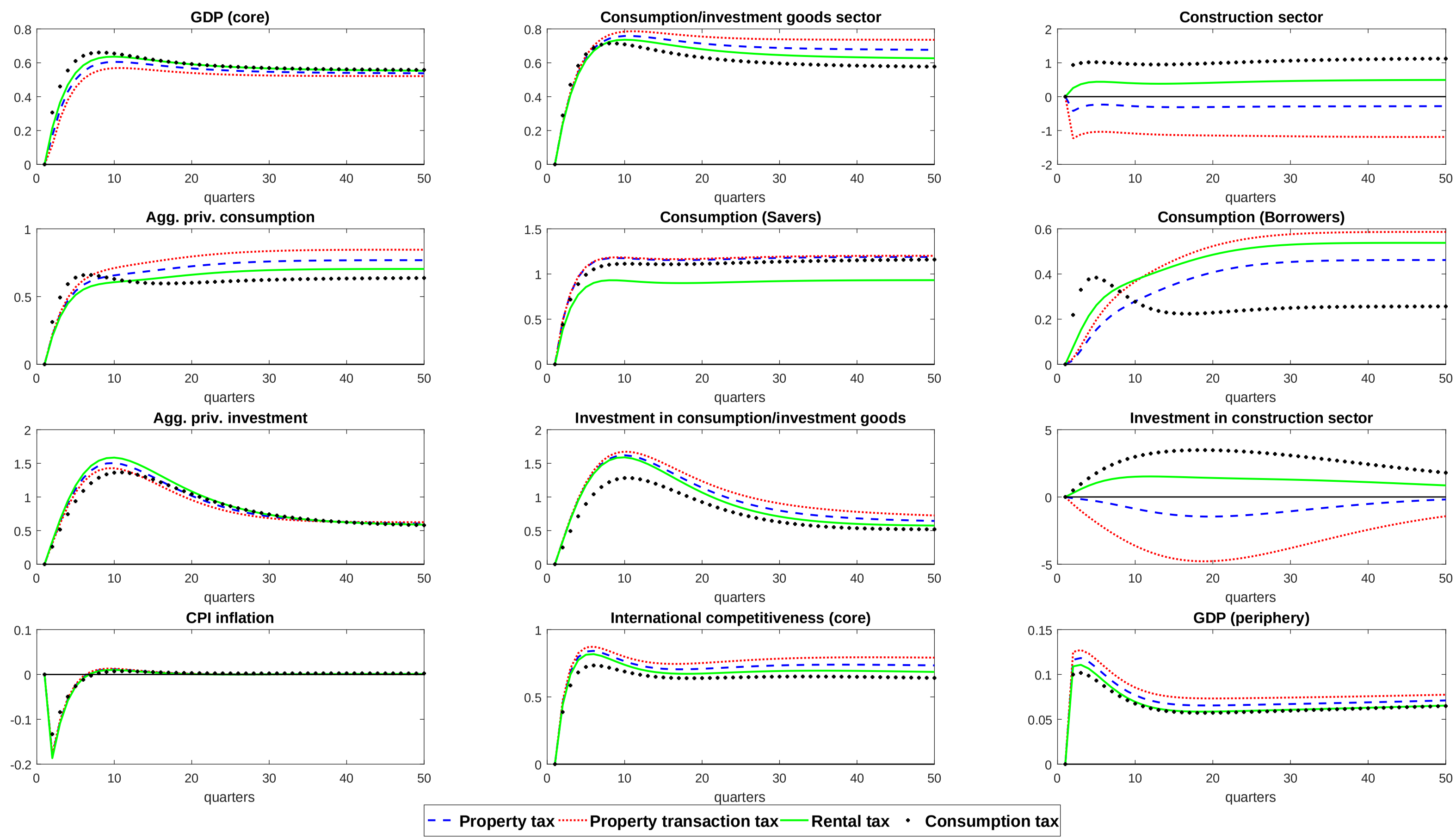


Figure 3: Medium-term effects of policy change on key macro variables



When using *taxes on rental income* to finance the labor tax wedge reduction, this has a relatively strong effect on the rental price as savers can pass on the tax burden to renters. For borrowers, owning a house becomes more attractive and demand for owner-occupied housing of both, savers and borrowers, increases. The positive price and quantity effects allows borrowers to take up more loans. However, compared to the previous scenarios, savers face an income loss due to lower net housing rental income. Thus, they increase private consumption by less, and aggregate private consumption does not rise as much as it does in the other policy scenarios. Aggregate GDP effects are still very similar even though the consumption/investment goods sector benefits less due to the fact that the construction sector benefits more.

From an aggregate perspective, financing a labor tax wedge reduction through property taxes or consumption taxes yields similar effects. Not surprisingly, however, housing and/or rental markets are negatively affected. That generates changes in tenure status, changes in the composition of GDP and redistribution of consumption and housing between household types. While both household types are able to increase private consumption, it not only becomes less attractive for borrowers to become a homeowner (except for the simulation in which taxes on rental income disproportionately increase rental prices), but borrowers also tend to rent fewer housing services (except for the the simulation in which property acquisition taxes are raised). The utility borrowers obtain from housing, depicted by the evolution of the housing composite, falls. Savers tend to benefit in all simulated scenarios. To what extent the gains of higher private consumption can compensate for the loss of housing utility will be addressed in the next subsection.

As mentioned at the beginning of this section, the fiscal authority can also abandon the deductability of property taxes from personal income taxation and/or tax credits on mortgage interest rate payments to finance the labor tax wedge reduction in our model. Unless the upper limit for the tax credit per household is large enough such that mortgage interest payments could finance the labor tax reduction (almost) entirely, which is generally not the case in European legislation (and not in our baseline calibration), the resulting ex ante labor tax wedge reduction that can be financed using either of these instruments is smaller compared to the 1 percentage point decrease in the labor tax wedge that has previously been discussed. Hence, while generating an analogous effect on the labor market, the effects are muted relative to the previously simulated scenarios by construction. Furthermore, the effective reduction in personal labor income taxation is reduced as there may no longer be deductions, which further dampens the positive effects on the labor market.

Apart from that, the effects on the housing market as well as on the core macroeconomic aggregates when *abandoning deductability of property taxes* are very similar to those resulting from a situation in which recurrent property taxes are used as the financing instrument. The reason is that, then, operating costs of house ownership increase in a similar manner.

Abandoning tax credits on mortgage interest payments to finance a labor tax wedge reduction, however, generates some differences. As taking up loans becomes more expensive, borrowers significantly reduce the demand for owner-occupied housing. As a result, house prices fall, which also leads to falling rental prices. Borrowers shift from home-ownership to renting housing services. Because taking up loans becomes more expensive, borrowers also cut demand for regular consumption goods in relative terms. Savers, on the other hand, relatively increase demand for housing and consumption goods because of cheaper housing. Overall, the aggregate macroeconomic effects are still of similar size. To save space, we show the detailed simulation results in the appendix.

There is another interesting side note we can make. As in Alpanda and Zubairy (2017), we also find that higher property taxation is suitable to reduce private household debt in an economy. This holds true for all measures except for an increase in rental income taxation as the latter augments the incentive for home ownership for borrowers and implies an increase in house prices as described above.

3.2. Welfare assessment

Having analyzed the macro effects of the different reforms, it now remains to answer the question of whether the increase in consumption of borrowers can compensate for their loss in housing utility, and who benefits from the reforms to what extent. To do so, we compute the life-time consumption-equivalent gain of each type of household as a result of the change in fiscal policy. We will take into account the welfare difference between the initial and the final steady state as well as the transition thereto. More precisely, we calculate the consumption-equivalent welfare gain, ce^i, such that

$$\sum_{t=0}^{\infty} \left(\beta^i\right)^t U\left((1+ce^i)\bar{c}^i, \bar{\tilde{h}}^i\right) = \sum_{t=0}^{\infty} \left(\beta^i\right)^t U\left(c_t^i, \tilde{h}_t^i\right),$$

where the utility function $U(\cdot)$ is given by equation (1) and the bar indicates initial steady-state values. Hence, ce^i represents the amount of initial steady-state consumption a household of type i is willing to give up in order to live in the alternative regime after the policy change. Economy-wide welfare is computed as $ce^{tot} = (1-\mu)ce^s + \mu ce^b$. The results are summarized in Table 4. Positive values imply a welfare gain, while negative values signal a welfare loss. Note that, as ce^i takes into account the transitional dynamics to the new steady state, we also report "pure" steady-state welfare changes in brackets (ignoring transitional dynamics).

The first observation we can make it that a labor tax wedge reduction increases aggregate as well as household-type-specific welfare independent of the financing instrument used. Second, when taking into account the transition, the aggregated welfare gain is somewhat lower compared to a pure steady-state comparison. This is primarily driven by some "undershooting" in the housing sector for borrowers and the fact that it takes time to reach the new steady state. Third, we see that property acquisition taxes as the financing instrument outperform all other instruments followed by recurrent property taxes and consumption taxes. Increasing rental income taxation is the least favorable tax instrument to finance the labor tax wedge reduction. Hence, our simulations suggest that the use of property taxation may outperform the use of consumption taxation to finance budget-neutral labor tax wedge reductions.

Table 4: Welfare assessment

Policy measure	Consumption equivalents		
	Savers	Borrowers	Aggregate
Increase in property tax rate	1.35 (1.34)	0.27 (0.37)	0.73 (0.77)
Increase in property acquisition tax rate	1.55 (1.48)	0.41 (0.49)	0.89 (0.91)
Increase in rental income tax rate	1.17 (1.18)	0.22 (0.33)	0.62 (0.69)
Increase in consumption tax rate	1.40 (1.50)	0.18 (0.22)	0.70 (0.76)

Note: Welfare presented as life-time consumption equivalents taking into account the transition. In brackets, we compare a pure steady-state comparison.

This is also found by Bielecki and Stähler (2018). However, they find that the use of property transaction taxation fares worse than the use of consumption taxation. The primary reason for this is that, in their model, households are “forced” to purchase housing. In our framework, they can decide to own or rent housing. While the negative macroeconomic effects of higher property acquisition taxes per se are similar in both frameworks, especially for housing market transactions, the fact that households rent more housing services after an increase in the property transaction tax rate affects the utility loss much less in our framework.

When calculating the welfare gains of abandoning the mortgage interest payment reduction, we find that borrowers no longer gain but actually lose 0.11% of their initial steady-state consumption, while savers gain as much as 3% (still generating an aggregate welfare gain of 1.33%). This can be explained by the corresponding shifts between housing and consumption goods described in the previous section (simulation results are shown in the appendix).

4. Conclusions

We use a New Keynesian DSGE model with a rental housing market where households can decide whether to buy or rent housing services to evaluate how financing a labor tax wedge reduction through higher property taxation affects the real economy and welfare.

We find that a budget-neutral reduction in the labor tax wedge has positive employment, demand and output effects, and that it fosters international competitiveness. This is independent of the financing instrument used. However, the housing and/or rental markets are negatively affected after an increase in property taxation, which changes tenure decisions and the composition of GDP, and it redistributes consumption and housing between household types. While both household types demand more regular consumption goods after an increase in property taxation than after an increase in consumption taxes to finance the labor tax wedge reduction, not only does it become less attractive for borrowers to become homeowners but also borrowers tend to rent fewer housing services in general. Hence, the utility borrowers obtain from housing falls, whereas savers tend to benefit in all simulated scenarios.

In terms of welfare, the increase in private consumption utility prevails over the loss in housing utility for borrowers in most scenarios. By contrast, welfare gains clearly depend on the exact instrument used. Property acquisition taxes outperform all other instruments as the financing instrument, which also stems from the fact that we allow households to purchase or rent housing services, and are followed by recurrent property taxes and consumption taxes. Increasing rental income taxation is the least favorable tax instrument, and abandoning tax credit on mortgage interest payments effectively harms borrowers.

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Appendix

In this appendix, we first show the simulation results of using the personal income tax rate to reduce the labor tax wedge instead of using social security contributions. Second, we report the results of abandoning tax credits on mortgage interest payments and the deductability of property taxes from gross labor income and compare these to the (modified) simulations presented in the main text. Last, we perform the labor tax wedge reduction in the periphery to test how much country-specific circumstances affect the results.

A.1. Using the personal income tax rate to reduce the labor tax wedge

The reduction in the personal labor income tax rate is calculated as

$$d\left(\bar{\tau}^{w}\right) = -0.01 \cdot \left(\frac{\bar{p}_B^{1-\omega-\psi}\left(\bar{N}^{tot}\bar{w} - \bar{\tau}^{p}\,\iota^{p}\,\bar{q}^{h}\bar{h}^{tot} - \iota^{\varrho}\left(\bar{R}^{h}-1\right)/\bar{\pi}\,\bar{b}^{b}\right)}{GDP}\right)^{-1}.$$

Due to the deductability of mortgage interest payments ($\iota^{\varrho} = 1$) and property taxes ($\iota^{p} = 1$), the reduction in the personal income tax rate is larger than the necessary reduction in the social security contribution rate as its tax base is lower ($\bar{\tau}^{w}$ needs to be reduced by 2.13 percentage points).

When reducing the personal labor income tax rate on the workers' side, their net labor income increases immediately. This is policy-induced and not a result of higher gross wage claims. On the contrary, in this case, gross wages actually fall because what households care about in the end is their net wage income (see Figure A.1). The fall in gross wages generates analogous effects on job creation, competitiveness and employment. But, first, it takes more time for the labor cost cut to materialize as there is staggered wage setting and, second, the resulting labor cost reduction is lower because the mechanism is only indirect. This implies a somewhat muted reduction in unemployment. Because gross wages fall, and these are the basis for personal income taxes and social security contributions, the impact on fiscal revenues is larger. In order to compensate for this revenue loss ex post, the other taxes have to be raised more (property taxes need to be increased by 0.12, property acquisition tax rates by 6.48, tax rates on rental income by 5.37 and the consumption tax rate by 1.17 percentage points). Clearly, the negative effects resulting from these tax hikes are larger. But they are generally analogous from a qualitative perspective.

Overall, we can state that, when using property-related taxes to finance the reduction in the personal labor income tax rate, the housing market is affected more negatively, with a larger shift towards private consumption goods. When using consumption taxes as the financing instrument, the opposite is true. The results are summarized in Figures A.1 to A.3 and Table A.1. This also implies that welfare gains are slightly muted relative to decreasing social security contributions.[12]

Table A.1: Long-run effects of policy change (PIT)

Variable	Policy measure			
	$\Delta\tau^{p}$	$\Delta\tau^{pa}$	$\Delta\tau^{z}$	$\Delta\tau^{c}$
GDP/Output (core)	0.39	0.33	0.44	0.49
...in consumption/investment goods sector	0.78	0.97	0.62	0.48
...in construction sector	-3.46	-6.50	-0.91	1.24
Consumption (aggregate)	0.93	1.19	0.72	0.54
...of savers	1.02	1.03	0.12	1.09
...of borrowers	0.86	1.30	1.16	0.14
Housing stock (aggregate)	-0.72	-1.36	-0.19	0.25
...of savers (owner-occupied)	-0.64	0.70	0.84	1.57
...of borrowers (owner-occupied)	-0.56	-6.82	6.61	-0.76
...of savers (tenement)	-0.95	3.11	-8.54	0.36
House prices (net)	-2.77	-5.21	-0.72	0.98
House prices (gross)	-2.77	0.91	-0.72	0.98
Rental prices	2.19	0.84	7.86	1.04
Unemployment	-0.38	-0.36	-0.39	-0.40
...employment consumption/investment goods sector	0.59	0.73	0.47	0.36
...employment construction sector	-0.21	-0.37	-0.08	0.03
Competitiveness (core)	0.82	1.02	0.65	0.51
GDP/Output (periphery)	0.10	0.13	0.08	0.07

Note: Table shows long-run changes of selected variables relative to initial steady-state values in percent (percentage points for rates and ratios).

[12]Note that, because of the larger increase in net labor income here, borrowers tend to benefit more and savers less from reducing the personal labor income tax rate relative to what is shown in the main text; see also Attinasi et al. (2018) for a detailed discussion.

Figure A.1: Medium-term effects of policy change on labor market variables (PIT rate)

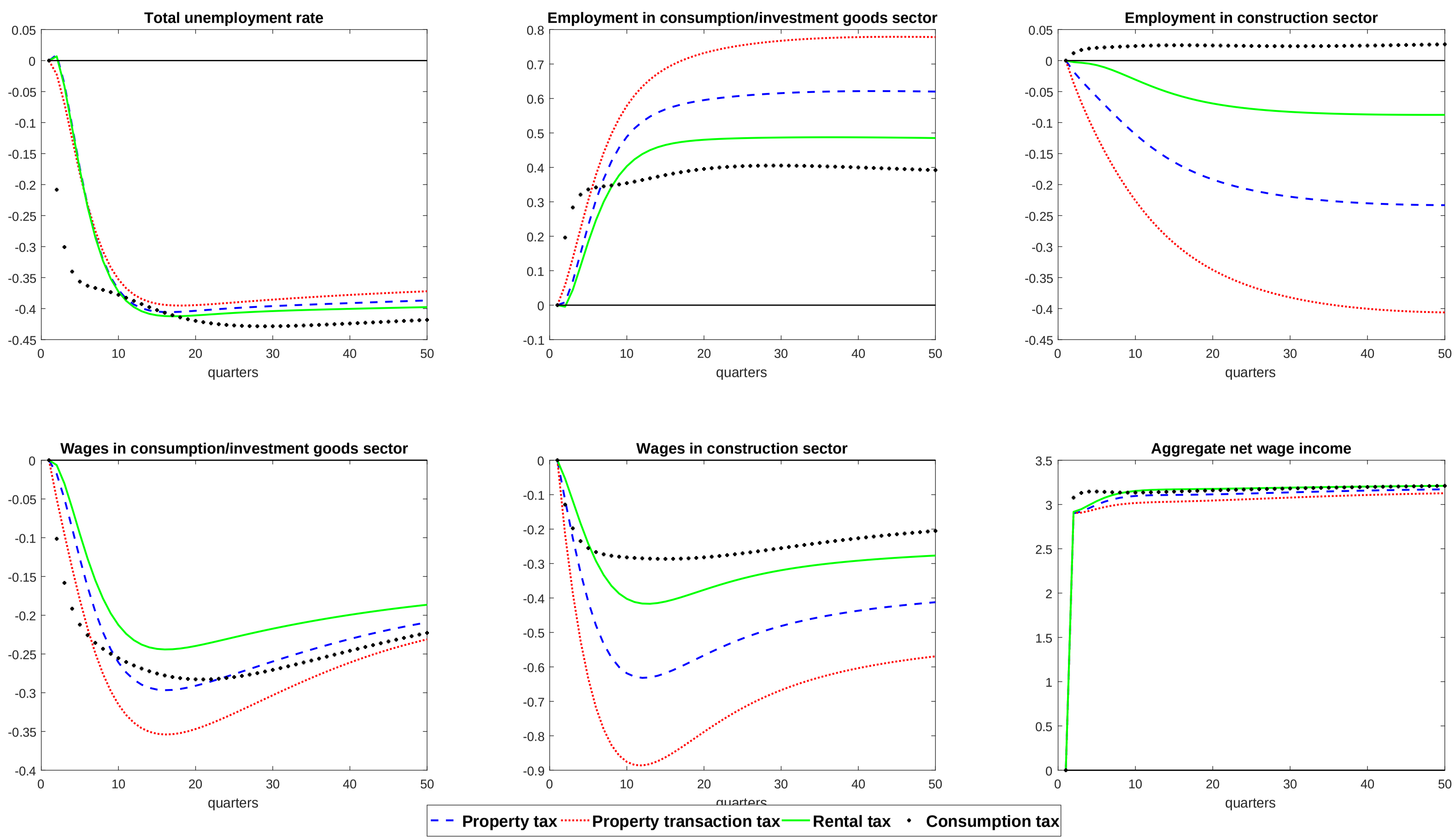


Figure A.2: Medium-term effects of policy change on key housing variables (PIT rate)

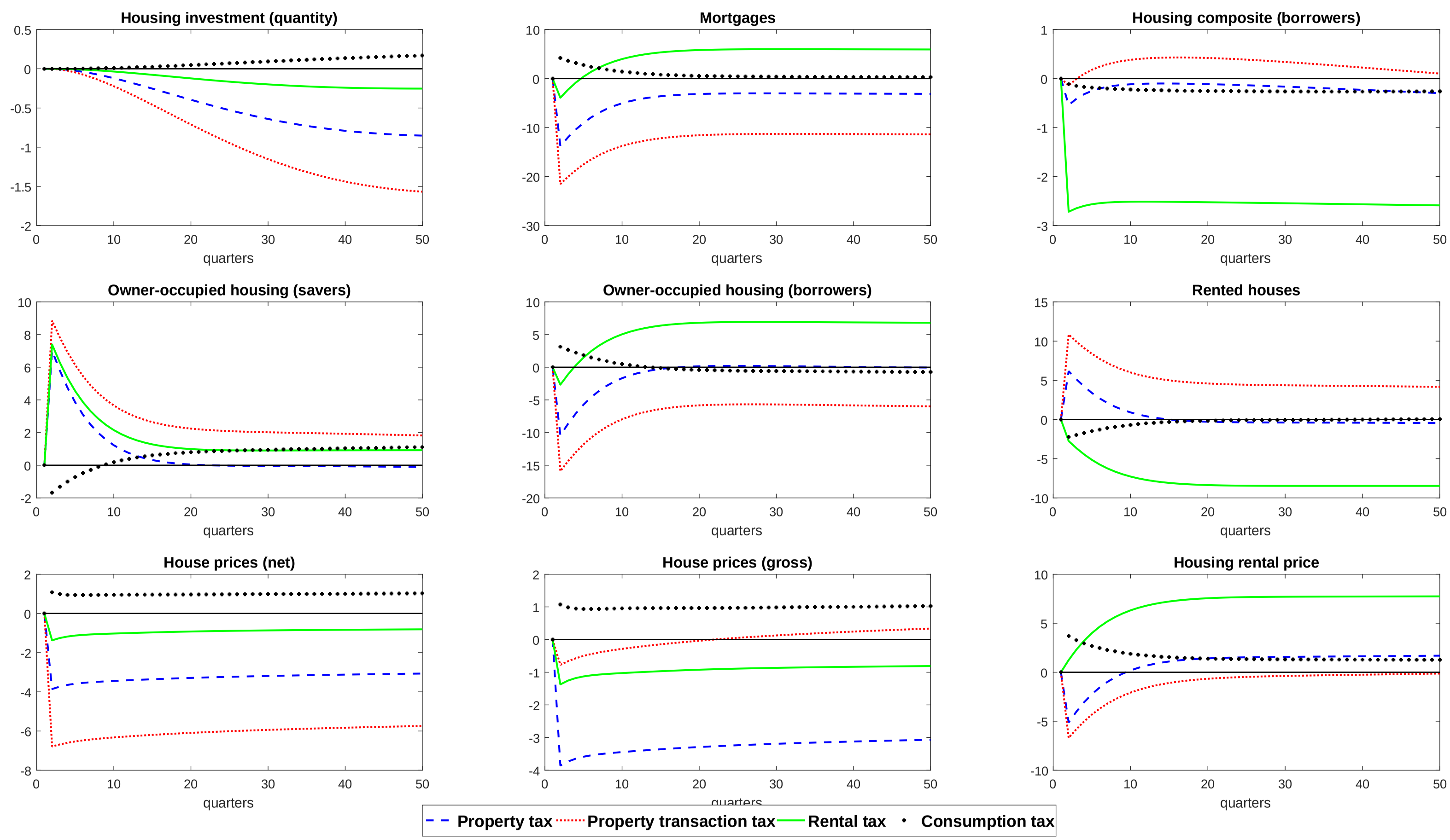
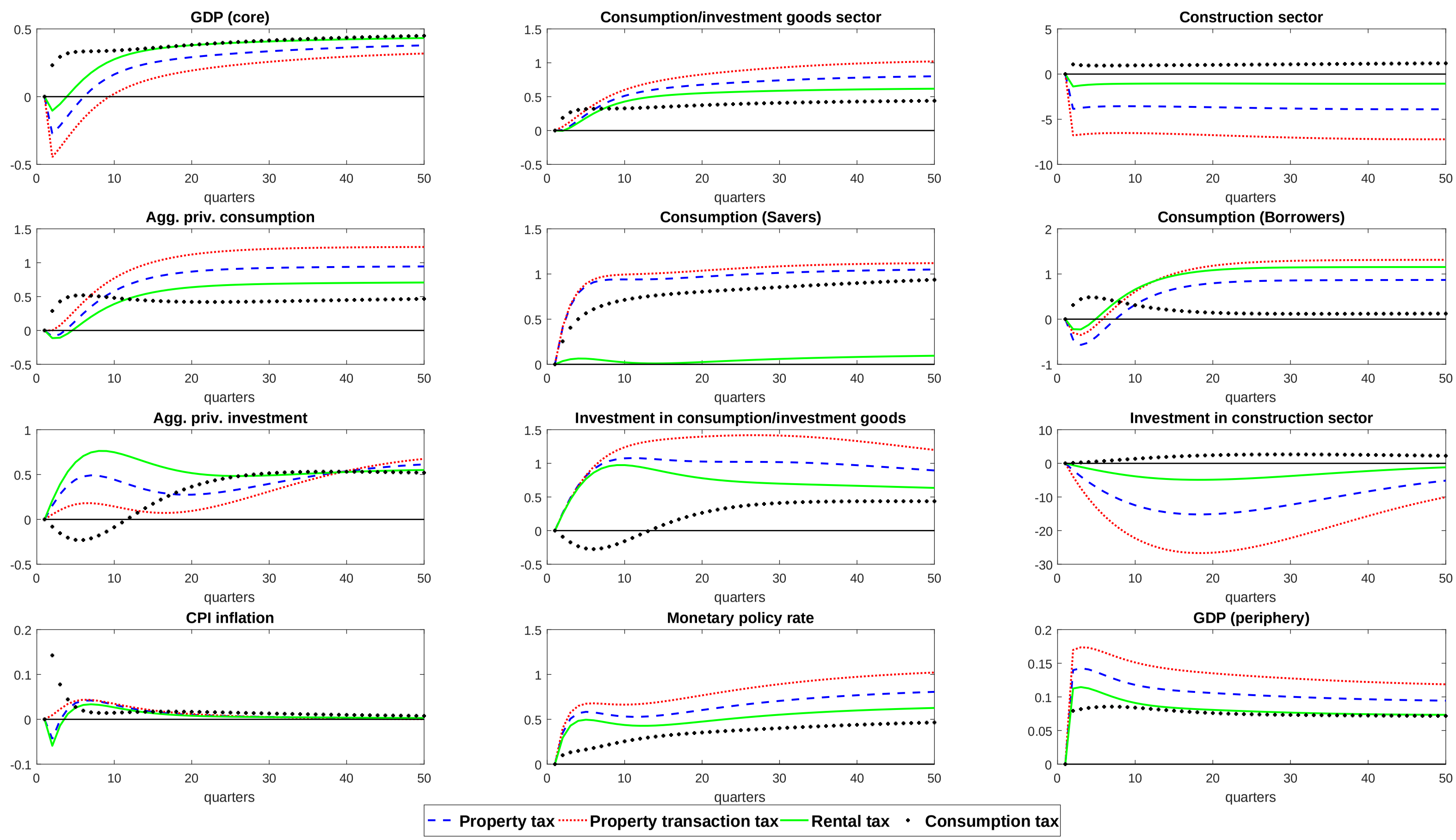


Figure A.3: Medium-term effects of policy change on key macro variables (PIT rate)



B.1. Abandoning tax credits to finance the tax wedge reduction

In this appendix, we present the simulation results of abandoning tax credits on mortgage interest payments (by setting $\iota^{\varrho} = 0$) and the deductability of property taxes from gross labor income (by setting $\iota^{p} = 0$) to finance a labor tax wedge reduction. As these measures by themselves are not sufficient to finance a labor tax wedge reduction that generates an increase in the ex ante primary deficit-to-GDP ratio by 1 percentage point, we assume that, first, the "financing" instrument is increased and, then, calculate the resulting decrease in the labor tax rate ex post. In order to then compare these measures to those described in the main text, we take the resulting labor tax rate reduction (instead of the one generating an ex ante decrease in the primary deficit-to-GDP ratio by 1 percentage point) and re-do the corresponding simulations. Tables B.1 and B.2 present the resulting tax rate changes; simulation results are plotted in Figures B.1 to B.3 and B.4 to B.6, respectively.

Table B.1: Changes in tax rates corresponding to $\iota^{\varrho} = 0$

Change in..	Financing instrument			
	$\Delta\tau^{p}$	$\Delta\tau^{pa}$	$\Delta\tau^{z}$	$\Delta\tau^{c}$
SSC rate	-1.891	-1.891	-1.891	-1.891
Property tax rate	0.03	0	0	0
Property acquisition tax rate	0	1.77	0	0
Tax rate on rental income	0	0	1.25	0
Consumption tax rate	0	0	0	0.29

Table B.2: Changes in tax rates corresponding to $\iota^{p} = 0$

Change in..	Financing instrument			
	$\Delta\tau^{p}$	$\Delta\tau^{pa}$	$\Delta\tau^{z}$	$\Delta\tau^{c}$
SSC rate	-1.1691	-1.1691	-1.1691	-1.1691
Property tax rate	0.02	0	0	0
Property acquisition tax rate	0	1.04	0	0
Tax rate on rental income	0	0	0.74	0
Consumption tax rate	0	0	0	0.18

Figure B.1: Medium-term effects of policy change on labor market variables ($\iota^{\varrho} = 0$)

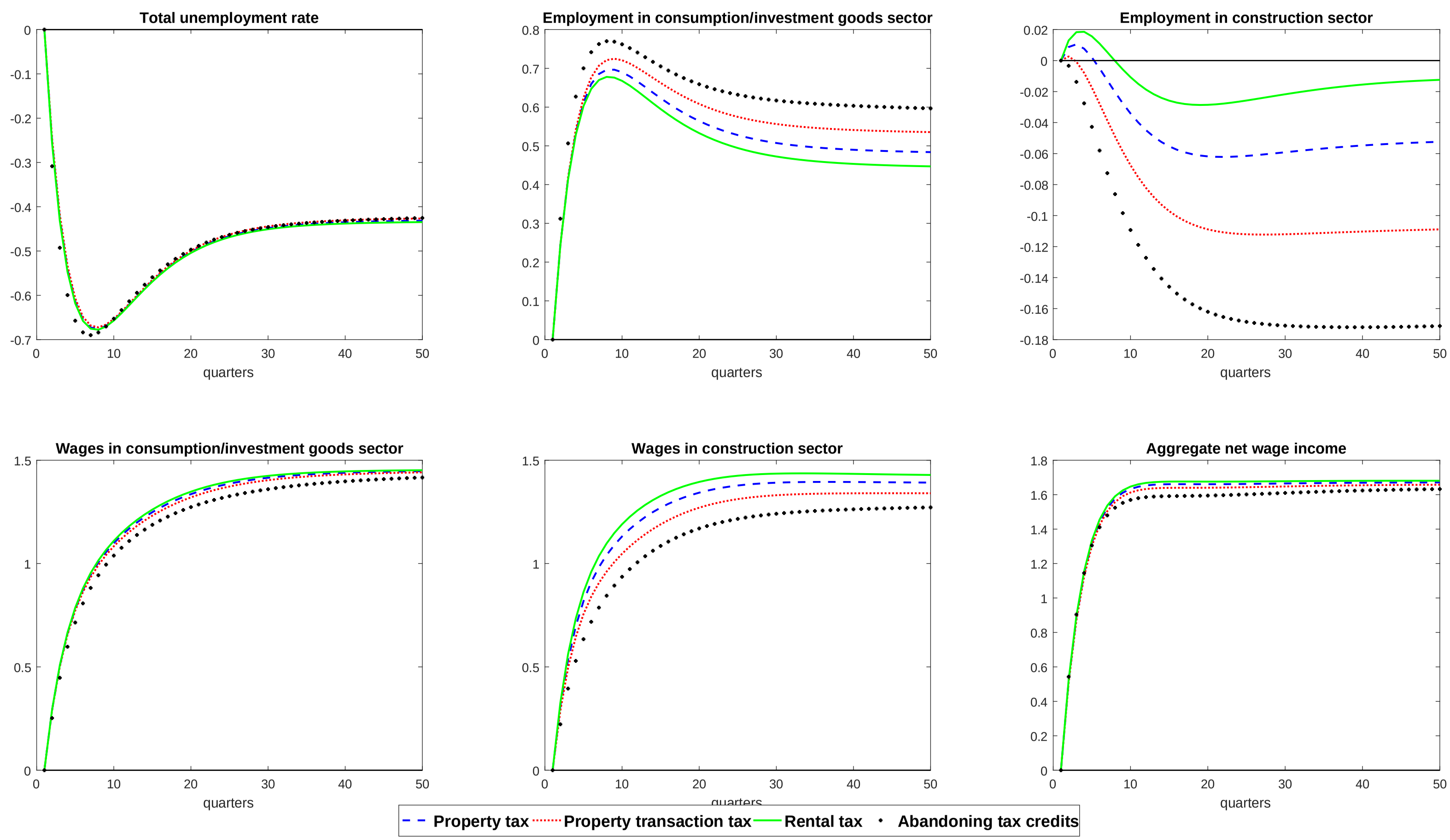


Figure B.2: Medium-term effects of policy change on key housing variables ($\iota^{\varrho} = 0$)

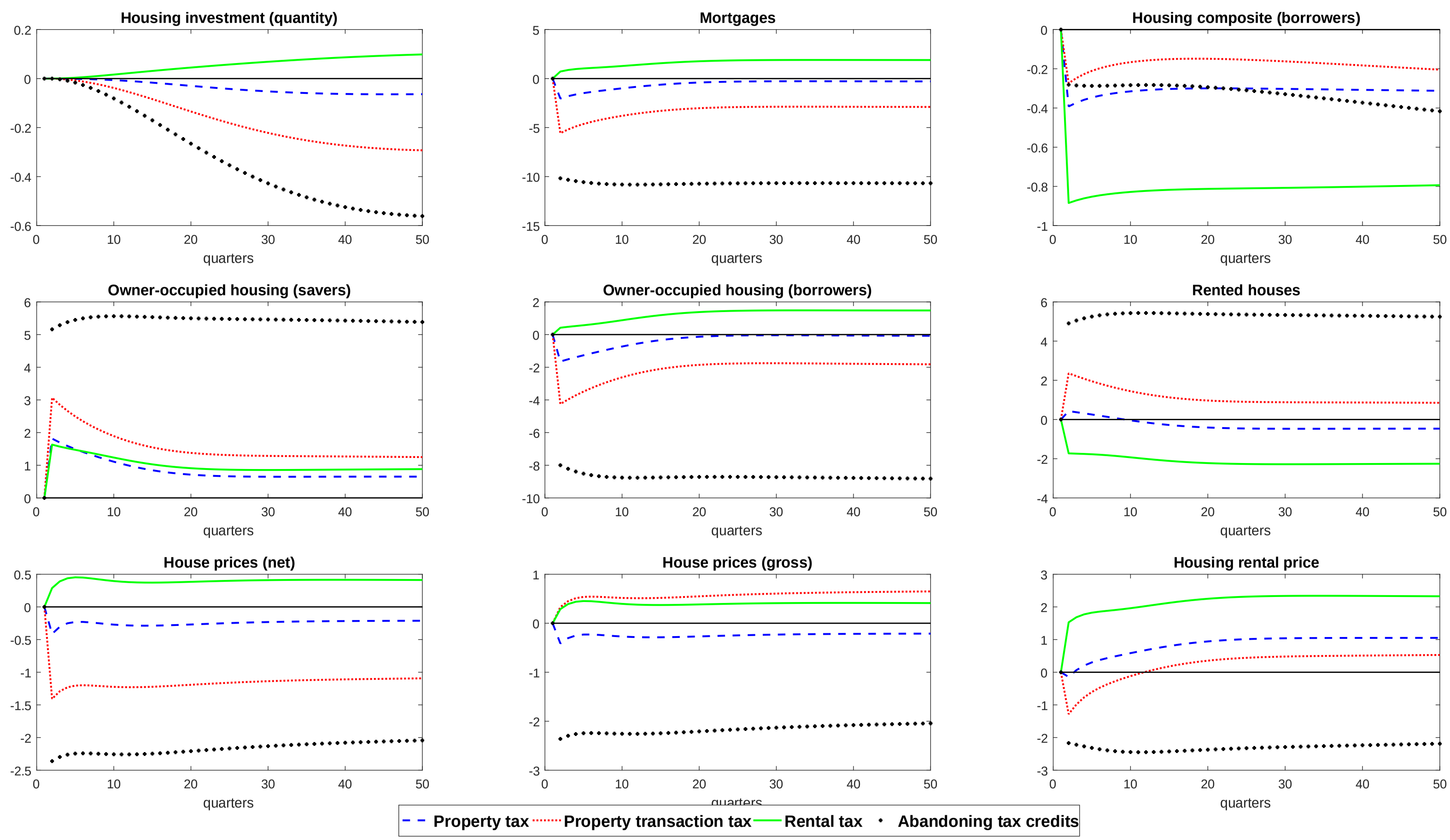


Figure B.3: Medium-term effects of policy change on key macro variables ($\iota^{\varrho} = 0$)

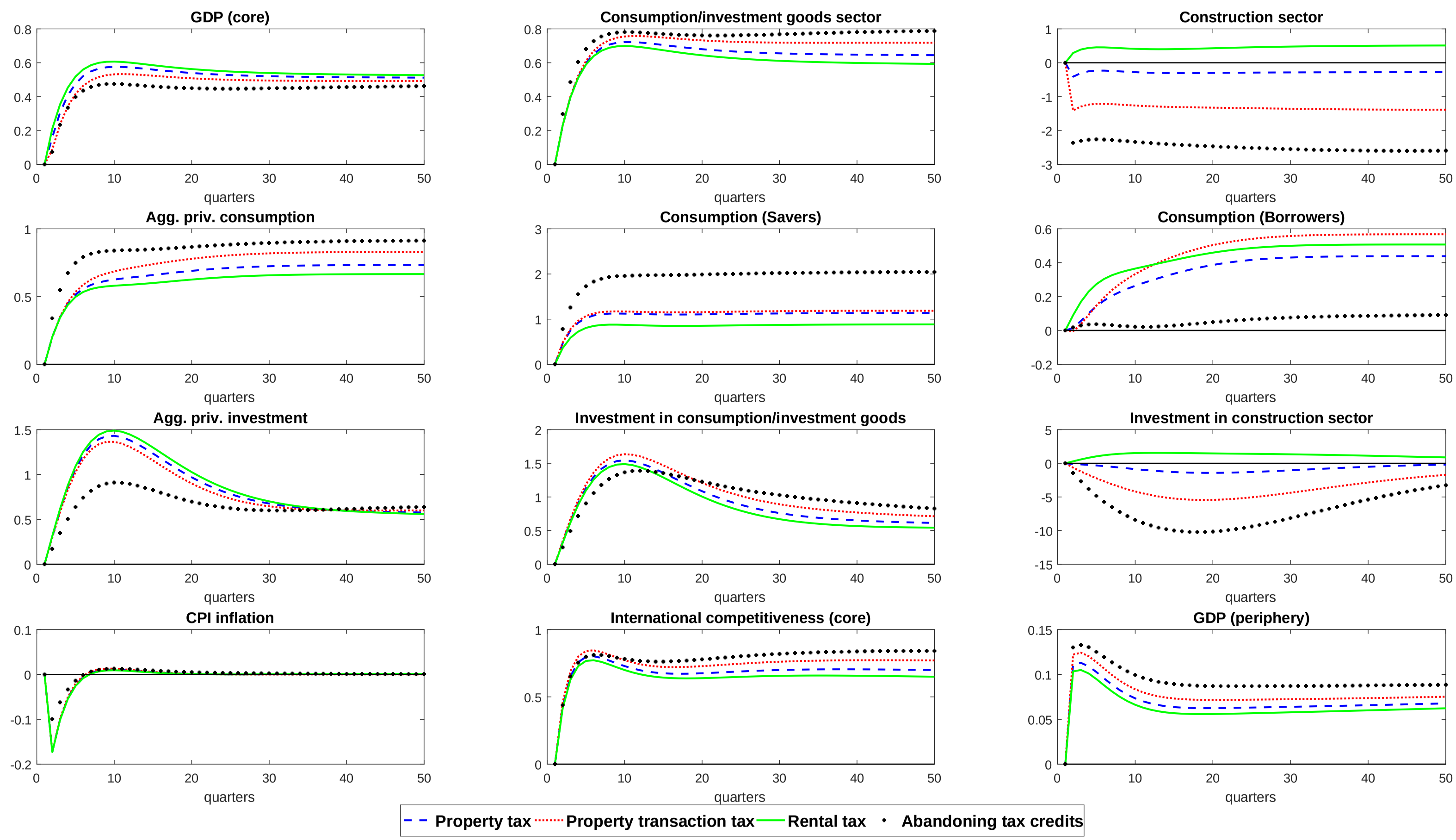


Figure B.4: Medium-term effects of policy change on labor market variables ($\iota^p = 0$)

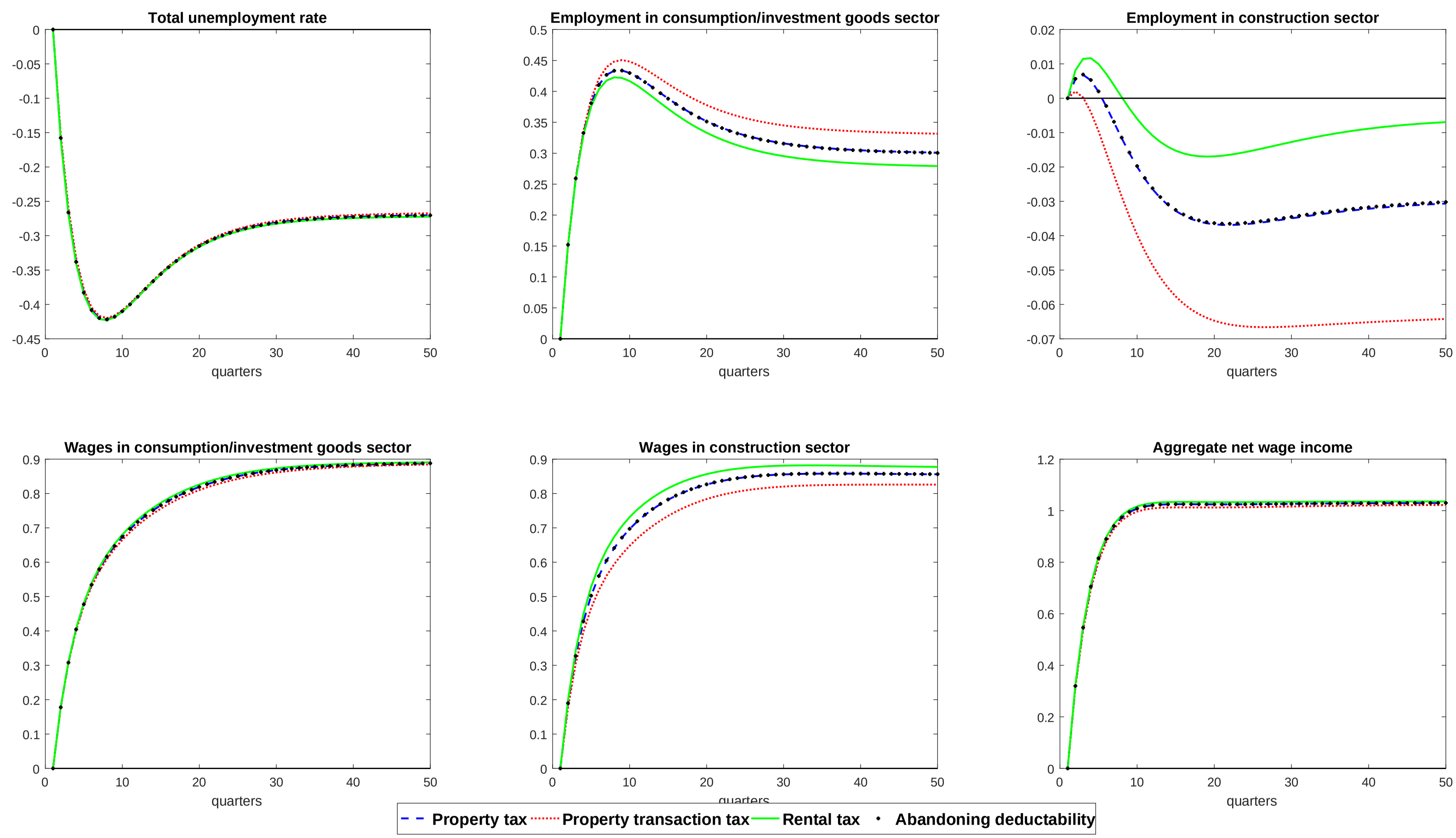


Figure B.5: Medium-term effects of policy change on key housing variables ($\iota^p = 0$)

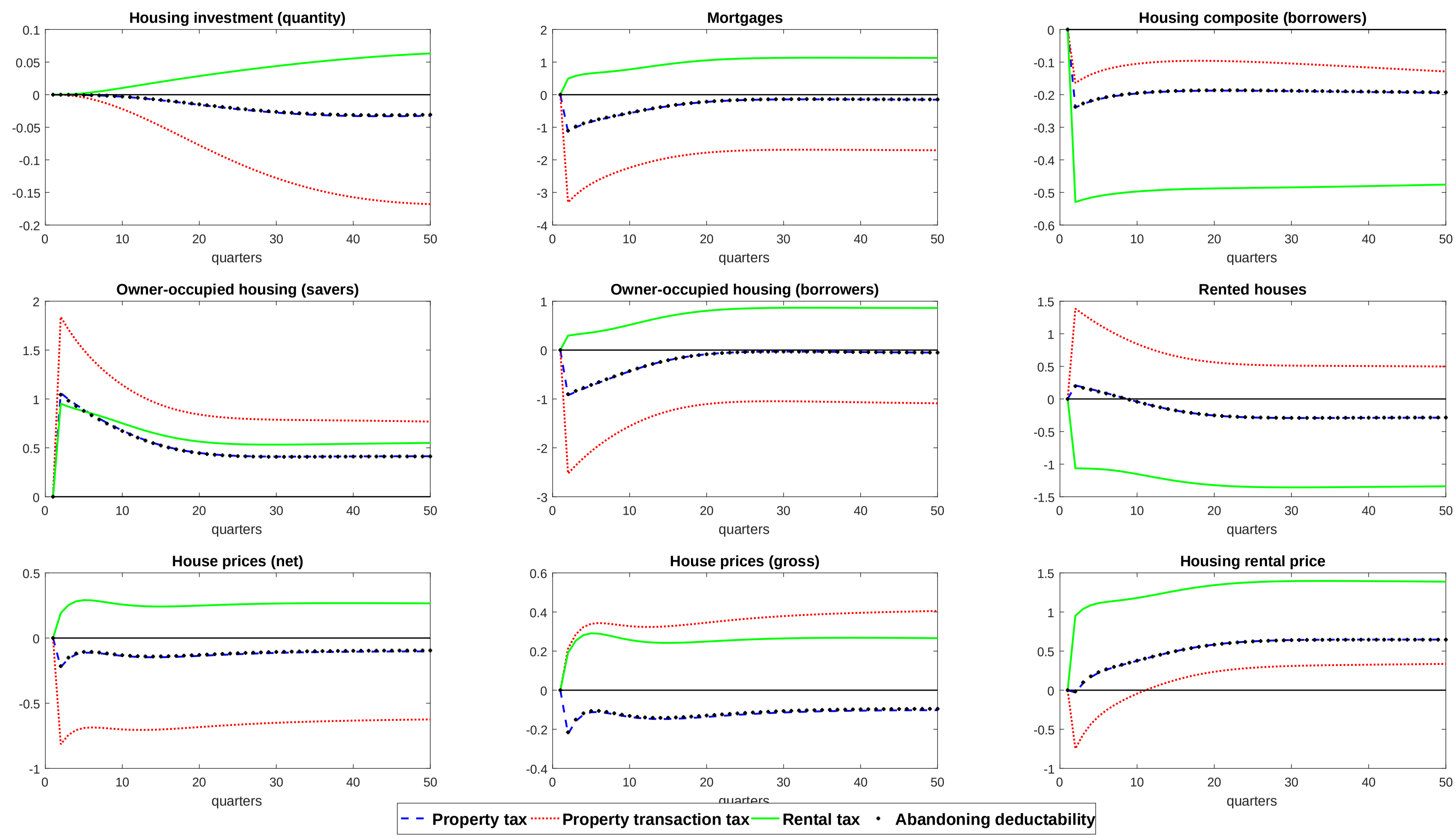
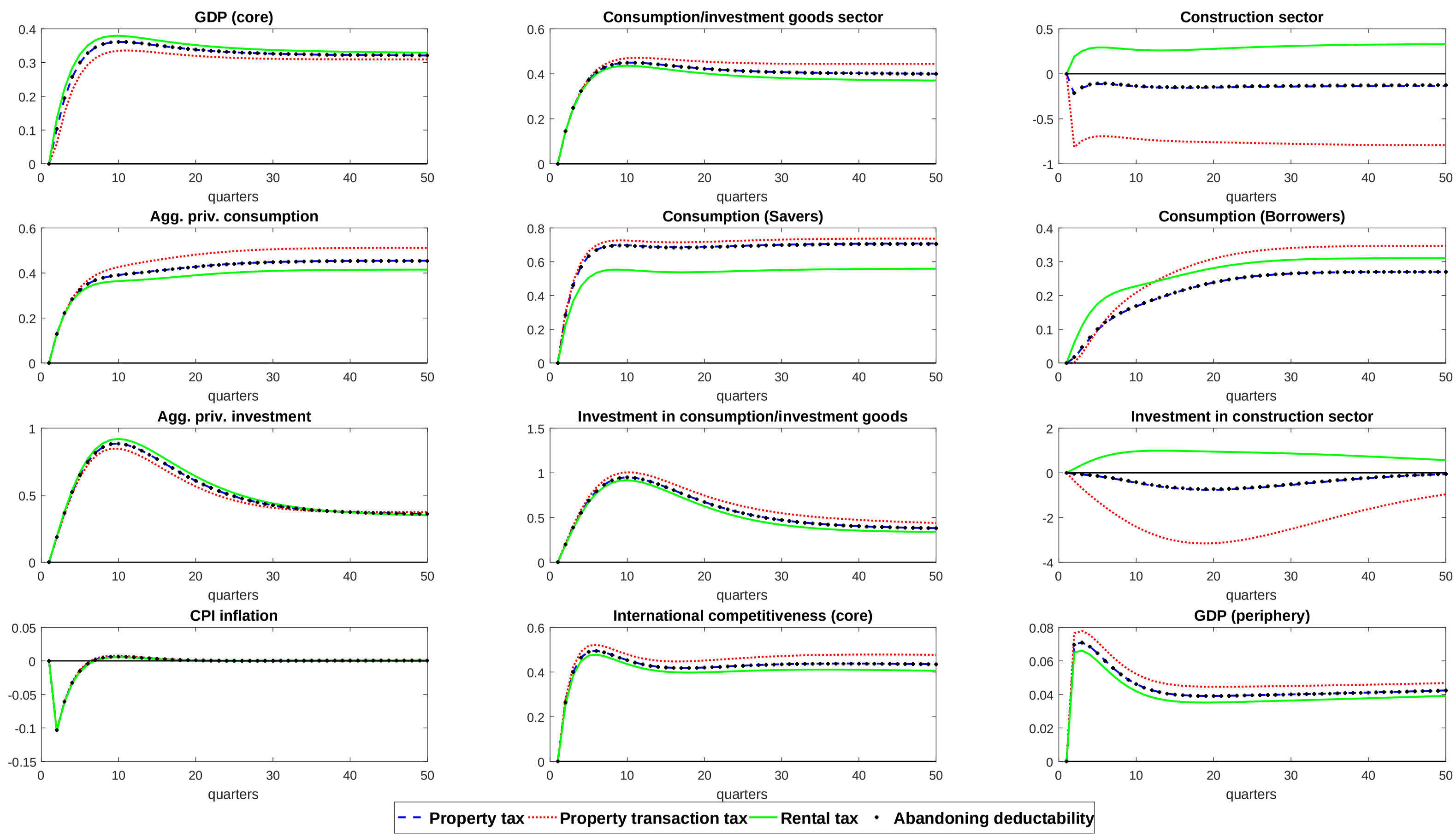


Figure B.6: Medium-term effects of policy change on key macro variables ($\iota^p = 0$)



C.1. Tax shift undertaken in the periphery

In this section, we conduct exactly the same simulation as described in the main text except that, now, the policy change is undertaken in the periphery. As we can see, the effects are qualitatively analogous but slightly smaller quantitatively.

Table C.1: Long-run effects of policy change in the periphery

Variable	Policy measure			
	$\Delta\tau^{p}$	$\Delta\tau^{pa}$	$\Delta\tau^{z}$	$\Delta\tau^{c}$
GDP/Output (periphery)	0.33	0.23	0.39	0.46
...in consumption/investment goods sector	0.45	0.54	0.40	0.33
...in construction sector	-0.04	-1.20	0.62	1.48
Consumption (aggregate)	0.53	0.67	0.45	0.35
...of savers	1.06	1.24	0.62	1.39
...of borrowers	0.34	0.47	0.39	-0.03
Housing stock (aggregate)	-0.01	-0.24	0.12	0.30
...of savers (owner-occupied)	0.48	0.95	0.44	1.40
...of borrowers (owner-occupied)	-0.30	-2.80	0.98	-0.71
...of savers (tenement)	-0.62	0.12	-1.29	-0.71
House prices (net)	-0.03	-0.96	0.49	1.18
House prices (gross)	-0.03	1.20	0.49	1.18
Rental prices	1.10	0.92	1.64	1.18
Unemployment	-0.26	-0.26	-0.27	-0.27
...employment consumption/investment goods sector	0.31	0.37	0.27	0.23
...employment construction sector	-0.04	-0.11	-0.01	0.04
Competitiveness (periphery)	0.51	0.61	0.45	0.37
GDP/Output (core)	0.02	0.02	0.02	0.01

Note: Table shows long-run changes of selected variables relative to initial steady-state values in percent (percentage points for rates and ratios).

Figure C.1: Medium-term effects of policy change on labor market variables in Periphery

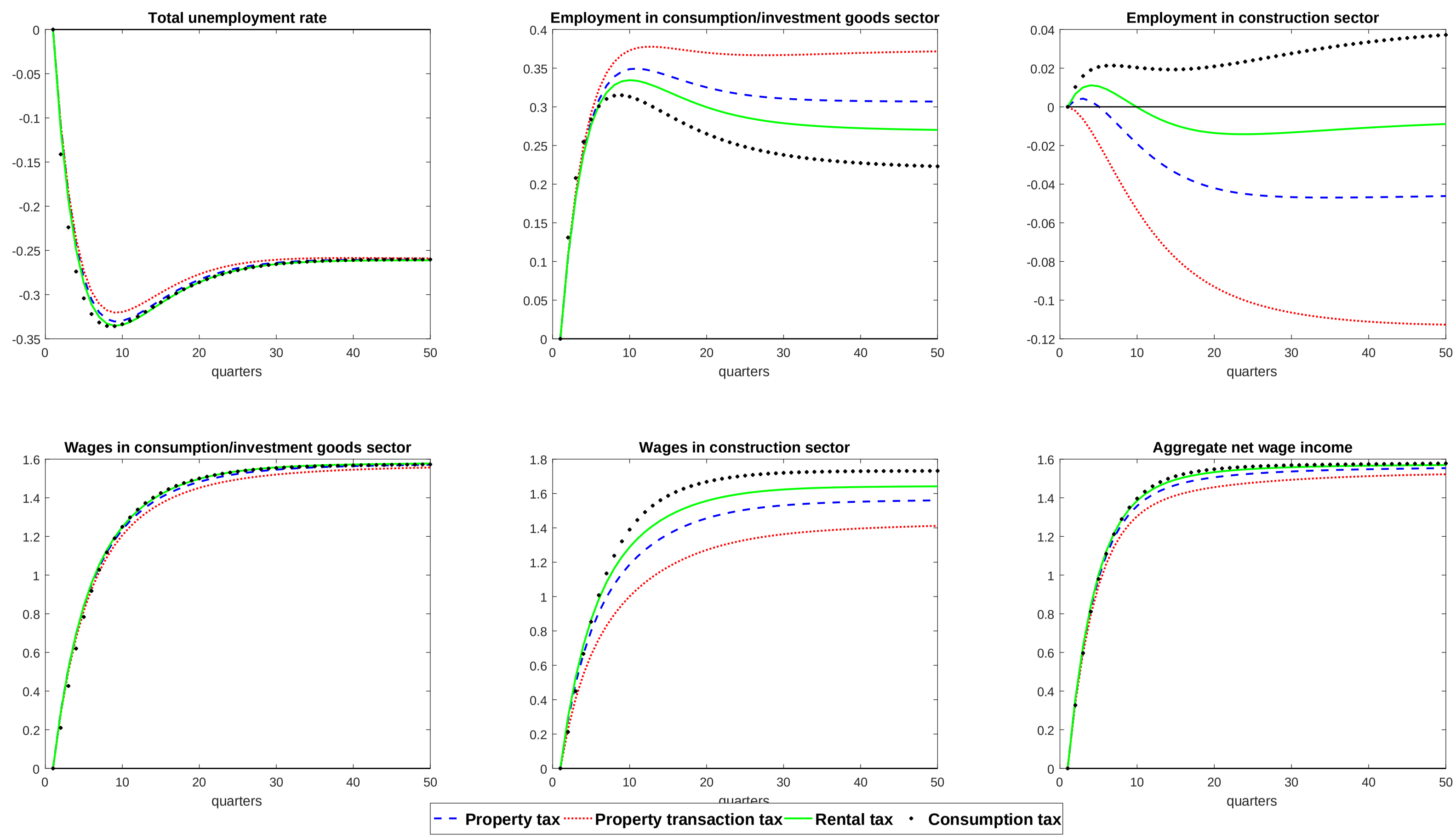


Figure C.2: Medium-term effects of policy change on key housing variables in Periphery

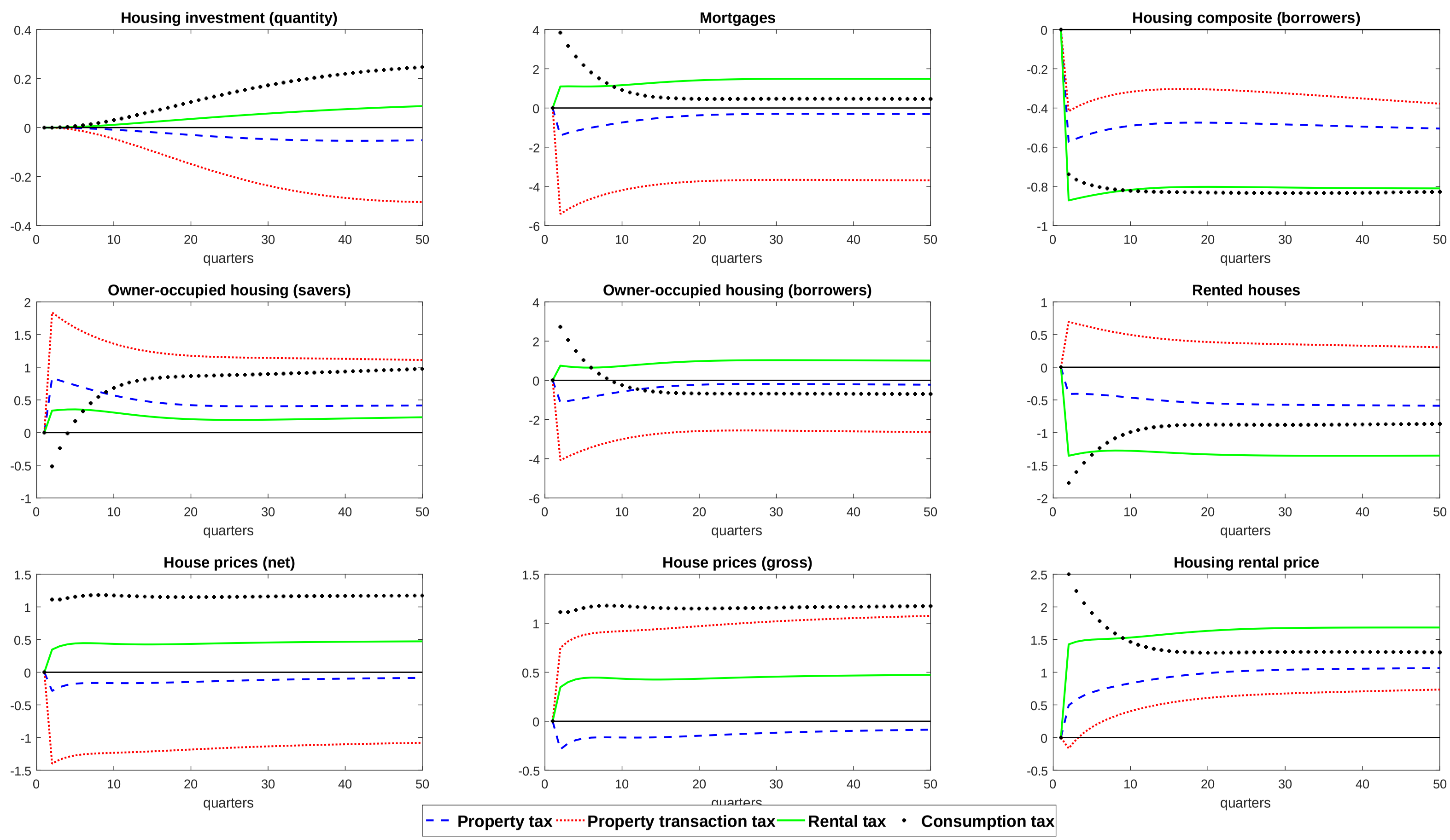
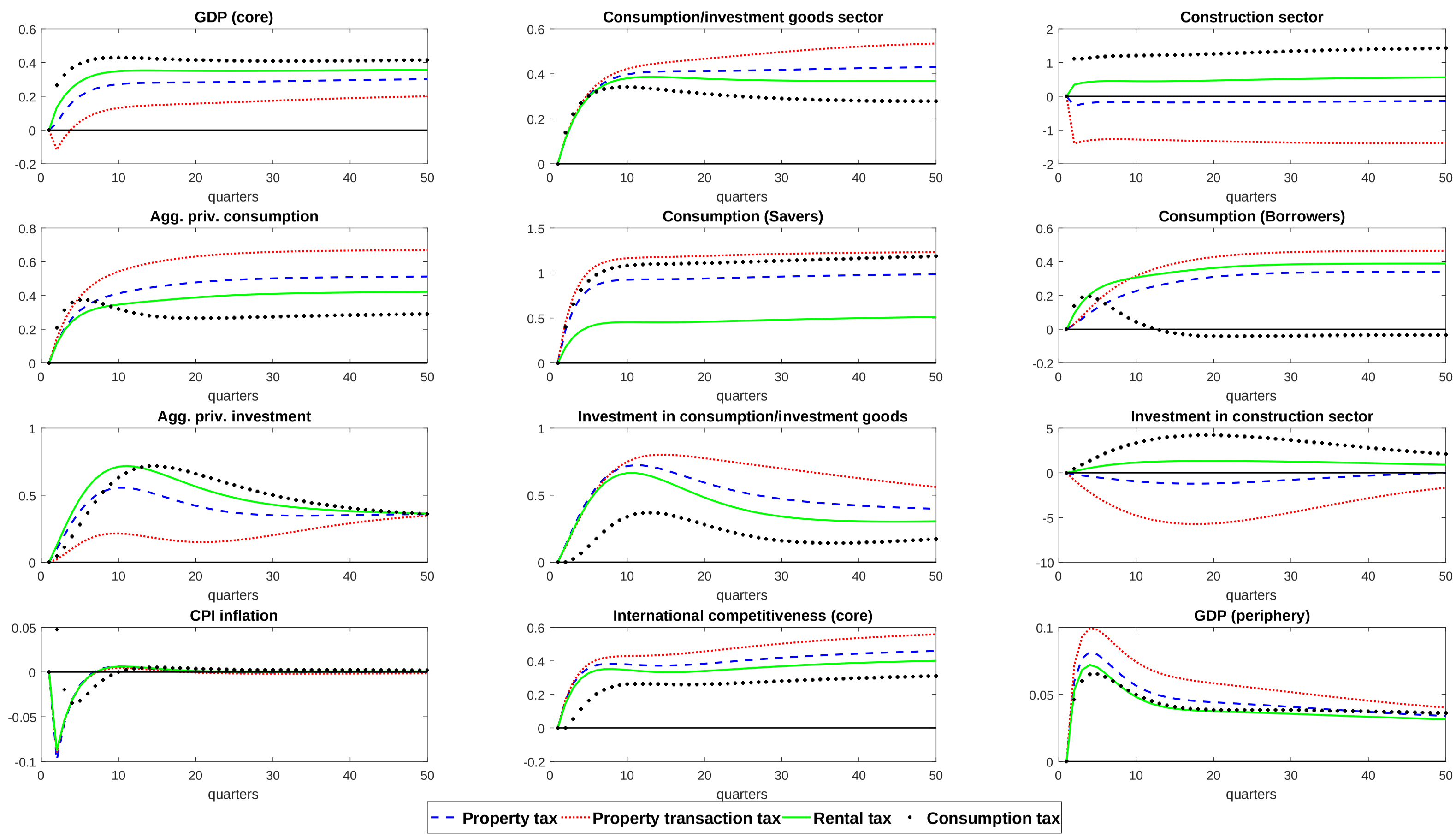


Figure C.3: Medium-term effects of policy change on key macro variables in Periphery



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