DEUTSCHE BUNDESBANK
EUROSYSTEM

Discussion Paper

Deutsche Bundesbank
No 30/2018

Labor tax reductions in Europe: the role of property taxation

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Internet http://www.bundesbank.de

ISBN 978–3–95729–488–3 (Printversion)
ISBN 978–3–95729–489–0 (Internetversion)

Non-technical summary

Research Question

Relative to other OECD countries, the labor tax wedge is high in most European economies. Therefore, the European Commission has repeatedly called for budget-neutral labor tax reductions. Such a reduction financed by higher consumption taxes (often called "fiscal devaluation") indeed generates positive macroeconomic effects because indirect taxes are generally less distortive. But the literature on optimal tax policy also argues that, in this respect, property taxation should be part of a cost-efficient strategy. Recently, this argument has gained some attention and there are calls to shift from taxing labor to taxing property.

Contribution

In this paper, we evaluate how financing a labor tax wedge reduction by higher property taxation affects the real economy and welfare. We do so by means of a state-of-the-art New Keynesian DSGE model with search frictions on the housing market. The latter assumption allows us to explicitly differentiate between stocks (the tax base for recurrent property taxes) and flows (the base for property transaction taxes).

Results

Simulation results suggest that a budget-neutral labor tax wedge reduction generates positive macroeconomic effects and aggregate welfare gains independent of the financing instrument used (consumption, recurrent property or property transaction taxes). In terms of welfare, using recurrent property taxation as financing instrument outperforms the other instruments as it prevents a policy-induced increase in the costs for private consumption goods while negative effects on the housing market are kept at minimum. The latter are over-proportionately high when using property transaction taxes as financing instrument. Therefore, using property transaction taxes to finance the labor tax wedge reduction generates the smallest gains compared to the other instruments.

Nichttechnische Zusammenfassung

Fragestellung

Verglichen mit anderen OECD-Staaten ist die Steuerlast auf den Faktor Arbeit in den meisten europäischen Staaten relativ hoch. Die EU-Kommission hat daher wiederholt angemahnt, diese budgetneutral zu senken. Eine durch höhere Konsumbesteuerung gegenfinanzierte Lohneinkommensteuerentlastung (Schlagwort "Fiscal Devaluation") generiert wegen relativ geringerer Verzerrungswirkung von indirekten Steuern positive gesamtwirtschaftliche Effekte. Die Literatur zur optimalen Besteuerung sagt aber auch, dass Immobilienbesteuerung diesbezüglich vergleichsweise kosteneffizient ist, weshalb in letzter Zeit des Öfteren diese Steuerart zur Gegenfinanzierung ins Spiel gebracht wird.

Beitrag

Dieses Papier untersucht und vergleicht die makroökonomischen Auswirkungen einer budgetneutralen Reduktion der Lohneinkommensteuerlast bei Verwendung verschiedener Instrumente zur Gegenfinanzierung (Konsumsteuer, Grundsteuer und Grunderwerbsteuer) im Rahmen eines modernen makroökonomischen Simulationsmodells. Auch die unterschiedlichen Verteilungs- und Wohlfahrtswirkungen bei Verwendung verschiedener Finanzierungsinstrumente werden untersucht. Im Modell ist der Immobilienmarkt durch Suchfriktionen gekennzeichnet, um zwischen Immobilienbeständen (die Basis für die Grundsteuer) und Immobilientransaktionen (die Basis der Grunderwerbsteuer) explizit differenzieren zu können.

Ergebnisse

Die Simulationsergebnisse zeigen, dass eine budgetneutrale Reduktion der Steuerbelastung des Faktors Arbeit unabhängig von dem verwendeten Gegenfinanzierungsinstrument (Konsumsteuer, Grundsteuer und Grunderwerbsteuer) positive gesamtwirtschaftliche Effekte und Wohlfahrtsgewinne generiert. Aus Wohlfahrtsgesichtspunkten wäre gemäß Simulationsergebnissen die Grundsteuer als Finanzierungsinstrument zu bevorzugen, weil auf eine politikinduzierte Kostenerhöhung für private Konsumgüter verzichtet wird, während die negativen Auswirkungen auf dem Immobilienmarkt gering sind. Bei der Grunderwerbsteuer sind letztere überproportional hoch, sodass sie die geringsten positiven Effekte aufweist.

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Labor Tax Reductions in Europe: The Role of Property Taxation*

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Abstract

We use a New Keynesian DSGE model with search frictions on the housing market to evaluate how financing a labor tax reduction by higher property taxation affects the real economy and welfare. Search on the housing market enables us to explicitly model stocks and flows, which is necessary to differentiate between recurrent property taxes (levied on stocks) and property transaction taxes (levied to flows). We find that using recurrent property taxation as financing instrument outperforms other instruments although all policy measures increase aggregate economy-wide welfare. Our simulations suggest that using property transaction taxation as financing instrument is the least favorable measure.

Keywords: Search Frictions in Housing Markets, Property Taxation, Tax Reform, General Equilibrium

JEL classification: E51, E6, R31, K34.

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1 Introduction

Budget-neutral reductions of the labor tax to foster economic performance and international competitiveness range high on the political agenda within many euro area economies, see European Commission (2013, 2014, 2015, 2016). Theory on optimal tax policy argues that it is most efficient to tax objects with an immobile base and where tax-induced distortions are kept at minimum,[1] and it is claimed that "*property taxation* (...) *avoids many distortions* [and] *should*, [therefore], *be part of a cost-efficient taxation strategy*" (OECD, 2015, pp. 100-101; also see OECD, 2012; and IMF, 2014). While the macroeconomic literature has extensively discussed a tax shift away from direct labor income to indirect consumption taxation (see, among others, Attinasi, Prammer, Stähler, Tasso, and Van Parys, 2018; Engler, Ganelli, Tervala, and Voigts, 2017; Jacquinot, Lozej, and Pisani, 2018; Lipińska and von Thadden, 2009, 2013; which we will discuss in more detail below), it has paid surprisingly little attention to using property taxation as a financing instrument to decrease labor taxes. This paper, to our knowledge the first, fills this gap by analysing the macroeconomic and welfare effects of a labor tax reduction financed by property taxes.

To conduct our analysis, we build a New Keynesian two-country monetary union model featuring a housing sector. The two economies are populated by patient and impatient households (lenders and borrowers, respectively) as well as final, intermediate and housing goods producers. Borrowers face collateral constraints depending on their housing wealth in line with Kiyotaki and Moore (1997) and Iacoviello (2005). New housing units are produced using land and final goods, similar to Kiyotaki, Michaelides, and Nikolov (2011) and Davis and Heathcote (2005). Monetary policy follows a Taylor rule and operates on a union-wide basis, while fiscal policy is executed at the country level. Since in most European countries there is a difference between recurrent property taxation, which applies to the housing stock, and property transactions taxation, which applies to flows, we assume that the housing market is characterized by search frictions in the spirit of Burnside, Eichenbaum, and Rebelo (2016), Caplin and Leahy (2011), Díaz and Jerez (2013), Head, Lloyd-Ellis, and Sun (2014), Hedlund (2016a,b), Ngai and Tenreyro (2014) and Ungerer (2015). This implies that not everyone who would like to buy or sell a house immediately finds the corresponding counterpart, and that we are able to explicitly differentiate between stocks and flows, which is necessary when introducing property transaction taxes.

As expected, we find that labor tax reduction fosters private employment, consumption, investment, GDP and international competitiveness. The latter results from lower unit labor costs because households accept lower gross wages due to lower labor tax burden. Because of the positive net income effect, the demand for housing, house prices and housing investment also rise, ceteris paribus. The direct spillovers of a labor tax reduction to the housing sector are, however, small. Higher policy-induced consumption costs resulting from using consumption taxes as an instrument to finance the revenue losses resulting from reduced labor taxation does not overcompensate these positive effects in the long run, which is in line with the literature mentioned above and discussed in more detail below.

[1] See, among many others, Mankiw, Weinzierl, and Yagan (2009), Feldstein (2006), Slemrod (1990) and Diamond and Mirrlees (1971).

When using property taxation to finance a decrease in the labor tax, we find that, in the long run, the positive effects on GDP and consumption are larger than those of using consumption taxes as financing instrument. In the end, this is a result of the fact that, then, there is no policy-induced increase the price of consumption goods. However, the housing market is more negatively affected, implying a reduction in the housing stock, lower turnover rates in the housing market and a fall in net house prices (i.e. housing wealth). Also, along the transition, the use of property taxation may generate recessionary effects before the positive effects on the rest of the economy start to materialize. This is a result of the fact that investment in housing is a component of GDP, and it takes time before the positive economic effects in the rest of the economy dominate the negative effects on the housing market. The negative effects on the housing market are strongest when using property transaction taxes to finance the reduction in the labor tax.

In order to assess which measures are preferable in terms of households' well-being in our model economy, we perform a welfare analysis. We observe that aggregate economy-wide welfare increases independent of whether property or consumption taxation is used to finance lower labor taxation. Hence, reducing the labor tax in a budget-neutral way seems to be a viable policy option. The measure that generates the most favorable effects in terms of higher GDP, consumption and welfare as well as lowest welfare redistribution between household types is financing the labor tax reduction by higher recurrent property taxation. All other measures imply notable redistribution between lenders and borrowers. Because of the negative spillovers from the housing sector to the rest of the economy when using property transaction taxes as financing instrument, especially along the transition, this is the least favorable measure.

The rest of the paper is structured as follows. An overview of related literature is given in Section 2. In Section 3, we describe the model, while the analysis is undertaken in Section 4. Welfare is analyzed in Section 5. Section 6 concludes.

2 Related literature

Our analysis relates to the literature on budget-neutral labor tax reductions and on the literature on modelling housing in modern dynamic macroeconomics.

It is well known that labor income taxation generates distortions in the labor market and, hence, negatively affects the overall economy. In a simple labor supply model, Prescott (2004) finds that the differences in aggregated hours of work between Europe and the United States are primarily driven by discrepancies in the marginal effective tax rates.[2] This finding is affirmed, among others, by Coenen, McAdam, and Straub (2008); Coenen, Erceg, Freedman, Furceri, Kumhof, Lalonde, Laxton, Lindé, Mourougane, Muir, Mursula, Resende, Carlos, Roberts, Roeger, Snudden, Trabandt, and in't Veld (2012) in a more complex DSGE model and by Ohanian, Raffo, and Rogerson (2008) in a neoclassical growth model.

Therefore, permanent reductions in the labor tax financed by higher consumption taxation have recently gained some attention, also with a focus on international competi-

[2] Alesina, Glaeser, and Sacerdote (2006) present a critical evaluation of Prescott's argument. Even though the authors recognise the importance of taxes, they consider other labour market institutions more relevant. Empirically, Nickell, Nunziata, and Ochel (2005) discuss this issue for OECD countries.

tiveness. Such a tax shift is often referred to as "fiscal devaluation".[3] Beneficial effects of such a tax shift are supported by Boscá, Doménech, and Ferri (2013), Gadatsch, Stähler, and Weigert (2016), Gomes, Jacquinot, and Pisani (2016), Langot, Patureau, and Sopraseuth (2014), Lipińska 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, when reducing labor taxes levied on employers, the beneficial effects may be increased which, at least for the short run, is confirmed in an analysis by Burgert and Roeger (2014). Jacquinot et al. (2018) show that, if monetary policy is accommodative, positive effects are larger. Attinasi et al. (2018) also compare the effects of a labor tax reduction financed by higher consumption taxes to those using other financing instruments such as lower public purchases or public employment. None of the papers mentioned above uses property taxation as a financing instrument. To our knowledge, we are the first to provide a formal analysis of this aspect.

Turning to the literature on housing, an overview of the advanced body of housing-related analyses goes beyond the scope of our paper. Important papers for our analysis, more in terms of the dynamic modelling approach, include Kiyotaki and Moore (1997), Davis and Heathcote (2005), Iacoviello (2005), Iacoviello and Neri (2010), Kiyotaki et al. (2011), Rubio (2014), Arce, Hurtado, and Thomas (2016) and Bielecki, Brzoza-Brzezina, Kolasa, and Makarski (2017). In terms of using a tractable search model of the housing market, our paper relates to Burnside et al. (2016), Caplin and Leahy (2011), Díaz and Jerez (2013), Head et al. (2014), Hedlund (2016a,b), Ngai and Tenreyro (2014) and Ungerer (2015).[4] Roughly summarizing, all these papers deal with different aspects of spillovers from the housing market to the real economy and/or credit markets and vice versa. To our knowledge, our paper is the first to address tax policies in such a framework. In what follows, we will restrict ourselves to discussing the literature related taxation in housing markets in more detail.

Early contributions on the issue date back to the beginning of the last century (see, for example, Bickerdike, 1902), becoming popular again at the end of the century motivated by property tax reforms in the United States (see, among others, Poterba, 1990, 1992). Using a dynamic macroeconomic framework with an overlapping generations structure, Gervais (2002) shows that abandoning mortgage interest payment deduction and taxing imputed rents reduces home ownership and is welfare detrimental. This, however, is a result of the assumption that house prices are fixed, as shown by Sommer and Sullivan (2018). In their model, especially low-income households benefit when house prices fall after the tax reform. In our model, we use a dynamic New Keynesian framework with endogenous house prices. It is more related to Alpanda and Zubairy (2016) and Mora-Sanguinetti and Rubio (2014). Both papers discuss the impact of taxation in the housing market. Alpanda and Zubairy (2016) address the effects of recurrent property taxes, the elimination of mortgage interest deductions and depreciation allowances for rental income

[3] In a strict sense, fiscal devaluation is not the right term to be used here, even though sometimes done in the literature. Farhi, Gopinath, and Itskhoki (2014) provide a formal analysis of fiscal devaluations in a New Keynesian open economy DSGE model. They find that an intended nominal devaluation can be robustly replicated with a small set of fiscal instruments: lower labor income financed by higher consumption taxes. However, fiscal devaluation there is a sequence of taxes that replicates a sequence of nominal exchange rates while leaving the labor tax wedge constant (see also Kaufmann, 2016).

[4] Earlier contributions introducing search frictions in the housing market include Wheaton (1990), Krainer (2001) and Novy-Marx (2009).

as well as the property tax deduction for personal income taxation. They find that increases in property-related taxation are recessionary and, overall, welfare detrimental. Mora-Sanguinetti and Rubio (2014) discuss the effects of an increase in VAT taxes on housing purchases and those of a removal of tax deductions when purchasing housing. They also find recessionary effects, even when the labor tax rate is decreased. Although we cannot assess removals of tax deductions related to home ownership as our model does not include such deductions, we are able model a "true" property transaction tax because we explicitly model stocks and flows. We then find that, under these circumstances, increasing property taxation – especially the property transaction tax rate – to finance a reduction in the labor tax is, after a short to medium-run recession, expansionary in the long run.[5]

In addition to most of the housing literature discussed so far, we use an open-economy framework which allows us to assess the implications of the changes in the tax system on international competitiveness, similar to Rubio (2014) and Bielecki et al. (2017). An interesting extension of our way of modelling the housing market could be to allow domestic agents to purchase foreign housing and vise versa along the lines of Funke and Paetz (2013) to assess if and how local (tax) policies have contributed to the divergence regional housing markets in Europe. We leave this extension to future research.

3 The model

We build a New Keynesian two-region monetary union model featuring a housing sector with search frictions. The two regions of the model depict the core and periphery of the Euro Area. 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.

3.1 Households

Following Kiyotaki and Moore (1997) and Iacoviello (2005), we assume that each country is populated by a share $\mu \in [0,1)$ of borrower (impatient) households and a remaining share $(1-\mu)$ of lender (patient) households. Lenders are characterized by a higher subjective discount rate, $\beta^l > \beta^b$, where the superscript $i = b, l$ indicates borrowers and lenders, respectively. The welfare function for a representative household of type i at time t is

[5] Property transaction taxes are not present in Alpanda and Zubairy (2016) and the VAT tax on housing purchases in Mora-Sanguinetti and Rubio (2014) acts more like tax on housing investment rather than a transaction tax. Furthermore, note that both Alpanda and Zubairy (2016) and Mora-Sanguinetti and Rubio (2014) use a framework that includes a housing rental market along the lines of Ortega, Rubio, and Thomas (2011). Given the search and matching framework in the housing market in our model, we abstract from such a complication.

given by

$$\sum_{\tau=t}^{\infty} \left(\beta^i\right)^{\tau-t} \cdot \underbrace{\left(\log\, c_\tau^i + \zeta^h \cdot \log\, h_\tau^i - \zeta^n \cdot \frac{\left(n_\tau^i\right)^{1+\sigma^n}}{1+\sigma^n} \right)}_{=U\left(c_t^i, h_t^i, n_t^i\right)}. \tag{1}$$

As we will study unexpected tax shocks, which only happen once (MIT shock), and simulate the model under perfect foresight, we use the subscript t to denote transitions and abstract from an expectations operator. c_t^i denotes consumption of final goods. In line with Ungerer (2015), households also obtain utility from fit-for-occupation housing services h_t^i, where ζ^h is the weight of housing services relative to final goods consumption. Following Ungerer (2015), we assume that preferences are superable between consumption and housing and abstract from non-separable preferences (as in, for example, Piazzesia, Schneider, and Tuzel, 2007) for simplification. However, the macroeconomic implications in such a framework would not be different to our results from a qualitative perspective. Additionally, households face disutility from providing labor services n_t^i, with ζ^l being a scaling parameter and $\sigma^n > 0$ denoting the inverse of the Frisch elasticity.

A fraction $z \in (0,1)$ of occupied housing units h_t^i becomes unfit for its current residents at the end of period t. In case a housing unit becomes unfit, it becomes effectively vacant v_t^i and no longer yields utility benefits to its current owner. Such a shock can be motivated by the fact that household members may have to change their location of residence because they receive long-distance job offers, their family composition changes, or changes in their health status no longer allow them to live in their current dwelling. This line of argument is similar to the motivation of the location preference shock in Sterk (2015). Hence, the total housing stock held by households of type i is $H_t^i = h_t^i + v_t^i$, while only the stock h_t^i yields utility. Moreover, a fraction δ^h of total housing stock depreciates. The flow equations for fit-for-occupation and vacant housing, respectively, are given by

$$h_t^i = \left(1 - z - \delta^h\right) h_{t-1}^i + a_t^i + h_t^{n,i}, \tag{2}$$

and

$$v_t^i = \left(1 - p_t^s\right) \left(\left(1 - \delta^h\right) v_{t-1}^i + z\; h_{t-1}^i\right), \tag{3}$$

where a_t^i are acquisitions of fit-for-occupation housing units on the secondary market while $h_t^{n,i}$ are acquisitions of newly built housing on the spot market. In order to acquire housing on the secondary market, households search with effort $e_t^i \geq 0$, which is associated with some per-period search cost κ^b. Given the probability that searchers will match with a vacant house p_t^b, this implies that the number of new acquisitions in each period is given by $a_t^i = p_t^b \cdot e_t^i$. The probability that a vacant home offered to potential buyers will actually be sold is denoted by p_t^s.[6] The matching probabilities p_t^b and p_t^s, as well as the intensity of search effort e_t^i, will be determined below.

[6]Note that, in the steady-state equilibrium, $a_t^i = p_t^s \left(\left(1 - \delta^h\right) v_{t-1}^i + z\; h_{t-1}^i\right)$, i.e. the number of houses bought must equal the number of houses sold. Hence, $H_t^i = (1 - \delta^h) H_{t-1}^i + h_t^{n,i}$, which is the familiar housing accumulation equation from the literature.

3.1.1 Lender households

The lender households earn labor income, interest income on their deposits that are managed by investment funds and receive firms' dividend payments. With this they finance consumption expenditure and lump sum taxes on lenders. Moreover, they sell a part of their vacant housing stock to new occupiers, while at the same time covering costs of purchasing new housing units on spot and secondary housing markets, cover search costs and pay property taxes. Their real budget constraint summarizes as

$$\begin{aligned}(1+\tau_t^c)c_t^l + d_t^l + \tau_t^l = (1-\tau_t^w)w_t^l\, n_t^l + q_t^h\, p_t^s\, \left((1-\delta^h)\, v_{t-1}^l + z\; h_{t-1}^l\right) \\ + R_{t-1}^d\, \frac{d_{t-1}^l}{\pi_t} + r_t^L L^l + div_t^l - q_t^n\, h_t^{n,l} - (1+\tau_t^{pa})(1+\tau_t^c)\, q_t^h\, a_t^l - \kappa^b\, e_t^l - \tau_t^p\, q_t^h\;\; \left(v_t^l + h_t^l\right)\end{aligned} \tag{4}$$

where d_t^l are per-person deposits of lenders paying a known-in-advance interest rate R_{t-1}^d, τ_t^l denote per-capita taxes net of transfers, w_t^l is the real wage rate received by lenders, r_t^L denotes rent on land L^l and div_t^l are dividend payments of firms. CPI inflation is denoted with π_t, while τ_t^c and τ_t^w are the consumption and labor income tax rates, respectively. Regarding the housing variables, q_t^h is the real price of housing bought on the secondary market and q_t^n is the real price of newly built housing bought on the spot market. The cost of property purchases is augmented by the *property acquisition tax* τ_t^{pa}, while τ_t^p denotes the recurrent *property tax* due independent of houses being occupied or vacant. Finally, $\kappa^b\, e_t^l$ denotes final goods cost of search effort.[7]

The first order conditions with respect to consumption and deposits are standard, yielding $\lambda_t^l = 1/c_t^l\,(1+\tau_t^c)$ as the marginal utility of consumption, where λ_t^l is the Lagrangian multiplier on equation (4), and $\lambda_t^l = \beta^l\, E_t\left\{\lambda_{t+1}^l R_t^d/\pi_{t+1}\right\}$ as the consumption-Euler equation for assets. We will focus on housing and labor supply decisions in more detail below.

It is useful, however, to already derive the household's marginal utility of owning fit-for-occupation and vacant housing. Defining $V^{v,l} = \omega_t^{v,l}/\lambda_t^l$ and $V^{h,l} = \omega_t^{h,l}/\lambda_t^l$, where $\omega_t^{v,l}$ and $\omega_t^{h,l}$ are the Lagrangian multipliers on equations (3) and (2), respectively, these marginal utilities are given by

$$V_t^{v,l} = -\tau_t^p\, q_t^h + \left(1-\delta^h\right)\beta^l\, \left\{\frac{\lambda_{t+1}^l}{\lambda_t^l}\left[p_{t+1}^s\, q_{t+1}^h + \left(1-p_{t+1}^s\right) V_{t+1}^{v,l}\right]\right\} \tag{5}$$

[7] Note that, when we assume away search frictions in the housing market by setting $z=0$ (no housing disutility shock), $p_t^b = p_t^s = 1$ (certain matching per period) and $\kappa^b = 0$ (no search costs), plus assuming no property taxation ($\tau_t^{pa} = \tau_t^p = 0$), we get $v_t^l = 0$, $a_t^l = e_t$ and $e_t = h_t^l - (1-\delta^h)h_{t-1}^l - h_t^{n,l}$. Substituting into equation (4), the households' budget constraint boils down to the well-known one used in Iacoviello (2005), for example. Also note that property acquisition taxes are levied on the gross price of housing purchases including consumption taxes, $(1+\tau_t^c)\, q_t^h$, which corresponds to the property tax legislation in most EMU countries.

and

$$V_t^{h,l} = \frac{\zeta^h}{h_t^l\,\lambda_t^l} + \frac{z}{1-\delta^h}\cdot V_t^{v,l} - \frac{1-z-\delta^h}{1-\delta^h}\cdot q_t^h \tau_t^p + (1-z-\delta^h)\,\beta^l\left\{\frac{\lambda_{t+1}^l}{\lambda_t^l}\,V_{t+1}^{h,l}\right\}. \tag{6}$$

Holding one vacant housing unit v_t today does not yield any utility flow today. Instead, households face the property tax payment. With probability δ^h a vacant house will depreciate. With expected probability $E_t\{p_{t+1}^s\}$, the vacant house will be sold tomorrow at an expected price $E_t\{q_{t+1}^h\}$, which generates a positive expected income flow. With expected probability $E_t\{(1-p_{t+1}^s)\}$, the vacant housing unit is not sold, thus generating marginal value of a vacant house tomorrow, too. Holding a fit-for-occupation housing unit h_t^l, in turn, generates marginal utility equal to $\zeta^h/h_t^l\lambda_t^l$ in terms of consumption-utils. With probability z, today's housing becomes vacant. In this case, the previously occupied housing has the same marginal value to the household as a vacant housing unit. If this does not happen, the household continues enjoying undepreciated fit-for-occupation housing tomorrow. Of course, the household also has to pay property taxes.

3.1.2 Borrower households

The budget constraint of the borrower households is analogous to the one of unconstrained households, with the difference that borrower households take out loans l_t^b for which they have to pay ex-ante determined interest rate R_{t-1}^l. Furthermore, they do not receive dividends nor land rents, and they pay per-capita taxes net of transfers τ_t^b levied on borrower households only. Hence, their budget constraint reads

$$\begin{aligned}(1+\tau_t^c)c_t^b + R_{t-1}^l\,\frac{l_{t-1}^b}{\pi_t} + \tau_t^b = (1-\tau_t^w)w_t^b\,n_t^b + l_t^b + q_t^h\,p_t^s\,(1-\delta_h)\,\left(v_{t-1}^b + z\;h_{t-1}^b\right)\\ - q_t^n h_t^{n,b} - (1+\tau_t^{pa})(1+\tau_t^c)\,q_t^h\,a_t^b - \kappa^b\,e_t^b - \tau_t^p\,q_t^h\;\left(v_t^b + h_t^b\right).\end{aligned} \tag{7}$$

Marginal utility of consumption is analogous to that of lenders, we only have to substitute the superscript l by b. Different to the previous household type, borrowers' access to credit is constrained by the value of their housing collateral. This constraint is given by[8]

$$R_t^l l_t^b \leq \varrho^b\,\left\{\pi_{t+1}\,q_{t+1}^h\,\left(1-\delta^h\right)\left(v_t^b + h_t^b\right)\right\} \tag{8}$$

where ϱ^b is the loan-to-value ratio (LTV). Thus, the sum of principal and interest payments on outstanding debt, which will be due tomorrow, must not exceed tomorrow's expected value of the housing collateral, which includes undepreciated occupied and vacant houses. The corresponding first-order condition for loans in CPI-deflated real terms is $\lambda_t^b = \beta^b\,E_t\left\{\lambda_{t+1}^b R_t^l/\pi_{t+1}\right\} + \mu_t^b\,R_t^l$, where μ_t^b is the Lagrangian multiplier on equation (8), which takes the value zero only if the constraint is not binding. As is common in the literature, and because lender households are more impatient, the constraint will always be binding in equilibrium such that $\mu_t^b > 0$. As regards the marginal value of vacant and

[8] See Arce et al. (2016) for a model that allows for long-term debt relations.

fit-to-occupy housing for the constrained household, they are given by

$$V_t^{v,b} = -\tau_t^p\, q_t^h + \left(1-\delta^h\right)\beta^b \left\{\frac{\lambda_{t+1}^b}{\lambda_t^b}\left[p_{t+1}^s\, q_{t+1}^h + \left(1-p_{t+1}^s\right) V_{t+1}^{v,b}\right]\right\} \\ + \varrho^b\, \mu_t^b\, \left(1-\delta^h\right)\left\{\frac{\pi_{t+1}\, q_{t+1}^h}{\lambda_t^b}\right\} \tag{9}$$

and

$$V_t^{h,b} = \frac{\zeta^h}{h_t^b\, \lambda_t^b} - \frac{1-z-\delta^h}{1-\delta^h}\cdot\left(q_t^h \tau_t^p - \varrho^b\, \mu_t^b \left\{\frac{\pi_{t+1}\, q_{t+1}^h}{\lambda_t^b}\right\}\right) \\ + \frac{z}{1-\delta^h}\cdot V_t^{v,b} + \left(1-z-\delta^h\right)\beta^b \left\{\frac{\lambda_{t+1}^b}{\lambda_t^b}\, V_{t+1}^{h,b}\right\}, \tag{10}$$

Derivations and interpretation are analogous to the ones of the lender households. But borrower households attach additional value to housing because housing at a potentially higher (lower) price tomorrow increases (decreases) the amount of debt that they are able to take up today. This is reflected in the last terms on the right-hand-side of equation (9) and also in equation (10).

3.2 Search and matching and price setting in the housing market

We assume that the number of matches on the housing market in period t is described by a linear homogeneous matching function depending on the aggregate amount of vacant housing in that period ($(1-\delta^h)v_{t-1} + z h_{t-1}$) and the amount of aggregate search effort e_t.[9] Following Pissarides (2000), the matching process is given by a Cobb-Douglas matching function,

$$M_t = \kappa^e\, (e_t)^{1-\gamma}\, \left((1-\delta^h)v_{t-1} + z h_{t-1}\right)^{\gamma}, \tag{11}$$

where κ^e is the matching efficiency parameter and $\gamma \in (0,1)$ is the matching elasticity with respect to vacancies. The probability for one vacant housing unit to be sold per period depends on the number of matches in that period divided by the number of vacant housing units, i.e. $p_t^s = M_t / \left((1-\delta^h)v_{t-1} + z h_{t-1}\right) = \kappa^e\, \theta_t^{1-\gamma}$, where $\theta_t = e_t / \left((1-\delta^h)v_{t-1} + z h_{t-1}\right)$ reflects the tightness in the housing market. The probability of finding a match per unit of effort is given by $p_t^b = M_t / e_t = \kappa^e\, \theta_t^{-\gamma}$. Note that, because household-type specific effort may potentially be different, so may be the type-specific matching probability $a_t^i = e_t^i\, p_t^b$.

In order to derive this effort, households maximize their utility subject to the individual budget constraints and flow equations with respect to e_t^i, which yields

$$V_t^h \equiv V_t^{h,l} = V_t^{h,b} = \frac{\kappa^b}{p_t^b} + (1+\tau_t^{pa})(1+\tau_t^c)\, q_t^h. \tag{12}$$

This condition states that the value households attach to occupied housing must equal ex-

[9] Note that aggregate economy-wide values are given by $v_t = (1-\mu)v_t^l + \mu\, v_t^b$, $h_t = (1-\mu)h_t^l + \mu\, h_t^b$ and $e_t = (1-\mu)\, e_t^l + \mu\, e_t^b$, which implies that housing units can also be sold between lenders and borrowers.

pected search costs of finding a house, κ^b/p_t^b, plus the gross purchasing price of the housing unit including the property acquisition tax. Search costs are given by per-period search costs times the average search duration $1/p_t^b$. Given that the aggregate purchasing probability and the house price are the same for constrained and unconstrained households, the marginal values each household type attaches to occupied housing equalize. Equation (12) is the analogue to the firms' free entry condition in the labor market literature as described in more detail in Ungerer (2015).

Additionally, both types of households can purchase newly built housing units on the spot market. Optimizing with respect to those purchases yields $V_t^h \equiv V_t^{h,l} = V_t^{h,b} = q_t^n$, which implies that both household types attach the same marginal value to newly built housing.

The benefit from selling a housing unit is given by the selling price q_t^h per unit. The benefit from purchasing a house is given by $(V_t^h - (1+\tau_t^{pa})(1+\tau_t^c)\, q_t^h)$, i.e. the marginal utility attached to occupied housing less the gross purchasing costs including property transaction taxes. Assuming Nash bargaining between a seller and a buyer, where the seller's bargaining power is $\varsigma \in (0,1)$, we get

$$q_t^h = \varsigma\, ((1+\tau_t^{pa})(1+\tau_t^c))^{-1}\, V_t^h \quad \Rightarrow \quad q_t^h = \frac{\varsigma}{1-\varsigma}\, ((1+\tau_t^{pa})(1+\tau_t^c))^{-1}\, \frac{\kappa^b}{p_t^b}. \tag{13}$$

Sellers and buyers share the value of occupied housing accruing to households depending on the seller's bargaining power. The higher this bargaining power is, the higher is the share of this surplus a seller can collect. If there is property acquisition taxation, this share decreases, as the tax burden is shared between the buyer and the seller, too. Again, how much of the tax burden a buyer can roll over to the seller depends on the bargaining power.

3.3 Investment funds

Investment funds collect deposits from lender households and then allocate them across a number of asset classes: loans to lender households, international and government bonds, as well as investments in physical capital which is then rented to firms. As the investment funds are owned by lender households, they discount future revenue flows at the same rate as their owner households do. Therefore, they aim to maximize

$$\left\{ \beta^l \lambda_{t+1}^l \left(\frac{R_t^l}{\pi_{t+1}} l_t + \frac{R_t^b}{\pi_{t+1}} b_t + \frac{R_t}{\pi_{t+1}} d_t^g + r_{t+1}^k k_t - \frac{R_t^d}{\pi_{t+1}} d_t \right) \right\}, \tag{14}$$

where l_t, b_t, d_t^g, k_t and d_t denote per capita loans to borrower households, international and government bonds, physical capital and deposits of lender households, respectively, R_t^b and R_t are gross nominal interest rates on international and government bonds and r_{t+1}^k is the ex-ante uncertain rate of return on capital. The interest rate on international bonds is augmented with the component reacting to the foreign indebtedness of the economy, $\Psi_t = \exp\left(\psi^d \left(b_t - \bar{b}\right)\right)$.[10]

[10] Open-economy DSGE models, in general, feature steady-state indeterminacy and non-stationary dynamics of net foreign assets. Among others, Schmitt-Grohé and Uribe (2003), Erceg, Guerrieri, and Gust (2005), Hunt and Rebucci (2005) and Benigno (2009) discuss a number of alternative mechanisms

The maximization problem is subject to the loanable funds constraint $d_t = l_t + b_t + d_t^g + i_t^k$, where i_t^k denotes per capita investment in physical capital, which is subject to the investment adjustment costs as in Christiano, Eichenbaum, and Evans (2005). The law-of-motion for capital is given by

$$k_t = (1 - \delta^k)\, k_{t-1} + \left(1 - \frac{\psi^k}{2}\left(\frac{i_t^k}{i_t^k} - 1\right)^2\right) i_t^k \tag{15}$$

which states that today's capital stock equals yesterday's capital stock net of depreciation plus new investments net of investment adjustment costs, influenced by the parameter ψ^k. Solving the maximization problem gives the well-known no-arbitrage condition and, thus, the corresponding interest rates.

3.4 Labor market

The labor market and the remaining setup of the model are quite standard. Therefore, we will keep the description short. Differentiated labor services of patient and impatient households are purchased by competitive aggregators who transform them into standardized labor services n_t using the following technology

$$n_t = \left[(1-\mu)^{1/\phi^n}\ \left(n_t^l\right)^{\frac{\phi^n-1}{\phi^n}} + \mu^{1/\phi^n}\ \left(n_t^b\right)^{\frac{\phi^n-1}{\phi^n}}\right]^{\frac{\phi^n}{\phi^n-1}}, \tag{16}$$

where $n_t^b = \left[\frac{1}{\mu}\int_0^\mu n_t^b(i)^{1/\nu^w} di\right]^{\nu^w}$ and analogously for lenders. ϕ^n measures the elasticity of substitution between patient and impatient labor input and ν^w is the households' markup over competitive wage levels (i.e. the market power of workers).

Nominal wages set by the households are sticky as in the Calvo (1983) scheme, and within each period only a fraction $(1-\theta^w)$ receives a signal to re-optimize. Those who do not receive such a signal update their wages according to $\pi_t^{\varrho^w} = \varrho^w\, \pi_{t-1} + (1-\varrho^w)\, \bar{\pi}$, where $\bar{\pi}$ stands for the steady-state level of CPI inflation and ϱ^w is the weight of past inflation in the wage indexation scheme. As we assume that there exists a representative household for each type, households share risk perfectly within each type through large families (or through access to complete markets for Arrow-Debreu securities). This implies that wage stickiness does not translate into consumption and housing stock heterogeneity.

3.5 Production

There are three types of producers in the economy: final and intermediate goods producers as well as housing producers. All of them are owned by lender households. Final and housing goods producers operate in perfectly competitive markets. Production of final goods requires intermediate goods as inputs, which in turn are produced by monopolistically competitive sector that employs capital and labor. The housing goods sector uses land and final goods as production inputs.

to circumvent this problem. Here, we follow Schmitt-Grohé and Uribe (2003) and assume that, when international debt exceeds a threshold $\bar{b}$, the home country has to pay a risk premium which reacts with sensitivity ψ^d. Alternative ways to address this issue do not change our results qualitatively.

Final goods producers purchase domestic $f_{H,t}$ and foreign $f_{F,t}$ intermediate goods varieties and produce a homogeneous final good according to the following technology

$$f_t = \left[\eta_H^{1/\phi^f} \, f_{H,t}^{\frac{\phi^f-1}{\phi^f}} + (1-\eta_H)^{1/\phi^f} \, f_{F,t}^{\frac{\phi^f-1}{\phi^f}} \right]^{\frac{\phi^f}{\phi^f-1}}, \tag{17}$$

where $f_{H,t} = \left[\int_0^1 f_{H,t}(\iota)^{\frac{1}{\nu^f}} \right]^{\nu^f}$ and analogously for foreign intermediates. η_H reflects the home bias in consumption/investment and ϕ^f is the elasticity of substitution between domestic and foreign intermediate goods, where ν^f is the corresponding markup. Note that $f_t = c_t + i_t^k + i_t^h + g_t$ in equilibrium, which implies that private and public consumption as well as investments in physical capital and housing are aggregated according to the same CES function such that there is no differences between home bias in private and public consumption or investments.

Similar to Kiyotaki et al. (2011) and Davis and Heathcote (2005), **new housing** h_t^n is produced using land and final good inputs according to the following production technology

$$h_t^n = L^{\gamma^h} \left(i_t^h \right)^{1-\gamma^h} \tag{18}$$

where L indicates a fixed stock of land and i_t^h denotes aggregate purchases of final goods for housing investment. It is straightforward to derive the rental price of land, r_t^L when maximizing $q_t^n h_t^n - r_t^L L - i_t^h$.

Monopolistically competitive **intermediate goods producers** indexed by i employ capital and labor to produce output according to the Cobb-Douglas production technology, with α denoting the aggregate capital share of output. Output is supplied to domestic and foreign final goods producers. Hence, market clearing for each intermediate goods variety i is given by

$$f_{H,t}(i) + \frac{1-\omega}{\omega} f_{H,t}^*(i) = n_t(i)^{1-\alpha} k_t(i)^{\alpha}. \tag{19}$$

All firms set their prices independently for the domestic and foreign markets according to the Calvo (1983) scheme. Both markets have their own price reoptimization probabilities, denoted respectively by $(1-\theta_H)$ and $(1-\theta_F^*)$. When not being allowed to reoptimize, firms update prices according to $\pi_t^{\varrho_H} = \varrho_H \, \pi_{t-1} + (1-\varrho_H) \, \bar{\pi}$ in the domestic and according to $\pi_t^{\varrho_F *} = \varrho_F \, \pi_{t-1}^* + (1-\varrho_F) \, \bar{\pi}^*$ in the foreign market, with the ϱ's controlling the weights of past inflation in the indexation schemes.

3.6 Policy

As already explained, each **fiscal authority** collects consumption, labor, recurrent property, property acquisition and per-capita taxes to finance government expenditures g_t. It can also issue debt, for which it has to pay interest R_t in the next period. The budget

constraint is, hence, given by

$$d_t^g + \tau_t^p\, q_t^h\, (v_t + h_t) + \tau_t^{pa}\, (1+\tau_t^c)\, q_t^h\, M_t + \tau_t^c\, q_t^h\, M_t + \tau_t^c\, c_t \\ + \tau_t^w\, \left((1-\mu)\, w_t^l\, n_t^l + \mu\, w_t^b\, n_t^b\right) + (1-\mu)\tau_t^l + \mu\tau_t^b = g_t + \frac{R_{t-1}}{\pi_t} \cdot d_{t-1}^g. \tag{20}$$

In line with Galí, López-Salido, and Vallés (2007), we assume that, in steady state, the net per-capita taxes on lender and borrower households are such that their private consumption is the same in the initial steady state, i.e. $\bar{c}^b = \bar{c}^l = \bar{c}$. Given that we will assume steady-state labor, consumption and property tax rates as well as the steady-state debt-to-GDP and the government spending-to-GDP ratios to correspond to their counterparts in the data (see the calibration section below), the government budget constraint will be closed by varying τ_t^l accordingly.[11]

The **monetary authority** sets the short term interest rate reacting to union-wide variables according to a Taylor-like formula

$$\log\left(\frac{R_t}{\bar{R}}\right) = \rho^R\, \log\left(\frac{R_{t-1}}{\bar{R}}\right) + \xi^\pi\, \log\left(\frac{\pi_t^{EU}}{\bar{\pi}^{EU}}\right) + \xi^y\, \log\left(\frac{y_t^{EU}}{\bar{y}^{EU}}\right) \tag{21}$$

where ρ^R controls the degree of interest rate smoothing, while ξ^π and ξ^y control the strength of the policy rate's response to area-wide inflation and and output deviations from target/steady state, where $\pi_t^{EU} = {\pi_t}^{\omega}\ {\pi_t^*}^{1-\omega}$ and $y_t^{EU} = \omega\, y_t + (1-\omega)\, y_t^*$.

3.7 Closing the model

Real gross domestic product at market prices y_t is defined as the sum of private and government consumption, investments in physical capital and housing, search costs in the housing market and net exports nx_t:

$$\begin{aligned} y_t &= f_t + \kappa^b\, e_t + nx_t, \\ &= c_t + i_t^k + i_t^h + g_t + \kappa^b\, e_t + nx_t, \end{aligned} \tag{22}$$

where $nx_t = (1-\omega)/\omega\, s_t\, p_{H,t}^*\, f_{H,t}^* - p_{F,t}\, f_{F,t}$. Here, $p_{H,t}^*$ depicts real prices for goods produced in core purchased in periphery, $p_{F,t}$ denotes real prices of goods produced in periphery and purchased in core, and $s_t = P_t^{c*}/P_t^c$ stands for the real exchange rate of core vis-a-vis periphery (remember that, due to the monetary union assumption, nominal exchange rates are one). Real net foreign assets in core, b_t, are given by

$$b_t = \frac{\Psi_t R_t^*}{\pi_t} \cdot b_{t-1} + nx_t. \tag{23}$$

As net foreign assets in the entire economy have to be zero, it must hold that $b_t^{f*} = -(1-\omega)/\omega\, s_t\, b_t^f$.

We also impose the standard set of market clearing conditions, implying that housing markets must clear, private and public consumption plus capital and housing investment

[11] Note that, if $\bar{\tau}^l < 0$, this will be a subsidy to lenders instead of a tax.

and net exports must equate GDP, labor demand equals labor supply, and net foreign assets evolve as just described. This allows us to derive the relevant prices in our economy.

3.8 Calibration

In calibrating the model, our strategy consists of (i) matching steady-state values of selected model variables with the corresponding data averages, summarized in Table 1, and (ii) of carefully choosing the remaining free parameters values in line with the existing literature, summarized in Table 2. Unless stated otherwise, the data we use is based on a large data set for the Euro Area containing a rich set of quarterly fiscal variables, described in more detail in Gadatsch, Hauzenberger, and Stähler (2016). 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. One period is equivalent to one quarter. 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. Core's relative population size is thus 60% and, when normalizing core's per-capita GDP to one, periphery's per-capita GDP amounts to 0.875 (also see Moyen, Stähler, and Winkler, 2016). Furthermore, we normalize the terms of trade to one, set the net foreign asset position to zero and assume an annual inflation rate of 2% in the initial steady state. Together with targeting a GDP-weighted average of domestic expenditure shares of 85 percent in core and 74.2 percent in periphery in line with Balta and Delgado (2009), this allows us to derive the corresponding home bias parameters endogenously. The elasticity of substitution between domestic and foreign goods is set to 1.5 following Coenen et al. (2008).

As in Iacoviello (2005), the discount factor for patient households β^l is set to 0.99, and the one for impatient households β^b to 0.98. These are standard values from the literature generating an annual steady-state interest rate of about 4%. Following Bielecki et al. (2017), we target the private debt to annual GDP ratios to be 0.52 and 0.7 in core and periphery Europe, respectively. This generates a share borrowers in core of 0.39 and in periphery of 0.53, values that are also in line with Le Blanc, Porpiglia, Teppa, Zhu, and Ziegelmeyer (2014). In both countries, we set the loan-to-value (LTV) ratio to the standard value of 0.75.

Table 1: Targeted values

Target	Symbol	Value	
		Core	Periphery
Relative population share	$\omega; (1-\omega)$	0.600	0.400
Per-capita GDP	$\bar{y}$	1.000	0.875
Import shares	$\bar{f}_F/\bar{y}$	0.150	0.258
Annual inflation rate	$\bar{\pi}$	2%	
(Average) Labor income tax rate	$\bar{\tau}^l$	0.465	0.463
Consumption rate	$\bar{\tau}^c$	0.205	0.215
Property tax rate	$\bar{\tau}^p \bar{q}^h \bar{h}^{tot}/(4\bar{y})$	0.010	
Property transfer tax rate	$\bar{\tau}^{pa} \bar{q}^h \bar{M}^{tot}/(4(1+\bar{\tau}^c)\bar{y})$	0.005	
Public spending	$\bar{g}^g/\bar{y}$	0.179	0.187

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Target	Symbol	Value	
		Core	Periphery
Public debt-to-annual-GDP ratio	$\bar{d}^g/(4G\bar{D}P)$	0.700	0.885
Private debt-to-annual-GDP ratio	$\mu\bar{l}^b/(4G\bar{D}P)$	0.520	0.700
Total housing stock	$\bar{h}^{tot}$	1.000	
Share of vacant housing	$\bar{v}$	0.100	
Probability of housing becoming unfit	z	0.020	
Housing wealth over GDP	$\bar{q}^h\bar{h}^{tot}/(4\bar{y})$	1.780	
Search costs over GDP	$\kappa^b\,\bar{e}/(\bar{y})$	0.010	
Housing investment over GDP	$\bar{q}^h\bar{i}^h/(\bar{y})$	0.060	
Capital investment over GDP	$\bar{i}^k/(\bar{y})$	0.160	
Loan-to-value ratio	ϱ^b	0.750	

Source: Target values as described in the main text. Data sources are the European System of Accounts (ESA), the European Commission and the OECD. We drop the $*$ for convenience.

As regards the housing market, we assume an average duration of home ownership of about 13 years, implying $z = 0.02$ (see the data for United Kingdom in Ngai and Tenreyro, 2014).[12] The depreciation rate of housing is set at 1% quarterly following Mora-Sanguinetti and Rubio (2014). The matching elasticity is set to 0.5 following the standard assumptions in the literature. We target a total housing stock of one in the economy, of which 10% are assumed to be vacant. The average share of investment in housing to GDP is set at 6% and the ratio of housing wealth to GDP is set to 1.78 (in annual terms), following the data for Euro Area countries for years 1995-2016 (see also Bielecki et al., 2017). Given a target for aggregate search effort, $\bar{e} = 0.07$, as well as aggregate search costs (assumed to amount to 1% of annual GDP), this allows us to derive the matching probabilities, the matching elasticity parameter, utility weights of housing and the search cost parameter κ^b endogenously. Different assumptions about the search effort as well as search costs over GDP do not alter our results qualitatively (unless search costs exceed 10% of GDP, which seems implausibly high). Parameters governing the production function of new housing are derived endogenously, and the obtained land's share of new home value of between 28 and 36 percent is in line with the estimates for the US by Davis and Heathcote (2007).

In the intermediate goods production sector, we set the capital share to one third, and target $\bar{n} = 0.33$, which are also standard assumptions in the literature. Following Coenen et al. (2008), we set the elasticity of substitution between patient and impatient households to 6, assume a steady-state wage and price markup of 1.2 for both goods sold domestically and internationally, and assume that both types of firms also face a Calvo parameter of 0.75. Analogous parameters are set in staggered the wage-setting process. The depreciation rate of physical capital is assumed to be 1.4% quarterly to match a capital investment over GDP of 16%, and investment adjustment cost parameter is set

[12] In contrast to the United States, there is surprisingly little data on the average length of home ownership in Europe (with the UK being an exception). The value for z chosen here seems to be an upper bound, given that UK residents seem to move more often than continental European ones (see http://www.at-home-in-europe.eu/home-life/europe/europeans-only-move-four-times-in-their-lives). Lower values for z, however, do not change our results qualitatively.

at $\psi^k = 4.2$ in line with the literature (there, values range from 3.5 to 5, while the exact value does not affect our results qualitatively).

Table 2: Calibrated parameter values

Parameter	Symbol	Value	
		Core	Periphery
Share of borrower households^e	μ	0.397	0.535
Discount factor of lender households	β^l	0.990	
Discount factor of borrower households	β^l	0.980	
Utility of housing^e	ζ^h	0.329	0.3400
Disutility of labor^e	ζ^n	9.686	9.921
Inverse of Frisch elasticity	σ^n	2.000	
Depreciation rate of housing stock	δ^h	0.010	
Goods cost per unit of searching effort^e	κ^b	0.143	0.125
Matching efficiency^e	κ^e	0.188	0.188
Matching elasticity w.r.t. vacancies	γ	0.500	
Housing sellers' bargaining power^e	ς	0.938	0.939
Depreciation rate of capital stock^e	δ^k	0.014	
Investment adjustment cost	ψ^k	4.200	
Elasticity of substitution btw. lender and borrower workers	ϕ^n	6.000	
Wage markup	ν^w	1.200	
Calvo parameter for wages	θ^w	0.75	
Weight of past inflation in wage indexation	ϱ^w	0.5	
Elasticity of substitution btw. home and foreign goods	ϕ^f	1.5	
Goods markup	ν^f	1.2	
Stock of land^e	L	$4 \cdot 10^{-4}$	$1.01 \cdot 10^{-4}$
Land share in housing production^e	γ^h	0.368	0.284
Capital share of output	α	0.33	
Calvo parameter for intermediate goods	θ	0.75	
Weight of past inflation in goods price indexation	ϱ	0.5	
Elasticity of risk premium wrt. foreign debt	ψ^d	0.01	
Autocorrelation in fiscal instruments	ρ^X	0.00	
Reaction to deviation in debt-to-GDP ratio	$\xi^{X,debt}$	0.001	
Taylor rule autocorrelation	ρ^R	0.900	
Reaction of nominal interest rate to inflation	ξ^π	2.000	
Reaction of nominal interest rate to output gap	ξ^y	0.150	

Source: Parameter values as described in the main text. Those marked by an e are derived endogenously to match the steady-state targets of Table 1. Again, we drop the $*$ for convenience.

Turning to fiscal policy, tax rates are implicit rates calculated from national accounts, as is the government spending-to-GDP ratio. Labor tax rates include social security and health care contributions. The data is described in detail in Gadatsch et al. (2016). The steady state tax rates related to property taxation reflect the average share of respective tax revenues in GDP. Due to the lack of comparable country-specific data, they are assumed to be equal to the EA-12 average value in both regions. The public debt-to-GDP ratio is equal to 70% of annual GDP in core and 88.5% in periphery. We assume that debt-stabilization along the transition is taken care of by tax instrument changed permanently, but the sensitivity on debt deviations is small, $\xi^{X,debt} = 0.01$. Autocorrelation of the fiscal instrument used is assumed to be zero (see also the description of the simulation design in the next section for details).[13] As regards monetary policy, we assume a high

[13]To guarantee stationarity, we assume that the financing instrument evolves according to $\log\left(X_t/\bar{X}\right) = \xi^{X,debt} \log\left(d^g_{t-1}/(\omega^d\,\bar{y})\right)$ for $X \in \{\tau^c, \tau^p, \tau^{pa}, \tau^l\}$, where $\xi^{X,debt} = 0.001$ measures the responsiveness of the corresponding instrument to deviations in the debt-to-GDP ratio from its long-run target, ω^d (see, among others, Schmitt-Grohé and Uribe, 2007, for a discussion). The bar indicates steady-state values.

autocorrelation parameter in the Taylor rule, amounting to 0.9, a stance on inflation of 2 and some response to aggregate union-wide output fluctuation of 0.15.

4 Analysis

Simulation design: In this section, we analyze the effects of a permanent reduction in the labor tax in Core financed by either (i) an increase in the property tax rate, (ii) an increase in the property acquisition tax rate, or (iii) an increase in the consumption tax rate. We also perform simulations for the policy change undertaken in Periphery. Results are relegated to the appendix to save space. They are analogous to conducting the reform in Core (yielding somewhat smaller effects quantitatively). To build intuition, we also show the results of financing the labor tax reduction by per-capita taxes levied to savers only as a supplementary simulation. Because, by construction, the per-capita tax which only savers have to pay does not generate any distortions in the system (ie Ricardian equivalence holds), this allows us to assess the effects of a labor tax reduction in isolation.

In order to make things comparable, we assume that, in all scenarios, the labor tax rate is decreased such that it generates an increase in the primary deficit-to-GDP ratio by one percentage point. This increase in the primary deficit-to-GDP ratio is then financed ex post by one of the fiscal instruments mentioned above. Ex-post financing means that we assume the debt-to-GDP ratios to remain constant in the initial and the final steady state. Changing the tax mix changes macroeconomic variables and, thus, has an impact on the corresponding tax bases. This would affect government revenues permanently and, hence, alter the public debt-to-GDP ratio in the new steady state. In order to avoid this, we assume that the financing instrument is adjusted such that the government's budget is balanced ex post. Were we to assume that the government's budget was closed ex ante (ie ignoring the "second-round" effects in determining the final value of the financing instrument), we would generate a somewhat stronger increase in the financing instrument and a mild decrease in the debt-to-GDP ratio without altering the results qualitatively.

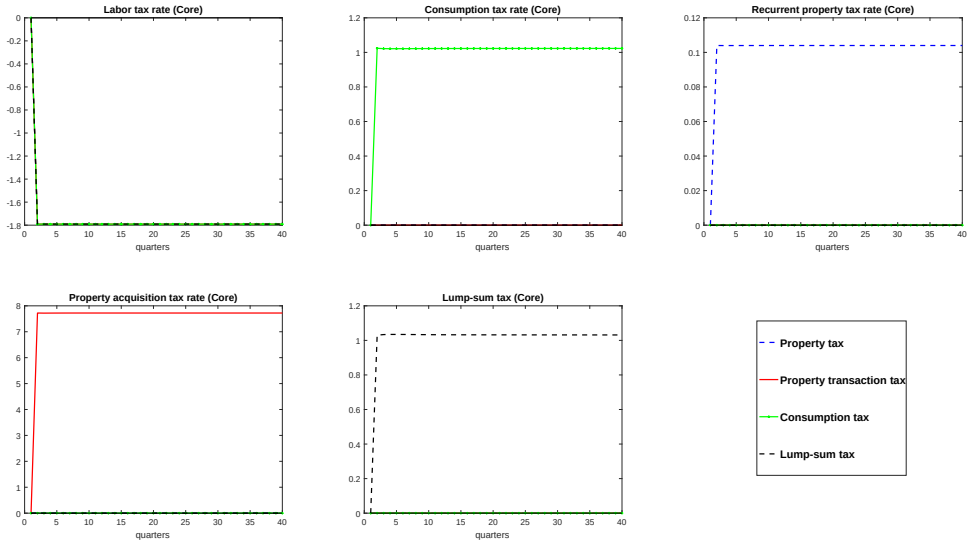
For simplicity, we assume that, at the time of the fiscal change, the economy is in its initial steady state, that the changes are unanticipated and that there are no future shocks in the economy after the change in tax policy. This allows us to isolate the effects of changes in property taxation from other shocks. We simulate the model in a non-linear manner and under perfect foresight.

Results: Figure 1 shows the resulting changes in the fiscal instruments. As the figure reveals, the labor tax rate is reduced by 1.79 percentage points in all scenarios. The necessary increases in the consumption tax rate to finance this labor tax reduction amounts to 1.02 percentage points, while property tax rates only have to be increased by 0.1 percentage points. Property acquisition tax rates need to be increased by as much as 7.66 percentage points, and lump-sum taxes by 1.02 percentage points.

In what follows, Figure 2 depicts the implications of the policy change on the housing market. A disaggregated view of the housing market can be seen in Figure 3. Macroeconomic effects for Core are shown in Figure 4, while those for Periphery as well as for international competitiveness are shown in Figure 5. Table 3 summarizes the long-run changes relative to the initial steady state.

To start, let us first describe the effects of a labor tax reduction financed by higher lump-sum taxes levied on lenders only, which allows us to have a relatively isolated view on what happens due to the reduced tax burden on labor. As we see in Figure 4, a lower labor income tax rate increases net labor income for households. The positive income effect makes them increase consumption and, ceteris paribus, enjoy more leisure. However, as the increase in net labor income overcompensates for the disutility of labor, households also expand labor supply and, in the end, work more. Higher labor supply and lower taxes dampen gross wages (at least in the medium term due to the rigidities in the wage setting process), such that labor supply meets labor demand again. Lower unit labor costs allow firms to decrease prices, which also fosters international competitiveness (see Figure 5), generates higher output and fosters investment in physical capital. Because of increased consumption and investment demand, spillovers to the periphery are positive.

Figure 1: Changes in fiscal policy instruments



As regards the housing market, we see that the positive income effect resulting from lower labor income taxation also spills over to the housing market. In Figure 2, we see that housing demand increases, which is represented by an increase in market tightness, more housing matches and higher investments in new housing. Given the overall increase in housing, utility-bearing fit-for-occupy housing stock increases. The increase in total housing demand leads to an increase in house prices and allows borrower households to take out more loans. However, Figures 2 and 3 as well as Table 3 reveal that the effects on the housing market are relatively small. Figure 3 also reveals that the effects of financing a labor tax reduction by lump-sum taxes are qualitatively equivalent and quantitatively similar for borrowers and lenders.

Turning to a labor tax reduction financed by an increase in consumption taxes, we see that the effects are not very different. Figure 4 and Table 3 show that, again, households consume and work more, wages fall, competitiveness increases and output as well as

private capital investment rise. Overall, however, the effects are slightly smaller relative to those using lump-sum taxes as the financing instrument because a higher consumption tax rate directly increases consumption costs and, thus, introduces more distortions into the system.[14]

The labor tax reduction again implies an increase in aggregate housing demand. However, we observe in Figure 2 that net house prices now fall. This directly affects the value of collateral and now also induces borrower households to take out less loans. The reason for falling net house prices can be explained by the fact that the higher consumption tax rate also applies to housing purchases in our model. Thus, to some extent, the consumption tax acts like a property transaction tax – which is in line with the legislation in most EMU member states, however. While the increase in the consumption tax rate leads to falling net house prices, it still increases gross purchasing prices of housing as the fall in net house prices does not overcompensate for the policy-induced purchasing price (see Figure 2). Because the households' value of housing equals the gross purchasing price (plus search costs), the former must increase. Higher consumption, which reduces the marginal utility from consumption and, thus, the relative marginal value of housing, already increases this value. But the consumption increase is too strong relative to the increase in house prices. Hence, lender households compensate for this by demanding more housing, which again reduces marginal utility of housing until an equilibrium is reached (see Figure 3). Borrower households, however, reduce housing demand. The effect just described is also present for borrowers. But they attach additional utility to housing, which they can use as collateral, and the collateral value falls resulting from falling house prices. The latter effect dominates the former such that they need to increase the relative marginal value of housing to equate housing utility with purchasing prices (plus search costs). They do this by lowering housing demand.

When ignoring the policy-induced house purchasing price increase after a consumption tax rate hike by assuming that consumption taxes are only increased for consumption goods (while the rate for housing purchases is kept at the initial steady state value), we indeed observe a rise in net house prices, and the positive housing demand effect, especially for borrowers, is much stronger (see bracket values for the consumption tax rate simulation Table 3). Because of the reduction in the tax base necessary to finance the labor tax reduction, however, the consumption tax rate must be increased by more which, in the end, somewhat dampens the positive consumption increase and, thus, the effects on GDP, employment, and so on. In the Appendix, we provide figures comparing our baseline scenario in which consumption taxes apply to consumption and housing goods to a scenario in which the consumption tax increase only applies to consumption goods by fixing the consumption tax rate on housing purchases to its initial steady state value.

[14]Note that, on impact, using consumption taxes as the financing instrument increases consumption of lenders while consumption of borrowers is depressed. The reason for this is that, now, the tax burden is shared between lenders and borrowers directly, while lump-sum taxes were only levied on lenders in the previous simulation by assumption. In the long-run, however, the distortionary effect of higher consumption taxes dominates and, thus, aggregate effects are still smaller relative to using lump-sum taxes.

Figure 2: Implications on housing market

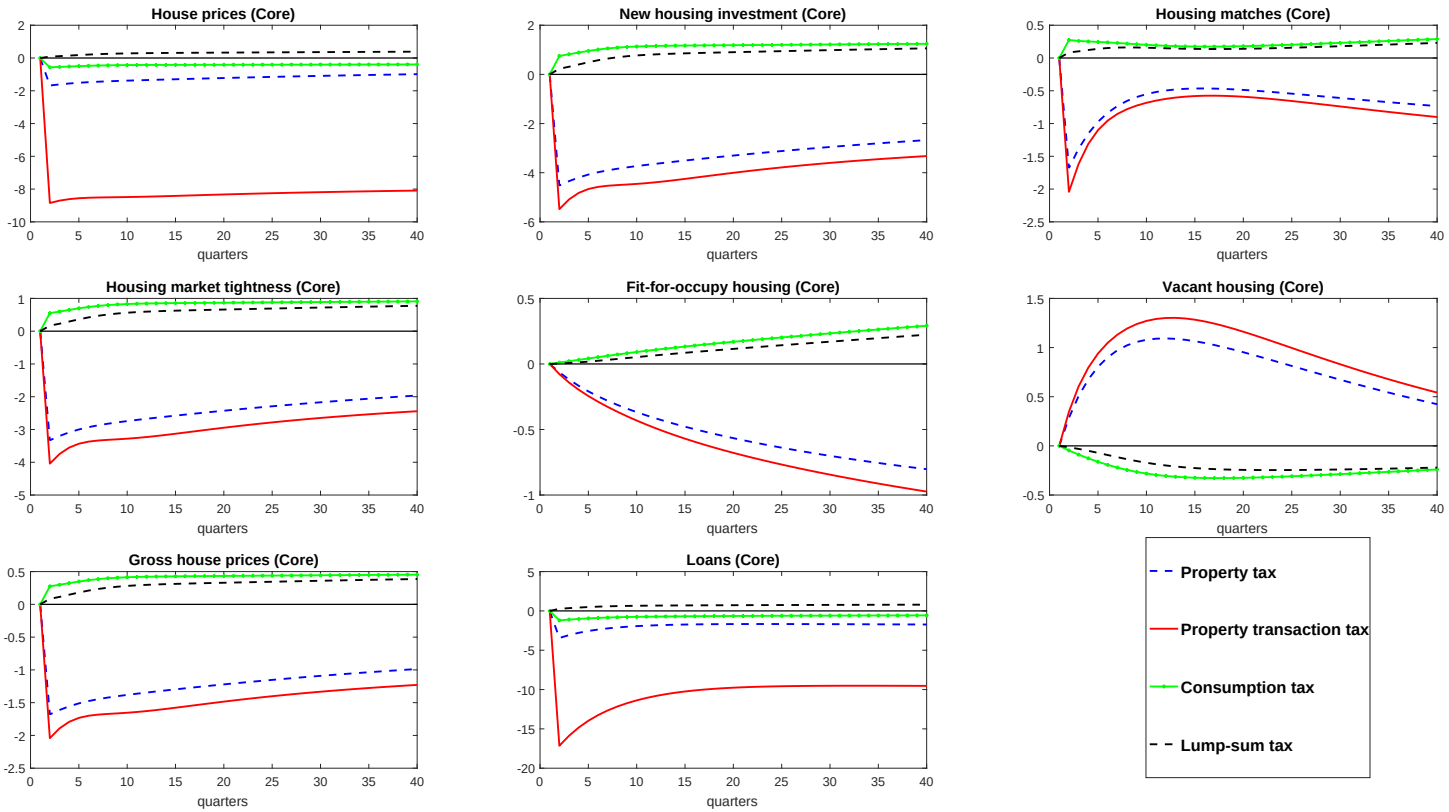


Figure 3: Disaggregation on housing market

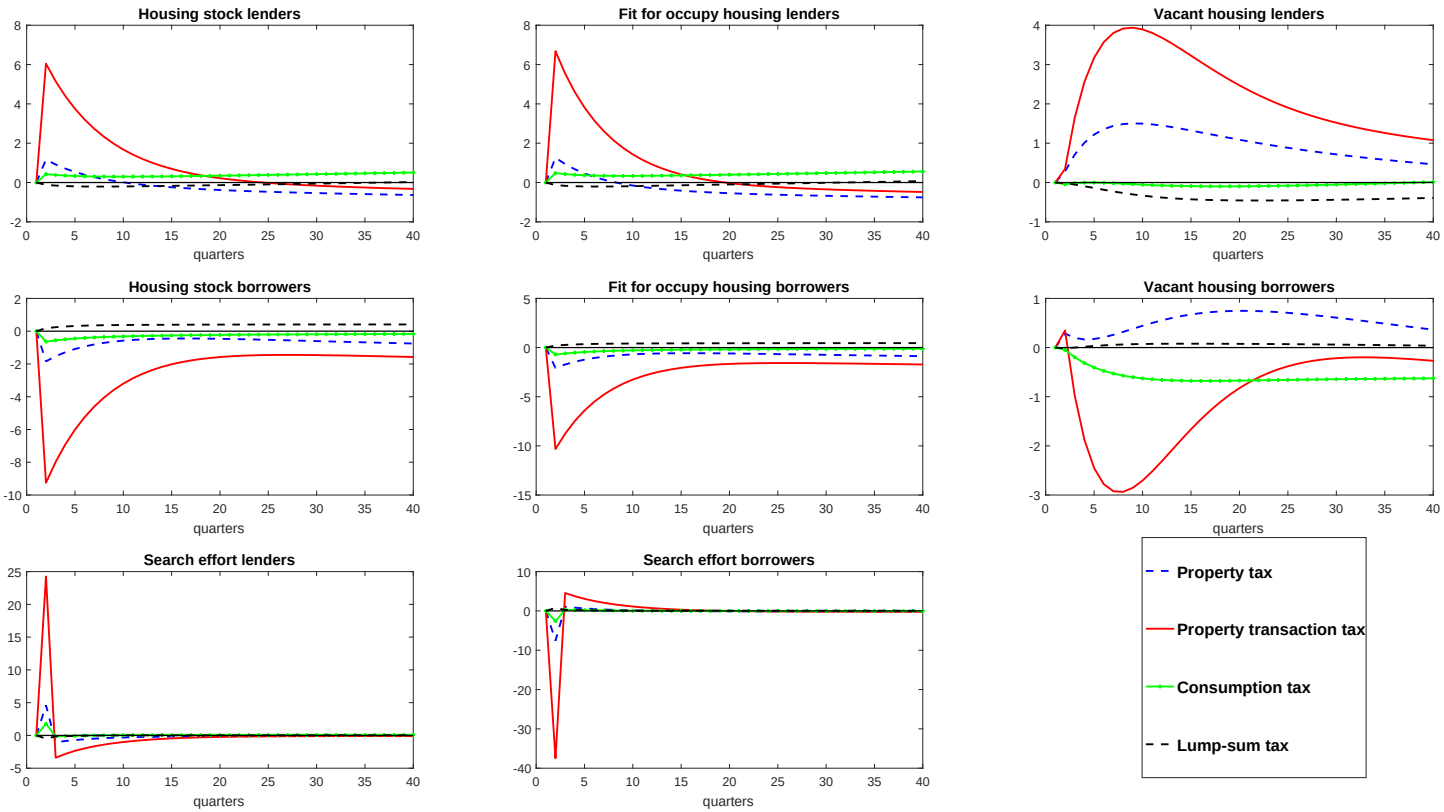


Figure 4: Implications on Core macro variables

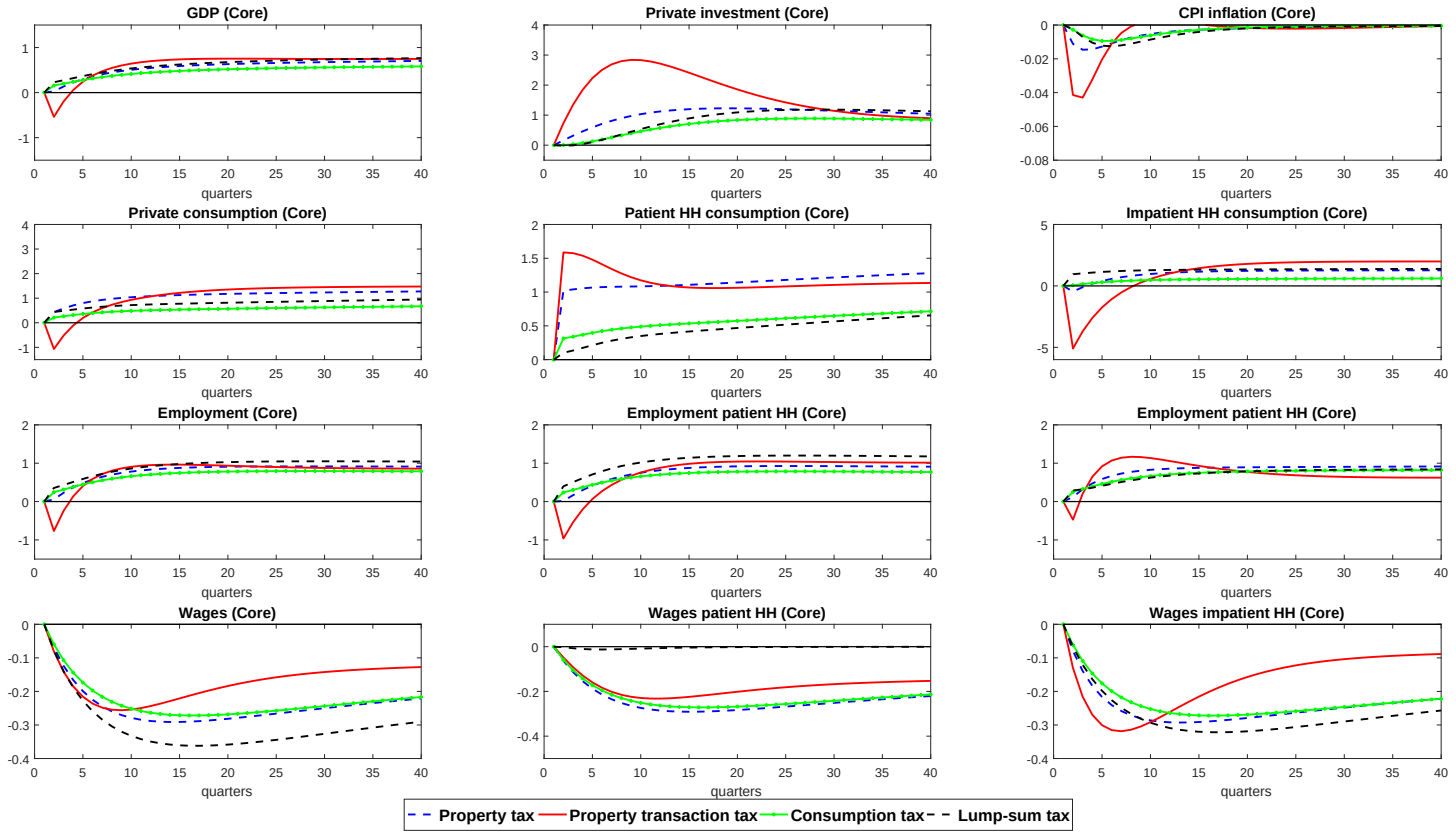
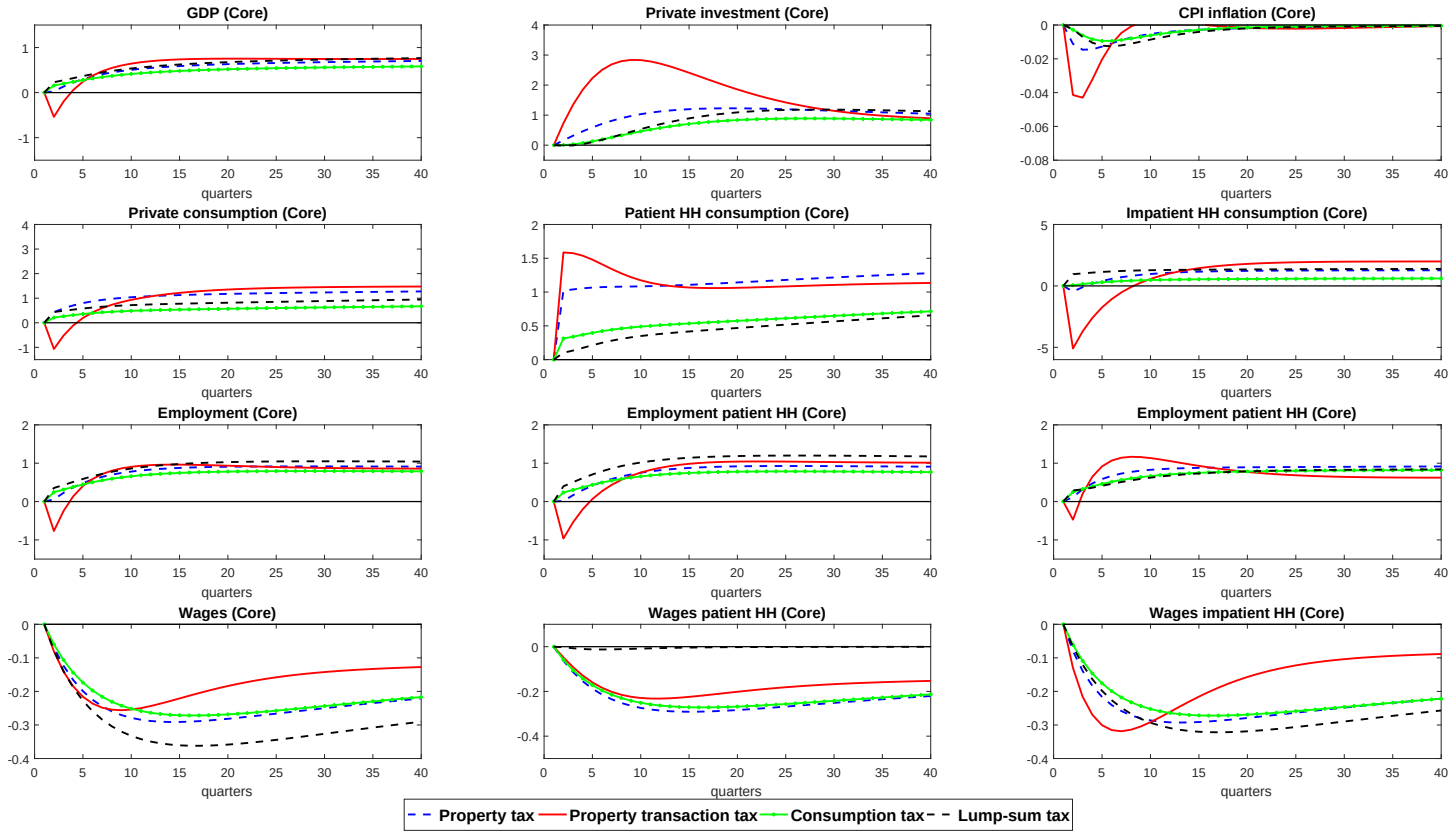


Figure 4: Implications on Core macro variables



When using property transaction taxes as the financing instrument, we see a rather extreme effect on the housing market (see Figure 2). An increase in the property transaction tax rate by almost 10 percentage points has a large effect on the gross purchasing price of housing. Naturally, this implies a strong reduction in housing demand as a result of the bargaining process. On impact, net house prices fall by about 10% which is a result of the sharp decease in housing demand. The fall in net prices compensates for the policy-induced price increase. However, aggregate housing demand stays significantly below its initial value due to the policy-induced tax wedge on housing purchases even in the long run (see Table 3). The negative demand effect implies that, even though net house prices fall by 9.95 percent in the long run, purchasing prices still fall by a bit more than 1.5%. Along the transition, the policy-induced purchasing price of housing implies a sharp increase in housing demand for lenders and a sharp fall in housing demand for borrowers on impact. Again, the reason is the fact that the purchasing prices (plus search costs) must equal the marginal value households attach to housing. As the collateral value of housing falls with falling net house prices, borrowing households decrease housing demand on impact, while lenders' housing demand first increases. The fall in net house prices pushes these effects back but, in the end, housing demand falls below its initial level.

These effects generate strong spillovers to the rest of the economy. Because borrowers' consumption is constrained by the loans they can take up, and these loans fall as a result of the loss in collateral value, their consumption on impact decreases significantly and translates into a decrease in aggregate consumption (see Figure 4). This, plus the fall in housing investment generates a recessionary effect that cannot be overcompensated for by higher lenders' consumption and higher capital investment. Therefore, GDP falls by one percent on impact. Hence, in this case, the positive effects of the labor tax reduction are initially overturned by the negative effects of the property transaction tax increase. As the housing market "normalizes", the positive effects of the labor tax reduction start to dominate. Because of the shift away from housing towards consumption demand, long-run GDP and aggregate consumption effects are actually stronger in this policy experiment relative to using consumption taxes as the financing instrument. However, this comes at the cost of a recession on impact. As lender households are not credit-constrained, they able to move forward some of these positive effects on impact already, implying no consumption decrease for them.

Financing the labor tax reduction by an increase in the recurrent property tax rate also reduces the attractiveness of holding housing with analogous effects as already described (see Figures 2 and 3). Even though there is no direct policy-induced effect on the (gross) housing purchasing price, it now becomes more expensive to hold housing units (given that the tax applies each period) and, therefore, the demand for housing falls. Although the property tax rate increases by only 0.13 percentage points, demand for housing, housing investment and (net) house prices fall, and there is a clear incentive for households to shift from housing to consuming standard consumption goods (see Figure 4). In total, these effects are similar to those using property transaction taxes but at a lower level – except for the higher consumption increase of lenders, whose income is not diminished as much as in the previous simulation because interest income from loans to borrowers does not decrease as much while, at the same time, the incentive for shifting towards regular consumption goods is strengthened (due to the fact the gross purchasing prices do not

fall that much with the corresponding effects on marginal utilities). In terms of aggregate GDP and consumption, the effects are similarly strong as those using property transaction taxes as the financing instrument, but the measure avoids the strong recession (see Table 3 and Figure 4).

Table 3: Permanent effects of labor tax reduction with different financing instruments

	Financing instrument			
	Property taxes	Property transaction taxes	Consumption taxes	Lump-sum taxes
Long-run changes in				
GDP	0.80	0.78	0.66 (0.65)	0.88
Consumption	1.42	1.46	0.88 (0.80)	1.22
...of lenders	1.51	1.13	1.03 (1.01)	1.06
...of borrowers	1.28	1.96	0.66 (0.47)	1.45
Investment	0.78	0.76	0.65 (0.63)	0.86
Ivestment in housing	-1.70	-2.33	1.09 (1.58)	1.03
Net labor income P	4.11	4.26	3.96 (3.92)	4.29
Net labor income I	4.20	3.94	4.11 (4.13)	4.14
Wages	-0.11	-0.11	-0.09 (-0.09)	-0.13
...of lenders	-0.11	-0.13	-0.08 (-0.07)	-0.14
...of borrowers	-0.12	-0.07	-0.11 (-0.11)	-0.11
Employment	0.89	0.87	0.74 (0.72)	0.98
...of lenders	0.85	1.02	0.67 (0.62)	1.06
...of borrowers	0.95	0.64	0.84 (0.87)	0.87
Loans	-1.91	-9.81	-0.37 (0.99)	1.01
Housing (lenders)	-0.90	-0.97	1.02 (1.30)	0.64
Housing (borrowers)	-1.23	-2.09	0.11 (0.43)	0.60
Net house prices	-0.62	-7.75	-0.45 (0.57)	0.38

Notes: Table shows deviations of final relative to initial steady-state values in per cent (percentage points for rates and ratios). In brackets, we report the simulation results when assuming consumption tax rates on housing purchases to be fixed (as explained in the main text).

Summarizing, we can state that using property taxation to finance a decrease in labor taxation generates positive GDP and consumption effects that dominate the use of consumption taxes as a financing instrument in the long run. However, the housing market is more negatively affected, implying a reduction in the housing stock, turnover rates in the housing market and lower net house prices (i.e. housing wealth). Furthermore, the use of property taxation may generate pronounced recessionary effects in the medium term before the positive effects on the rest of the economy start to materialize. This makes it difficult to assess whether or not the use of property taxation is beneficial in terms of welfare for several reasons. First, how does the decrease in housing wealth affect households' utility even though consumption tends to increase? Second, do the negative recessionary effects along the transition potentially outweigh the positive steady-state effects? We will address these questions in the next section.

5 Welfare

We are now interested in how to evaluate reforms described above in terms of the well-being of the inhabitants of the reforming country. The advantage of having a theoretical model like ours is that we are able to calculate (household type-specific) welfare to address this issue. In doing so, we compute the life-time consumption-equivalent gain of each type of household in line with Lucas (2003) as a result of the change in fiscal policy. More precisely, we calculate the consumption-equivalent welfare gain, ce^i, such that

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

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. The economy-wide consumption equivalent is computed as $ce = (1-\mu)ce^s + \mu ce^b$. Results are summarized in Table 4.

We observe that aggregate economy-wide welfare increases under all policy scenarios independent of whether or not the transition is included. Hence, reducing labor taxation in a budget-neutral way seems to be a viable policy option. In terms of aggregate welfare, using consumption taxation as the financing instrument yields the largest gains. The reason for this is that, even though direct consumption gains are lowest (relative to the other policy options), the increase in employment and the utility loss from reduced housing wealth are also lowest. This measure is followed by using recurrent property taxation which is then followed by using property transaction taxation as the financing instrument in terms of aggregate welfare. The main reason is that, while generating similar consumption and employment gains, losses of housing wealth are more pronounced when using property transaction taxes. The ranking holds for the steady-state comparison. When taking into account the transition, recurrent property taxation seems to be the financing instrument of choice, mainly because of the immediately more pronounced increase in lenders' consumption.

However, we also observe that lenders and borrowers may be affected quite differently by the measures. Welfare gains may be distributed unequally between the two household types. Let us define $\Delta^{ce} = ce^b/ce^l$ as a measure of equality of welfare.[15] Then, $\Delta^{ce} = 1$ implies an equal welfare distribution, $\Delta^{ce} \in [0,1)$ a shift of welfare towards lenders and $\Delta^{ce} > 1$ a shift towards borrowers after the policy experiment.

We note that the use of consumption taxation as the financing instrument clearly benefits lenders, as $\Delta^{ce} = 0.35$ in the steady-state comparison ($\Delta^{ce} = 0.29$ when taking into account the transition). This also holds for recurrent property taxation as the financing instrument, however, implying less redistribution and with a somewhat smaller difference between taking into account the transition or not ($\Delta^{ce} = 0.51$ and $\Delta^{ce} = 0.56$, respectively). When using property transaction taxes as the financing instrument, steady-state welfare gains are clearly shifted towards borrowers ($\Delta^{ce} = 2.17$) because of the high

[15] Note that, while ce directly depends on the relative size of the two household types, ce^i, with $i = b, l$ does not (it does so only indirectly through potentially different transmission). Hence, comparing the ce^i's seems more adequate to compare welfare (re-)distribution.

consumption increases and relatively modest employment expansion which both seem to compensate for the loss in housing wealth (see Table 3). However, nothing of this relative steady-state welfare gain is left when taking into account the transition ($\Delta^{ce} = 0.13$), mainly because of the high consumption and housing stock losses on impact.

Table 4: Welfare effects of labor tax reduction with different financing instruments

	Financing instrument		
	Property taxes	Property transaction taxes	Consumption taxes
Long-run welfare effects...			
ce^l	0.87	0.41	1.16 (1.27)
ce^b	0.45	0.89	0.41 (0.33)
ce	0.70	0.60	0.86 (0.90)
...including transition			
ce^l	0.79	0.72	0.79 (0.80)
ce^b	0.44	0.09	0.23 (0.24)
ce	0.65	0.47	0.56 (0.58)

Notes: Table presents steady-state welfare gains/losses after the reform measures in terms of how much of initial steady-state consumption (in per cent) a household of type $i = l, b$ would be willing to give up in order to be indifferent between living in the original or in the alternative regime. We also calculate the welfare gains/losses including the transition paths. Total economy-wide welfare gains/losses are define as $ce = (1-\mu)ce^l + \mu ce^b$, where μ is the share or borrowers. In brackets, we report the simulation results when assuming consumption tax rates on housing purchases to be fixed (as explained in the main text).

Summarizing, our analysis suggests that, when taking into account the transition to the new steady state, reducing labor taxation financed by recurrent property taxation seems to outperform the use of consumption taxation, both in terms of aggregate welfare gains and in terms of minimizing welfare re-distribution between household types. And both these measures clearly outperform the use of property transaction taxes. Using recurrent property taxes to finance a labor tax reduction also generates highest output gains at the cost of modest negative effects on the housing market.[16]

6 Conclusions

Using a New Keynesian DSGE model with search frictions on the housing market, we evaluate how financing a labor tax reduction by higher property taxation affects the real economy and welfare. We compare this to a simulation using higher consumption taxes as the instrument financing the reduction in labor taxation. Search on the housing market enables us to explicitly model stocks and flows, which is necessary to differentiate between recurrent property taxes (levied on stocks) and property transaction taxes (levied to flows).

[16]Aggregate welfare gains for using lump-sum taxes as the instrument amount to $ce = 1.10$ for the steady-state comparison and $ce = 0.76$ when taking into account the transition, and they clearly re-distribute welfare towards borrowers ($\Delta^{ce} = 1.49$ and $\Delta^{ce} = 2.55$, respectively) because borrowers do not face any financing requirement. However, such an instrument does not seem to be available in practice.

As expected, we find that a labor tax reduction fosters private employment, consumption, investment, GDP and international competitiveness. The latter is a result of lower unit labor costs because households accept lower gross wages due to a lower labor tax burden. Because of the positive net income effect, the demand for housing, house prices and housing investment also rise. Spillovers of a labor tax reduction to the housing sector are, however, small. Higher policy-induced consumption costs resulting from using consumption taxes as an instrument to finances the losses due to reduced labor taxation does not overcompensate these positive effects.

When using property taxation to finance a decrease in the labor tax, we find that, in the long run, the positive GDP and consumption effects are larger than those of using consumption taxes as financing instrument. In the end, this is a result of the fact that, then, there is no policy-induced increase the price of consumption goods. However, the housing market is more negatively affected, implying a reduction in the housing stock, lower turnover rates in the housing market and a fall in net house prices (i.e. housing wealth). Also, along the transition, the use of property taxation may generate recessionary effects before the positive effects on the rest of the economy start to materialize. This is a result of the fact that housing is a component of GDP, too, and it takes time before the positive economic effects in the rest of the economy dominate the negative effects on the housing market. The negative effects on the housing market are strongest when using property transaction taxes to finances the reduction in labor taxation.

In order to assess which measures are preferable in terms of households' well-being in our model economy, we perform a welfare analysis. We observe that aggregate economy-wide welfare increases independent of whether property or consumption taxation is used to finance lower labor taxation. Hence, reducing the labor tax in a budget-neutral way seems to be a viable policy option. The measure that generates the most favorable effects in terms of higher GDP, consumption and welfare as well as lowest welfare redistribution between household types is financing the labor tax reduction by higher recurrent property taxation. All other measures imply notable redistribution between lenders and borrowers. Because of the negative spillovers from the housing sector to the rest of the economy when using property transaction taxes as financing instrument, especially along the transition, this is the least favorable measure.

Appendix

In the Appendix, we first simulate our model by assuming that the consumption tax rate levied on housing purchases remains constant at its initial steady-state level. This enables us to isolate the the effects of an increase in the consumption tax rate for regular consumption goods from those resulting from an increase of the tax rate on housing purchases. Second, we perform the same policy experiments conducted in Core in the main text in the periphery countries to show that results are analogous.

Constant tax on consumption goods: The consumption tax rate now has to be increased by a bit more (relative to the baseline simulation in the main text) because its base has now decreased. Figures 6 to 9 are the analogues to Figures 1 to Figure 4 presented in the main text. The long-run outcome of this simulation is presented in brackets in Table 3. We briefly addressed the differences in the main text.

Figure 6: Changes in fiscal policy instruments (alternative VAT simulation)

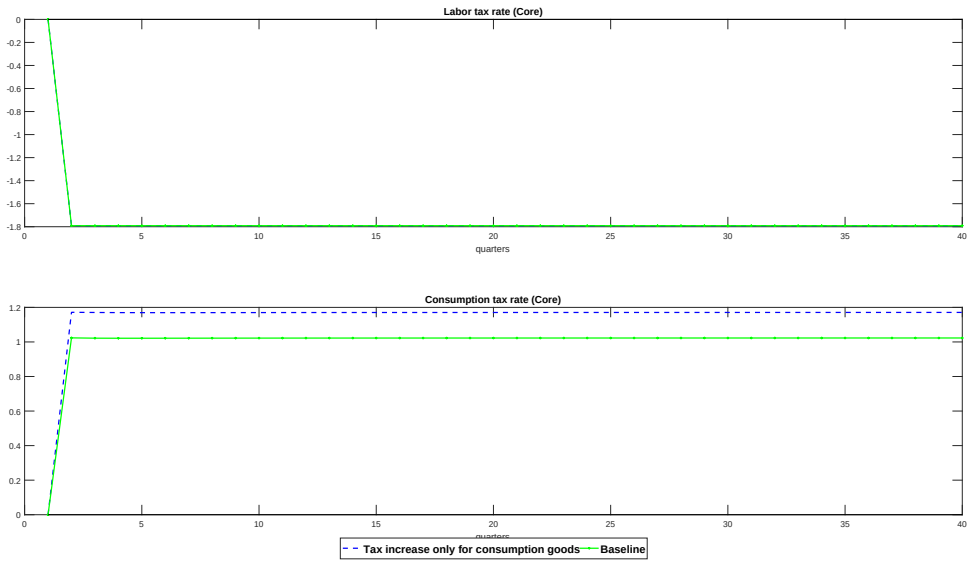


Figure 7: Implications on housing market (alternative VAT simulation)

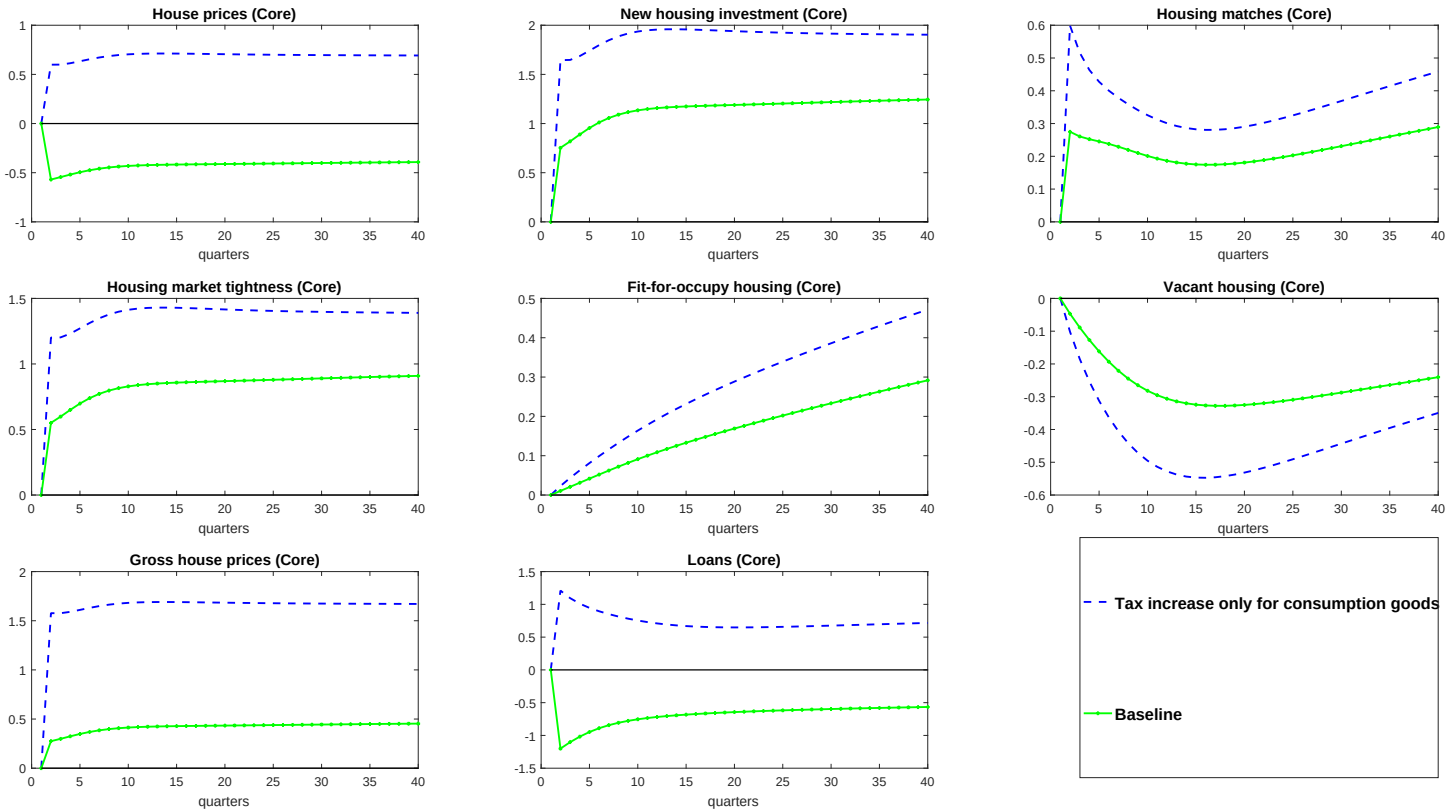


Figure 8: Implications on disaggregated housing market (alternative VAT simulation)

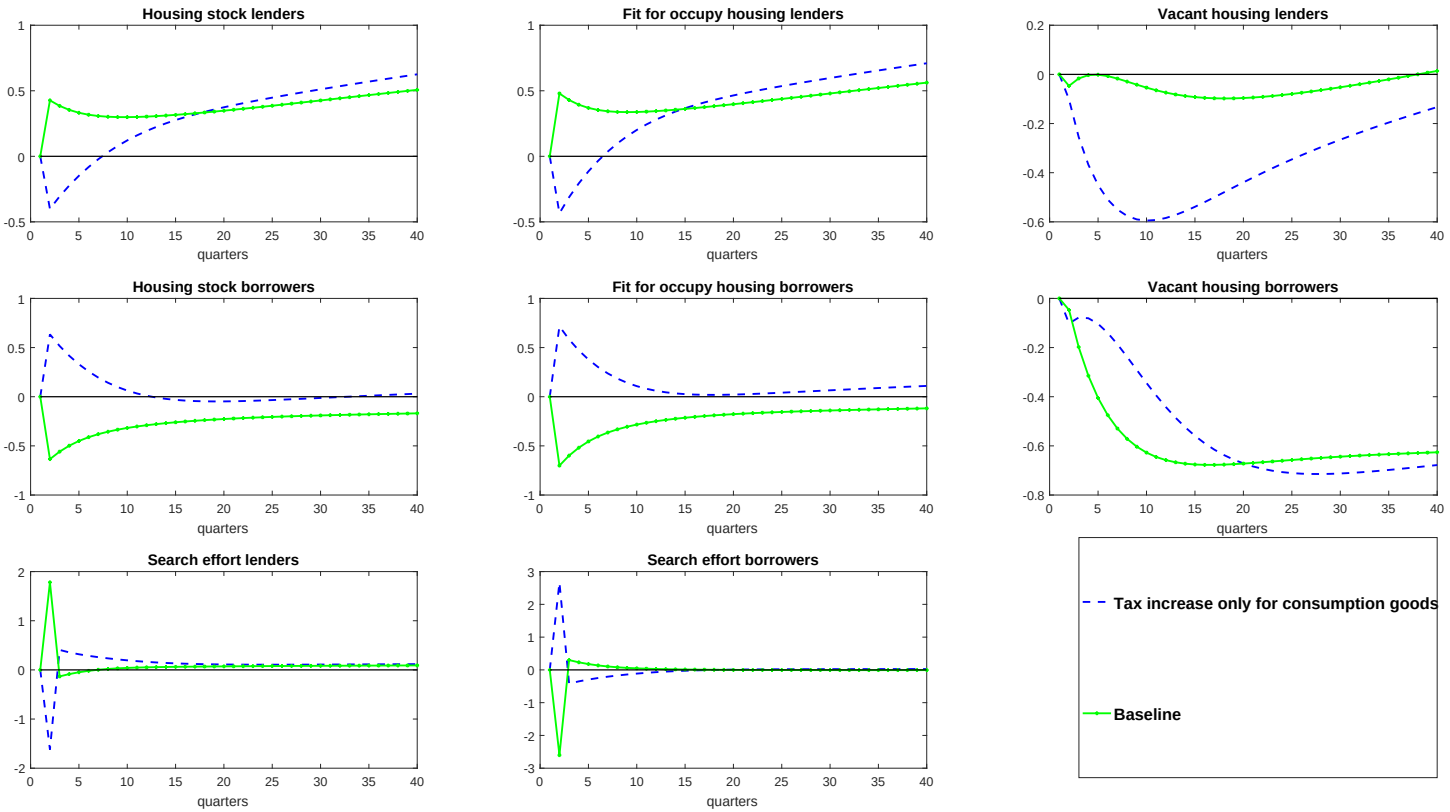
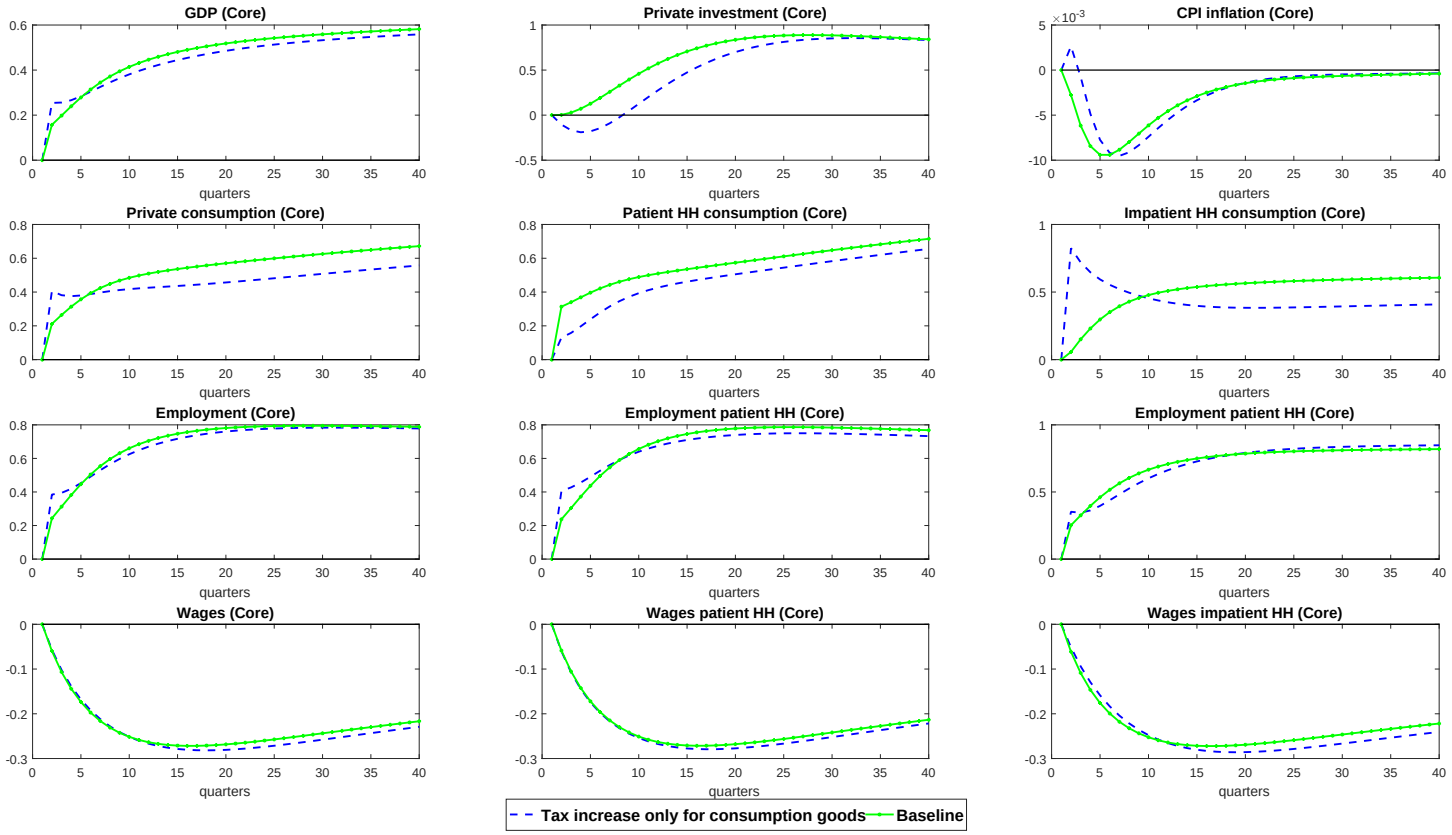


Figure 9: Implications on Core macro variables (alternative VAT simulation)



Policy experiment in Periphery When conducting the same policy experiments that we have simulated for Core in the main text in Periphery, the results are analogous. As we can see in Figure 10, the changes in the tax instruments are somewhat larger because of different parametrization of Periphery and, thus, the resulting positive effects are muted relative to conducting the simulations in Core (see Figures 11 to 13 as well as Table 5). Nevertheless, this also translates into analogous welfare effects and the same welfare ranking (see Table 6).

Figure 10: Changes in fiscal policy instruments in Periphery

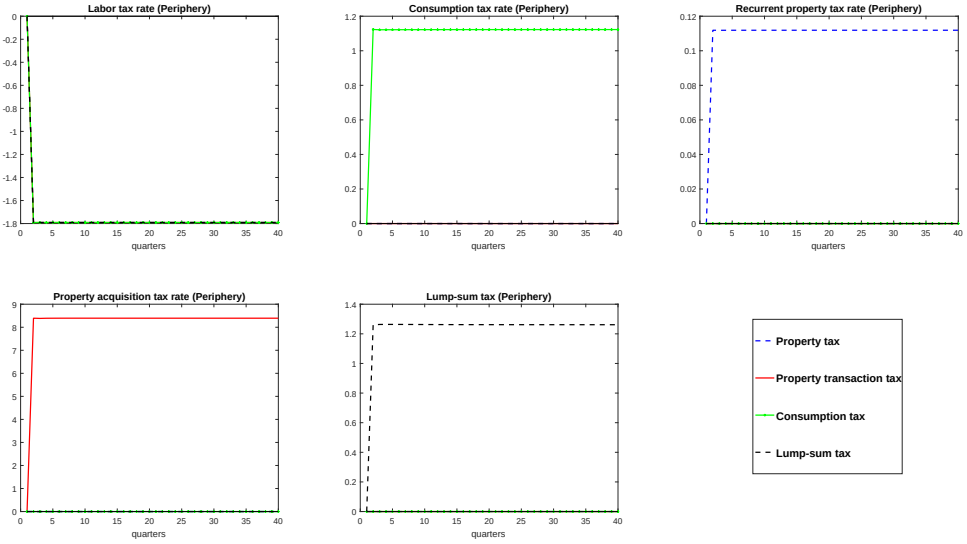


Table 5: Permanent effects of labor tax reduction with different financing instruments in Periphery

	Financing instrument			
	Property taxes	Property transaction taxes	Consumption taxes	Lump-sum taxes
Long-run changes in				
GDP	0.48	0.45	0.39	0.54
Consumption	1.42	1.51	0.81	1.16
...of lenders	1.52	0.80	1.01	0.80
...of borrowers	1.33	2.12	0.63	1.48
Investment	0.66	0.63	0.54	0.75
Ivestment in housing	-2.13	-3.16	0.85	0.85
Net labor income P	3.97	4.26	3.82	4.25
Net labor income I	4.05	3.74	3.97	3.98
Wages	-0.19	-0.18	-0.15	-0.21
...of lenders	-0.18	-0.23	-0.14	-0.24
...of borrowers	-0.19	-0.13	-0.17	-0.19
Employment	0.85	0.81	0.70	0.96
...of lenders	0.80	1.13	0.60	1.13
...of borrowers	0.89	0.53	0.78	0.82
Loans	-2.40	-11.09	-0.68	0.92
Housing (lenders)	-1.17	-1.39	1.19	0.52
Housing (borrowers)	-1.71	-2.78	0.05	0.64
Net house prices	-0.58	-8.35	-0.71	0.23

Notes: Table shows deviations of final relative to initial steady-state values in per cent (percentage points for rates and ratios). In brackets, we report the simulation results when assuming consumption tax rates on housing purchases to be fixed (as explained in the main text).

Figure 11: Implications on housing market in Periphery

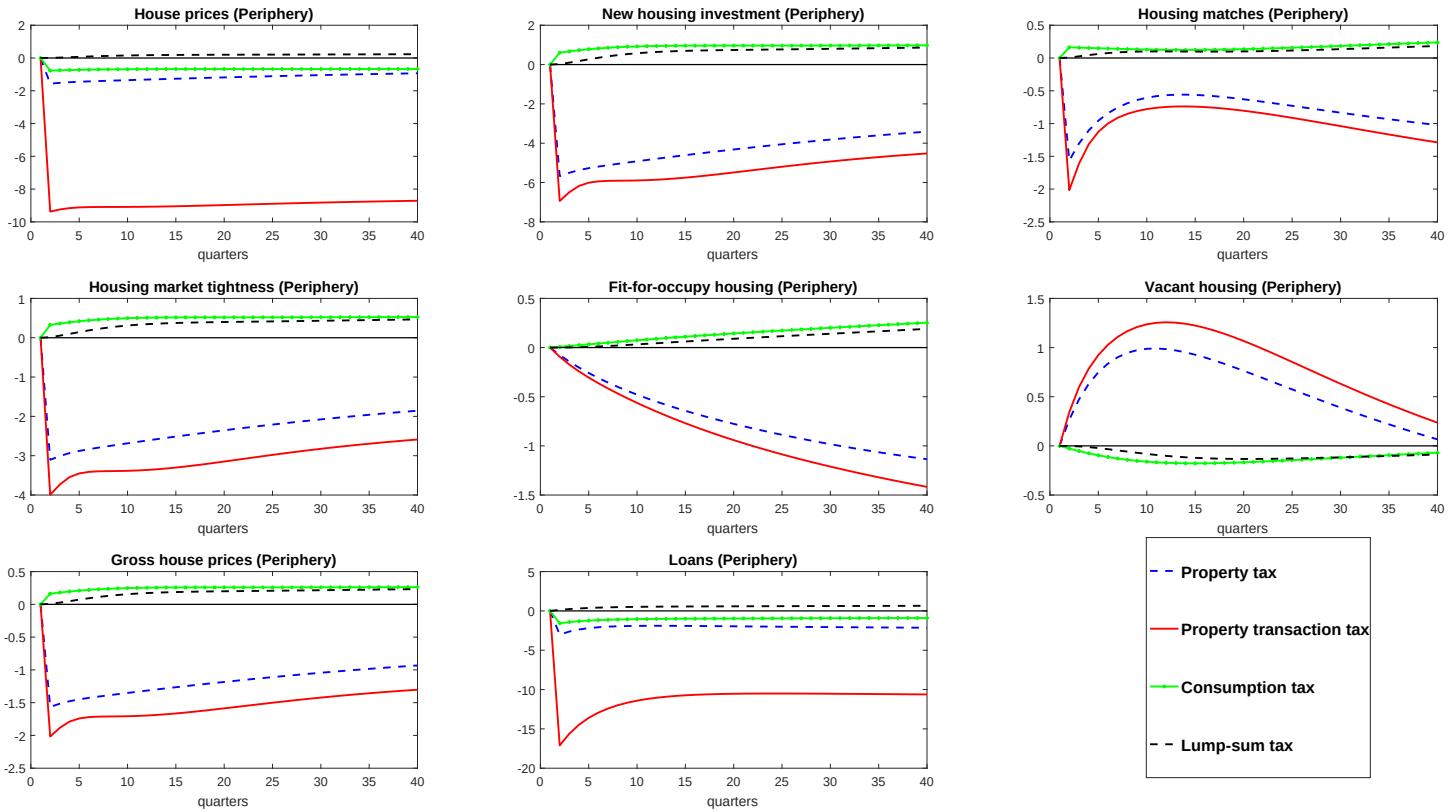


Figure 12: Disaggregation on housing market in Periphery

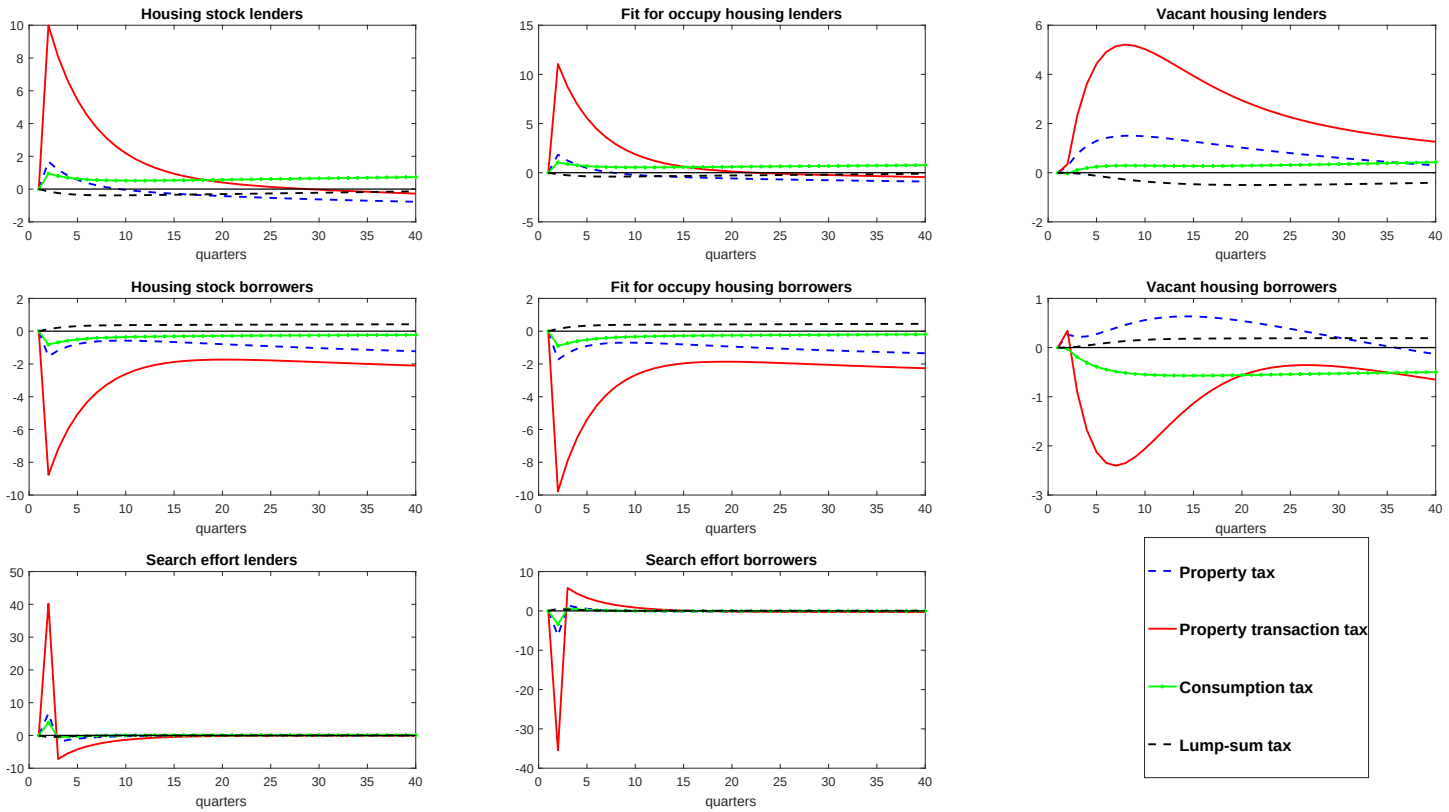


Figure 13: Implications on Core macro variables in Periphery

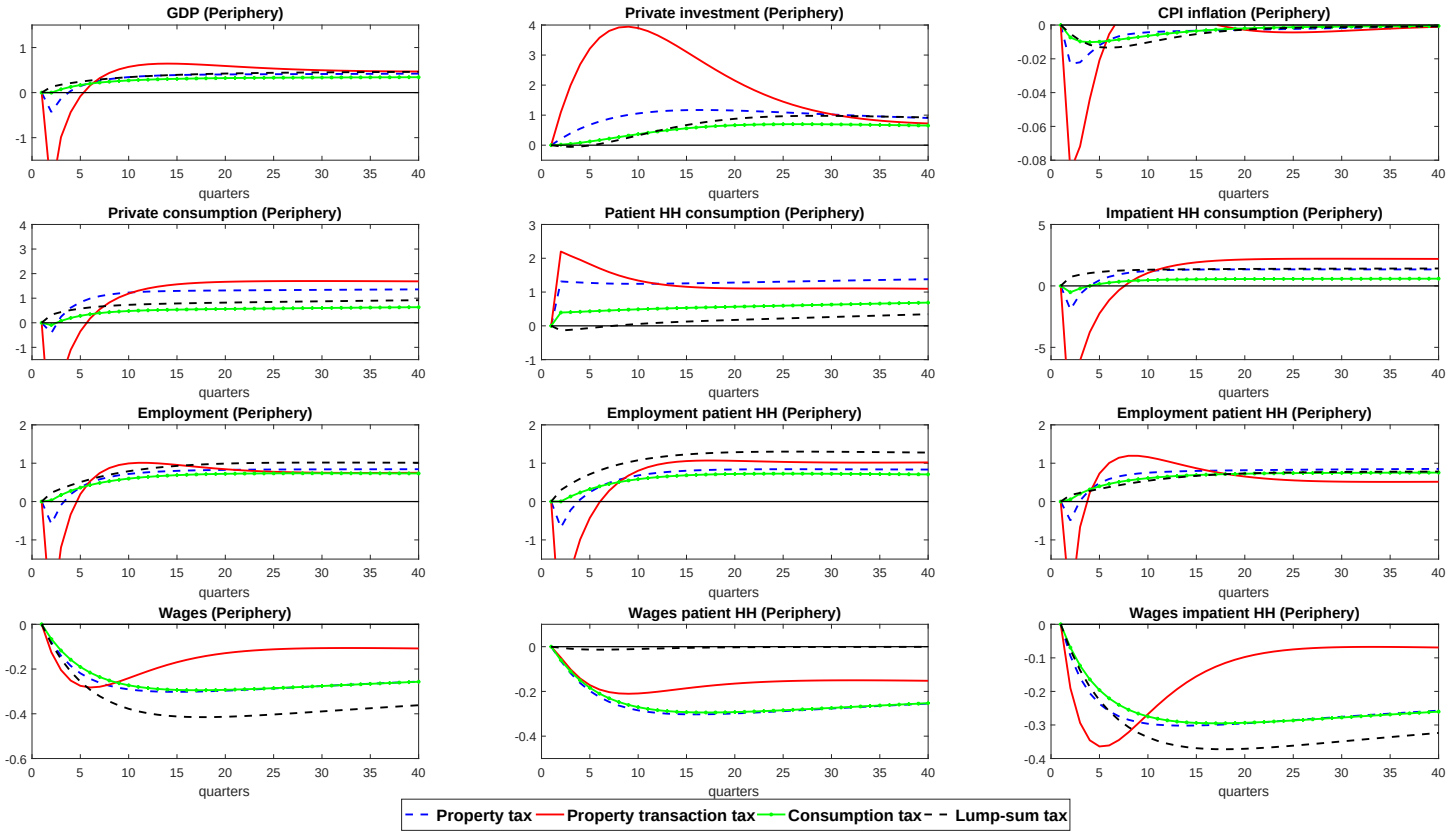


Figure 14: Implications on Periphery macro variables in Periphery

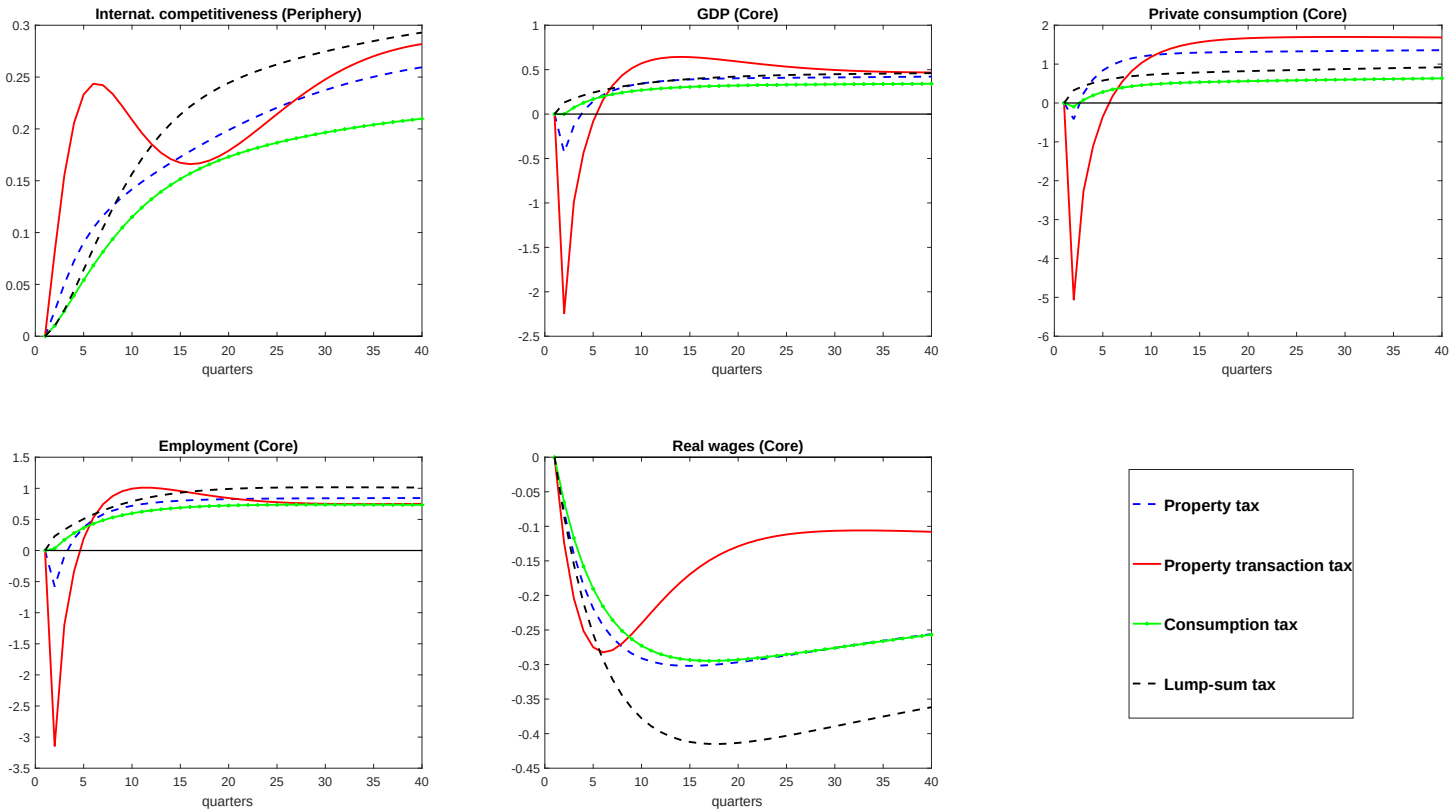


Table 6: Welfare effects of labor tax reduction with different financing instruments in Periphery

	Financing instrument		
	Property taxes	Property transaction taxes	Consumption taxes
Long-run welfare effects...			
ce^l	0.78	-0.13	1.24
ce^b	0.34	0.82	0.36
ce	0.54	0.38	0.77
...including transition			
ce^l	0.81	0.60	0.86
ce^b	0.41	0.09	0.18
ce	0.60	0.33	0.49

Notes: Table presents steady-state welfare gains/losses after the reform measures in terms of how much of initial steady-state consumption (in per cent) a household of type $i = l, b$ would be willing to give up in order to be indifferent between living in the original or in the alternative regime. We also calculate the welfare gains/losses including the transition paths. Total economy-wide welfare gains/losses are define as $ce = (1 - \mu)ce^l + \mu ce^b$, where μ is the share or borrowers.

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