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REGULAR ARTICLE

Inequality and imbalances: a monetary union agent-based model

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Abstract

Our paper investigates the impact of rising inequality in a two-country macroeconomic model with an agent-based household sector characterized by peer effects in consumption. In particular, the model highlights the role of inequality in determining diverging balance of payments dynamics within a currency union. Inequality may drive the two countries into different growth patterns: where peer effects in consumption interact with higher credit availability, rising income inequality leads to the emergence of a debt-led growth. Where social norms determine weaker emulation and credit availability is lower, an export-led regime arises. Eventually, a crisis emerges endogenously due to the sudden-stop of capital flows from the net lending country, triggered by the excessive risk associated with the dramatic amount of private debt accumulated by households in the borrowing country. Monte Carlo simulations for a wide range of calibrations confirm the robustness of our results.

Keywords Inequality · Current account · Currency union · Agent-based model

JEL Classification C63 · D31 · E21 · F32 · F43

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1 Introduction

In the period between the introduction of the Euro and the outburst of the recent financial crisis, Member States of the European Economic and Monetary Union (EMU) accumulated large current account imbalances that, relative to GDP, are similar in size to those of the US or China (Schmitz and Von Hagen 2011). In particular, core nations (e.g. Germany, Finland and the Netherlands) ran large current account surpluses since the early 2000s, while the so-called periphery (i.e. Greece, Ireland, Portugal, and Spain) ran marked current account deficits that increased significantly in the run up to the crisis (Hale and Obstfeld 2016; Schmitz and Von Hagen 2011). Recent empirical evidence suggests that such differences may be explained by the rise of income inequality in a context of financial liberalisation: Marzinotto (2016) finds that grater inequality and the relaxation of collateral constraints for lower-income groups in the EMU, led to greater demand for credit and household indebtedness in the periphery. This was financed through domestic and foreign lending that eventually allowed for higher spending and current account deficits. By contrast, the stagnant reaction of consumption demand in core countries favored the emergence of trade surpluses with domestic underspending. Therefore, the source of financing of current account deficits in the periphery is to be found in the increase of cross-border capital flows in the form of endogenously generated credit supply from the banks in the core that (recklessly) decided to lend to the periphery.[1] In fact, Baldwin and Giavazzi (2015) and De Grauwe (2013) show that after the introduction of the Euro and before the beginning of the Global Financial Crisis, financial institutions in core countries de facto lent to the peripheral so that the Eurozone exhibited a remarkable amount of cross-country financial flows.[2]

There is a growing literature focusing on the link between the major rise in income inequality that characterized the global economy in the last 40 years (Atkinson and Morelli 2011; Milanovic 2010; Piketty and Saez 2013) and the changes in the dynamics of the balance of payments. Kumhof et al. (2012), for example, recently argued that current account deficits in developed economies are often accompanied by a dramatic increase in income inequality. The authors argue that the rise in income disparities accounts for a major part of the large current account deficits in countries such as the United States or the United Kingdom. The authors point to financial liberalization as the transmission mechanism from higher inequality to greater current account deficits: in order to alleviate the living conditions of the lower segments of society that are mostly affected by widening income disparities, policy makers

[1] Note that our interpretation of current account imbalances in the EMU departs from the so called "excess savings view" illustrated by Borio and Disyatat (2011), in that we believe that current account deficits in the periphery were not financed by the excess savings in the core. In a modern monetary economy, savings and financing can be untied, since money creation is endogenous (see e.g. Borio and Disyatat 2011; McLeay et al. 2014; Palley 2002).

[2] "By 2007, Germany was, on net, lending almost $250 billion per year to other EZ nations. [...] Spain was by far the largest net borrower, with its capital inflows reaching $150 billion in the year before the crisis" (Baldwin and Giavazzi 2015, p. 27). The fact that these current account imbalances (both of the core and of the periphery) were with third countries plays a minor role in our analysis, as we will see in Section 2.

rarely draw on the use of fiscal polices that tackle the structural source of inequality. Instead, the predominant approach typically relies on facilitating access to credit markets, that is, financial liberalization in order to prevent a large drop in the consumption of poor and middle class households (Fitoussi and Saraceno 2011; Kumhof et al. 2012; Stockhammer 2015; Cardaci and Saraceno 2018).The main consequence of higher inequality in this financially lax context is that households at the bottom of the income distribution borrow from both domestic and foreign institutions in order to keep up with social consumption norms in the face of stagnant or falling real wages (Belabed et al. 2018; Stockhammer 2015). This eventually leads to a financial account surplus, on the one hand, and rising consumption and current account deficit, on the other hand. Hence, the economy turns into a debt-led growth regime in which household debt accumulation sustains consumption and aggregate demand only temporarily. In fact, the heavy debt burden that spreads in the system jeopardizes economic stability by triggering a series of defaults and a recession (Cardaci 2018; Russo et al. 2016).

Symmetrically, rising income inequality can be associated also with large current account surpluses in poorly financialized economies that do not allow poorer households to access both domestic and foreign credit markets to borrow. The consequence, in this case, is sluggish internal demand and stagnating imports (Kumhof et al. 2012; Stockhammer 2015).

Starting from these considerations, we build a two-country macroeconomic model with an agent-based household sector aimed at showing how the rise of inequality—which, given the purpose of our analysis, is taken as exogenous[3]—leads to the emergence of current account imbalances in a currency union. The model is characterized by imitation and peer effects in household consumption decisions, as well as by the presence of a flexible bank lending behavior that allows us to replicate different kinds of *financialization* scenarios. The model shows that the impact of inequality drives the two countries into different growth patterns: where peer effects in consumption interact with higher credit availability from both the national and the foreign banking sector, rising income inequality leads to the emergence of a debt-led growth. Yet, in the country where social norms determine weaker emulation and a more parsimonious consumption behavior, jointly with net capital outflows, an export-led regime arises. This results in different growth regimes with symmetrical boom-and-bust cycles in the two economies, together with diverging dynamics in the balance of payments. Hence, in our view, our model represents a suitable theoretical framework that might contribute to the study of the current account imbalances in the Eurozone in the presence of rising inequality.

The paper is organized as follows: the rest of this section provides a brief review of some recent macroeconomic models dealing with the impact of rising inequality in an open economy. In Section 2 we introduce our model, providing a description of the sequence of events and the key mechanisms at work; Section 3 discusses our

[3]The introduction of endogenous inequality would certainly enrich the structure of the model. Yet, at this stage, our focus is not on the determinants of inequality but, rather, on its consequences, with a specific attention to household debt dynamics and consumption. The exogenous distribution serves this purpose while lowering the degree of complexity of the model.

main findings regarding model results and the sensitivity analysis. Finally, Section 4 concludes.

1.1 Related macroeconomic models

In the recent years, a growing number of contributions have analyzed the macroeconomic implications of increasing inequality, with a particular focus on economic and financial stability. This topic has received particular attention by the authors in the area of agent-based models (ABM). In general, there seems to be a consensus on the destabilizing effects of rising inequality. For example, Fischer (2012) builds a simple model with heterogeneous households showing that increasing inequality leads to higher financial volatility due to the accumulation of net worth by richer households at the top of the income distribution. Russo et al. (2016) show that consumer credit contributes to increasing aggregate demand for a short period of time. Eventually, greater credit availability exacerbates the tendency of the economic system towards a crisis, due to the decline of the firms' profit rate.

Dosi et al. (2013) analyze the effect of inequality under different monetary and fiscal policies. Their model includes Keynesian mechanisms of demand generation, a Schumpeterian innovation-fuelled process of growth with Minskian credit dynamics. Their results show that more unequal societies suffer from more severe business cycle fluctuations as well as higher unemployment rates. This increases the likelihood of economic crises.

Cardaci (2018) and Cardaci and Saraceno (2018) study the consequence of rising inequality in a macro ABM. The former introduces peer effects in consumption and a housing market that allows for home-equity extraction, while the latter focus on different consumer-credit regimes. Both papers conclude that increasing income inequality leads to the emergence of business fluctuations as a consequence of a massive accumulation of household debt that sustains consumption at the price of greater instability.

All these contributions, however, investigate the impact of inequality and financial deepening in a closed economy. Hence, our model differs in that we are interested in the implications of widening income disparities in the context of an open economy. Our research question is in line with other recent works that, however, do not use an ABM approach. For example, Belabed et al. (2018) build a three-country macroeconomic model in the tradition of Post-Keynesian economics and the Stock-Flow Consistent (SFC) approach spawned by Godley and Lavoie (2007). This open-economy model analyses the interplay of household income inequality and current account imbalances, with the inclusion of imitating behavior in consumption decisions. The model is calibrated by using data for the United States, China and Germany. Their results show that the major increase in household debt and the decrease in the current account in the United States in the years preceding the recent crisis can be explained by the rise in top-end household income inequality.

Another relevant work discussing this topic is the model by Kumhof et al. (2012). The authors build a dynamic stochastic general equilibrium (DSGE) model that investigates the impact of greater inequality in a two-country setting, which shows

that financial liberalization allows households to smooth consumption at the cost of greater debt accumulation and larger current account deficits. Their model features workers and investors, with the former having a declining income share at the expense of investors. Hence, workers obtain loans from domestic and foreign investors that support aggregate demand at the price of an expanding current account deficit.

2 The model

Our work builds upon Cardaci and Saraceno (2018) by extending the macroeconomic agent-based model developed therein to a two-country economy in order to emphasize the role of inequality in determining diverging dynamics of the balance of payments within a currency union. Our modelling strategy relies on the *KISS* (Keep It Simple, Stupid!) principle, in that our assumptions aim at accounting only for the relevant elements of the story we want to describe, thus discarding other features that would certainly enrich the model but would also increase its complexity.

The two countries in our model are denoted by the subscript $c = A, B$, and they have the same number of heterogeneous households ($h = 1, ..., H$), a commercial bank (b), an aggregate productive sector (f), a government (g) and a national central bank (cb). We assume the two economies belong to a currency union and, as such, we include a common supranational central bank (ccb). Thus, in an extremely simplified manner, the framework of our model replicates the general setting of the Eurozone, including a rather stylized version of the Target 2 mechanism.[4]

The essential features of our open economy are as follow:

- Each country has one aggregate productive sector only, which is owned by all households and distributes all its earnings, thus retaining zero profits. Also, there is no investment in capital goods. The supply side of the economy is simplified to a feedback mechanism that mechanically reacts to changes in aggregate demand.
- Heterogeneous households' desired consumption is based on imitative behavior, in line with recent contributions in behavioral economics (Frank et al. 2014).
- Income distribution is based on individual income shares that are constant over time. These are drawn from a Pareto distribution, which is identical in the two countries. This is consistent with empirical evidence suggesting that income is generally distributed according to a power-law distribution and, more specifically, to a Pareto, particularly at top of the income scale (Clementi and Gallegati 2005; Jones 2015).
- Households can allocate consumption between domestic and foreign goods so that international trade occurs in the economy.
- Each country has a representative commercial bank that extends non-collateralized consumption loans to households.

[4]It is worth pointing out that the Target 2 mechanism does not represent the core of our analysis, as our focus is on the implications of rising inequality and financial deepening. For this reason we leave the discussion on the design of the Target 2 mechanism to Appendix A.

The functioning of the economy is therefore identical in the two countries. There is only one exception: we assume that the banking sector of *B* is willing to provide credit both at home and abroad, whereas the commercial bank in *A* only lends to the domestic households. Such feature is meant to design a theoretical framework that resembles the main dynamics that took place in the Eurozone (Baldwin and Giavazzi 2015), where country A acts as the periphery of the Eurozone, while B represents the core. Indeed, the driving force of the dynamics described in the following pages is given by the capital flows from countries/regions with financial repression, or higher savings rate, towards countries/regions with higher propensity to borrow. This matches the observed pattern of EMU countries prior to the crisis. While the initial interpretation of the crisis that played a role in determining the turn towards austerity blamed mostly fiscal profligacy (see e.g. Sinn 2014), the subsequent consensus view mentioned above (Baldwin and Giavazzi 2015) correctly puts back capital flows at the center of the stage. Consistently with this "consensus", we choose to make the assumption that our monetary union is a closed economy. In fact, even though it is true that both the trade surplus of core countries and the trade deficit of peripheral countries were with third parties (mostly East Asia, as noted in the detailed analysis by Chen et al. 2013), the EMU as a whole exhibited a broadly balanced current account in the run up to the crisis.[5]

Our model has a sequential structure. Hence, the sequence of events in each country is as follows:

1. **Production.** The firm produces homogenous perishable goods using domestic labor as the only input.
2. **Income distribution.** The firm retains no profit thus distributing all its earnings as wages to households in the same country. The commercial bank distributes a fraction of its profits (if any) to domestic households. This distribution process is based on the above-mentioned individual income shares.
3. **Government revenues.** Households pay taxes on income based on an exogenous progressive taxation system. Collected taxes add up to the government deposit account held at the national central bank.[6]
4. **Desired consumption and financial assessment.** Each household computes its desired consumption based on imitative behavior. Households can be savers if internal resources are higher than desired consumption and due debt—thus holding savings in the form of zero interest rate deposits—or borrowers, otherwise. Note that borrowers can obtain loans in order to finance desired consumption

[5] As a robustness check, we have experimented the introduction of a stylized rest of the world in order to replicate actual EMU countries' trade patterns. The qualitative results of the model are unchanged. See on-line Appendix B.

[6] Our model also allows for the presence of public debt since the government can supply bonds bought by households with positive savings. However, the amount of government deposits collected through taxation represents a buffer that is always enough to finance public expenditure in all the simulations. Hence, de facto, the bond market never opens. For this reason, in order to simplify the description of our model structure and results, bond supply and demand are omitted (and greyed in Fig. 1). The complete model is available upon request.

as well as to rollover their debt, that is, to pay back the debt from the previous period.

5. **Policy targets.** Policy institutions decide their targets: the supranational central bank sets the policy interest rate while the national government sets its desired public expenditure. Both decisions follow a counter-cyclical rule based on the value of the "demand gap" in the previous period.
6. **First pay-back-phase (PBP).** Households pay back the loan (principal plus interest) from the previous period. Borrowers who lack the internal resources to meet their debt obligations enter the credit market to roll over their debt. Afterwards, they will go through a second PBP in order to repay the loan from the previous period.
7. **Credit market.** The commercial bank sets its total available credit supply as a function of its equity and total credit demand. The bank ranks households in ascending order based on their financial soundness. Loan applications, computed by households at step 4, are satisfied until the bank runs out of total credit supply. This implies that credit-rationing may occur in the market: more financially fragile households may not obtain any loans from the commercial bank. Credit-rationed households will not be able to finance their desired consumption entirely and to roll over their debt. Hence, they will go bankrupt and as such they will not be allowed to apply for a new loan for a number of periods. The second PBP then opens: households that successfully obtained a new loan now pay back the loan from the previous period.
8. **Goods market.** Based on the ratio between domestic and foreign prices, households allocate their demand between the two countries. For simplicity, we assume that the national government only buys domestic goods, based on its desired level of expenditure. If the output produced by the firm at the beginning of each period is lower than demand, rationing takes place. By contrast, in case of excess supply, we assume the firm gets rid of the unsold amount of its perishable goods at no cost.
9. **Macroeconomic closure.** Finally, all the macroeconomic variables (e.g. GDP, public and private debt, balance of payments) are updated.

Figure 1 provides a graphical representation of all the transaction flows in our economy, as described by the sequence reported above.

2.1 Households

Household disposable income is the sum of wages ($w_{t,h,c}$) and profits from the commercial bank of the country ($\pi_{t,h,c}$), net of taxes ($T_{t,h,c}$).

$$yd_{t,h,c} = w_{t,h,c} + \pi_{t,h,c} - T_{t,h,c} \tag{1}$$

Wages are distributed by the firm—that retains no profits—at the beginning of each period t. In particular, the firm allocates the entire amount of revenues ($D_{t-1,F}$) to all households based on constant individual income shares that are drawn from a Pareto distribution (see Fig. 2 in Section 3). Additionally, we assume that the bank

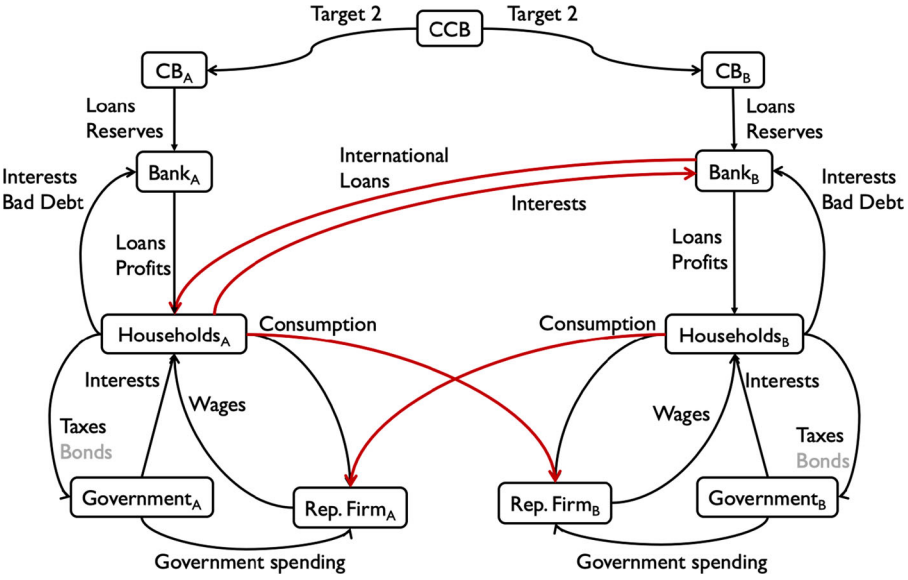

Fig. 1 Transaction flows in our economy

distributes a fixed share (δ) of its profits (if any) to the household sector based on the same exogenous individual income shares.

Consumption behavior in our model is based on peer effects and imitation, in line with the empirical literature on behavioral economics showing that households tend to learn consumption patterns from their social reference group, thereby comparing their living standard with that of their neighbors or richer households (Fazzari and Cynamon 2013; Bertrand and Morse 2016). Our formulation is very similar to the Expenditure Cascades hypothesis introduced by Frank et al. (2014) and relies on upward-looking comparisons.

$$C^d_{t,h,c} = k\, yd_{t,h,c} + a_c\, C_{t-1,j,c} \tag{2}$$

$$a_c = a - a_p \tag{3}$$

Equation 2 describes h's desired consumption as a function of disposable income ($yd_{t,h}$) and the actual previous-period consumption of j, who is the household ranking just above h in the income scale (i.e. $j = h + 1$, based on ascending disposable income ranking).[7] k is the propensity to consume out of disposable income and it is unrelated to income level or rank, while a_c is the country-specific effective rate of imitation, a sensitivity measure such that $0 \leq a_c \leq 1$. When $a_c = 1$, the impact of j on h's consumption is maximum; whereas when $a_c = 0$, there is no expenditure

[7] In this setting, the richest household—the one at the very top of the income distribution—has no richer peer to imitate. As such, we assume that its desired consumption is a exclusively function of its disposable income, with no imitation component.

cascade. Equation 3 shows the calculation of the imitation sensitivity. This follows the approach introduced by Belabed et al. (2018) who assume that all individuals are associated with a "natural rate of imitation", a, which is grounded in the the quest for social status and upward-looking comparisons and it is unrelated to country-specific factors. However, the effective rate of imitation, a_c, is computed by subtracting a penalty rate, a_p, from the natural rate. As argued by Belabed et al. (2018), the penalty rate reflects country-specific elements—such as the provision of public goods, the level of social protection expenditure relative to GDP, the amount of public spending in health, and so on—which lower the extent to which households seek to emulate their richer peers.

Eventually, households assess their own financial position: positive savings take the form of zero interest rate deposits held at the commercial bank of the same country. By contrast, if the sum of desired consumption and the repayment on home and foreign loans from the previous period ($RS^{c}_{t-1,h,c} + RS^{-c}_{t-1,h,c}$) is greater than the sum of disposable income and past deposits, households have a positive demand for loans ($L^{d}_{t,h}$).[8]

$$L^{d}_{t,h,c} = max\{0, C^{d}_{t,h,c} + RS_{t-1,h,c} + RS^{-c}_{t-1,h,c} - yd_{t,h,c} - D_{t-1,h,c}\} \tag{4}$$

Notice that borrowers in A are assumed to have a home bias, such that they first apply for a loan to the banking sector in their country. Hence, only in case of rationing in the domestic credit market will they send their loan applications abroad to the commercial bank in B.

Additionally, the actual individual demand for consumption is defined as the minimum between desired consumption and household deposits, that is $min(C^{d}_{t,h,c}, D_{t,h,c})$. Indeed, if h is credit-rationed it is not able to finance its desired consumption in full. In this case, demand for consumption is constrained by the amount of household deposit.

Eventually households allocate individual demand at home and abroad ($DC^{c}_{t,h,c}$ and $DC^{-c}_{t,h,c}$ respectively), based on the ratio between domestic and foreign prices $\left(P_{t,c}/P_{t,-c}\right)$ multiplied by a sensitivity parameter (γ) (Eqs. 5 and 6).[9]

$$DC^{c}_{t,h,c} = \left(1 - \gamma \frac{P_{t,c}}{P_{t,-c}}\right) min(C^{d}_{t,h,c}, D_{t,h,c}) \tag{5}$$

$$DC^{-c}_{t,h,c} = \left(\gamma \frac{P_{t,c}}{P_{t,-c}}\right) min(C^{d}_{t,h,c}, D_{t,h,c}) \tag{6}$$

Finally, each household's actual consumption spending is defined as $C_{t,h,c} \leq min(C^{d}_{t,h,c}, D_{t,h,c})$. Note that $C_{t,h,c}$ may in fact be lower than individual demand because of possible rationing in the goods market. Indeed, if production is lower than aggregate demand, we assume that all households will be equally rationed by a fraction (defined as the ratio between production and demand, $Q_{t,c}/AD_{t,c}$)

[8]The repayment schedule on both home and foreign loans is defined in Section 2.4.

[9]Notice that γ is a positive parameter such that $1 - \gamma \frac{P_{t,c}}{P_{t,-c}} \geq 0$ and $\gamma \frac{P_{t,c}}{P_{t,-c}} \geq 0$, that is individual demand (at home or abroad) cannot be negative.

2.2 Firms

In order to keep the structure of the model as simple as possible, we have introduced a rather simplified aggregate productive sector in each country, with a representative firm owned by the domestic population. Each firm distributes wages to the household sector based upon the already mentioned individual Pareto shares.

The two firms also set total production ($Q_{t,c}$) and prices ($P_{t,c}$) by reacting to disequilibria in the goods market, as described by Eqs. 7 and 8. That is, $Q_{t,c}$ and $P_{t,c}$ depend on their previous period level and on a sensitivity parameter ($\phi_{Q,c}$ and $\phi_{P,c}$ respectively) multiplied by the demand gap ($gap_{t-1,c}$):[10]

$$Q_{t,c} = Q_{t-1,c}\left(1 + \phi_{Q,c} \cdot gap_{t-1,c}\right) \tag{7}$$

$$P_{t,c} = P_{t-1,c}\left(1 + \phi_{P,c} \cdot gap_{t-1,c}\right) \tag{8}$$

The demand gap measures the real term excess demand or supply and is defined as the difference between aggregate demand ($AD_{t,c}$) and production, divided by production itself (9).

$$gap_{t,c} = \frac{AD_{t,c} - Q_{t,c}}{Q_{t,c}} \tag{9}$$

Aggregate demand (10) is the sum of domestic demand for consumption, government spending ($G^d_{t,c}$, defined in the next section) and exports, which are computed as the sum of individual demand for goods by foreign households.

$$AD_{t,c} = \sum_{h \in c} DC^c_{t,h,c} + G^d_{t,c} + \sum_{h \in -c} DC^c_{t,h,-c} \tag{10}$$

2.3 Government

The government in each country sets the ratio of desired public spending over GDP at the beginning of each period, based on a counter-cyclical rule. In particular, the initial value of the ratio $\left(\overline{\frac{G^d}{GDP}}\right)$ changes based on its sensitivity (ϕ_G) to the demand gap in the previous period.

$$\frac{G^d_{t,c}}{GDP_{t-1,c}} = \left(\overline{\frac{G^d_c}{GDP_c}} - \phi_G \; gap_{t-1,c}\right) \tag{11}$$

The government also collects taxes via a progressive tax system. The total amount of taxes collected in country c amounts to $TG_c = \sum_{h=1}^{H} T_{t,h,c}$.

[10] Notice that, if we had a fully fledged modelization of the supply side of the economy, prices would not only depend on excess demand, but also on supply-side factors such as labor costs. Our choice to focus on the demand side yields a very simple price dynamics equation. We only allow for some *ad hoc* response of productive capacity (potential output) to excess demand, captured by the parameter $\phi_{Q,c}$.

2.4 Banks

On the demand side, the credit market features households that apply for a loan in order to finance their desired consumption or to pay back the loan from the previous period. Additionally, some borrowers in financial distress can do both.

The formation of credit supply follows the mechanism described in Cardaci and Saraceno (2018): the commercial bank sets the maximum allowable credit supply ($LS_{t,c}$) as the minimum between a multiple of its equity ($NWB_{t,c}$) and a fraction ($v_{t,c}$) of total credit demand ($LD_{t,c}$).

$$LS_{t,c} = min\left[\frac{NWB_{t,c}}{\beta}; v_{t,c}\ LD_{t,c}\right] \tag{12}$$

A few remarks are necessary. First of all, notice that β identifies the capital requirement coefficient so that, in line with the regulatory framework introduced by Basel III (Basel Committee on Banking Supervision 2011), the commercial bank has to comply with a prudential regulation.

Second, as already mentioned, bank B is allowed to lend internationally, so that the total credit demand (i.e. the sum of individual demand for loans by households) in B is equal to $LD_{t,B} = \sum_{h\in A} L^d_{t,h,A} + \sum_{h\in B} L^d_{t,h,B}$, while $LD_{t,A} = \sum_{h\in A} L^d_{t,h,A}$.

Finally, also note that $v_{t,c} \in [v_{min}, v_{max}]$, that is, each commercial bank endogenously changes the value of $v_{t,c}$ within two asymptotes (v_{min} and v_{max}) the values of which are exogenously set in the initialization phase of the model (Conditions 13 and 14). In particular, $v_{t,c}$, which can be interpreted as the willingness to lend of the banking system, evolves as a function of country-level risk that is proxied by the household debt-to-GDP ratio ($X_{t,c}$) in the previous period. The evolution depends on a sensitivity threshold (χ), so that if the ratio is higher (lower) than the threshold, the commercial bank decreases (increases) $v_{t,c}$.

$$v_{t,c} = \begin{cases} v_{t-1,c} + \phi_v(v_{min} - v_{t-1,c}) & \text{if } X_{t,c} > \chi \quad (13) \\ v_{t-1,c} + \phi_v(v_{max} - v_{t-1,c}) & \text{if } X_{t,c} \leq \chi \quad (14) \end{cases}$$

Notice that the two commercial banks are assumed to have the same sensitivity to country-level risk. However, while the bank in A is sensitive only to the household debt in A, the bank in B focuses on the mean of the debt ratio in the two countries, as its credit supply targets households of both A and B.

The bank in each country ranks households in ascending order based on a measure of their financial soundness—namely, the total debt service ratio (TDS), defined as the ratio between household repayment schedule and disposable income—and supplies credit by matching each individual demand until it exhausts its credit supply. As already mentioned, households in A apply for a loan to the commercial bank of the same country. Once credit availability falls down to zero, households eventually send their loan applications to the foreign bank in B. This circumstance takes place whenever $v_{t,A} < 1$: in this case, less financially sound applicants, that is, households with a higher TDS, will be rationed on the domestic credit market. As a result, they apply for a loan at the commercial bank in B. If $v_{t,B} < 1$, households will be credit rationed also in B and, as a consequence, they will not be able to pay back their

previous loan and, in some cases, finance their desired consumption entirely. Therefore, they will go bankrupt, thus being excluded from the credit market for a limited number of periods (identified by the parameter $freeze$.).

We assume each loan is a one-period debt contract corresponding to a repayment schedule defined as $RS_{t,h,c} = L_{t,h,c}(1 + r^L_{t,h,c})$, to be paid back entirely in the following period. In line with other contributions (e.g. Cardaci 2018; Russo et al. 2016), the interest rate on loans is made of three components (15).

$$r^L_{t,h,c} = \overline{r_t} + \widehat{r_{t,c}} + r_{t,h,c} \tag{15}$$

$\widehat{r_t}$ is a system-specific component that reflects the sensitivity (ρ) of the bank to country-level risk (i.e. the household debt-to-GDP ratio) of the economy, so that $\widehat{r_{t,A}} = \rho \frac{debt_{t-1,A}}{GDP_{t-1,A}}$ and $\widehat{r_{t,B}} = \rho \overline{\frac{debt_{t-1}}{GDP_{t-1}}}$. Eventually, $r_{t,h,c}$ is a household-specific component equal to $\mu\, TDS_{t,h,c}$, where μ is the bank sensitivity to the household total debt service ratio. This element reflects the evidence that lenders tend to ask a higher premium on external finance when borrowers' financial conditions worsen (Bernanke et al. 1999; Battiston et al. 2012). Finally, $\overline{r_t}$ is the policy rate set by the supranational central bank at the beginning of each period as a reaction (ϕ_{CB}) to changes in the average demand gap of the economy ($gap_{t-1,AB}$).[11]

$$\overline{r}_t = \overline{r}_{t-1} + \phi_{CB}\ gap_{t-1,AB} \tag{16}$$

After completing all the transactions in the credit market, all borrowers who have rolled over their debt can now pay back their outstanding loan from the previous period, $RS_{t-1,h,c}$.

Also notice that, in case of negative net worth, each commercial bank is bailed out by the national central bank of the corresponding country via a transfer of assets.[12]

2.5 Balance of payments

Equation 17 defines the current account of country c as the difference between exports ($X_{t,c}$) and imports ($M_{t,c}$), where $X_{t,c} = DC^c_{t,h,-c}$ and $M_{t,c} = DC^{-c}_{t,h,c}$.

$$CA_{t,c} = X_{t,c} - M_{t,c} \tag{17}$$

Since we assume that the bank in B can supply loans to households in A, while bank A cannot lend internationally, we provide the trivial definition of the financial account of A: this is described in Eq. 18 as the value of loans from bank B to house-

[11] Notice that as we focus on demand fluctuations, quantities and prices move in the same direction, so that the supranational central bank is implicitly targeting inflation as well.

[12] Note that central banks usually lend secured to commercial banks, thereby taking collateral to protect against the possibility of loss due to credit and market risk (Rule 2015). However, as in Cardaci and Saraceno (2018), our simplified framework implies that bailout operations do not require any collateral or reimbursement so that the national central bank does not receive any asset in exchange for the transfer of reserves to the commercial bank. This simplification allows us to rule out banking crises in our model, and to focus exclusively on household debt as the trigger of financial instability.

holds A ($L^A_{t,B}$), net of the amount paid back by borrowers ($PB^A_{t,B}$). The financial account of B will be equal in absolute value but of opposite sign.

$$FA_{t,A} = L^A_{t,B} - PB^A_{t,B} \tag{18}$$

Finally, the difference between the current account and the financial account corresponds to change in net Target 2 position of the country.[13]

3 Model results

We investigate the micro and macro properties of the model by means of computer simulations. To this purpose, we analyze three main scenarios and a set of policy experiments. In particular, we replicate the following:

- Baseline scenario (BS): individual income shares remain constant through the simulations;
- Rising-inequality scenario (RS): income shares exogenously change over time in both countries in order to simulate increasing income disparities;
- Credit-inequality scenario (CS): the maximum propensity to lend of the banking sector increases in both countries together with the rise of inequality as in RS.

The policy experiments include fiscal policies that are simulated with and without coordination between the two countries. In particular, we replicate:

- a *Keynesian* policy consisting in a bolder reaction of desired government spending to the demand gap in RS;
- a *Progressive* policy implemented through changes in the marginal tax rates towards a more progressive tax system in RS and CS.

Additionally, we test the ability of the model to replicate some key micro and macro empirical regularities by looking at cross-correlations and other relevant statistics.[14] In doing so, we also exploit one of the main advantages of the agent-based approach, which consists in the analysis of the distribution of key economic variables among heterogeneous agents. This is particularly useful in order to shed some light on the microeconomic dynamics behind changes in the aggregate patterns. Finally, we perform both univariate and multivariate sensitivity analysis, thus testing the robustness of model results to changes in parameter values.

The model is calibrated as reported in Table 1. When possible, parameter values are the same as in Cardaci and Saraceno (2018) or they are retrieved from the literature, such as for the value of the capital requirement coefficient that is in line with

[13] See Appendix A for more details on the design of the Target 2 mechanism in our model. In general, outside of a currency union, the difference between current account and financial account would be matched by a variation in reserves.

[14] Notice that our modelling framework does not include many real world features, such as investment in capital goods, employment dynamics in the labor market, innovation and progress. As such, we do not carry out a full-scale empirical validation. Rather, we investigate whether our simple framework captures some essential facts about inequality and credit.

Table 1 Model calibration

Parameter		Value
T	Number of periods	4000
H	Number of households in each country	200
k	Propensity to consume for $h = 1 : H - 1$	0.8
k_H	Propensity to consume for $h = H$	0.6
a_A	Sensitivity parameter to j's past consumption in A	0.57
a_B	Sensitivity parameter to j's past consumption in B	0.21
δ	Household share of bank profits	0.2
γ	Sensitivity parameter to relative prices	0.6
v_{max}	Maximum propensity to lend	0.3
v_{min}	Minimum propensity to lend	0.1
ρ	Bank sensitivity to country-level risk	0.005
μ	Bank sensitivity to TDS	0.005
β	Capital requirement coefficient	0.08
$\phi_Q A$	Output sensitivity to output gap in A	0.01
$\phi_Q B$	Output sensitivity to output gap in B	0.01
$\phi_P A$	Price sensitivity to output gap	0.1
$\phi_P B$	Price sensitivity to output gap	0.01
ϕ_G	Government sensitivity to output gap	0.05
ϕ_{CB}	Central bank sensitivity to output gap	0.05
ϕ_v	Speed of adjustment for credit supply	0.05
$freeze$	Number of "freezing" periods for bankrupt borrowers	5
χ	Bank sensitivity threshold	0.5

Basel Committee on Banking Supervision (2011). Exceptions include a_A and a_B: the calculation of these two values follows a procedure similar to the one adopted by Belabed et al. (2018). First, for each country we build a vector the elements of which correspond to some key variables that identify the importance of socio-economic factors (such as the long term unemployment rate, the employment by job tenure interval, health expenditure as a percentage of GDP, etc.) that mitigate the impact of social norms, in line with the approach discussed in Section 2.1. We collect the data for each variable from different datasets with reference to Germany and Greece, which are used as proxies for the core and the periphery of the Eurozone, respectively. Eventually, we compute the Euclidean norm of the two vectors to calculate the penalty rate for each of the two countries. These are equal to 0.64 for Germany (i.e. country B) and 0.28 for Greece (country A). Finally, the effective rate of imitation is obtained by subtracting such penalty rates from the natural rate, which is equal to 0.85. Hence, the effective rate of imitation equals 0.21 for B (Germany) and 0.57 for A (Greece).[15]

[15] The value of the natural rate of imitation is taken from Belabed et al. (2018). Also notice that the penalty rate for B falls within the range $[0.18 - 0.35]$ empirically identified by Drechsel-Grau and Schmid (2014) as the effective rate of imitation for Germany.

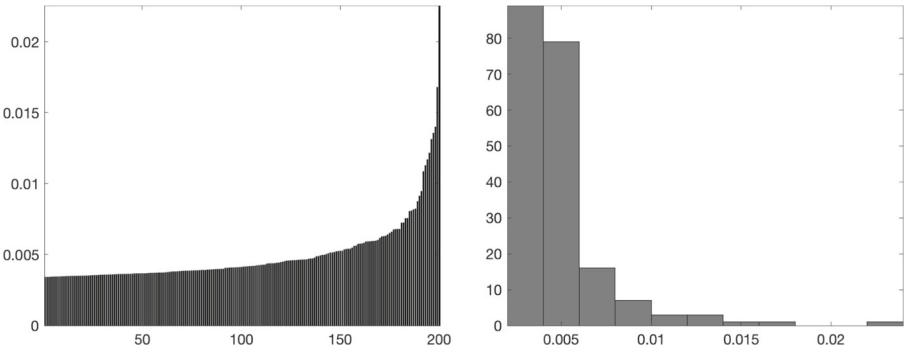

Fig. 2 Individual income shares: bar chart (left) and histogram (right)

In all the scenarios, the model starts with the same income distribution (Fig. 2), which is designed to provide an income share of 29.68% for the top 10% in the two countries, a value in line with the 1970 mean for the countries reported in Cardaci and Saraceno (2018).

Simulations are replicated by means of Monte Carlo (MC) analysis, selecting a different random seed at each run, in line with the prevailing approach in the macroeconomic agent-based literature (Cardaci 2018; Russo et al. 2016; Delli Gatti et al. 2011). In particular, we perform 100 MC repetitions for each scenario and we compute the cross-simulation mean. Hence, each of the graphs reported in this section features the average of the time series across the 100 MC repetitions for each of the three scenarios. Also notice that we drop the first 200 periods, the so-called *transients*, that is, the stabilization phase of the model. Graphs only show the remaining

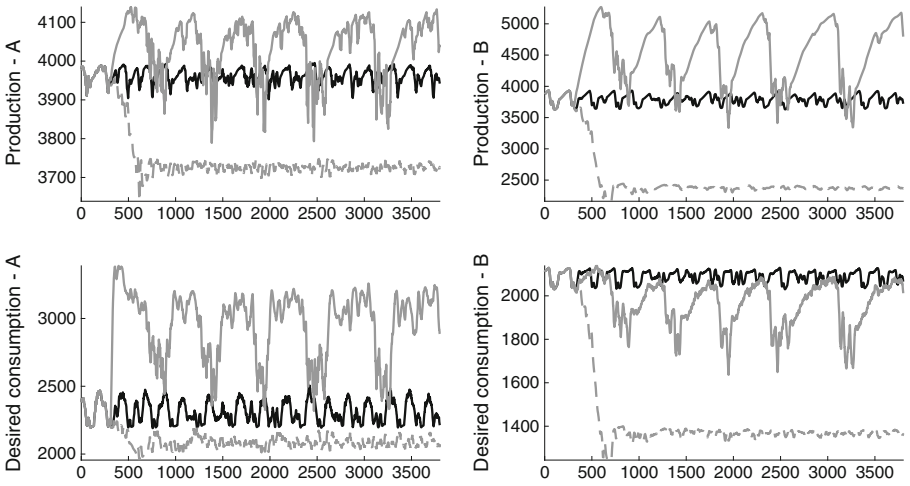

Fig. 3 Top: real GDP in A (left) and B (right) in BS (black), RS (dashed grey) and CS (grey). Bottom: aggregate desired consumption in A (left) and B (right) in BS (black), RS (dashed grey) and CS (grey)

3800 periods for this reason. Finally, we also represent the key data series as simple moving averages so as to smooth the cyclical fluctuations.

3.1 Scenario analysis

The individual income shares remain constant in BS, while RS and CS replicate the following permanent shocks to the distribution of income:

– **RS:** the income share of the top 10% increases gradually (from period 301 to period 600) from 29.68% to 36.84% in both countries, a value that corresponds to the 2007 mean for the countries reported in Cardaci and Saraceno (2018).
– **CS:** in addition to the same shock as in RS, in CS v_{max} rises from 0.3 to 0.65 in period 401.

In general, the baseline scenario (BS) is stable, as all the key time series (in particular GDP and aggregate desired consumption) in both countries show minor oscillations along a rather stationary trend (Figs. 3 and 4). Stability is also found at the individual level by looking, in particular, at the distribution of individual desired consumption over time. Figure 5 shows that this remains roughly stable over time for any household in both A and B. As expected, the same graph also shows that desired consumption varies when moving from the bottom to the top of the income distribution.

Also notice the rather different shape of the mesh graphs for the two countries: this shows that desired consumption is more unequally distributed in A, rather than in B. This is due to the presence of stronger peer effects in A, which, due to the Pareto distribution of income, result in a more uneven distribution of desired consumption. This is confirmed also by the ratio between desired consumption at the richest 20% and at the poorest 20% of the population, which equals 1.76 in A and 1.54 in B, as well as by the Gini coefficient for desired consumption, which is equal (on average) to 0.13 in A and 0.09 in B (Table 2).

Eventually, when inequality rises but credit conditions are unchanged, the economy performs rather badly in both A and B compared to the baseline: production falls and it remains persistently below its baseline level. The dynamics of the balance of payments shows a minor increase in the current account of A. On the contrary, the

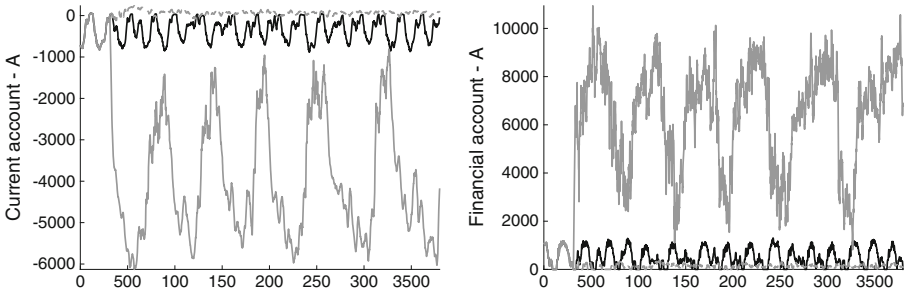

Fig. 4 Current Account (left) and Financial Account (right) in A in BS (black), RS (dashed grey) and CS (grey)

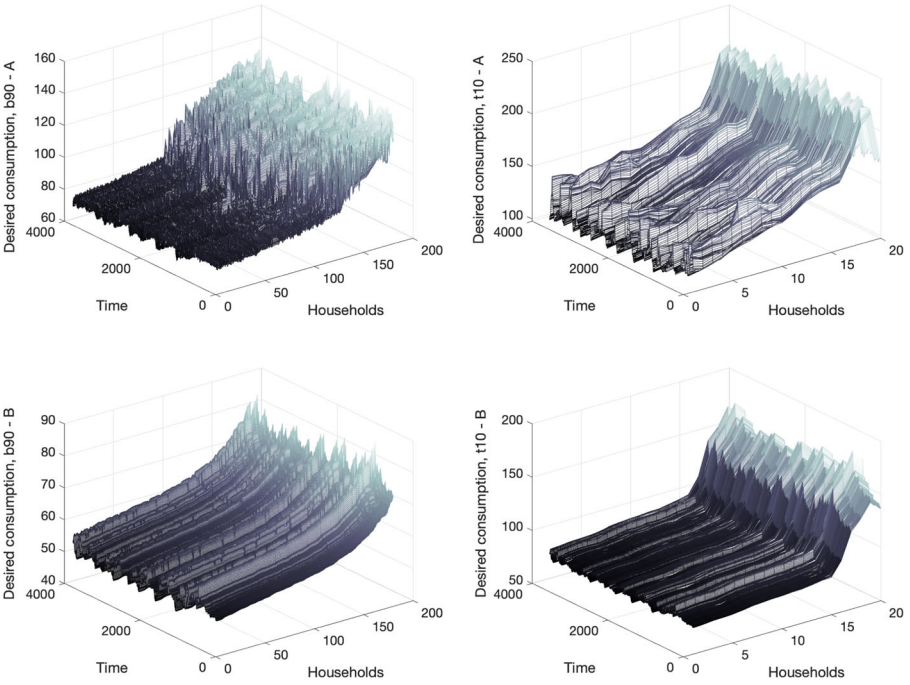

Fig. 5 Distribution of individual desired consumption over time at the bottom 90% of the income distribution (left) and at the top 10% (right) in country A (top) and B (bottom) in BS

rise of inequality in CS results in a much larger current account deficit for A. Moreover, the time series of GDP show the presence of major boom-and-bust dynamics in both economies, with bigger magnitude in B, as confirmed by Table 3.

Table 2 Different measures of (actual and desired) consumption inequality in A and B in the three scenarios

Variable	Scenario	Average 20/20 ratio		Average Gini coefficient	
		A	B	A	B
Individual consumption	BS	2.03	1.53	0.25	0.09
	RS	4.57	3.29	0.39	0.27
	CS	5.84	3.38	0.41	0.29
Individual desired consumption	BS	1.76	1.54	0.13	0.09
	RS	3.95	3.35	0.31	0.27
	CS	4.71	3.48	0.35	0.29
Desired consumption ratio	BS	1.14	0.95	0.09	0.08
	RS	1.21	1.01	0.12	0.09
	CS	1.33	1.11	0.15	0.11

Table 3 Key statistics for selected variables in the three scenarios

Variable	Scenario	Mean		Coefficient of variation	
		A	B	A	B
GDP	BS	3961.20	3789.65	0.0045	0.0194
	RS	3737.21	2445.47	0.0125	0.1131
	CS	4038.20	4535.30	0.0178	0.1037
Aggregate desired consumption	BS	10994.84	10050.56	0.0473	0.0173
	RS	5715.05	4451.63	0.1892	0.2737
	CS	18051.39	11571.48	0.1616	0.1187
Household debt	BS	1576.97	960.11	0.2242	0.3878
	RS	681.078	680.93	0.2063	0.2282
	CS	13873.14	3832.38	0.3280	0.6714
Current account	BS	−332.42	332.42	−0.7659	0.7659
	RS	65.06	−65.06	0.8416	−0.8416
	CS	−4008.95	4008.95	−0.3491	0.3491
Domestic consumption (% of GDP)	BS	23.77	21.38	0.0210	0.0053
	RS	26.60	17.63	0.0310	0.0505
	CS	28.53	17.51	0.0414	0.0277
Exports (% of GDP)	BS	32.34	35.24	0.0138	0.0259
	RS	29.58	28.59	0.0252	0.0293
	CS	27.71	40.20	0.0426	0.0586

Let us now provide a detailed discussion on the impact of growing income inequality with and without changes in the level of financial deepening in the economy.

3.1.1 RS scenario

The impact of rising inequality on the economies of the two countries is roughly similar, in that higher income disparities with unchanged credit conditions eventually lead to falling GDP and aggregate desired consumption (Fig. 3). The negative performance of the two countries is explained by the increase of income disparities in the presence of peer effects without any increase in the willingness to lend of the banking sector or any change in the capital requirement coefficient. Indeed, desired consumption rises for a few periods after the inequality shock as a consequence of growing expenditure cascades in both economies, even though the imitation effect is larger in A. This is consistent with the empirical evidence by Bertrand and Morse (2016), who show that systematic changes in the behavior of the non-rich individuals that result in greater spending, after an increase of top income levels, can be linked to social comparison. However, since the level of financial deepening has not been modified, households at the bottom of the income distribution do not find the necessary resources to finance their higher desired consumption so that greater inequality

eventually triggers the fall in consumption and GDP in both economies. This result is also in line with the closed economy version of this model (Cardaci and Saraceno 2018) and, in general, it follows the stream of literature that builds on Kaldor (1955) to show that changes in the (functional) distribution of income lead to a contraction of aggregate demand (Brown 2004; Carvalho and Rezai 2016; Fitoussi and Saraceno 2011; Onaran and Galanis 2013).

It is also interesting to analyze the distribution of desired consumption following the increase in inequality in this scenario. This allows in fact to have a better understanding of the mechanisms driving model dynamics. Figure 6 shows that this variable is, on average, much higher for households at the top of the income distribution, while it is lower for those at the bottom. Table 2 shows that both the average 20/20 ratio and the Gini coefficient increase in RS compared to BS in both A and B, thus indicating that rising income inequality also results in greater consumption inequality. Hence, our finding supports the recent empirical result that consumption inequality tracks income inequality (Aguiar and Bils 2015; Attanasio et al. 2014).

As in Cardaci (2018), it is possible to spotlight the economic pressure that rising inequality under peer effects has on poorer households and their consumption decisions, by analyzing the change in the distribution of the desired consumption ratio. This is defined as the ratio between individual desired consumption and disposable

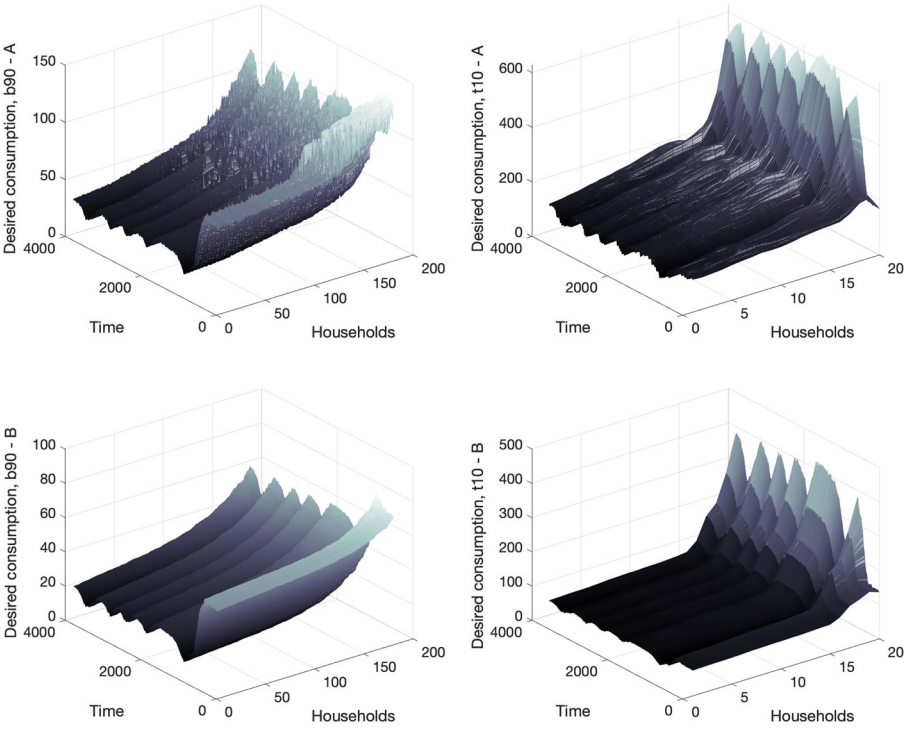

Fig. 6 Distribution of individual desired consumption over time at the bottom 90% of the income distribution (left) and at the top 10% (right) in country A (top) and B (bottom) in RS

income. Our analysis shows that such measure is distributed unevenly in all three scenarios. This is due to the inequality in desired consumption: In fact, peer effects are stronger (relative to income) at the bottom of the distribution, thus causing the desired consumption ratio to be distributed unequally (even more so than disposable income). In addition, when inequality rises, the desired consumption ratio increases for all households in both countries, even though it is slightly more unevenly distributed in RS compared to BS. Indeed, Table 2 reports that the average 20/20 ratio increases from 1.14 in BS to 1.21 in RS in A, and from 0.95 to 1.01 in B. Also the average Gini coefficient increases in RS compared to BS (from 0.09 to 0.12 in A; from 0.08 to 0.09 in B). This suggests that rising inequality in a poorly financialized context worsens the performance of the economy, as the increase in desired consumption by richer individuals does not compensate the fall by poorer households. As such, the economy enters a recession in both countries.

As already mentioned, the recession in RS is accompanied by a minor increase in the current account of A (Fig. 4), which is the consequence of a reduction in imports (-29.57% in absolute real terms) that exceeds the reduction in exports (-13.69% in absolute real terms). Indeed, since the relative price of goods in A with respect to B falls from 0.98 to 0.85, households in A increase the share of demand for goods allocated at home.

3.1.2 CS scenario

In this scenario, higher income inequality under peer effects and a greater level of financialization lead to an increase in desired consumption in both countries (Fig. 3). Households in country A, which have stronger imitation in consumption, borrow extensively from the foreign banking sector in order to finance consumption of both domestic and foreign goods. The consequence is the emergence of a current account deficit and a financial account surplus for A, with symmetrically different dynamics for B (Fig. 4). Eventually, the massive accumulation of household debt implies a greater number of household defaults and an increase in the perception of risk by the foreign banking sector, which lowers the credit supply thus contributing to a contraction of consumption spending. Hence, the economies experience a financial account reversal and a recession. Therefore, this scenario is characterized by the presence of endogenous business cycle fluctuations along a constant trend (Fig. 3).

Our results seem to go against the stream of literature that was prevailing in the period before the financial crisis in the United States, which welcomed the greater and easier access to credit as an efficient means to insure against income fluctuations (Krueger and Perri 2006). Indeed, in our model, higher availability of credit in a context of rising inequality comes at the price of greater instability in the overall economy and the emergence of external imbalances between the two countries.

Let us provide a detailed analysis of the three major phases of each business cycle, corresponding to the expansion of the economy, the turning point and, in the end, the recession.

Economic expansion. Growing income disparities impact on desired consumption that rises dramatically in both countries (Fig. 3). Also in CS, it is possible to evaluate the distribution of desired consumption at the individual level (Fig. 7). Table 2

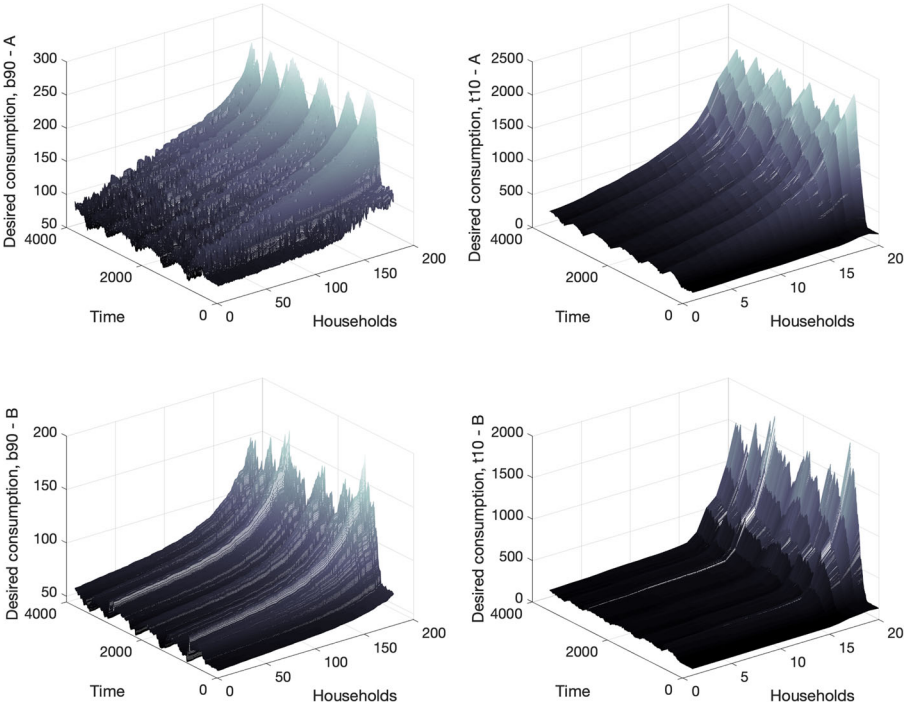

Fig. 7 Distribution of individual desired consumption over time at the bottom 90% of the income distribution (left) and at the top 10% (right) in country A (top) and B (bottom) in CS

shows that both the average 20/20 ratio and the average Gini coefficient for actual and desired consumption in country A and B are larger in CS compared to the other two scenarios. Most notably, the inequality of the desired consumption ratio in both countries increases in CS: the 20/20 ratio rises to 1.33 in A and 1.11 in B, while the Gini coefficient reaches 0.15 in A and 0.11 in B. In line with Cardaci (2018), these results suggest that households at the bottom of the income distribution experience a greater need for loans to finance higher desired consumption in order to catch-up with households that rank above them in the income scale. Indeed, Fig. 8 shows that aggregate desired consumption is positively correlated with aggregate consumption loans in both A and B (particularly at lag 0, 1 and 2). Hence, rising inequality results in greater expenditure cascades that trigger higher credit demand in the present and in future periods.

Notice that, in the initial phase, credit demand rises only in A (Fig. 9) due to stronger peer effects in consumption compared to country B. Hence, a greater number of people at the bottom of the distribution in country A need external finance to pay for the increased desired consumption.

The most striking implication is that household debt skyrockets in A, so that the ratio of household debt relative to GDP exceeds the sensitivity threshold set by the banking sector in A (Fig. 9). Hence, bank A cuts the fraction of credit demand that it is willing to supply: $v_{t,A}$ falls, as shown in Fig. 10. Consequently, a rising fraction of

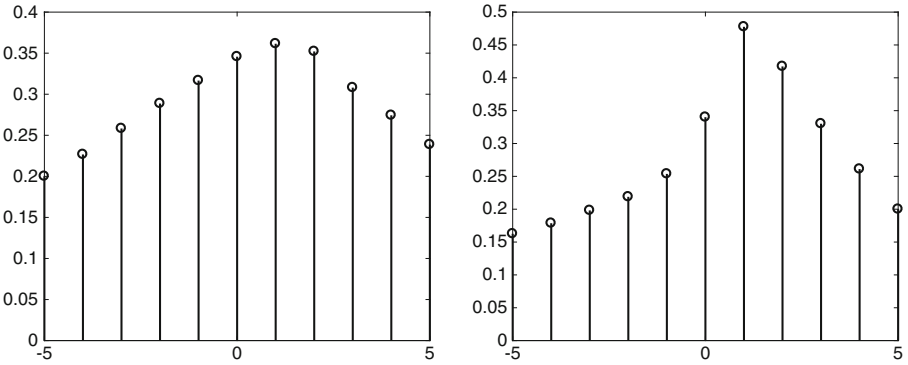

Fig. 8 Cross-correlation between aggregate desired consumption and demand for consumption loans in A (left) and B (right) in CS

households in A become credit-rationed at home, thereby sending their loan applications abroad to the commercial bank in B. This is confirmed in the bottom graph in Fig. 10, which shows that the percentage of households in A who borrow from the bank in B rises from roughly 20% to almost 80% in the aftermath of the shock. In fact, the two series—namely, the willingness to lend of the banking sector in B and

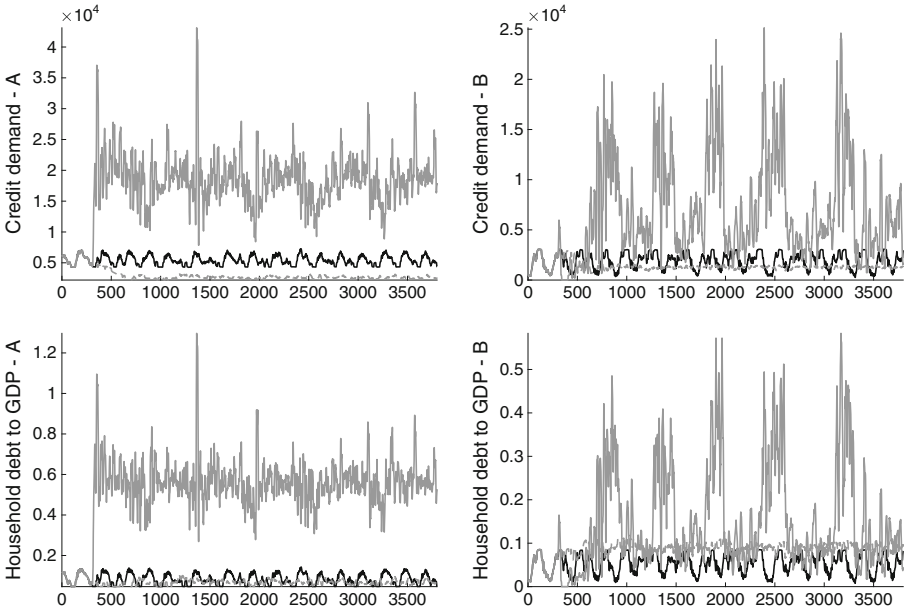

Fig. 9 Top: total credit demand in CS (black) compared to BS (grey) in country A (left) and B (right); bottom: household debt relative to GDP in CS (black) compared to BS (grey) in country A (left) and B (right)

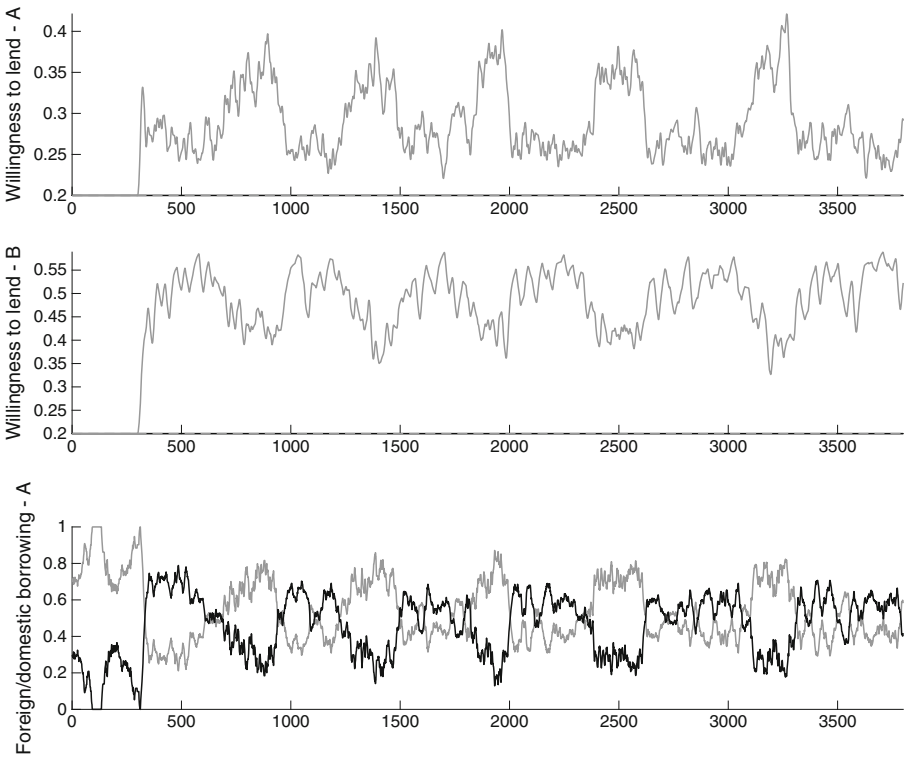

Fig. 10 Top: willingness to lend of bank A in BS (black), RS (dashed grey) and CS (grey); middle: willingness to lend of bank B in BS (black), RS (dashed grey) and CS (grey); bottom: percentage of households from A that get a loan from bank A (grey) and bank B (black) in CS

the percentage of households in A that borrow from the bank abroad—are strictly correlated (77.1%, significant at 5%).[16]

Notice that even though household debt in A keeps on rising, the banking sector in B is still willing to provide an increasing fraction of credit (middle graph in Fig. 10). The reason why $v_{t,B}$ does not fall following a rise of household debt in A is that the commercial bank in B sets its sensitivity threshold based on the average value of household debt to GDP in the overall economy (as pointed out in Section 2.4). That is, since households in B are still poorly indebted, the banking sector in B is prone to lend.

At this stage, rather different patterns emerge in the two countries (Fig. 11): during the ascending phase of the business cycle, country A evolves into a debt-driven economy with higher real household consumption relative to GDP (28.53% compared to 23.77% in BS), while country B shifts to an export-led pattern with increased exports to GDP (40.20% compared to 35.24% in BS). These remarkable differences between

[16]In general, it seems that the capital requirement coefficient plays a very limited role in driving model dynamics in CS. In fact, most of the times (98.76% of all periods t, on average across simulations) the maximum bank supply is equal to the fraction $v_{t,c}$ of total credit demand that the bank in each country is willing to supply. See Eq. 12 above.

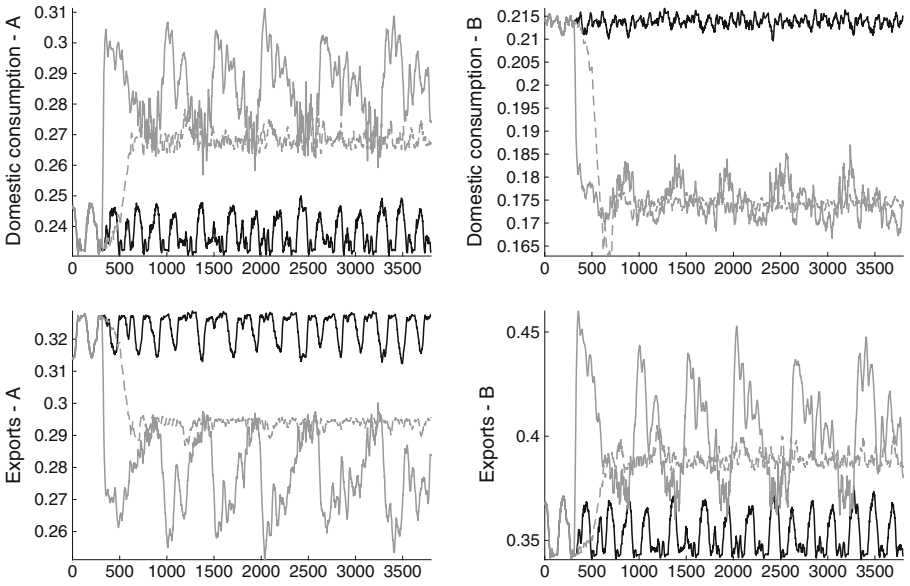

Fig. 11 Top: real domestic consumption relative to GDP in BS (black), RS (dashed grey) and CS (grey) in country A (left) and B (right); bottom: real exports relative to GDP in BS (black), RS (dashed grey) and CS (grey) in country A (left) and B (right)

the two economies arise from the heterogeneity in the imitation parameters, as well as from the greater financialization of the overall economy. In other words, households in A increase their consumption faster than production due to the increased credit availability from the banking sector in B.

As noted above, greater credit availability with increased demand for loans from households in A drives the dynamics of both the current account and the financial account in the two countries. As households in A borrow a greater amount of loans from the commercial bank in B, the financial account of A rises, while the current account deficit worsens due to increasing imports from B (Fig. 4).

Turning point. After a number of periods, the level of household debt in B starts to rise, in particular in correspondence to the peak of GDP in the same country. Thus, the average household debt to GDP in the overall economy rises above the sensitivity threshold set by the commercial bank in B, so that credit availability shrinks. Since the banking sector in B lends almost exclusively to households from A, the increasing shortage of credit supply affects mostly foreign households, thus having two major consequences: first, the percentage of successful credit applicants among households in A starts to fall—from almost 80% it eventually reaches roughly 20%—so that household debt in A decreases and the willingness to lend of the commercial bank of A improves; second, a growing percentage of households from A send their loan applications back to the commercial bank in the same country.

Bust. The whole process of credit contraction generates a dramatic fall of aggregate demand in A, since households lack the external resources to finance desired consumption. On the other hand, A's imports drop and its current account improves.

The financial account of A, instead, falls as a result of the lower amount of loans from the foreign banking system. Country B also experiences a recession, but in this case it is characterized by plunging real exports (equal to A's imports).

Notice that all dynamics revert after a few periods, such that a new business cycle starts again whenever the commercial bank in B restores its willingness to lend.

3.2 Policy responses

In addition to the three scenarios discussed above, we analyze how model dynamics change when policy makers react to rising inequality by implementing different kinds of fiscal policies in the two countries. In particular, first we assess the effectiveness of a *Keynesian* type of policy consisting in a bolder reaction of desired government spending to the demand gap. Eventually, we analyze the consequences of a change in the tax system into a more progressive one. Similar to the closed economy version of the model, our results suggest that the second type of policy has a clearer and stronger effect on the overall economy with respect to an intervention of the first type.

The simulation procedure for the Keynesian policy follows Cardaci and Saraceno (2018), in that we randomly draw 20 different values for ϕ_G and for each of them we also perform 100 MC repetitions in each of the three scenarios (hence, we perform 6000 computer simulations in total). This policy intervention is simulated with and without coordination: in the first case, ϕ_G changes equally in both countries, whereas in the second case, the change is different in A and B.

Regardless of the presence of coordination, our results indicate that a bolder fiscal policy does not prevent the economy from entering a recession in both countries in RS, and its implications are also non-tangible in the CS scenario, as the time series of all the key variables do not show any significant difference in terms of magnitude, duration and volatility of the boom and bust cycles.

The second kind of fiscal policy consists in changing the marginal tax rates in a way such that the system becomes more progressive. In particular, we simulate 10 different compositions of the marginal tax rates (which are the same in the two countries) and we run 100 Monte Carlo repetitions for each of them (thus having 1000 simulations in total).

Our results show that such policy has a positive impact on the overall economy. In particular, a more progressive tax system manages to counterbalance (at least partially) the negative effect of rising inequality in RS.[17]

Our result seems to support the arguments recently put forward by the International Monetary Fund that advanced economies with relatively low levels of progressivity in their taxation systems may have scope for raising the top marginal tax rates as this does not hamper economic growth (IMF 2017).

[17]The degree of progressivity is measured as follows: first, for each class of income we calculate the percentage change in the corresponding marginal tax rate in each simulated tax composition. Eventually, we calculate the mean of such percentage changes and we consider this as the change in the overall degree of progressivity.

Table 4 The impact of progressive taxation for selected different degrees of progressivity. The column "GDP variation" identifies the variation of average GDP with the new tax rates with respect to the RS scenario

Progressivity variation (%)	Country	Average GDP	GDP variation (%)	Coefficient of variation
RS with baseline tax rates	A	3737.21		0.0125
	B	2445.47		0.1131
+4.89	A	3764.11	0.72	0.010
	B	2582.66	5.61	0.071
+7.49	A	3770.47	0.89	0.008
	B	2608.09	6.65	0.063
+17.8	A	3782.80	1.22	0.005
	B	2668.74	9.13	0.035
+23.69	A	3789.16	1.39	0.004
	B	2675.83	9.42	0.032

In fact, Table 4 shows that when the marginal tax rates change, thus becoming more progressive in both countries, the average GDP in RS is higher. It is also worth noticing that a more progressive tax system corresponds to lower volatility, as the coefficient of variation is lower for higher progressivity variations. Hence, a more progressive tax system allows a greater share of poorer households to rely on internal financial resources, thus implying lower levels of debt accumulation and a more stable economy. In a sense, redistributive policies bring the system back towards the baseline scenario with stable GDP dynamics. Notice, however, that GDP still remains below the baseline value in both countries and this result holds true for any of the 10 simulated tax systems.

A more progressive tax system seems to have positive effects also in the context of greater financialization. Indeed, while the ameliorating impact on average GDP is relatively low, the improving performance of the economy in terms of stabilization is more sensible. In fact, even though in the presence of greater credit availability the economy remains fairly more volatile compared to RS, Table 5 shows that the higher the strength of the structural change in the tax rates in CS, the lower the coefficient of variation. This result suggests that greater progressivity is successful at reducing the degree of volatility of the economic system. The intuition is that a more progressive tax system compensates the negative impact of rising inequality by mitigating poorer households' need to rely on external finance for consumption purposes (also confirmed by the lower average values of household debt-to-GDP ratios, which are not reported here for the sake of brevity).

In general, our simulations confirm the positive impact of a progressive tax system also in the context of an open economy (within a currency union). However, before concluding this section, we want to point out that our rather simplified mod-

Table 5 The impact of progressive taxation for selected different degrees of progressivity. The column "GDP variation" identifies the variation of average GDP with the new tax rates with respect to the CS scenario

Progressivity variation (%)	country	Average GDP	GDP variation (%)	Coefficient of variation
CS with baseline tax rates	A	4038.20		0.0178
	B	4535.31		0.1037
+4.89	A	4039.51	0.03	0.0150
	B	4546.02	0.24	0.0826
+7.49	A	4042.79	0.11	0.0135
	B	4553.89	0.41	0.0763
+17.8	A	4055.25	0.42	0.0119
	B	4591.26	1.23	0.0666
+23.69	A	4073.81	0.88	0.0115
	B	4595.78	1.33	0.0631

elling framework does not allow us to take into account the possible distortionary effects that greater progressivity may have on other aspects of the economy, such as the functioning of labor markets or firm profits and investment decisions. The interpretation of our results should therefore be limited to considering that an increase in progressivity is more efficient than macroeconomic policies at tackling the expenditure cascades that follow the rise of inequality. Any further interpretation would be unwarranted given the simplified structure of our model.

3.3 Sensitivity analysis

The purpose of univariate and multivariate sensitivity analysis is to assess the robustness of our results by running the simulations under different calibrations. In other words, we want to understand whether the main findings of our model are biased by the choice of our parameter vector.

Univariate analysis allows to look at variations in the outcome of the model while changing one parameter at a time, leaving all the others constant. We follow the same approach adopted for the robustness check of the closed-economy version of this model reported in Cardaci and Saraceno (2018): we select 17 parameters and we randomly draw 20 values within a reasonable *min-max* interval for each individual parameter at a time, leaving all the other ones unchanged. For each of the 20 parameter values, we run 100 Monte Carlo repetitions, each with a different random seed, in all the three scenarios (i.e. BS, RS and CS). As such, for each single parameter, the univariate analysis results in 6000 simulations. Since we explore 17 parameters, we run 102000 simulations in total.

Table 6 *Min-max* variations in parameter values for univariate sensitivity analysis, together with corresponding cross-series variation in GDP at time 500 in BS and at time 1000 in RS and CS, for both country A and B

Parameter	Variation in parameter (%)	Country	Variation in GDP-BS at t 500 (%)	Variation in GDP-RS at t 1000 (%)	Variation in GDP-CS at t 1000 (%)
k	45.89	A	4.29	10.78	8.67
		B	29.36	111.95	75.13
a_A	113.31	A	4.12	9.31	6.22
		B	36.12	82.66	58.48
a_B	154.14	A	3.87	10.04	9.33
		B	28.01	87.98	90.93
ρ	3325.3	A	0.89	2.29	3.54
		B	6.29	17.91	23.86
μ	3466.94	A	1.48	4.10	3.35
		B	5.29	23.63	20.33
$\phi_Q A$	866.31	A	14.31	20.11	18.47
		B	8.93	24.59	24.58
$\phi_Q B$	287.84	A	1.12	7.08	2.79
		B	15.02	62.43	32.96
γ	227.46	A	2.73	7.16	6.20
		B	7.62	32.07	28.19
δ	266.97	A	2.23	5.51	5.43
		B	15.47	54.46	38.41
$\phi_P A$	166.47	A	1.41	4.39	5.53
		B	3.48	21.63	30.07
$\phi_P B$	837.36	A	2.18	10.15	3.43
		B	14.29	30.85	16.54
ϕ_G	737.71	A	1.31	4.35	3.67
		B	5.43	26.06	18.67
$\phi_C B$	838.14	A	1.09	5.72	2.94
		B	6.34	32.69	17.75
ϕ_V	360.01	A	1.08	6.02	3.19
		B	6.81	29.12	20.79
χ	471.85	A	0.73	4.53	7.31
		B	8.24	26.97	71.63
$freeze$	596.13	A	2.38	3.01	4.47
		B	22.21	35.21	27.44
β	341.75	A	1.95	6.38	11.76
		B	3.41	4.64	9.89

The results of our univariate analysis highlight the robustness of our results. In fact, in most cases, output variations are greatly smaller than the variations in the parameters. Table 6 reports the variation for each parameter between its minimum and maximum value in the sensitivity analysis and the corresponding cross-series variation in GDP at time 500 for BS and at time 1000 for RS and CS for both country A and B. Results also confirm that country A is less sensitive to changes in model parameters compared to country B since, for any change in the calibration of the model, min-max variations in model output are larger in country B (with the exception of the univariate analysis of $\phi_Q A$ in BS). Among the most relevant parameters, in terms of impact on model dynamics, the univariate analysis seems to confirm the primary role of the consumption parameters k, a_A and a_B. Compared to the closed economy model (Cardaci and Saraceno 2018), the *min-max* cross-series variation in GDP is larger in RS than in CS in most cases, such as for univariate changes of k, μ, γ, etc.

Another robustness check that we perform consists in computing the percentage of consistent simulations for each of the parameters tested in the univariate analysis. To this purpose, we calculate the mean and the variance of selected key variables (i.e. GDP, desired consumption, household debt, credit demand and household default rate) along the entire time span in the three scenarios for each of the two countries. Eventually, we compare these values, obtained under the different calibrations used in the sensitivity analysis, with the same values obtained with the standard calibration reported in Table 1.

For example, based on the standard calibration, both the mean and the variance of GDP are lower in RS and higher in CS, compared to the baseline values, in both A and B. As such, we check whether GDP has the same qualitative behavior in terms of mean and variance in any other univariate simulation. For instance, we find that, *ceteris paribus*, most of the randomly selected values of k imply that both the mean

Table 7 Percentage of consistent simulations in the univariate sensitivity analysis

Parameter	Consistent simulations (%)	Parameter	Consistent simulations (%)
k	80.83	$\phi_P A$	95.83
a_A	95.5	$\phi_P B$	93.3
a_B	85.5	ϕ_G	94.16
ρ	98.3	$\phi_C B$	95.83
μ	95.3	ϕ_V	90
$\phi_Q A$	97.2	χ	93.05
$\phi_Q B$	66.7	$freeze$	94.72
γ	93.05	β	97.6
δ	85.5		
		Average	91.36

and the variance of GDP are lower in RS and higher in CS. In particular, we claim that 80.83% of the univariate simulations for k are successful.

After repeating this experiment for all the parameters tested in the univariate analysis (Table 7), we find that, on average, 91.36% of univariate simulations are consistent with our initial calibration, based on the criterion mentioned above.

Multivariate analysis consists in analyzing model results under different calibrations of model parameters. In this case, we build 20 vectors for our parameters and we randomly draw each value in the vector within a reasonable interval. Eventually, for each of the 20 vectors, we perform 100 MC repetitions, each with a different random seed. We do so in the three scenarios, thereby running a total amount of 6000 simulations.

In addition, the multivariate analysis shows that the behavior of the model is robust to parameter changes. Indeed, we compute the percentage of consistent simulations also for the multivariate analysis. Based on the same criteria described above, our test identifies 73.3% of consistent simulations in the multivariate case, thus leading us to conclude that the model is robust also to multivariate changes in model parameters.

4 Conclusion

Baldwin and Giavazzi (2015) and De Grauwe (2013) show that, in the period between the introduction of the Euro and the outburst of the recent financial crisis, the Eurozone accumulated a sizeable amount of cross-country capital flows from the core countries to the peripheral ones. Hence, in their view, peripheral nations relied heavily on intra-Eurozone foreign lending to finance their current account deficits, while core nations reported substantially large current account surpluses. Recent empirical works (such as Marzinotto 2016) show that such imbalances in the Eurozone seem to be due to the increase in income disparities in a context of financial deepening. Indeed, easier access to credit for the poorer segments of society resulted in a massive accumulation of household debt via domestic and foreign lending, thereby leading to current account deficits in the periphery and surpluses in the core. In general, Belabed et al. (2018) and Kumhof et al. (2012) show that rising inequality can determine a diverging pattern in the balance of payments of different countries, depending on the level of financialization of the economy.

In line with these contributions, our paper extends Cardaci and Saraceno (2018) by introducing two countries operating in a currency union. Our model allows us to capture the major role that inequality plays in determining large external imbalances. In particular, our results suggest that rising inequality with a higher level of financial deepening leads to the emergence of a debt-led consumption growth regime in the country with stronger peer effects, while resulting in an export-led regime and sluggish internal demand growth in the other country, as suggested by Stockhammer (2015). The former records a current account deficit and a financial account surplus due to the massive inflow of consumption loans supplied by the foreign banking sec-

tor, which allow households to finance the higher desired spending for consumption at home and abroad. Hence, our model captures the flow of capital that finances the imbalances over the expanding phase of the economy. Eventually, a crisis emerges endogenously as a consequence of the massive accumulation of household debt that triggers a change in the perception of country-level risk on behalf of the banking sector of the lending country. As such, a sudden stop occurs, in that the representative commercial bank in this country shrinks the credit supply thereby forcing households in the deficit country to lower their domestic consumption and imports substantially.

We believe that our model represents a suitable theoretical framework that contributes to the study of these macroeconomic imbalances in the Eurozone in the presence of rising inequality. Yet, different improvements could be implemented in future research. In our view, the most interesting extension might consist in the introduction of endogenous wage inequality, which could be implemented with the introduction of heterogeneous firms that can hire and fire workers, thus allowing for the simulation of bargain processes in wage setting mechanisms. This would also allow us to study changes in unemployment dynamics in the different phases of the economic cycle.

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Appendix A: Balance of payments and Target 2 imbalances

Our model features the inclusion of a stylized version of the Target 2 (T2) mechanism. The framework we have adopted is based on a post-crisis setting (Auer 2014; Cecchetti et al. 2012). Hence, for simplicity we assume there is no interbank lending in our economy. This has two major consequences: 1) whenever a country records a current account (CA) deficit, this is matched by changes in T2 positions, unless the CA deficit is outbalanced by a capital inflow in the form of deposits arising from household debt with the foreign bank; 2) a current account deficit does not change the reserve account of the commercial bank of the deficit country because any loss of reserves is entirely matched by a refinancing operation by the national central bank, in that the national central bank provides the commercial bank with an unsecured loan ($LCB_{t,c}$ in our model). Indeed, since we assume that banks do not provide any collateral when they borrow from the corresponding national central banks, there is no limit to the changes in the net Target 2 position of a country.

Therefore, the design of the T2 mechanism in our model implies that the net Target 2 position of a country changes automatically in order to match the gap between

current and financial accounts. Hence, a CA deficit (surplus) that is not matched by a financial surplus (deficit) is going to be matched by a negative (positive) variation of the T2 position of the country vis-a-vis the ECB. This is in line with the actual functioning of T2 in the Euro area, where the compensation between current and financial accounts runs through Target 2: "The system works by providing national central banks with credits and debits in the form of a bilateral position vis-a-vis the ECB, usually recorded on the balance sheets as either *Intra-Eurosystem Claims* or *Intra-Eurosystem Assets*" (Whelan 2014, p. 7). Therefore, Target 2 does a job similar to creating foreign exchange reserves for a country that faces a balance of payments crisis. As argued by Cecchetti et al. (2012, p. 5), "the only limit on capital outflows, and the only limit on the liability that the country's central bank can amass with respect to the remainder of the Eurosystem, is the collateral that the country's banks have available to bring to the refinancing operation". However, since the system operates automatically, there seems to be no natural break. In essence, this is what happened after the 2009–2010 sudden stop that occurred in the Euro periphery: if these countries had not been Euro-area members, they would have likely suffered a harsh current account adjustment through a currency crisis. Indeed, outside the Eurozone, if a country with a fixed exchange rate regime and a CA deficit happens to experience a so-called "sudden stop" (e.g. a capital account reversal because of a confidence loss by investors), the country will have a depletion of foreign reserves. Yet, this is obviously limited by the amount of foreign reserves owned by the national central bank. In order to avoid losing all of its foreign reserves, the country has no other option than devaluating its currency or allowing to let it float on the open market. Instead, the countries in the periphery of the Eurozone, "remained in the Euro area and continued to run current account deficits, despite rapidly falling private capital inflows, and, in some cases, capital flight" (Hale 2013, p. 4). In fact, this was possible because of Target 2. Indeed, according to Auer (2014) and Cecchetti et al. (2012), T2 balances were actually financing the flight of private capital from the periphery to the core that was due to the sudden stop triggered by the global financial crisis. Cecchetti et al. (2012) finds that, starting from 2012, the relationship between current accounts and T2 balances strongly favors this interpretation, since the changes in T2 balances substantially exceeded the value of current accounts. Also Auer (2014) points out that changes in T2 balances simply reflected the fact that the financing of CA deficits changed with the onset of the financial crisis, due to the reversal of capital flows.

In addition to this, the specific design of the T2 mechanism in our model, which implies the presence of unsecured refinancing operations, is a direct representation of the difficulty of refinancing through interbank lending. Indeed, any transactions between two countries change the amount of reserves that a commercial bank has in its account at the national central bank. Hence, in the deficit country, the bank can recover from the reserve-loss by borrowing on the interbank market directly from another commercial bank abroad (the typical pre-2008 solution in the Eurozone). This would clear the net Target 2 positions of the two countries since there is a cross-country payment going from one country to other, in the opposite direction with respect to the original transaction. Yet, suppose that interbank borrowing becomes

difficult so that the market breaks down, as it has after the 2008 crisis (Cesaratto 2013). In this case, there would be no loans flowing from a bank to the other and, as a consequence, some banks would not recover from the loss of reserves. Hence, the solution is that the central bank replenishes the reserve account of the commercial bank through a short or long term refinancing operation. The central bank supplies a loan to the commercial bank as in our model. This operation does not change the net T2 position of the countries.

Appendix B: Rest of the world

In this appendix we introduce the *ROW* extension, a slightly modified version of our model set-up that accounts for the presence of a third country (labelled as rest of the world, or RoW). In the spirit of the KISS principle mentioned earlier, we assume that RoW can import goods exclusively from country A, while it exports only to country B. With a real-world parallelism, this simplification is meant to mimic the essential features of the trade relationships between core countries (most notably Germany), the European periphery and a third major actor, namely China. Indeed, while it is true that the period before the Global Financial Crisis was characterized by massive capital flows from Germany to the periphery of Europe, there was no corresponding increase in imports of German goods in the periphery: German export performance was ameliorated by the export of intermediate manufacturing goods to China, rather than Greece. Similarly, the worsening trade balance of the periphery was not due to an increase of imported goods from Germany, but from China.

The presence of a third country in our model allows us to capture such dynamics, thus increasing the realism of our model specifications. However, the purpose of this model extension is to show that model dynamics in the simulated monetary union do not change even by accounting for the role of the rest of the world. In other words, given the scope of our analysis—i.e. the interaction between inequality and financialization in a currency union—our two-country setting represents a good approximation. This statement is robust to different specifications of the role of RoW.

Let us briefly introduce the modifications implemented in the ROW extension of the model.

First, we modify Eq. 6 with the introduction of the parameter $\psi \in [0, 1]$, which determines the share of A's demand for imports allocated to B and RoW. Hence, we generate two new equations: Eq. 19 describes A's import demand for B's goods, while Eq. 20 identifies the demand for RoW's ones.

$$DC^{B}_{t,h,A} = \psi \left(\gamma \frac{P_{t,A}}{P_{t,B}} \right) min(C^{d}_{t,h,A}, D_{t,h,A}) \tag{19}$$

$$DC^{RoW}_{t,h,A} = (1 - \psi) \left(\gamma \frac{P_{t,A}}{P_{t,RoW}} \right) min(C^{d}_{t,h,A}, D_{t,h,A}) \tag{20}$$

For simplicity, we assume $P_{t,RoW} = P_{t,B}$.

Table 8 Scenarios implemented in the *ROW* extension of the model

Parameter values	Interpretation
$\psi = 0, \eta = 0, \xi = 0$	The model with no ROW extension
$0 < \psi < 1, \eta = 1, \xi = 0$	RoW's current account fixed to zero
$0 < \psi < 1, \eta < 1(\text{or} > 1), \xi = 0$	Fixed negative (or positive) RoW's current account
$0 < \psi < 1, \eta < 1(\text{or} > 1), \xi = 1$	Randomly fluctuating RoW's current account

We then define RoW's demand for imports from B as equal to RoW's exports to A multiplied by the sum of a parameter $\eta \in (-\inf, +\inf)$ and dummy variable ξ times $\epsilon \sim U(0.5, 0.5)$. In particular, η determines whether RoW has a current surplus (if $\eta > 1$), deficit (in the opposite case) or a balance (if $\eta = 0$). ϵ is a stochastic component that introduces some noise in the current account of RoW. Finally, the dummy variable allows to control for the presence of the noisy component thus increasing the number of scenarios that we can replicate.

$$DC^{B}_{t,h,RoW} = DC^{RoW}_{t,h,A}(\eta + \xi\epsilon) \tag{21}$$

Note that, since this rather simple extension does not feature any financial flows to/from the rest of the world, when the parametrization of the model is such that RoW's CA is imbalanced, foreign reserves change accordingly in order to have a balance of payments equal to zero.

Scenarios We simulate the same BS, RS and CS scenarios described above. Our model extension allows for different characterizations of the role of the rest of the world, which are reported in Table 8.

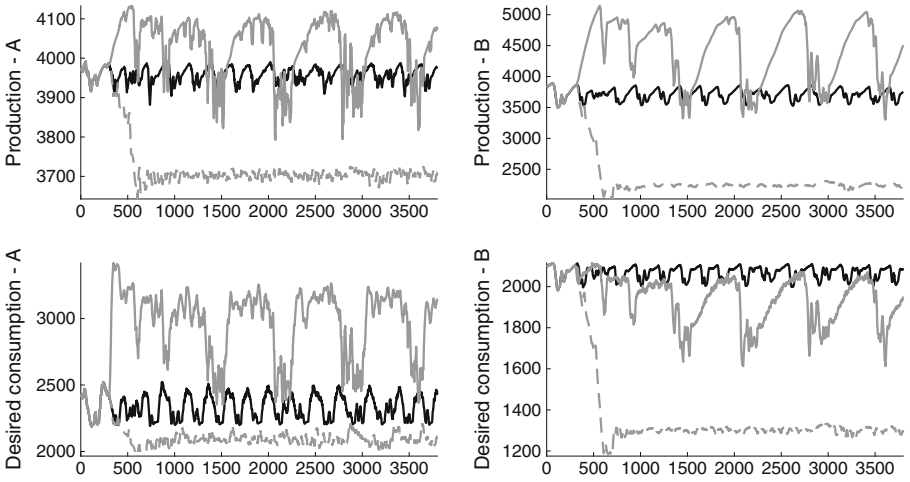

Fig. 12 Top: real GDP in A (left) and B (right) in BS (black), RS (dashed grey) and CS (grey). Bottom: aggregate desired consumption in A (left) and B (right) in BS (black), RS (dashed grey) and CS (grey)

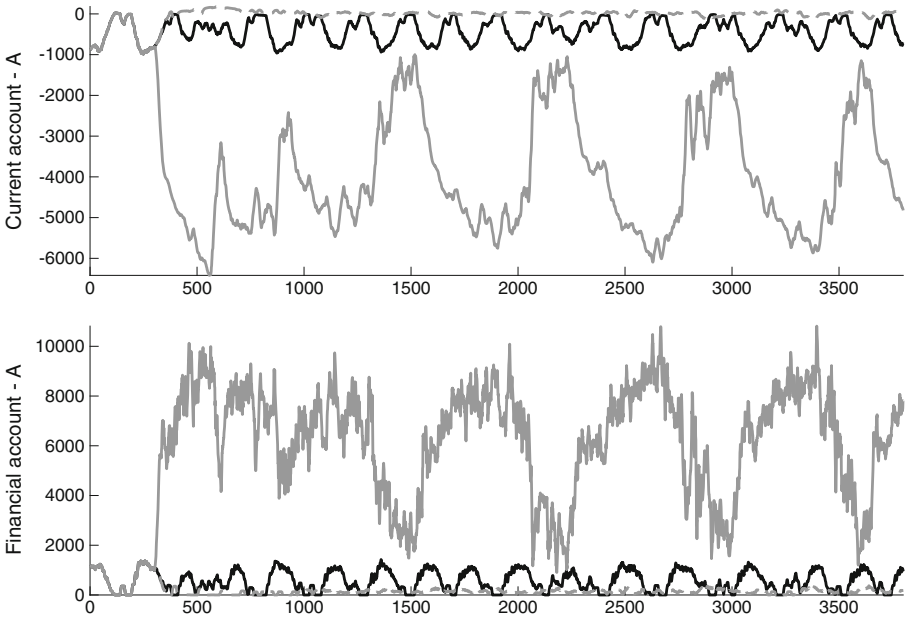

Fig. 13 Current Account (left) and Financial Account (right) in A in BS (black), RS (dashed grey) and CS (grey)

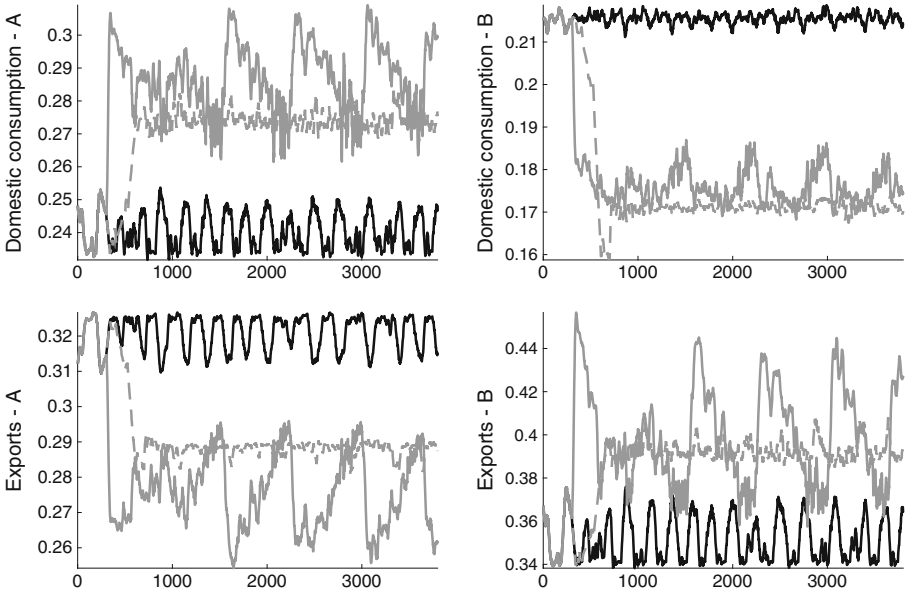

Fig. 14 Top: real domestic consumption relative to GDP in BS (black), RS (dashed grey) and CS (grey) in country A (left) and B (right); bottom: real exports relative to GDP in BS (black), RS (dashed grey) and CS (grey) in country A (left) and B (right)

Results In general, our results suggest that, regardless of specification of the role of RoW, qualitative dynamics are unchanged compared to the two country case discussed in the rest of the paper. Hence, for the sake of brevity, we report the main time series in BS, RS and CS for the following calibration: $\psi = 0.8$, $\eta = 0.8$ and $\xi = 1$.

A visual inspection of Figs. 12, 13 and 14 shows that macroeconomic time series are substantially unchanged compare to the two-country version of the model. This is also confirmed by the average values of the key variables. As an example, the average values of GDP in the three scenarios are extremely close the same values reported above, both in A (3957.3 in BS, 3715.5 in RS and 4030.1 in CS) and B (3706.3 in BS, 2311.5 in RS and 4412.6 in CS). The same consideration applies to the corresponding coefficients of variation (A: 0.0048 in BS, 0.0135 in RS and 0.0185 in CS; B: 0.0234 in BS, 0.1263 in RS and 0.1093 in CS).

Appendix C: Tax rates

The marginal tax rates are computed endogenously in the first period. The procedure is as follows:

First, the population is divided in eight income classes (four below the median and four above it) with randomly assigned marginal tax rates. Then, an optimizing algorithm finds the new optimal tax rates that minimize the difference between the steady state value of desired government deposits and the actual amount collected. This process produces an iterative loop that stops either when the tax rates reach the exogenously given boundaries, i.e. the minimum and maximum rates for the eight classes, or when the distance between desired government deposits and the actual amount collected is in fact minimized.

Eventually, the marginal tax rates endogenously found in period 1 remain constant throughout the rest of the periods t.

When the progressive policy experiment is implemented, we change the marginal tax rates exogenously.

Appendix D: Agents' balance sheets

Table 9 represents the balance sheets for each typology of agent, with the following stock variables for each country c: household deposits ($D_{t,h,c}$), loans ($L_{t,h,c}$), government deposits ($D_{t,g,c}$), reserves ($R_{t,c}$), firm deposits ($D_{t,f,c}$), central bank loans ($LCB_{t,c}$), Target 2 claims for the national central bank ($T2A_{t,c}$), Target 2 liabilities for the national central bank ($T2L_{t,c}$). The model could easily be adapted to become more general: in this case, the Target 2 balances would become reserves for the national central banks (and the exchange rate regime would have to be modeled).

Table 9 Agents' balance sheets in our economy

$Households_A$		$Bank_A$		$Firm_A$		$Government_A$		$CentralBank_A$	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
$D_{t,h,A}$	$L_{t,h,A}$	$L_{t,h,A}$	$D_{t,h,A}$	$D_{t,f,A}$		$D_{t,g,A}$		$T2A_{t,A}$	$T2L_{t,A}$
		$R_{t,A}$	$D_{t,f,A}$					$LCB_{t,A}$	$R_{t,A}$
			$LCB_{t,A}$						$D_{t,g,A}$

$Households_B$		$Bank_B$		$Firm_B$		$Government_B$		$CentralBank_B$	
Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
$D_{t,h,B}$	$L_{t,h,B}$	$L_{t,h,B}$	$D_{t,h,B}$	$D_{t,f,B}$		$D_{t,g,B}$		$T2A_{t,B}$	$T2L_{t,B}$
		$R_{t,B}$	$D_{t,f,B}$					$LCB_{t,B}$	$R_{t,B}$
			$LCB_{t,B}$						$D_{t,g,B}$

CCB	
Assets	Liabilities
$T2L_{t,A}$	$T2A_{t,A}$
$T2L_{t,A}$	$T2A_{t,B}$

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