Why HANK Matters for Stabilization Policy

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Abstract

We characterize jointly optimal fiscal and monetary Ramsey policies in Heterogeneous-Agent New Keynesian (HANK) economies with both price and wage rigidities. We compare aggregate allocations to Representative-Agent (RA) benchmarks. A major force drives the qualitative response of the optimal policy and the divergence between RA and HA cases: the time-varying tightness of borrowing constraints, summarized by a new sufficient statistic – the Marginal Value of the Credit Constraint (MVCC). When fiscal instruments are restricted, the MVCC rises and HA–RA gap widens. In such cases, persistent inflation becomes optimal as a costly substitute for missing labor-tax instruments.

Keywords: Heterogeneous agents, optimal monetary policy, optimal fiscal policy.
JEL codes: E52, D52, E21.

1 Introduction

Since 2020, macroeconomic policy has entered uncharted territory. Governments in the United States and Europe launched large-scale fiscal interventions during the pandemic, with trillions of dollars in emergency support, while central banks cut interest rates at extraordinary speed. As inflation surged and concerns over wage-price spirals re-emerged, monetary policy reversed abruptly to the fastest tightening cycle in decades. These exceptional developments have brought renewed attention to the coordination between fiscal and monetary stabilization policies.

Heterogeneous-agent New-Keynesian (HANK) models offer a renewed environment to understand these fiscal and monetary interactions. They describe economies with realistic distribution of income, wealth, and consumption, resulting from credit constraints and incomplete markets. They lead to relevant marginal propensity to consume (MPC) of households, a departure from the Ricardian equivalence, as well as amplification effects of aggregate demand channels. However,

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the normative implications of those HANK models for optimal monetary and fiscal stabilization policy remain unclear, as shown in the literature review below.

The goal of this paper is to draw general lessons for optimal fiscal and monetary policy and to determine how those lessons differ between HANK and Representative-agent New-Keynesian (RANK) economies. We address the following questions: Do HANK models generate new mechanisms for fiscal-monetary policy mix? When and why do the implications for optimal stabilization in HANK differ from those in RANK?

We answer these questions in a large class of HA models featuring both wage and price stickiness, subject to a wide variety of aggregate shocks: a productivity shock, a government spending shock, a preference shock, and an uncertainty shock. Our strategy rests on the known result that any real effect of monetary policy can be replicated by a well-chosen set of fiscal instruments, regardless of the nature of the aggregate shock. Indeed, we first characterize a fiscal system, under which the planner optimally implements the flexible-price allocation, and where optimal price and wage inflation rates are zero, after any aggregate shock. We refer to this benchmark fiscal system as a *complete* fiscal system. It comprises three labor tax instruments (employer contributions, employee contributions, and total labor income tax), a capital tax, and public debt. This extends the equivalence findings of Correia et al. (2008) or LeGrand et al. (2025a) to an environment featuring both price and wage nominal rigidity. Identifying this complete tax system allows us to characterize the role of inflation, when some fiscal instruments are missing.

We first identify new stabilization mechanisms in a tractable HA environment with a complete fiscal system, where prices can thus be assumed to be flexible. Our main finding is that the nature of the aggregate shock plays a pivotal role for the optimal stabilization policy and its difference with the one in RA economies. For supply (e.g., TFP) shocks, optimal stabilization involves a constant debt-to-GDP ratio and a constant labor tax. The resulting optimal aggregate allocation (savings and consumption) is also constant in proportion to GDP. This implies that the aggregate dynamic response in the HA economy is identical to the one in the RA economy, even though steady states differ. For demand shocks (e.g., discount factor shocks), the optimal paths of public debt to GDP and labor tax are time-varying, and so are consumption and savings to GDP ratios. The resulting optimal allocation responses differ between HA and RA economies.

The reasons behind these two very different responses is the agents' precautionary saving motive. For demand shocks, we prove that precautionary saving is time-varying because the tightness of the credit constraint is not constant. For supply shocks, precautionary saving is time-invariant and shocks only induce a homogeneous scaling effect of planner's instruments and allocation. HA and RA economies respond similarly, which rationalizes existing results in the literature.

We capture this property by introducing a new sufficient statistic: the Marginal Value of the Credit Constraint (MVCC), that positively comoves with the Lagrange multiplier on binding household borrowing constraint. We show that the dynamics of the MVCC are crucial for determining when stabilization policy is HA specific. These qualitative insights are general and carry over to a quantitative framework. We also explain how the MVCC relates to the discount-factor wedge used Nakajima (2005), Werning (2015), Acharya and Dogra (2021) and

Berger et al. (2023).

In a second step, we solve for optimal fiscal-monetary policy in the general HA model with both sticky wages and sticky prices. Our analysis starts from the complete fiscal environment in a general HANK with both price and wage stickiness, for which optimal price and wage inflation is zero. In this setting, we confirm the results of the tractable model. After supply shocks, the ratios of instruments (public debt and labor tax revenues) and allocation (ratios of consumption and savings) to GDP are almost time invariant. Conversely, after a demand shock, instruments and allocation do markedly move over the business cycle. The MVCC again provides a useful statistic. It remains nearly constant after supply shocks, because the tightness of credit constraint is not time-varying after these shocks.

Building on this zero-inflation/full-instruments benchmark, we then solve for optimal policy in HA and RA economies when some fiscal instruments are constrained and thus held constant. We identify which missing fiscal tools generate the most significant optimal deviations from price and wage stability. With four taxes in total, we explore many possible subsets of time-varying instruments, and for each configuration we examine the effects of four aggregate shocks. In total, we simulate 120 economies. In this general environment, we compute the average dynamics of the MVCC in each case to understand the deviations between RA and HA economies.

This general investigation yields three main results. First, when some labor taxes cannot vary over time, we observe sizable optimal deviations from price stability. This occurs when the aggregate shock generates a labor wedge—when the real wage differs from the marginal product of labor. In this situation, price inflation becomes a second-best instrument—a costly substitute for missing time-varying labor taxes—to mitigate the labor wedge when nominal wages are sticky. As also present in RA models, this mechanism is not specific to HA economies, but its quantitative importance differs substantially in HA models when fiscal tools cannot vary optimally.

Second, when the planner cannot optimally adjust the capital tax, short-lived movements in inflation also act as an imperfect substitute for time-varying capital taxation in HA models. By contrast, the absence of an optimal capital tax has no effect in RA models. However, substantial inflation adjustments through this channel require relatively flexible prices.

Third, we derive predictions for the optimal path of public debt. In HA models, the initial change in debt is always smaller in absolute value than in RA models. Because public debt serves as a buffer stock in HA environments, the planner reduces its volatility relative to the complete-market benchmark. Public debt is highly persistent in both RA and HA economies, but slightly more so in HA economies.

Related literature. This paper contributes to three strands of the literature: (i) optimal policy in HA environments, (ii) the interaction between fiscal and monetary policies in RANK and HANK models, and (iii) literature aiming at understanding the implications of both price and wage stickiness.

First, our analysis relates closely to the growing literature on optimal fiscal or monetary policy with heterogeneous agents, in HANK model following the analysis of Kaplan et al. (2018). If, with complete markets, the optimal fiscal policy (Werning, 2007) or monetary policy (La'O and Morrison, 2024) can be characterized, the task becomes even more challenging with incomplete markets and aggregate shocks. Limited heterogeneity (Bilbiie and Ragot, 2021), CARA environment without capital (Acharya et al., 2023), zero-liquidity (Challe, 2020), or continuous-time techniques (Nuño and Moll, 2018 and Nuño and Thomas, 2022 among others), have provided a renewed understanding of the transmission mechanisms of such policies. Bhandari et al. (2021) provide a general perturbation method in HANK models without credit constraints. Dyrda and Pedroni (2023) solve numerically the optimal coefficient of parametric fiscal rules, as does Yang (2022) for the monetary Taylor rule, while McKay and Wolf (2022) characterize these rules in the linear-quadratic framework. Dávila and Schaab (2023) use the primal approach in continuous-time and Açikgöz et al. (2022) solve the general Lagrangian in infinite dimension. Auclert et al. (2024a) use the dual approach to study the existence and long-run properties of such an environment. Applications of these tools in HA models are numerous: studying macroprudential policy (Farhi and Werning, 2016), imperfect instruments (Dávila and Walther, 2021), informational frictions (Angeletos and La'O, 2020), redistribution and investment (Morrison, 2023), sectoral shocks (Caratelli and Halperin, 2025), liquidity effects of fiscal policy (Bayer et al., 2023a), automatic stabilizers (McKay and Reis, 2021), unemployment insurance (Kekre, 2023) or optimal carbon taxation (Bourany, 2025).

In comparison, in this paper, we rely on the tools developed by LeGrand and Ragot (2022a) and their subsequent improvements, and construct a finite state-space representation of HANK models. This approach makes it possible to solve for optimal policy with multiple instruments, various nominal frictions, and different aggregate shocks. Whereas LeGrand et al. (2025a) solve for optimal monetary policy and LeGrand and Ragot (2025) solve for optimal fiscal policy, the current paper is the first to solve jointly for optimal and monetary policy, to the best of our knowledge.

Second, the conduct of optimal policy naturally depends on the interaction between fiscal and monetary policy. Our analysis starts from the equivalence result between the path of interest rates and taxes in Correia et al. (2008). We show how to generalize such equivalence result in HANK model, with a wide set of shocks and general nominal rigidities, related to the unconventional policy equivalence result by Seidl and Seyrich (2023) and transfer equivalence by Wolf (2025).

In contexts where both fiscal and monetary policy interact, a long line of research has investigated the fiscal origin of inflation, e.g. Leeper and Leith (2016) and Cochrane (2023) for a review, or more recently in the analysis of Bianchi et al. (2023), Barthélemy and Plantin (2019), or Bassetto and Miller (2025). These questions have been reinvigorated due to the stronger role of indirect effects in HANK models. Surveys by Auclert et al. (2025), or Eichenbaum (2025) provide an overview of these questions in the canonical RANK and HANK models. More recently, Bilbiie et al. (2024) provide a tractable approach to study such interaction in TANK models, while Kaplan et al. (2023) study the fiscal root of inflation in the long-run equilibrium of HA models, and Angeletos et al. (2024) and Rachel and Ravn (2025) analyze the conduct of these policies in OLG models with slow fiscal adjustment.

Finally, the recent 2021-2023 inflation surge has originated from multiple sources studied in the literature: energy shocks (Auclert et al., 2023 and Bayer et al., 2023b), supply chain disruptions (Comin et al., 2023), or fiscal shocks (Barro and Bianchi, 2023 and Cochrane, 2025). This has highlighted the "wage-inflation spirals" at the heart of the transmission and amplification mechanism of shocks. In the framework of our paper, we investigate how the presence of both price and wage stickiness – as reviewed in Taylor (2016) – matters for the design of optimal fiscal-monetary policy. The early contributions of Blanchard (1986), Galí (2015, chapter 6), or Blanchard and Galì (2007) included wage rigidities in the standard NK model. In such a framework with both wage and price rigidities, Erceg et al. (2000) studied optimal monetary policy, while Chugh (2006) analyzes both optimal monetary policy and labor taxation. More recently, Lorenzoni and Werning (2023) have analyzed wage-price dynamics in such an environment. Our paper analyzes the design of optimal policies in this framework.

2 Optimal policy differences between RA and HA economies: a tractable exploration

In this section, we analyze a tractable model, where we characterize analytically the difference between optimal policies and allocations in HA and RA economies. The key simplifying assumption is to consider deterministic productivity fluctuations, following the approach of Woodford (1990).[1] Although our goal is to study the optimal fiscal-monetary policy mix, we further streamline the exposition by focusing on the flexible price economy. This corresponds to the benchmark of our general model, in which the fiscal system is sufficiently rich to let monetary policy focus on price stability only. Starting from this benchmark case allows us to identify the core mechanisms.

Production. The production function transforms each unit of labor L_t into Z_t units of output, such that aggregate output is given by $Y_t = Z_t L_t$. Since prices are flexible, the real wage is equal to TFP: $\tilde{w}_t = Z_t$.

The agents. The economy is populated by two types of agents, denoted by A and B. A unit mass of agent A has a productivity 1 in every odd period and a productivity 0 in every even period. Conversely, a unit mass of agent B has a productivity 1 in every even period and a productivity 0 in every odd period. Thus, in each period, there is a unit mass of agents with productivity 1, and income fluctuations are deterministic. Agents with positive productivity are referred to as "employed" (subscript e), while those with zero productivity are referred to as "unemployed" (subscript u).

In this simple model, agents' preferences are represented by a Greenwood-Hercowitz-Huffman (GHH) utility function: $U(c,l) = \log(c - \frac{l^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}})$, where c and l are individual consumption and labor supply respectively, and $\varphi > 0$ is the Frisch elasticity of labor supply. We assume that agents discount utility from period $t+1$ in period t by a possibly time-varying discount factor β_t, with $0 < \beta_t < 1$. Following Galí (2015) among others, we interpret changes in β_t as a demand

[1] In a previous version of the paper, we considered a production function with capital and labor. The results are qualitatively similar, but at the cost of heavier algebra. In LeGrand and Ragot (2025), we use an economy with capital to study optimal capital tax.

shock. The discount factor for utility in period t as of period 0 is:

$$\Theta_t = \Pi_{k=0}^t \beta_t,$$

which simplifies to β^t if β_t is constant over time.

The only friction in the economy is a credit constraint: Agents cannot borrow. We denote $c_{e,t}, a_{e,t}, c_{u,t}, a_{u,t} \geq 0$ as the consumption and saving levels of employed and unemployed agents in period t, respectively. We denote as r_t and w_t the real post-tax interest rate and wage rate, respectively. They differ from pre-tax rates due to linear taxes detailed below. The budget constraints for employed and unemployed agents are:

$$c_{e,t} + a_{e,t} = (1 + r_t)a_{u,t-1} + w_t l_{e,t}, \tag{1}$$

$$c_{u,t} + a_{u,t} = (1 + r_t)a_{e,t-1}. \tag{2}$$

For simplicity, we assume that initial wealth is zero: $a_{e,-1} = a_{u,-1} = 0$. The Euler equations for employed and unemployed agents are:

$$U_c(c_{e,t}, l_{e,t}) \geq \beta_t(1 + r_{t+1})U_c(c_{u,t+1}, 0), \tag{3}$$

$$U_c(c_{u,t}, 0) \geq \beta_t(1 + r_{t+1})U_c(c_{e,t+1}, l_{e,t+1}), \text{ with equality if } a_{u,t} > 0. \tag{4}$$

with $U_c(c, l) = (c - \frac{l^{1+1/\varphi}}{1+1/\varphi})^{-1}$. Because they have a null productivity, unemployed agents do not work: $l_{u,t} = 0$. Due to the GHH utility function, the labor supply of employed agents is pinned down by the real wage. Aggregate labor supply L_t is therefore:

$$L_t = l_{e,t} = w_t^{\varphi}. \tag{5}$$

Government. The government issues a quantity of public debt B_t. Financial market clearing requires:

$$a_{e,t} + a_{u,t} = B_t. \tag{6}$$

The government raises linear capital tax τ_t^K and labor tax τ_t^L to finance public debt repayments. If $\tilde{r}_t$ denotes the net pre-tax interest rate, the gross post-tax interest rate is $r_t = (1 - \tau_t^K)\tilde{r}_t$. Similarly, the post-tax wage rate is $w_t = (1 - \tau_t^L)\tilde{w}_t$. The government budget constraint writes as $(1 + \tilde{r}_t)B_{t-1} \leq B_t + \tau_t^K \tilde{r}_t(a_{e,t-1} + a_{u,t-1}) + \tau_t^L \tilde{w}_t L_t$, which can be simplified into:

$$(1 + r_t)B_{t-1} = (Z_t - w_t)L_t + B_t. \tag{7}$$

The Ramsey allocation. For a given sequence of MIT shocks, known at date 0, $\{\beta_t, Z_t\}_{t\geq 0}$, the Ramsey program selects the path of instruments $\{\tau_t^K, \tau_t^L, B_t\}_{t\geq 0}$ that implements the competitive equilibrium achieving the highest aggregate welfare (given the initial conditions). The aggregate welfare criterion used is the standard Utilitarian objective, in which both agents are equally weighted. Since the discount factors correspond to those of the agents, they may therefore be time-varying.

We follow a standard tradition since Chamley (1986) and express the Ramsey program in terms of post-tax instruments. The planner is assumed to choose the paths of post-tax rates and public debt, $\{r_t, w_t, B_t\}_{t\geq 0}$ to maximize aggregate welfare. The Ramsey program is:

$$\max_{(c_{e,t},c_{u,t},a_{e,t},a_{u,t},l_{e,t}B_t,A_t,R_t,w_t)_t} \sum_{t=0}^{\infty} \Theta_t \left(\log\left(c_{e,t} - \frac{l_{e,t}^{1+\frac{1}{\varphi}}}{1+\frac{1}{\varphi}} \right) + \log(c_{u,t}) \right) \tag{8}$$

$$\text{subject to: } c_{e,t}, c_{u,t}, a_{e,t}, a_{u,t}, l_{e,t}, l_{u,t} \geq 0, \tag{9}$$

$$a_{e,-1} = a_{u,-1} = 0, \tag{10}$$

and subject to: the constraints (1)–(5) guaranteeing the optimality of individual choices (budget constraints, Euler equations and labor first-order condition (FOC) with GHH utility function, respectively); the financial market clearing condition (6); and the government budget constraint (7).

A particularity of this simple no-capital setup is that only the post-tax interest rate r_t is determined. In other words, for any pre-tax interest rate $\tilde{r} > 0$, the capital tax $\tau_t^K = 1 - \frac{r_t}{\tilde{r}}$ implements the optimal allocation.

2.1 The RA economy

To be consistent with the HA model, the RA economy is an economy populated by an agent of mass two endowed with the same GHH utility function as in the general case. This agent has the average productivity of the population in the HA economy, which is 1/2. In this setting, the Ramsey problem involves maximizing the agents' intertemporal welfare subject to the Euler equation and the resource constraint. The optimal policy is straightforward to characterize, as the first-best allocation can be achieved. Specifically, the planner sets $\tau_t^K = \tau_t^W = B_t = 0$. Under this policy, the labor supply is given by $L_t^{RA} = 2^{-\varphi} Z_t^{\varphi}$, and optimal consumption is $C_t^{RA} = Z_t L_t^{RA} = 2^{-\varphi} Z_t^{1+\varphi}$.[2]

2.2 The Ramsey allocation in the HA economy

As a preliminary remark, we can show that in the Ramsey program in equations (8)–(10), that the planner does not increase public debt to the point where credit constraints cease to bind for unemployed agents. Such a policy would imply a very high debt level and necessitate an excessively high and distortionary labor tax. We therefore guess and verify that credit constraint remains binding for unemployed agents. By substituting the labor supply expression (5), the program can considerably be simplified.

Our main result, stated in the following proposition, characterizes the optimal stabilization policy in the HA framework and summarizes how the resulting optimal aggregate HA allocation departs from the one in the RA economy. We denote the aggregate consumption in the HA economy by $C_t^{HA} := c_{u,t} + c_{e,t}$, and we denote as the public-debt-to-GDP ratio $b_t^{HA} = B_t^{HA}/Y_t^{HA}$ in the HA economy, and $b_t^{RA} = B_t^{RA}/Y_t^{RA}$ in the RA economy.

Proposition 1. *We consider arbitrary paths of TFP $(Z_t)_t$ and discount factor $(\beta_t)_t$.*

[2]Since the RA economy implements the first-best allocation—making aggregate consumption proportional to $Z_t^{\varphi+1}$—considering a RA economy with an agent of mass 1 and a unit productivity would let our results unchanged. But for the sake of consistency, we opted for the current version.

1. In the HA, economy, the optimal path of the labor tax $(\tau_t^{L,HA})_t$ *and of the public-debt-to-GDP ratio verify:*

$$\tau_t^{L,HA} = \frac{1}{2}\frac{1-\beta_t}{1+\varphi(1+\beta_t)}, \tag{11}$$

$$b_t^{HA} = \frac{(1/2+\varphi)^{1+\varphi}}{1+\varphi}\frac{\beta_t}{1+\beta_t}\left(\frac{1+\beta_t}{1+\varphi(1+\beta_t)}\right)^{1+\varphi}, \tag{12}$$

and

$$C_t^{HA} = \left(\frac{1}{2}+\varphi\right)^{\varphi}\left(\frac{1+\beta_t}{1+\varphi(1+\beta_t)}\right)^{\varphi} Z_t^{\varphi+1}.$$

2. In the RA economy, $\tau_t^{L,RA} = b_t^{RA} = 0$*, and* $C_t^{RA} = 2^{-\varphi} Z_t^{\varphi+1}$

3. Furthermore, the optimal allocations in the HA and RA economies are related as follows:

$$\frac{C_t^{HA}}{C_t^{RA}} = (1+2\varphi)^{\varphi}\left(\frac{1+\beta_t}{1+\varphi(1+\beta_t)}\right)^{\varphi}.$$

Proposition 1, whose proof can be found in Appendix A, highlights the main insights regarding the role of aggregate shocks in HA and RA models. We discuss the effect of each shock in turn.

TFP shocks $(Z_t)_t$ ***only*** As can be seen in equations (11) and (12), the labor tax and public debt ratio are independent of TFP shocks in the HA model. The effect of TFP on aggregate consumption in the HA economy is the same as the effect of TFP on consumption in the RA model. Formally, the ratio of aggregate consumption levels $\frac{C_t^{HA}}{C_t^{RA}}$ stays constant over time, or equivalently, the proportional deviations are the same $\hat{C}_t^{HA} = \hat{C}_t^{RA}$ (where $\hat{x}_t$ is the proportional deviation of x_t). Thus, although RA and HA economies have different steady states, their aggregate responses to TFP shocks are identical.

Discount factor shocks $(\beta_t)_t$ ***only*** For discount factor shocks, the optimal stabilization policy in the HA economy differs significantly from the TFP case. Public debt over GDP and labor tax are now time-varying in the HA model, whereas they a constant in the RA model. As a consequence, the aggregate consumption response differs from that of the RA economy, in which the allocation is invariant to discount factor shocks, and the ratio $\frac{C_t^{HA}}{C_t^{RA}}$ becomes time-varying, what implies $\hat{C}_t^{HA} \neq \hat{C}_t^{RA}$.

We introduce a simple statistic to explain the differences between allocations in RA and HA economies.

The Marginal Value of the Credit Constraints (MVCC). We define as ν_t the Lagrange multiplier associated to the credit constraint of unemployed agents. The multiplier is: $\nu_t := U_c(c_{u,t}, 0) - \beta(1+r_{t+1})U_c(c_{e,t+1}, l_{e,t+1})$. Intuitively, ν_t measures the gap between the current and future discounted marginal utilities of agents u and reflects how slack the Euler equation (4) of unemployed agents is. It equals 0 when credit constraints do not bind and is positive otherwise. The Marginal Value of Credit Constraints (MVCC) is defined as:

$$MVCC_t := \frac{1}{1-\nu_t/U_c(c_{u,t}, 0)}. \tag{13}$$

This statistic increases with the Lagrange multiplier $\nu_t \geq 0$ normalized by current marginal utility of unemployed agents. The tighter the credit constraint, the higher $MVCC_t$ and $MVCC_t \geq 1$. Combining the definitions of ν_t and of $MVCC_t$ yields:

$$U_c(c_{u,t}, 0) = \beta_t \times MVCC_t \times (1 + r_{t+1}) U_c(c_{e,t+1}, l_{e,t+1}). \tag{14}$$

Thus, $MVCC_t$ is the wedge between the return the agent would demand to save and the actual (market) return. $MVCC_t$ thus measures how much the market interest rate must rise to relax the credit constraints of unemployed agents. If credit constraints do not bind, the MVCC will equal one, because the agent already saves at the market interest rate.

The MVCC can be explicitly computed in this economy (see Appendix A):

$$MVCC_t = \frac{(1+2\varphi)^2}{(1+\varphi(1+\beta_{t+1}))\,(1+\varphi(1+\beta_t))}. \tag{15}$$

We can check that the $MVCC$ is time-varying only for discount factor shocks. As a consequence, for TFP shocks, RA and HA aggregate allocations have the same dynamics and the MVCC is constant. For discount factor shocks, the RA and HA aggregate allocations are divergent and the MVCC is time-varying.

To understand this outcome, we can prove the following result.

Lemma 1. *If the $MVCC_t$ is constant and $(Z_t)_{t\geq 0}$ and $(\beta_t)_{t\geq 0}$ are convergent, then the ratio of the marginal utilities of employed and unemployed workers, $U_c(c_{u,t}, 0)/U_c(c_{e,t}, l_{e,t})$, is constant.*

Lemma 1 shows that the dynamic properties of the MVCC determine how the aggregate shocks affect aggregate quantities in the HA economy and how the dynamic responses of RA and HA differ. When the MVCC is constant, ratios of marginal utilities are constant across states of the world and across time, which a well-known feature of complete market economies. This explains why in that case HA and RA economies share at the optimum a number of common properties. In particular, since TFP shocks imply constant MVCC, TFP shocks do not affect the ratio of marginal utilities. They play the same role in the HA economy as in the RA economy: they scale allocations. Since the scaling is proportional in the two economies, allocations of HA and RA economies are also proportional.[3]

Relation with the Discount Factor Wedge (DFW). Aggregate allocations in HA models can be interpreted as the equilibrium outcome of a RA model, augmented by the appropriate wedges . In particular, the *discount factor wedge* (DFW) scales the RA discount factor so that the allocation and interest rate in the HA economy emerge as the equilibrium outcome of the RA economy (Nakajima, 2005, Werning, 2015, Acharya and Dogra, 2021, and Berger et al., 2023). Formally, the DWF, denoted DFW_t, is defined through the Euler equation of a representative agent as: $U_c(C_t^{HA}, L_t^{HA}) = DFW_t \beta_t (1 + r_{t+1}^{HA}) U_c(C_{t+1}^{HA}, L_{t+1}^{HA})$, or after some algebra:

$$DFW_t = \frac{1 + \beta_{t+1} + 2(1 + 1/\varphi)}{1 + \beta_t + 2(1 + 1/\varphi)} \times \frac{1 + 2\varphi}{1 + \varphi\,(1 + \beta_{t+1})}. \tag{16}$$

[3] We can show that the scaling of TFP shocks depends only on production technology and preference parameters, which are identical in HA and RA economies.

The DWF measures variations in the aggregate consumption of all agents, both constrained and unconstrained, while the MVCC measures consumption variations when switching from unemployment to employment. This explains the difference in the analytical expressions. Although the proportional deviations of MVCC and DFW differ, both convey the same core piece of information in this simple model: they vary only with discount factor shocks, not TFP.[4]

To summarize, this simple model delivers two main results. First, optimal instrument dynamics and aggregate consumption in the HA model depend on the nature of the aggregate shock. Second, the MVCC captures the effect of macroeconomic shocks, and hence whether HA and RA models differ. These two results hold in the general model developed below.

3 A general framework with wage and price rigidities

We now explore the differences between optimal policy in HA and RA economies in a general setting.[5] The quantitative framework we consider relaxes the simplifying assumptions of the previous section. We study environments with both prices and wages rigidities, along with a rich fiscal structure and a monetary authority setting interest rates. The HA model features incomplete markets for idiosyncratic risk and credit constraint.

We consider a discrete-time economy populated by a continuum of size one of ex-ante identical agents. These agents are assumed to be distributed along a set J, with the non-atomic measure ℓ: $\ell(J) = 1$.[6]

3.1 Risk

Aggregate risks. Agents face an aggregate shock $(S_t)_t$. The shock is persistent but known at date 0 and should hence be considered as a MIT shock. The aggregate shock can affect the economy through different channels: the TFP of firms' production, Z_t; agents' discount factors, β_t; government public spending, G_t; or individual labor productivity levels, y_{it}. We specify the functional forms in the quantitative Section 5.

Idiosyncratic risk. Agents face idiosyncratic productivity risk. The productivity process, denoted y, follows a first-order Markov chain with transition matrix $(\pi_{yy'})_{y,y'}$ and takes value in a finite set $\mathcal{Y}$. With wage w and labor supply l, an agent with productivity y earns labor income wyl. In each period, the fraction of agents with productivity y is constant and denoted by n_y. We normalize average productivity to 1, i.e., $\sum_y n_{y\in\mathcal{Y}} y = 1$, where the y are the steady-state productivity levels. The history of idiosyncratic productivity shocks up to date t for agent i is denoted by $y_i^t = \{y_{i,0}, \ldots, y_{i,t}\}$, where $y_{i,\tau}$ is the productivity at date τ. In the case of

[4] In Appendix A, we show that the deviations of DFW_t and $MVCC_t$ are proportional, i.e., $\widehat{DFW}_t \propto \widehat{MVCC}_t$ iff labor supply is inelastic ($\varphi = 0$) or the steady-state discount factor is equal to 1 ($\beta = 1$). Thus, the statistics generally convey different information, though the quantitative message is similar when $\beta \approx 1$.

We report the MVCC in what follows because it provides a measure of the underlying friction in the economy, which is the binding credit constraint. We checked that the DFW provides similar interpretation.

[5] In a previous version of this paper, we solved the general model with capital, at the cost of more algebra. The qualitative results were the same and the quantitative results were very similar.

[6] We follow Green (1994) and assume that the law of large numbers holds.

uncertainty shock, we assume that agents face a temporary mean-preserving increase in the variance of idiosyncratic productivity level, explained in Section 5.

In the main text, we indeed primarily focus on two shocks: the TFP and the discount factors, as in the theoretical section. These two cases are sufficient to contrast Ramsey policies in HA and RA economies. Results for the public spending shock and the uncertainty shock are summarized in Section 5.5.

3.2 Preferences

Households are expected-utility maximizers with time-separable preferences and possibly time-varying discount factors. As in Section 2, the discount factor from $t+1$ to t is denoted $\beta_t \in (0,1)$, and the compounded discount factor from t to 0 by $\Theta_t = \Pi_{s=0}^{t-1}\beta_s$. In each period, households derive utility $U(c,l)$ from consuming the economy's unique consumption good c and experience disutility from supplying labor l. We further assume that in each period, the instantaneous utility is separable in consumption and labor: $U(c,l) = u(c) - v(l)$, where $u, v : \mathbb{R}_+ \to \mathbb{R}$ are twice continuously differentiable and increasing. Furthermore, u is concave, with $u'(0) = \infty$, and v is convex.

3.3 Taxes

We consider a rich fiscal system composed of four linear taxes, which can be viewed as a theoretical device to understand differences between HA and RA economies with both price and wage stickiness. Indeed, as shown in Section 3.8, this fiscal system is the minimal one required to ensure no deviation from price and wage stability in all cases. Although these taxes have empirical counterpart, they can also be seen as theoretical instruments to understand dynamic distortions, as we will consider various subsets of these taxes below. The first tax is a capital tax τ_t^K, levied on the interest payment of all assets.

The three other taxes affect labor. The total labor cost of the firm by efficient unit is denoted as $\tilde{W}_t$. The firms are paying a labor tax τ_t^E on this wage and this tax can be interpreted of as an *employer* social contribution. The post-employer-social contribution wage is denoted $\hat{W}_t = \tilde{W}_t(1-\tau_t^E)$. Second, workers pay additional social contribution τ_t^W (for *worker* social contribution). Their post-total-social contribution income is thus $\hat{W}_t(1-\tau_t^W) = \tilde{W}_t(1-\tau_t^E)(1-\tau_t^W)$. Finally, an income tax τ_t^L is levied on total labor income. The post-total tax labor tax, denoted W_t, is:

$$W_t = \tilde{W}_t(1-\tau_t^E)(1-\tau_t^W)(1-\tau_t^L) = \hat{W}_t(1-\tau_t^W)(1-\tau_t^L). \tag{17}$$

These three taxes operate on different margins and have different incidence. Based on empirical literature, we assume that workers bargain over $\hat{W}_t$.[7] This bargained wage can be sticky because of some adjustment cost, described below. As a consequence, the two social contributions have different direct economic effect.[8] Assume to simplify that $\hat{W}_t$ is fixed. τ_t^E

[7] The assumption on the incidence of the taxes, τ^W, τ^E, τ^L is based on the empirical literature (e.g., Saez et al., 2012 and Lehmann et al., 2013). An alternative specification would treat τ^L as a tax on all income, including capital income, at the cost of more algebra. However, results would remain unchanged., as the set of feasible optimal allocations would be identical.

[8] By *direct effect*, we refer to the partial equilibrium effect of each variable. In general equilibrium (with endogenous income), these taxes affect all variables through price variations.

has then a direct effect on employment for a given bargained wage $\hat{W}_t$, but not on the wage W_t, whereas τ_t^W has a direct effect on the post-tax wage W_t for a given wage $\hat{W}_t$, but no direct effect on employment. Finally, the income tax τ_t^L is not internalized by unions: It affects labor income but not the bargained wage. Overall, the three labor instruments (τ_t^W, τ_t^E and τ_t^L) are independent and non-redundant in the HA economy.

3.4 Production

The specification of the production sector follows the New-Keynesian literature on price stickiness, adapted to the tax structure described above. The consumption good Y_t is produced by a unique profit-maximizing representative firm that combines intermediate goods $(y_{j,t}^f)_j$ from different sectors indexed by $j \in [0,1]$ using a standard Dixit-Stiglitz aggregator with an elasticity of substitution ε_P: $Y_t = \left[\int_0^1 y_{j,t}^{f\,\frac{\varepsilon_P-1}{\varepsilon_P}} dj\right]^{\frac{\varepsilon_P}{\varepsilon_P-1}}$. For any intermediate good j, the production $y_{j,t}^f$ is realized by a monopolistic firm and sold at price $p_{j,t}$. Aggregate labor productivity Z_t is possibly affected by the aggregate shock S_t, where S_t will follow an AR(1) process. Intermediate firms face quadratic price adjustment costs à la Rotemberg, proportional to the magnitude of relative price changes: $\frac{\psi_P}{2}\left(\frac{p_{j,t}}{p_{j,t-1}} - 1\right)^2$. Denoting the price index by P_t, the price inflation rate by $\pi_t^P = \frac{P_t}{P_{t-1}} - 1$, the real marginal cost of labor by $\tilde{w}_t := \tilde{W}_t/P_t$, we obtain the standard Phillips curve:[9]

$$\pi_t^P(1+\pi_t^P) = \frac{\varepsilon_P - 1}{\psi_P}(\frac{1}{Z_t}\tilde{w}_t - 1) + \beta_t \mathbb{E}_t\left[\pi_{t+1}^P(1+\pi_{t+1}^P)\frac{Y_{t+1}}{Y_t}\right],\ Y_t = Z_t L_t. \tag{18}$$

With sticky prices, firms' profits, denoted Ω_t, are in general non zero and can be expressed as:

$$\Omega_t = \left(1 - \frac{1}{Z_t}\tilde{w}_t - \frac{\kappa}{2}(\Pi_t^P - 1)^2\right) Y_t. \tag{19}$$

3.5 Labor market: Labor supply and union wage decision

Following the New Keynesian sticky-wage literature, labor hours are supplied monopolistically by unions (Erceg et al., 2000; Chugh, 2006; Hagedorn et al., 2019; Auclert et al., 2024b among others). We adapt this environment to introduce the three labor taxes τ_t^E, τ_t^W and τ_t^L (see Appendix C for the details of the derivation). There is a continuum of unions of size 1 indexed by k. Each union k supplies L_{kt} hours of labor at date t with a nominal wage $\hat{W}_{kt}$, which is set to maximize the intertemporal welfare of union's members internalizing the labor demand by firms. We assume quadratic utility costs for the adjustment of the nominal wage: $\frac{\psi_W}{2}(\hat{W}_{kt}/\hat{W}_{kt-1} - 1)^2 dk$. The objective of union k is the sum of unweighted household utilities:[10]

$$\max_{(\hat{W}_{ks})_s} \mathbb{E}_t \sum_{s=t}^{\infty} \Theta_s \int_i \left(U(c_{i,s}, l_{i,s}) - \frac{\psi_W}{2}\left(\frac{\hat{W}_{ks}}{\hat{W}_{ks-1}} - 1\right)^2 \right) \ell(di),$$

[9] As is standard we assume subsidies for intermediate firms—financed out of lump sum taxes—to focus on the efficient steady state.

[10] We assume that unions are utilitarian. Considering alternative specifications (i.e. introducing additional weights) have no first-order effect on aggregate dynamics.

This maximization yields the New-Keynesian wage-Phillips curve:

$$\pi_t^W(\pi_t^W+1) = \frac{\varepsilon_W}{\psi_W}\underbrace{\left(v'(L_t) - \frac{\varepsilon_W - 1}{\varepsilon_W}(1-\tau_t^W)\hat{w}_t\int_i y_{i,t}u'(c_{i,t})\ell(di)\right)}_{\text{labor gap}}L_t + \beta_t\mathbb{E}_t\left[\pi_{t+1}^W(\pi_{t+1}^W+1)\right], \quad (20)$$

where $\pi_t^W = \frac{\hat{W}_t - \hat{W}_{t-1}}{\hat{W}_{t-1}}$ is the wage inflation rate, and $\hat{w}_t := \hat{W}_t/P_t$ is the real pre-tax wage. Note that the unions bargain over $\hat{w}_t$, which is costly to adjust. They internalize the effect of employees' social contribution τ_t^W, and the effect of employed social contribution τ_t^E through its effect on labor demand. The tax on total labor income appears in the budget constraint of the agents, and thus in the equilibrium level of consumption level $c_{i,t}$.

3.5.1 Real variables and inflation

To summarize, the net real interest rate and the real wages are defined as:

$$r_t := (1-\tau_t^K)\tilde{r}_t, \quad (21)$$

$$w_t := (1-\tau_t^L)(1-\tau_t^W)\hat{w}_t = (1-\tau_t^L)(1-\tau_t^W)(1-\tau_t^E)\tilde{w}_t. \quad (22)$$

Given that $\hat{W}_t/P_t = (W_t/(1-\tau_t^L)(1-\tau_t^W))/P_t = w_t/(1-\tau_t^L)(1-\tau_t^W)$, we derive the law of motion for the post-tax real wage as a function of inflation and taxes

$$(1+\pi_t^W)\frac{w_{t-1}}{(1-\tau_{t-1}^W)(1-\tau_{t-1}^L)} = \frac{w_t}{(1-\tau_t^W)(1-\tau_t^L)}(1+\pi_t^P). \quad (23)$$

3.6 Assets

The only asset is nominal public debt, with supply B_t at date t, paying a pre-determined before-tax nominal interest rate i_{t-1}. Public debt, issued by the government, is assumed to be default free. The real before-tax (net) interest rate for public debt, denoted by $\tilde{r}_t$, is defined by:

$$\tilde{r}_t = \frac{1+i_{t-1}}{1+\pi_t^P} - 1. \quad (24)$$

3.7 Agents' program

Each agent enters the economy with an initial endowment of public debt $a_{i,-1}$ and productivity level $y_{i,0}$. The joint initial distribution over public debt and productivity levels is Λ_0. In subsequent periods, agents learn their productivity $y_{i,t}$, supply labor, and earn savings payoffs. Since labor supply L_t is chosen by unions, post-tax labor income is $w_t y_{i,t} L_t$. The post-tax real financial payoff amounts to $r_t a_{i,t-1}$.

The agent's program can be finally be written as:

$$\max_{\{c_{i,t},a_{i,t}\}_{t=0}^{\infty}} \mathbb{E}_0 \sum_{t=0}^{\infty} \Theta_t U(c_{i,t}, L_t), \quad (25)$$

$$c_{i,t} + a_{i,t} = (1+r_t)a_{i,t-1} + w_t y_{i,t} L_t, a_{i,t}, \quad (26)$$

and subject to the credit constraint $a_{i,t} \geq -\underline{a}$, and the consumption positivity constraint $c_{i,t} > 0$. The notation $\mathbb{E}_0$ represents the expectation operator over idiosyncratic risk (as we consider a MIT shock). The solution to the agent's program is a sequence of functions, defined over $([-\bar{a};+\infty)\times\mathcal{Y})\times\mathcal{Y}^t\times\mathbb{R}^t$ and denoted by $(c_t,a_t)_{t\geq 0}$, such that:[11]

$$c_{i,t}=c_t((a_{i,-1},y_{i,0}),y_i^t,z^t),\; a_{i,t}=a_t((a_{i,-1},y_{i,0}),y_i^t,z^t). \tag{27}$$

For simplicity, we retain the i-index notation. Denoting by $\beta^t\nu_{i,t}$ the Lagrange multipliers of the credit constraint, the Euler equation corresponding to the agent's program (25) is:

$$u'(c_{i,t})=\beta_t\mathbb{E}_t\Big[(1+r_{t+1})u'(c_{i,t+1})\Big]+\nu_{i,t}. \tag{28}$$

with the complementary slackness condition:

$$a_{i,t}\geq -\overline{a}, \nu_{i,t}(a_{i,t}+\overline{a})=0,\;\; \nu_{i,t}\geq 0. \tag{29}$$

The Marginal Value of Cash Constraint (MVCC). As in Section 2, the MVCC for agent i is defined as $MVCC_{i,t}=(1-\nu_{i,t}/u'(c_{i,t}))^{-1}$. The Euler equation (28) of agent i becomes:

$$u'(c_{i,t})=\beta_t\mathbb{E}_t\Big[MVCC_{i,t}\times R_{t+1}u'(c_{i,t+1})\Big].$$

When agents are unconstrained, $MVCC_{i,t}=1$; and $MVCC_{i,t}\geq 1$. In the HA economy, there is a distribution of MVCC values. We will report the average MVCC which is defined as:[12]

$$MVCC_t=\int_i MVCC_{i,t}\ell(di).$$

3.8 Government and market clearing conditions

The financial market clearing condition and the economy's resource constraints are:

$$\int_i a_{i,t}\ell(di)=B_t, \tag{30}$$

$$\int_i c_{i,t}\ell(di)+G_t=\left(1-\frac{\psi_P}{2}(\pi_t^P)^2\right)Z_tL_t. \tag{31}$$

The government finances an exogenous public good expenditure G_t by raising the four taxes of Section 3.3 and issuing public debt (Section 3.6). The government also taxes firms' profits, Ω_t, which limits the distortions implied by profit distribution.[13] The government budget constraint

[11] See e.g. Miao (2006), Cheridito and Sagredo (2016), and Açikgöz (2018) for a proof of the existence of such functions.

[12] In this case with separable utility function, the DFW_t is defined as $u'(C_t)=\beta_t\mathbb{E}_t\Big[DFW_t\times R_{t+1}u'(C_{t+1})\Big]$, where C_t is the total consumption in the HA economy. The DFW_t is different from the $MVCC_t$ due to a Jensen inequality, and the time-varying correlation between $c_{i,t}$ and $MVCC_{i,t}$. We check that the difference is quantitatively small.

[13] Alternative modeling strategies could involve distributing profits to agents or introducing a fund that receives interest payments and profits (see LeGrand et al., 2025a for a discussion and references). We adopt the current assumption to simplify the algebra, as these alternatives yield quantitatively similar results.

can be expressed as:

$$G_t + \frac{1+i_{t-1}}{1+\pi_t^P} B_{t-1} \leq \Omega_t + B_t + \tau_t^L (1-\tau_t^W)\hat{w}_t L_t$$
$$+ \tau_t^K \tilde{r}_t \int_i a_{i,t-1}\ell(di) + \tau_t^W \hat{w}_t L_t + \tau_t^E \tilde{w}_t L_t.$$

Using the financial market clearing condition (30), the post-tax interest rate $\tilde{r}_t$ (24) and the post-tax rate definitions (21), we simplify the government budget constraint to:

$$G_t + r_t B_{t-1} + w_t L_t \leq \Big(1 - \frac{\psi_P}{2}(\pi_t^P)^2\Big) Y_t + B_t - B_{t-1}, \tag{32}$$

Equilibrium definition. We now formulate our definition of competitive equilibrium.

Definition 1 (Sequential equilibrium)**.** For any exogenous paths of aggregate shocks (S_t), characterizing TFP $(Z_t)_t$, public spending $(G_t)_t$, discount factors $(\beta_t)_t$, and productivity levels, $(\mathcal{Y}_t)_t$, a sequential competitive equilibrium is a collection of individual allocations $(c_{i,t}, a_{i,t}, \nu_{i,t})_{t\geq 0, i\in\mathcal{I}}$, aggregate quantities $(L_t, A_t, Y_t, \Omega_t)_{t\geq 0}$, price processes $(w_t, r_t, \tilde{r}_t, \hat{w}_t, \tilde{w}_t)_{t\geq 0}$, monetary policy $(i_t)_{t\geq 0}$, fiscal policies $(\tau_t^W, \tau_t^E, \tau_t^L, \tau_t^K, B_t)_{t\geq 0}$, and inflation dynamics $(\pi_t^W, \pi_t^P)_{t\geq 0}$ such that, for an initial wealth and productivity distribution $(a_{i,-1}, y_{i,0})_{i\in\mathcal{I}}$, and for an initial value of public debt satisfying $B_{-1} = \int_i a_{i,-1}\ell(di)$, we have:

1. given prices, the allocations $(c_{i,t}, a_{i,t}, \nu_{i,t})_{t\geq 0, i\in\mathcal{I}}$ solve the agent's optimization program (25)–(26);

2. financial and goods markets clear at all dates: for all $t \geq 0$, equations (30) and (31) hold;

3. the government budget is balanced at all dates: equation (32) holds for all $t \geq 0$;

4. firms' profits Ω_t are consistent with firms profit maximization of equation (19).

5. the price inflation path $(\pi_t^P)_{t\geq 0}$ is consistent with the price Phillips curve (18), while the wage inflation path $(\pi_t^W)_{t\geq 0}$ is consistent with the wage Phillips curve (20);

6. the real and nominal rates $(\tilde{r}_t, i_t)_{t\geq 0}$ verify (24);

7. post tax rates $(w_t, r_t, \tilde{r}_t, \hat{w}_t, \tilde{w}_t)_{t\geq 0}$ are defined in equations (21)–(22).

Social Welfare Function. We assume that the planner maximizes a generalized Social Welfare Function (SWF), where the weights ω on each period's utility can depend on the agent's current productivity. The planner's objective is:

$$W_0 = \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \Theta_t \left[\int_i \omega(y_t^i) U(c_t^i, l_t^i)\ell(di) - \frac{\psi_W}{2}(\pi_t^W)^2 \right] \right]. \tag{33}$$

This expression encompasses the utilitarian case, where $\omega(y) = 1$ for all y. This generalization of the standard SWF is now used either in both quantitative work (e.g., LeGrand and Ragot, 2025 and McKay and Wolf, 2022) and theoretical investigations as a deviation from the utilitarian case (see Dávila and Schaab, 2025). A theoretical foundation is provided in LeGrand et al. (2025b). We use it here to facilitate simulations and comparisons of economies in Section 5.[14]

We assume that the economy starts from a steady-state situation where the fiscal system is optimally determined. In period 0, the economy is hit by an aggregate shock affecting either G_t, Z_t, β_t or the productivity levels y_t. The entire path of these shocks is known in period 0, and the planner optimally sets its available instruments under commitment.

We have introduced five fiscal instruments $(\tau_t^W, \tau_t^E, \tau_t^L, \tau_t^K, B_t)_{t\geq 0}$. In what follows, we consider different fiscal systems, where only some fiscal instruments, rather than all, are available to the planner to smooth the effect of the aggregate shock. Specifically, we solve for optimal monetary policy considering subsets $\mathcal{I} \subset \{\tau^W, \tau^E, \tau^L, \tau^K\}$ of available fiscal instruments. Public debt is always optimally set, which is theoretically and empirically relevant in this environment. The set $\mathcal{I}$ is fixed and does not change across periods. For all other instruments $I \in \{\tau^W, \tau^E, \tau^L, \tau^K, B\} \backslash \mathcal{I}$, we assume that the instrument is constant and set to its steady-state value: $I_t = I_{ss}$ at all dates.

Ramsey equilibrium definitions. We start with the definitions when all instruments are available.

Definition 2 (Ramsey equilibrium)**.** For a given path of aggregate shocks $(S_t)_{t\geq 0}$, a Ramsey equilibrium with all instruments is the path of monetary policy $(i_t)_{t\geq 0}$, fiscal instruments $(\tau_t^W, \tau_t^E, \tau_t^L, \tau_t^K, B_t)_{t\geq 0}$, which selects a sequential equilibrium following Definition 1 and maximizing the SWF (33).

We turn to the steady state.

Definition 3 (Ramsey steady state)**.** A steady-state Ramsey equilibrium is a Ramsey equilibrium where aggregate real variables $(L_t, A_t, Y_t, \Omega_t, m_t)_{t\geq 0}$, prices $(w_t, r_t, \tilde{r}_t, \hat{w}_t, \tilde{w}_t)_{t\geq 0}$, monetary policy $(i_t)_{t\geq 0}$, fiscal policies $(\tau_t^W, \tau_t^E, \tau_t^L, \tau_t^K, B_t)_{t\geq 0}$, and inflation dynamics $(\pi_t^W, \pi_t^P)_{t\geq 0}$ are constant. The value of the instruments are denoted as $(\tau_{ss}^W, \tau_{ss}^E, \tau_{ss}^L, \tau_{ss}^K, B_{ss})$.

We then turn to the case of a limited set of instruments.

Definition 4 (Ramsey equilibrium with limited instruments)**.** For a given path of aggregate shocks $(S_t)_{t\geq 0}$ and a given set of available instruments $\mathcal{I} \subset \{\tau^W, \tau^E, \tau^L, \tau^K\}$, a Ramsey equilibrium with a limited number of instruments is the path of monetary policy $(i_t)_{t\geq 0}$, public debt $(B_t)_{t\geq 0}$, and fiscal instruments $\mathcal{I}$, which selects a competitive equilibrium maximizing the SWF (33) given that the unavailable instruments are set to their steady-state values: $I_t = I_{ss}$ for all $I \in \{\tau^W, \tau^E, \tau^L, \tau^K\} \setminus \mathcal{I}$.

We first solve the Ramsey model without aggregate shock to compute the steady-state values of instruments, $(\tau_{ss}^W, \tau_{ss}^E, \tau_{ss}^L, \tau_{ss}^K)$, and then we solve for the optimal dynamics of the available instruments. For the simulation of the dynamics for a given set of available instruments $\mathcal{I}$,

[14]The existence and the properties of a Ramsey steady state depend on both the SWF and the period utility function (Auclert et al., 2024a). Our specification ensures that a relevant Ramsey steady state exists. In LeGrand and Ragot (2025) we compute the optimal deviations from the Ramsey steady state for small aggregate shocks, in the GHH case. The effect of the nature of the SWF on these deviations is quantitatively very small.

observe that unavailable instruments are set to their steady-state value. Therefore, regardless of the choice of $\mathcal{I}$, the Ramsey equilibrium will feature the same steady-state allocation, as the aggregate shock is transitory.

4 Optimal policies with heterogeneous agents

4.1 Characterizing the Ramsey allocation

We derive optimal policies in HA economies for all aggregate shocks, given a set of available fiscal instruments $\mathcal{I}$. The Ramsey planner's program is:

$$\max_{(I_t:I\in\mathcal{I})_{t\geq 0},\left(w_t,r_t,L_t,B_t,\pi_t^P,\pi_t^W,(c_{i,t},a_{i,t},\nu_{i,t})_i\right)_{t\geq 0}} W_0 \tag{34}$$

where W_0 is defined by (33), and subject to the government budget constraint (32), the individual budget constraints (26), the individual Euler equations (28), the individual slackness conditions (29), the individual positivity constraints $c_t^i, l_t^i \geq 0$ (for given initial wealth a_{-1}^i), the price Phillips curve (18), the wage Phillips curve (20), the real wage dynamics (23), and that unavailable instruments verify $I_t = I_{ss}$ for all $I \notin \mathcal{I}$. We provide the full program in Appendix D, where we also derive the FOCss of the planner. We use aspects of Marcet and Marimon (2019) to write and factorize the Lagrangian. On a technical note, the factorization of the price and wage Phillips curve is straightforward, as both can interpreted as Euler-like equations, for firms and unions, respectively, what generalizes LeGrand and Ragot (2025).

We introduce the notion of *social valuation of liquidity (SVL) for agent i,* which represents the value to the planner of transferring one additional unit of the consumption good to agent i in period t.[15] From the Lagrangian denoted $\mathcal{L}$, we define the SVL $\psi_{i,t}$ as $\psi_{i,t} := \frac{\partial \mathcal{L}}{\partial c_{i,t}}$, which can also be expressed as:

$$\psi_{i,t} := \underbrace{\omega_t^i u'(c_{i,t})}_{\text{direct effet}} - \underbrace{\left(\lambda_{i,t} - (1+r_t)\lambda_{i,t-1}\right) u''(c_{i,t})}_{\text{effect on savings}} - \underbrace{\frac{\varepsilon_W - 1}{\psi_W}\gamma_{W,t}\frac{w_t y_{i,t} L_t}{1-\tau_t^L}u''(c_{i,t})}_{\text{effect on the bargained wage}}, \tag{35}$$

where $\Theta_t\lambda_{i,t}$ is the discounted Lagrange multipliers of the Euler equations (28) of agent i at date t—$\Theta_t$is the compounded discount factor—and $\Theta_t\gamma_{W,t}$ is the Lagrange multipliers on the wage Phillips curve (20).

Equation (35) decomposes the SVL into three terms. The first term, $\omega_t^i u'(c_{i,t})$, represents the private valuation of liquidity for agent i scaled by the planner's current weight for agent i. The second term in (35) reflects the impact of an additional unit of consumption on saving incentives from $t-1$ to t and from t to $t+1$. The third term captures the effect of the transfer on the unions' marginal incentives to bargain over wages and is hence proportional to the Lagrange multiplier γ_W.

This expression for $\psi_{i,t}$ holds for all HA economies we consider, regardless of the set of available instruments. We express all FOCs in terms of $\psi_{i,t}$ to simplify the algebra. The planner's FOCs depend on the specific set of available instruments, and we detail them in Appendix D.

[15] In LeGrand and Ragot (2025), we show that this statistics is related to the *Generalized Social Marginal Welfare Weights* (GSMWW) introduced by Saez and Stantcheva (2016).

Unlike the simple model of Section 2, we cannot explicitly express the value of the instruments as a function of the allocation. Instead, we derive general properties from the FOCs of the planner in Proposition 2 below and simulate the model to obtain quantitative results.

4.2 The equivalence result

We now state our main equivalence result.

Proposition 2 (An equivalence result)**.** *In the HA economy, when all instruments* $(\tau^L, \tau^E, \tau^W, \tau^K)$ *are optimally chosen, the planner exactly implements* $\pi_t^P = 0$ *and* $\pi_t^W = 0$*, for every path of aggregate shocks* $(S_t)_{t\geq 0}$*.*

Proposition 2 generalizes the equivalence result of Correia et al. (2008) and Correia et al. (2013) for RA economies and LeGrand et al. (2025a) for HA economy, to environments with both sticky prices and sticky wages. With this fiscal system, monetary policy only ensures stability after all aggregate shocks (i.e., TFP, public spending, discount factors, or uncertainty shocks), and the economy achieves the flexible price allocation. The proof is in Appendix D.2.

Relative to LeGrand et al. (2025a), we require two additional instruments (τ_t^L, τ_t^E), while introducing one additional nominal constraint, which is wage stickiness. The first labor tax τ^E enables the planner to "isolate" the pre-tax rate $\tilde{w}_t$ from the union wage. Removing τ^E links the factor price $\tilde{w}_t$ to the wage inflation path, forcing the planner to balance price inflation (determining $\tilde{w}_t$) against wage inflation (determining $\hat{w}_t$). The second labor tax τ_t^L allows the planner to set the labor supply optimally while closing the wage gap in the wage Phillips curve. Without τ^L, the planner faces a tradeoff between inefficient labor supply (due to union market power) and the cost of wage inflation. If either instrument is removed, Proposition 2 would no longer hold, and non-zero inflation in wages or prices would arise. Thus, Proposition 2 rationalizes our tax structure as the minimal tax system required for which optimal price stability.[16]

4.3 Simulating optimal policies in HA economies

We now provide a quantitative investigation of economies in which we vary the set of available fiscal instruments. We adapt the standard New Keynesian RA experiment to the HA case. We first solve for the optimal Ramsey policy at the steady state. We then assume that the economy starts from this Ramsey steady state and implement a period-0 transitory MIT shock to TFP or to discount factor. The magnitude of the economy's response to the shock depends both on the nature of the shock and on the planner's available instruments.

The steady state crucially depends on the SWF used in the Ramsey program and on the tools available to the planner. To ensure that all simulations start from the same steady state, we employ the inverse optimal taxation approach, as in Heathcote and Tsujiyama (2021) and LeGrand and Ragot (2025). We fix the steady-state fiscal instruments—$\tau^E = \tau^K = 0$, $\tau^L = 1/\varepsilon_w$ and $\tau^W > 0$—and estimate the SWF weights that rationalize this fiscal system as a steady-state

[16] More precisely, while other tax systems could also achieve price and wage stability—such as introducing a time-varying consumption tax, as in Correia et al. (2008)—the number of independent instruments would remain unchanged. We consider our tax system to be more realistic.

optimal Ramsey allocation. Each instrument generates a FOC, imposing a restriction on the SWF.[17] Nonetheless, because the number of weights exceeds the number of instrument FOCs, we select the SWF weights closest to the utilitarian benchmark (where all weights are equal) that satisfies these restrictions. We also verify that the choice of the SWF does not quantitatively affect the first-order dynamics of the allocation. We compute the SWF weights once, based on the full-instrument case, and hold them fixed across all fiscal sets. Setting unavailable instruments to their steady-state values and keeping the SWF unchanged ensure the steady-state allocation remains identical across cases.

Solving the Ramsey problem in HA models is computationally challenging because equilibrium involves a high-dimensional joint distribution across wealth and Lagrange multipliers.[18] To address this complexity, we apply the truncation method developed by LeGrand and Ragot (2022a) to approximate this joint distribution using finite idiosyncratic histories that are truncated to a given length N.[19] The accuracy of the method, both in the steady state and dynamics, has been analyzed in LeGrand and Ragot (2023). In addition, LeGrand and Ragot (2022b) propose an improvement to efficiently reduce the state space using a refined truncation. Further details in the present setup are provided in Appendix F.

We determine the steady-state values and SWF weights using the following algorithm:

1. Compute the steady-state allocation of the full-fledged Bewley model (with standard techniques) given realistic values of the fiscal instruments.

2. Construct the truncated representation of the economy by aggregating over truncated histories of length N.

3. Solve the steady-state Ramsey problem in the truncated economy and compute the SWF weights through the following steps:

    (a) Derive the planner's FOCs for each available instrument of $\mathcal{I}$ in the truncated representation.

    (b) If needed, estimate the SWF weights closest to unity that satisfy these FOCs.[20]

    (c) Compute the associated Lagrange multipliers.

4. Compute the optimal dynamics in the truncated economy using the planner's FOCs and the estimated SWF (with standard finite state space methods).

[17]This strategy ensures the existence of a consistent steady-state. An alternative approach would involve specifying a given SWF function and solving for the optimal Ramsey steady state. However, this method may yield unrealistic steady-state allocations (Auclert et al., 2024a or LeGrand and Ragot, 2025 for a discussion). As in standard New Keynesian models, optimal steady-state price and wage inflation rates are zero, regardless of the SWF. Consequently, steady-state price stability does not impose any additional restriction on the SWF.

[18]Optimizing simple rules in the spirit of Krusell and Smith (1998) is also difficult to implement due to the large number of independent instruments.

[19]For instance, we consider 10 idiosyncratic states, and the truncation length is $N = 8$. There are thus possibly, 10^8 different agents, as it is the number of idiosyncratic histories. The refined truncation of LeGrand and Ragot (2022b) is an efficient way to reduce this number, considering only relevant histories.

[20]The steady-state being the same regardless of $\mathcal{I}$, this step is only needed once. The SWF weights computed for a given $\mathcal{I}$ can be used for another set of instruments $\mathcal{I}'$.

4.4 The representative agent economy

We solve the same problem with a representative agent instead of the HA structure. For brevity, we present the problem and the FOCs in Appendix E, as the solution techniques are more standard. However, to the best of our knowledge, this problem has not been solved with such a rich fiscal structure.

5 Quantitative analysis of optimal policies

This section characterizes the differences between HA and RA allocations, as well as the deviations from price and wage stability. In each case, the economies differ only by the set of time-varying taxes available to the planner, while all other taxes remain at their steady-state values. The four tax instruments $(\tau^L, \tau^E, \tau^W, \tau^K)$ yield 15 subsets of time-varying tools (since $2^4 - 1 = 15$, as at least one tax must be adjustable to prevent public debt divergence). We examine the effects of four shocks (Z_t, β_t, G_t, y_t) in both RA and HA economies. Rather than presenting results for all these 120 combinations, we restrict attention to the economies that best clarify the relevant mechanisms.

Specifically, we contrast the implications of a TFP shock with those of a discount factor shock, extending the theoretical investigation in Section 2. These two shocks yield distinct implications for optimal policy. We analyze three policy environments: first, all fiscal instruments are available, $\mathcal{I}^{(1)} = (\tau^K, \tau^W, \tau^E, \tau^L)$; second, τ^W is held constant, $\mathcal{I}^{(2)} = (\tau^K, \tau^E, \tau^L)$; and third economy, τ^E is the only time-varying labor tax, $\mathcal{I}^{(3)} = (\tau^K, \tau^E)$. The rationale for this selection will become clear in the interpretation of the results. Section 5.5 discusses the effects of other missing instruments (notably τ^K) and of public spending and uncertainty shocks.

5.1 The calibration and steady-state distribution

The time period is a quarter. Table 1 summarizes the model parameters detailed below.

Aggregate shock. The aggregate shock (S_t) follows an AR(1) process, such that $S_t = \rho S_{t-1}$, where we set $\rho = 0.95$ to ensure the same persistence across all channels of the aggregate shock.

Technology and TFP shock. The production function is: $Y = ZL$. The TFP process is defined as $Z_t = \exp(z_0 S_t)$, where $z_0 \leq 0$ represents the initial negative TFP shock.

Preferences. The steady-state discount factor is $\beta = 0.99$, and the period utility function is: $\frac{c^{1-\sigma}-1}{1-\sigma} - \chi^{-1}\frac{l^{1+1/\varphi}}{1+1/\varphi}$. The Frisch elasticity of labor supply is set to $\varphi = 0.5$, which is the value recommended by Chetty et al. (2011) for the intensive margin in HA models. The scaling parameter is $\chi = 0.01$, which implies an aggregate labor supply of roughly one-third.

The process for β_t verifies $\beta_t = \beta \times \exp(b_0 S_t)$, where $b_0 \geq 0$ is a period-0 positive shock to the discount factor.

Idiosyncratic risk. We use a standard productivity process: $\log y_t = \rho_y \log y_{t-1} + \varepsilon_t^y$, with $\varepsilon_t^y \overset{\text{iid}}{\sim} \mathcal{N}(0, \sigma_y^2)$. We calibrate the persistence of the productivity process as $\rho_y = 0.994$ and the standard deviation as $\sigma_y = 0.06$. These values are consistent with empirical estimates (Krueger et al., 2018), and generate a steady-state Gini coefficient of wealth of 0.78, which aligns with the data.[21] Finally, we use the Rouwenhorst (1995) procedure to discretize the productivity process into 10 idiosyncratic states $\{y_1, \ldots, y_{10}\}$ with a constant transition matrix.

The idiosyncratic uncertainty shock, analyzed in Section 5.5, is implemented through a time-varying, mean-preserving change in idiosyncratic productivity. We define the date-t productivity as $y_{i,t} := y_i + (-1)^{1_{i\leq 5}} n_i^{-1} S_t v_0$, where $v_0 \geq 0$ is the initial variance shock, n_i is the share of agents with productivity y_i and $(-1)^{1_{i\leq 5}} = -1$ if $i \leq 5$ and 1 otherwise (recall that there are 10 productivity levels). This specification leaves the average productivity level unchanged but increases the variance. Low productivity levels decrease further, while high-productivity levels increase.

Steady-state taxes, public debt, and public spending shock. We first solve the model with constant exogenous taxes and explain the choice of the SWF below. We assume that employer social contributions and capital taxes are 0, $\tau^E = \tau^K = 0$.[22] The income tax τ^L is set to $\frac{1}{\varepsilon_W}$ to offset distortions on the labor market due to the monopoly power of unions. It ensures that at the steady state, labor supply is determined by $v'(L) = \hat{w} \int_i y_i u'(c_i)\ell(di)$. We assume $\tau^W = 16\%$. This value, combined with the value of public debt level described below, implies that public spending amounts to 18.8% of GDP, which is close to the US value in 2007. The amount of public debt (which is the only asset in this economy) is set to an annual value of 122% of GDP. Since public debt is the sole asset, we calibrate this level to achieve an average Marginal Propensity to Consume (MPC) of 0.3.[23]

The public spending shock, analyzed in Section 5.5, is defined as: $G_t = G \exp(g_0 S_t)$ where $g_0 \geq 0$ is the period-0 positive shock to public spending, G the steady-state public spending and S_t is the AR(1) aggregate shock defined above.

Monetary parameters. Following the literature, particularly Schmitt-Grohé and Uribe (2005), we assume that the elasticity of substitution is $\varepsilon_P = 6$ across goods and $\varepsilon_W = 21$ across labor types. The price adjustment cost is set to $\psi_P = 100$, such that the slope of the price Phillips curve is $\frac{\varepsilon_P - 1}{\psi_P} = 5\%$ (see LeGrand et al., 2025a, for a discussion and references). The wage adjustment cost is set to $\psi_W = 2100$, such that the slope of the wage Phillips curve is 1%, reflecting the assumption that wages are stickier than prices.[24] Since there is no steady-state inflation in prices or wages: $\pi^P = \pi^W = 0$, these coefficients only affect the dynamics.

Simulation parameters. We use the refined truncation approach, setting the refinement truncation length to $N = 8$. We check that the results do not depend on the choice of the

[21] The Gini coefficient of wealth is 0.78 using the SCF data in 2007, before the 2008 Great Recession.

[22] Setting a zero capital tax is necessary to facilitate the comparison between HA and RA models. In the latter, the optimal steady-state capital tax is 0 (when it exists), which is not necessarily the case in HA framework. See LeGrand and Ragot (2025) for a discussion.

[23] We thus adopt a liquid one-asset liquid wealth calibration to match a realistic MPC (Kaplan and Violante, 2022).

[24] Sensitivity analysis confirms that our qualitative results are robust to these values, although the volatility of price and wage inflation obviously increases with the slopes of Phillips curves.

truncation length. Consistent with LeGrand and Ragot (2022a), the truncation method provides accurate results.

Parameter	**Description**	**Value**	**Target**
	Preference and technology		
β	Discount factor	0.99	Quarterly calibration
σ	Curvature utility	2	
$\bar{a}$	Credit limit	0	
χ	Scaling param. labor supply	0.01	$L = 0.36$
φ	Frisch elasticity labor supply	0.5	Chetty et al. (2011)
	Shock process		
ρ_y	Autocorrelation idio. income	0.994	Krueger et al. (2018)
σ_y	Standard dev. idio. income	6%	$Gini = 0.78$
ρ_z	Autocorrelation TFP shock	0.95	
	Tax system		
τ^W	Worker social contribution	16%	$G/Y = 18.8\%$
τ^L	Income tax	4.76%	$1/\varepsilon_w$
τ^E, τ^K	Other tax	0%	
B/Y	Public debt over yearly GDP	122%	$MPC = 0.3$
G/Y	Public spending over yearly GDP	18.78%	Targeted
	Monetary parameters		
ε_p	Elasticity of sub. between goods	6	Schmitt-Grohé and Uribe (2005)
ψ_p	Price adjustment cost	100	Price PC 5%
ε_w	Elasticity of sub. labor inputs	21	Schmitt-Grohé and Uribe (2005)
ψ_w	Wage adjustment cost	2100	Wage PC 1%

Table 1: Parameter values for the baseline calibration. See the text for descriptions and calibration targets.

Calibration of the RA economy. The calibration of the RA economy retains the same preference parameters as in the HA economy. Allocations in the RA (resp., HA) economy are denoted with a superscript RA (HA). In the RA economy, the first-best allocation is achieved at the steady state. The steady-state labor supply, L^{RA} (with $\pi^W = 0$), is determined by the FOC: $v'(L^{RA}) = u'(ZL^{RA} - G^{RA})$. We set public spending in the RA economy, G^{RA}, such that the public-spending-to-GDP ratio is equalized across the two economies: $G^{RA}/Y^{RA} = G^{HA}/Y^{HA}$.

5.2 Economies with all instruments

We consider an economy where the planner has access to all fiscal instruments. Figure 1 displays the Impulse Response Functions (IRFs) of allocations and planner's instruments following either a transitory negative TFP shock or a transitory positive discount factor shock. Solid blue lines correspond to the HA economy and red dashed lines to the RA economy. We report the IRFs for nine key variables over 40 periods. Panel 1 shows aggregate consumption as a percentage proportional deviation from the steady state. The remaining panels plot variables in percentage level deviations in this order: price and wage inflation rates π^P and π^W, employer social contribution τ_t^E, the worker social contribution tax τ_t^W, the labor tax τ_t^L, the labor tax revenue-to-GDP, which is the sum of all revenues raised by labor tax instruments and normalized by GDP, defined as $\left(\tau_t^L(1-\tau_t^W)\hat{w}_t + \tau_t^W \hat{w}_t + \tau_t^E \tilde{w}_t\right) \frac{L_t}{Y_t}$, public debt-to-GDP, and the MVCC. We report the MVCC only for the HA economy, as the deviation of the MVCC in the RA economy is uniformly 0, because credit constraints never bind.

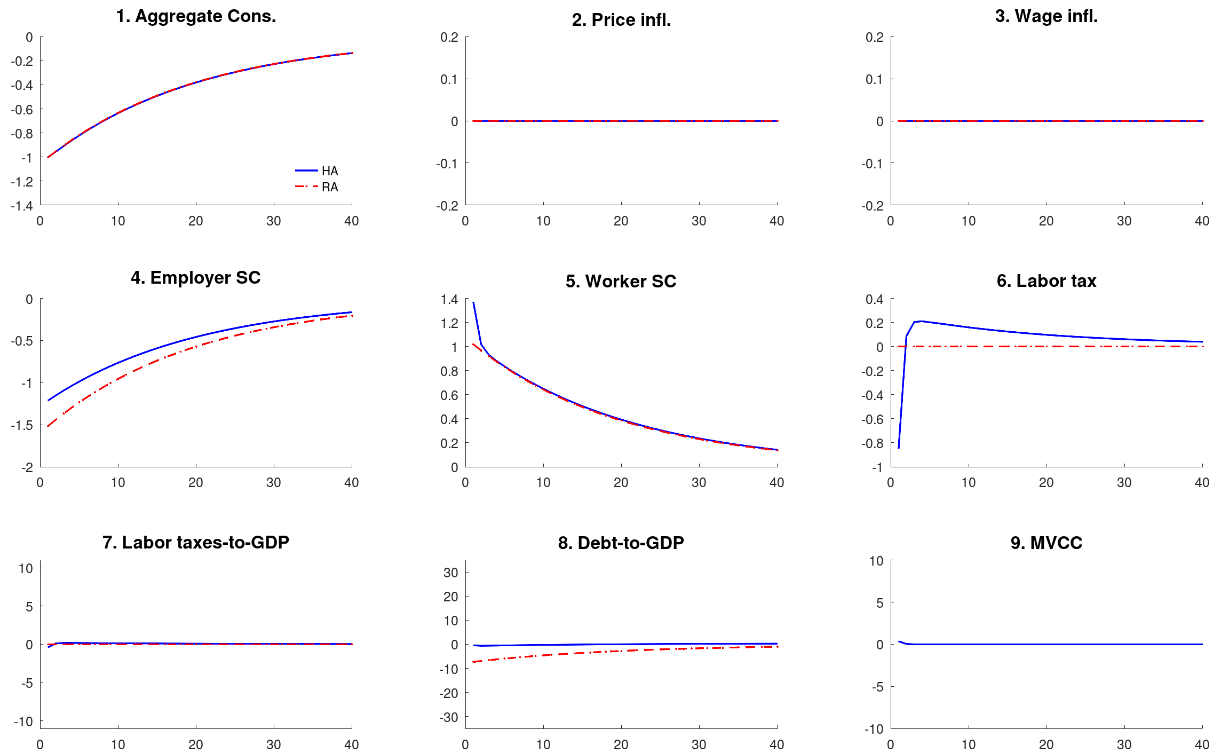
First, thanks to the availability of fiscal instruments, price and wage inflation rates remain at zero throughout the dynamics (see Figures 1a and 1b). This stability holds regardless of the shock origin, consistently with the equivalence result of Proposition 2. Second, the responses of labor taxes to GDP and public debt to GDP differ markedly across shocks. For TFP shocks, these variables remain virtually constant. In contrast, following a discount factor shock, both labor tax instruments react strongly on impact, in opposite direction, before converging back to zero in the HA economy. In the RA economy, labor taxes remain unchanged, but public debt increases strongly on impact, exceeding the increase in the HA economy.[25]

The pattern for aggregate consumption is also contrasted in the two economies. The response is identical in RA and HA economies after a TFP shock. However, following a discount factor shock, aggregate consumption does not react in the RA economy, but falls on impact before rapidly converging back to zero in the HA economy. The RA economy indeed implements the first-best allocation, which is independent of agents' discount factor; the interest rate adjusts to satisfy the Euler equation without affecting the allocation, and the public debt, determined by the government's budget constraint, scales proportionally to GDP.

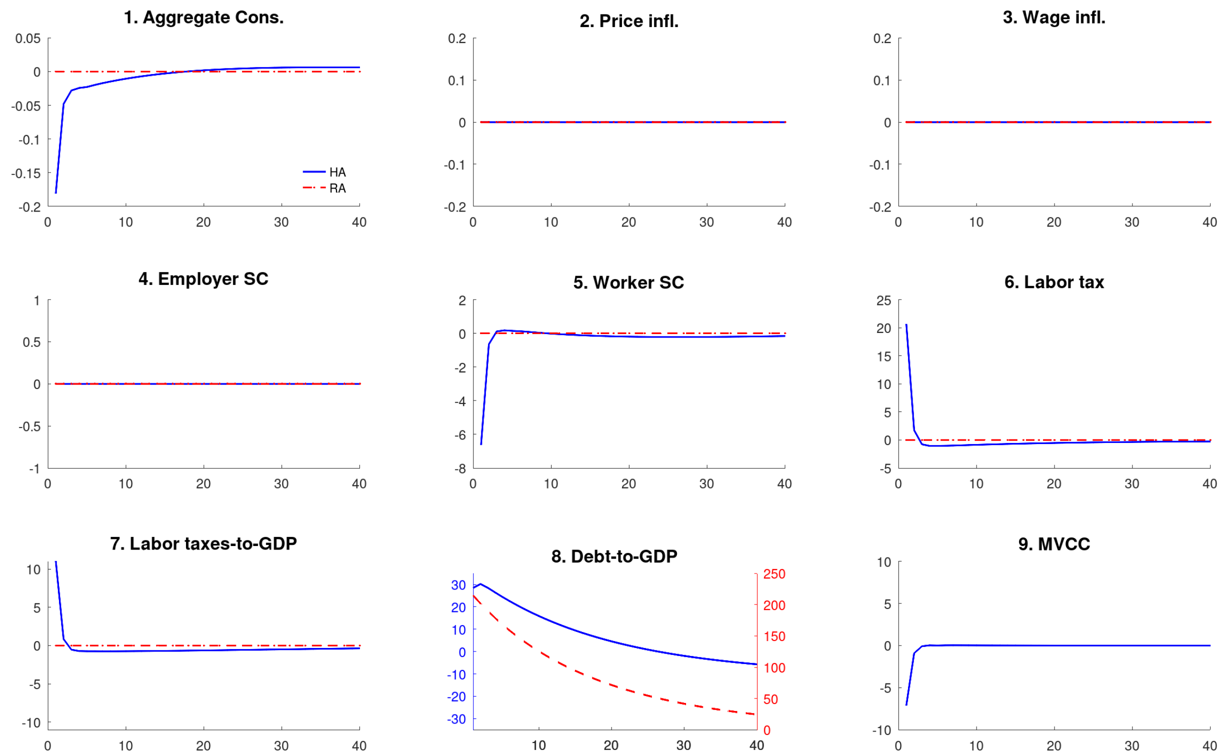
The results extend the insights from the simple model in Section 2. Under a TFP shock, the HA and RA economies share similar patterns: total labor taxes and public debt stay constant in proportion to GDP, and aggregate consumption responses are virtually identical. This confirms that the TFP shock has mostly an homogeneous scaling effect, that makes allocations in proportion to GDP almost unaffected by the shock. Under a discount factor shock, however, the implications differ substantially. In the HA economy, agents increased patience encourage them to save more. Because binding credit constraints make the economy non-Ricardian, these larger individual savings translate into lower aggregate consumption, explaining the drop on impact in Panel 1. Similarly, public debt must increase to accommodate the higher saving demand. As explained in Section 2, the MVCC (panel 9) serves as a sufficient statistic for the effect of the aggregate shock and thus for the divergence between HA and RA economies. The MVCC measures the tightness of the credit constraints and, thus, the degree to which the economy is non-Ricardian. For the TFP shock, the MVCC barely changes, explaining why it mostly has a scaling effect and allocation responses in HA and RA models nearly identical. For the discount factor shock, the MVCC responds strongly on impact, highlighting the quantitative importance of the non-Ricardian dimension, and why the shock also affects quantities-to-GDP ratios. HA and RA economies thus feature different responses.[26]

[25]Note that the debt-to-GDP panel features two different scales for HA and RA economies; the scale for the HA economy is unchanged across graphs and we only adapt here the scale for the RA case.

[26]A properly rescaled dynamics of the DFW, which we also computed, closely track the MVCC. As in the simple model, the two statistics convey quantitatively similar information.



(a) TFP shock.



(b) Discount factor shock.

Figure 1: Dynamics of the economy when all instruments are available, after a TFP and discount factor shock. The Heterogeneous-Agent economy (HA) is in blue and the Representative Agent (RA) is in red. Variables are in percentage level change, except aggregate consumption, which is in percentage proportional change.

Finally, the reaction of fiscal tools differs across economies and shocks. After TFP shocks, the planner substantially reduces the employer contribution (τ^E). This adjustment aligns the marginal cost and marginal productivity of labor, closing the labor wedge: Subsidizing labor demand mitigates the negative impact of the contraction. Conversely, the planner increases the worker social contribution (τ^W) by a comparable amount to prevent a change in the union-targeted wage and to avoid heavily distorting labor supply. These two sizable movements occur in both the HA and RA cases. Finally, the labor tax (τ^L) remains unaffected in the RA economy, where it is a redundant instrument.[27] After discount shocks, the employer social contribution does not move as it is not needed to close the labor wedge: cost of labor and the union target are constant here. However, ensuring price stability requires to decrease τ^W, which closes the gap between the marginal rate of substitution (between labor and consumption) and wage. Increasing τ^L allows to partly offset the sharp decrease of τ^W on households' budget constraints.

5.3 Economies when social contributions τ^E and τ^W are constrained

Figure 2 plots the responses of the HA and RA economies to TFP and discount factor shocks, when the planner is restricted to labor tax τ^L as its sole instrument. By construction, worker and employer social contributions (τ^W, τ^E) remain unchanged. This scenario can be seen as a standard case in the literature, as it is commonly assumed that the labor tax adjusts to balance the government budget.

The outcomes differ across the two shocks. First, for the TFP shock (Figure 2a), the real effects of the shock on aggregate consumption are similar in the HA and RA economies. This similarly extends to the responses of instruments (total labor tax and debt to GDP), a result corroborated by the negligible movement of the MVCC. Compared to the full-instrument case, the planner generates an inflation response in both prices and wages, though it remains similar across the HA and RA economies. Labor tax revenue to GDP also slightly responds on impact, although this response remains small and identical in HA and RA economies. Unlike in the full-instrument case, the labor tax τ^L sharply increases in the HA economy on impact, whereas it slightly decreased when all instruments were available. Labor tax and price inflation – lowering the real wage – substitutes for worker and employers social contribution τ^W and τ^E observed in the full-instrument case

Second, the discount factor shock (Figure 2b) yields different results. As in the full-instrument case, the responses differ between the HA and RA economies. This shock continues to have no impact on the RA economy, as reflected by the MVCC (which is zero). In the HA economy, however, consumption falls more steeply than in the full instrument case, highlighting the absence of τ^W and τ^E. In the full-instrument case, the worker social contribution sharply decreased, while the employer social contribution remained constant and the labor tax increased. Here, the inability to vary worker social contribution forces the labor tax to act as a substitute. Consequently, the planner must deviate from price and wage stability to compensate for the rigid worker social contribution. Finally, the public debt increases both in the RA and HA economies

[27] In the RA framework, individual and government budget constraints combine into a resource constraint, where the wage and the interest rates play no role. The wage rate w influences the Phillips curves (18)–(20) and the inflation consistency equation (23), analogously to $w/(1-\tau^L)$, making w and τ^L substitutes.

to smooth the effect of the change in taxes. The increase in the HA economy is however one order of magnitude smaller, as the demand for public debt is determined by self-insurance motives. In the RA economy, where Ricardian equivalence holds, public debt adjusts only to balance the budget of the government.

5.4 Economies when worker contribution τ^W and labor tax τ^L are constrained

Figure 3 displays the responses of the HA and RA economies to a TFP and a discount factor shock, when the employer contribution (τ^E) is the sole labor fiscal instrument available to the planner. By construction, worker social contribution (τ^W) and labor tax (τ^L) remain unchanged for both shocks.

The results differ markedly from the full-instrument case presented in Figure 1, and even from the scenario with only the labor tax (τ^L) in Figure 2. For both shocks, the responses differ between HA and RA economies, which is reflected in the MVCC. Additionally, the planner deviates from price and wage stability—for both shocks in the HA economy and for the TFP shock in the RA economy.

In response to the TFP shock, both price and wage inflations are used to implement a decline in the real wage following a negative TFP shock, reflecting that τ^E is not an effective instrument for the planner. This adjustment occurs in both the RA and HA economies, but the deviation from price stability is more pronounced in the HA economy. This experience suggests that when no efficient tax is available to reduce the labor wedge, i.e., the gap between the real wage and the marginal productivity of labor, then the planner relies on monetary policy, using price and wage inflations as substitutes for the missing instrument. This is corroborated by the slight decrease on impact of labor taxes-to-GDP. Public debt to GDP does not react much in the HA economy but it more volatile in the RA economy.

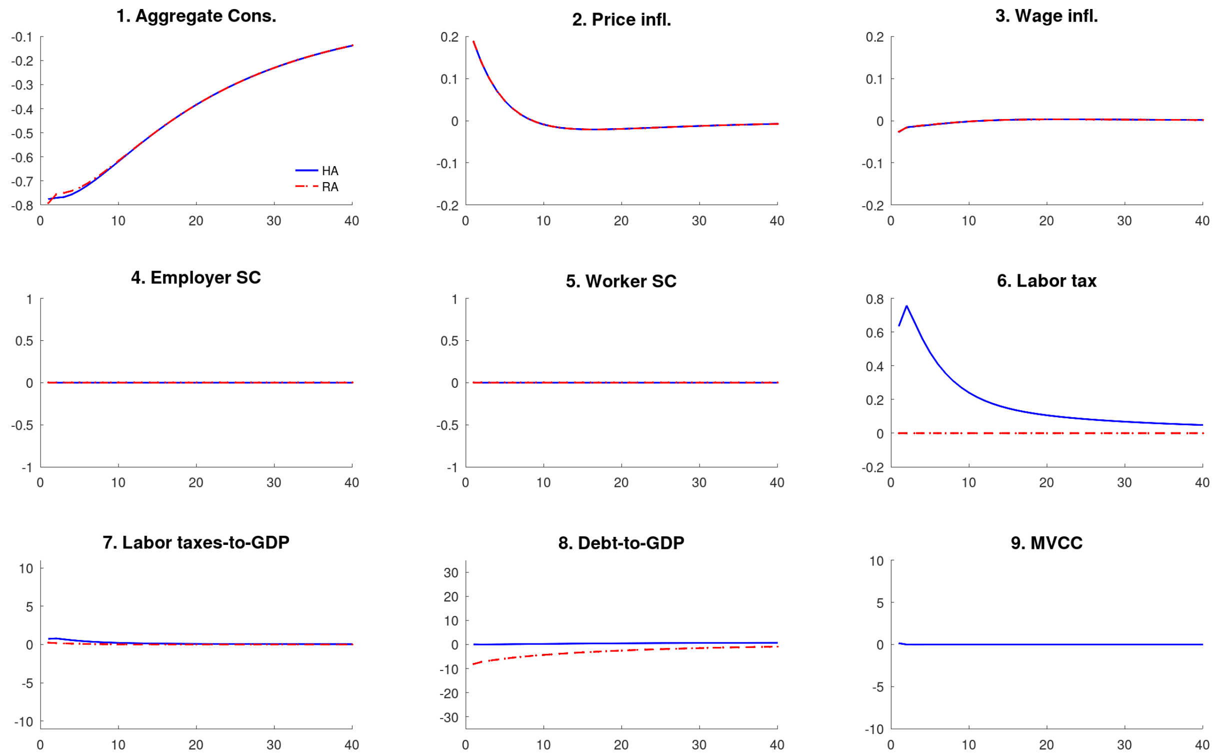
For the discount factor shock, both the allocation and the dynamics of price and wage inflation differ between the HA and RA economies. The planner implements an increase in the real wage, leveraging both price and wage inflation to achieve this adjustment. As for the TFP shock, the departure from price and wage stability is more pronounced in the HA economy, thereby illustrating that the absence of τ^W or τ^L is costlier. The labor taxes to GDP remain persistently below their long-term values, unlike the public debt to GDP that raises on impact to absorb this lower tax receipts. In the RA economy, the increase in public debt is again much higher than in the HA one.

In summary, we find that allocations, instruments, and price dynamics differ most significantly in response to the discount factor shock (which directly affects the MVCC), and also when no efficient labor tax is available to reduce the labor wedge.

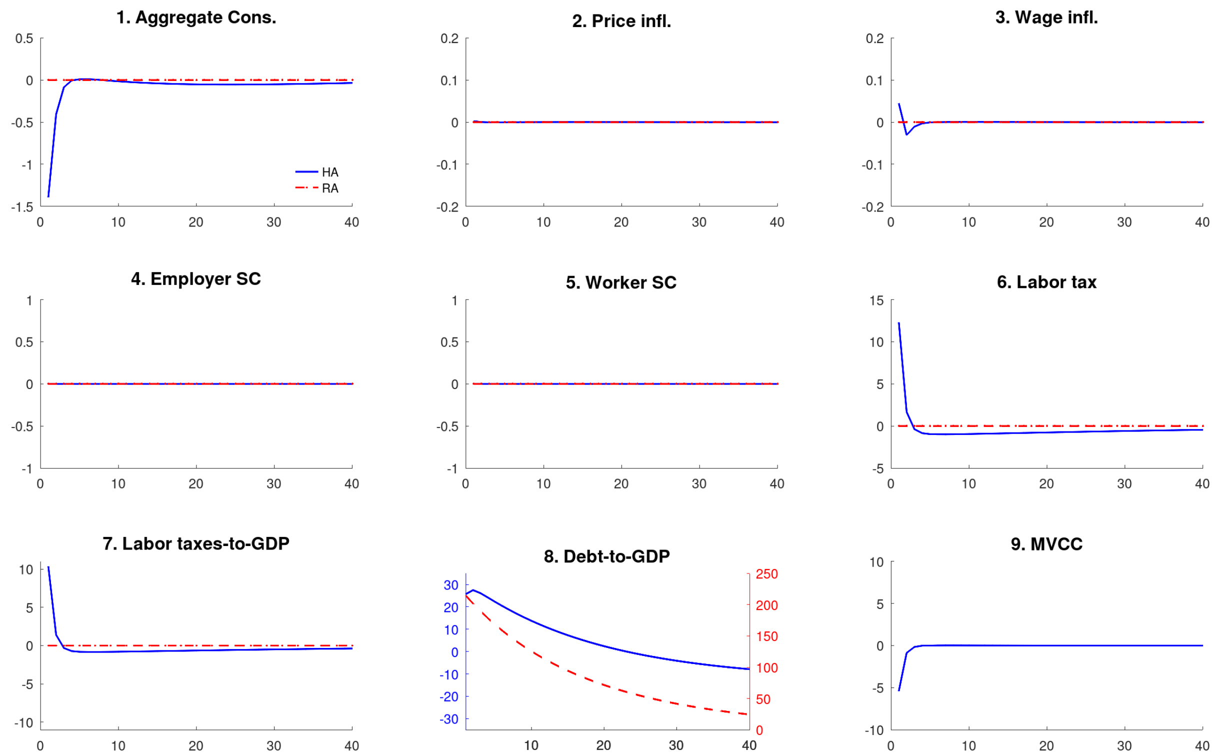
5.5 The effect of missing instruments and other shocks

We now present results from additional simulations. To save some space, we summarize key findings and refer to the IRFs in the Appendix.

First, we consider an economy in which the capital tax is held constant ($\tau_t^K = \tau_{ss}^K$), while the remaining labor fiscal instruments ($\tau_t^E, \tau_t^W, \tau_t^L$) are optimally time-varying (see Figure 4 in Appendix G). In the RA economy, optimal inflation remains zero, while, for the given calibration,

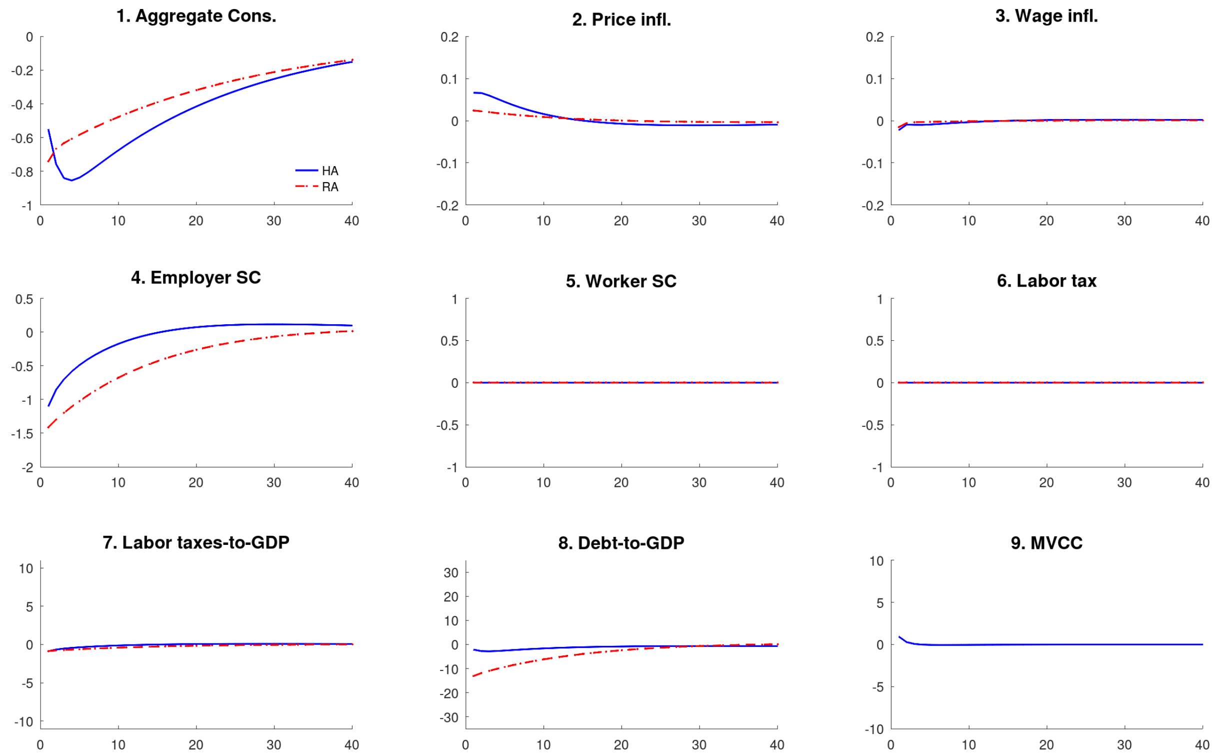


(a) TFP shock.

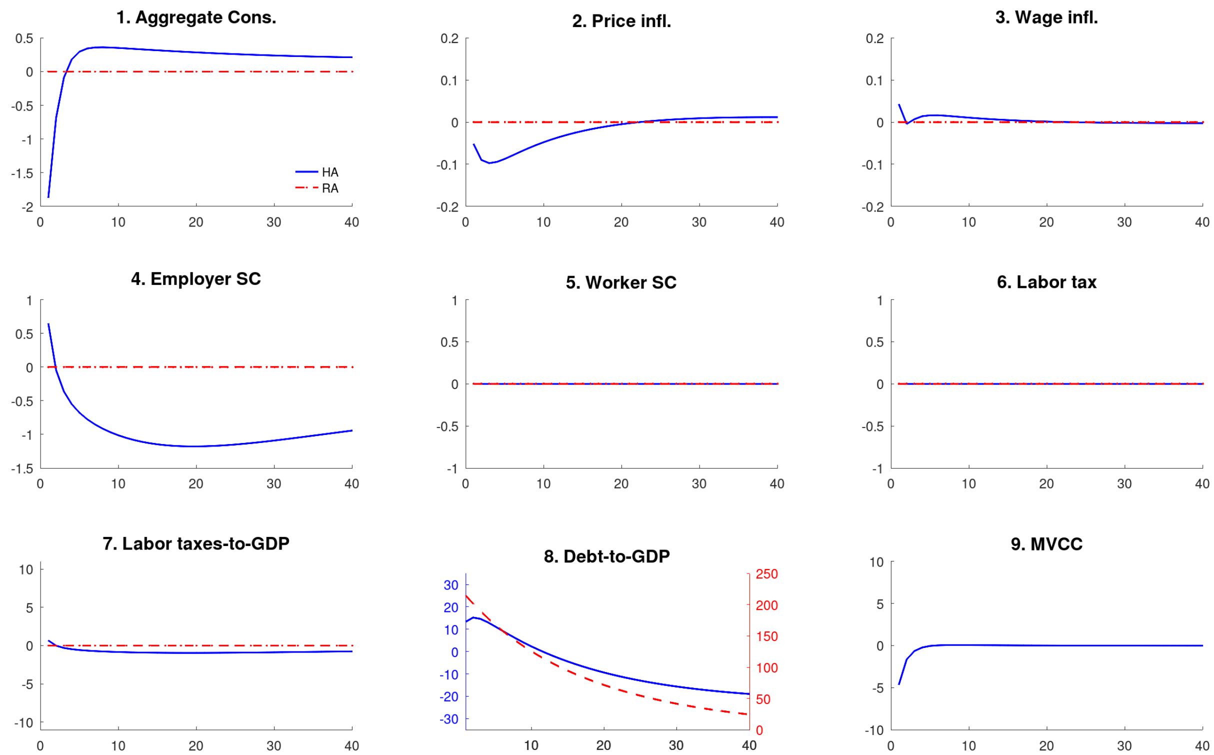


(b) Discount factor shock.

Figure 2: Dynamics of the economy when the labor tax τ^L is the only available fiscal instrument, following a TFP and a discount factor shock. The HA economy is represented in blue and the RA one in red. Variables are in percentage level change, except aggregate consumption, which is in percentage proportional change.



(a) TFP shock.



(b) Discount factor shock.

Figure 3: Dynamics of the economy when the employer social contribution τ^E is the only available labor fiscal instrument, following a TFP and a discount factor shock. The HA economy is represented in blue and the RA one in red. Variables are in percentage level change, except aggregate consumption, which is in percentage proportional change.

inflation in the HA economy moves slightly on impact. When we further reduce the coefficient of price stickiness from 100 to a low value of $\psi_p = 10$, the inflation – as expected – increases significantly on impact for one period. This spike in inflation acts as a substitute for the missing capital tax, as it lowers the real interest rate for one period through the Fisher effect, given its unexpected nature. Thus, inflation can substitute for the unavailable capital tax on impact, provided that prices are sufficiently flexible. This result aligns with the findings of LeGrand et al. (2025a).

Second, we implement the two other aggregate shocks: a public spending shock and a pure idiosyncratic uncertainty shock. The allocations after a public spending shock closely resemble those resulting from negative TFP shocks. This can be seen in Figure 5 of Appendix G.2. Conversely, the effects of the uncertainty shock mirror those of a discount factor shock, as both operate through the mechanism of a time-varying MVCC.[28] In the RA economy, this shock has no effect by construction, while in the HA economy, this shock induces time-varying precautionary saving, which directly affects the MVCC. This explains why the optimal paths of labor tax to GDP and of public debt to GDP, as well as of aggregate consumption, depart from their steady state values. A particularity of this aggregate shock is it is the sole aggregate risk for which public debt is more volatile in the HA economy than in the RA one. This comes from the fact that the uncertainty risk is completely mute in the RA economy: no RA variable, including public debt, reacts to this shock. Results are reported in Figure 6 of Appendix G.3.

6 Main lessons and conclusion

We have derived the optimal fiscal and monetary policy in an economies with both sticky prices and sticky wages. We compare RA and HA frameworks, considering a large range of fiscal systems, and aggregate shocks: TFP, discount factor, public spending, and idiosyncratic risk. As a benchmark, we first establish a complete fiscal system, where both price and wage inflation are optimally zero for any of those shocks. Our main result is that HA economies offer new insights into optimal stabilization policy, which are highly dependent on the nature of the shock and the set of available fiscal instruments.

More specifically, we derive four main lessons from our simulations. First, when the fiscal toolkit is sufficiently rich, allocations in HA and RA economies are very similar for both TFP and public spending shocks, but differ substantially in response to discount factor and idiosyncratic risk shocks. This is explained by MVCC – our sufficient statistics on the tightness of the credit constraint – differing accross shocks. Second, price and wage inflation responses act as imperfect substitutes for missing labor taxes to close the labor wedge. Third, optimal public debt response is always less volatile in HA economies than in RA ones, while being always more persistent. Debt plays very different roles in the two economies: in the HA economy, it provides a liquidity instrument and facilitate self-insurance, without no such role in RA economies. Finally, labor tax and worker social contribution are substitute instruments and are both reasonably effective in maintaining price and wage stability, as well as keeping the HA allocation close to the RA

[28] The effects of shocks affecting directly the credit constraint, as in Guerrieri and Lorenzoni (2017), would also have a similar direct effect on the MVCC.

one—at least for TFP shocks. Conversely, when those instruments are constrained, HA and RA allocations markedly differ for all shocks, and they depart from price and wage stability.

Our main policy take-away is that time-varying labor subsidies are valuable policy tools for reducing the labor wedge and act as non-Keynesian stabilizers. Indeed, these taxes help to stabilize the economy, but they do not affect aggregate demand, but instead reduce the wedge between the marginal productivity of labor and the real wage. Notably, such policies have been recently implemented in Europe, for instance, with Germany's *kurzarbeit* program and France's *activité partielle* scheme functioned as wage subsidies aimed at reducing layoffs during the Covid-19 crisis.

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Online Appendix

A Proof of Proposition 1

A.1 The HA case

The program of the planner in the economy with credit constraint (presented in Section 2) is—where $U(c,l) = \log(c - \frac{l^{1+1/\varphi}}{1+1/\varphi})$ is of the GHH form:

$$\max_{(c_{e,t},c_{u,t},a_{e,t},a_{u,t},l_{e,t}B_t,A_t,R_t,w_t)} \sum_{t=0}^{\infty} \Theta_t \Big(U(c_{e,t}, l_{e,t}) + U(c_{u,t}, 0) \Big) \tag{36}$$

$$\text{s.t. } c_{e,t} + a_{e,t} = (1+r_t)a_{u,t-1} + w_t l_{e,t}, \tag{37}$$

$$c_{u,t} + a_{u,t} = (1+r_t)a_{e,t-1}, \tag{38}$$

$$U_c(c_{e,t}, l_{e,t}) = \beta_t(1+r_{t+1})U_c(c_{u,t+1}, 0), \tag{39}$$

$$U_c(c_{u,t}, 0) \geq \beta_t(1+r_{t+1})U_c(c_{e,t+1}, l_{e,t+1}), \text{ with equality if } a_{u,t} > 0, \tag{40}$$

$$-U_l(c_{e,t}, l_{e,t}) = w_t U_c(c_{e,t}, l_{e,t}), \tag{41}$$

$$(1+r_t)B_{t-1} + w_t l_{e,t} = Z_t l_{e,t} + B_t. \tag{42}$$

$$A_t = B_t = a_{e,t} + a_{u,t}, \tag{43}$$

$$a_{e,t}, a_{u,t} \geq 0, \; c_{e,t}, c_{u,t} > 0 \text{ and } l_{e,t}, l_{u,t} \geq 0. \tag{44}$$

We guess-and-verify that the equilibrium with a binding credit constraint for unemployed agent exists. We thus set $a_{u,t} = 0$. The Euler conditions (39) and (40) imply that this is equivalent to $\beta R < 1$ at the steady state. We show below that it is indeed the case.

If $a_{u,t} = 0$, using the GHH property, the FOC for labor supply is $l_t = w_t^{\varphi}$. The Euler equation (39) of employed agents implies the following optimal savings:

$$a_{e,t} = \frac{\beta_t}{1+\beta_t}\frac{1}{1+\varphi} w_t^{1+\varphi}. \tag{45}$$

Combining the savings and labor expressions with the budget constraints (37) and (38) yields:

$$c_{e,t} = (1-\eta_t)x_t, \; c_{u,t} = (1+r_t)\eta_{t-1}x_{t-1}, \; c_{e,t} - \frac{l_{e,t}^{1+1/\varphi}}{1+1/\varphi} = \left(\frac{1}{1+\varphi} - \eta_t\right)x_t, \; L_t = x_t^{\frac{\varphi}{1+\varphi}}. \tag{46}$$

where we have defined $\eta_t := \frac{1}{1+\varphi}\frac{\beta_t}{1+\beta_t}$ and $x_t := w_t^{1+\varphi}$. Using $B_t = a_{e,t}$—coming from (43)—, the government budget constraint (42) becomes: $(1+r_t)\eta_{t-1}x_{t-1} = Z_t x_t^{\frac{\varphi}{1+\varphi}} - x_t + \eta_t x_t$. Using the above relationships, we deduce that the Ramsey program (36)–(44) becomes:

$$\max_{(R_t,x_t)} \sum_{t=0}^{\infty} \Xi_t \Big(\log x_t + \log(1+r_t) + \log x_{t-1} \Big) \tag{47}$$
$$- \sum_{t=0}^{\infty} \Xi_t \mu_t \left((1+r_t)\eta_{t-1}x_{t-1} - Z_t x_t^{\frac{\varphi}{1+\varphi}} + x_t - \eta_t x_t \right),$$

where $\Xi_t \mu_t$ is the Lagrange multiplier on the government budget constraint. The Ramsey allocation is characterized by the two FOCs associated to the Lagrangian (47) and the budget constraint (42), forming a system with three unknowns:

$$(1+\beta_{t+1})\,\frac{1}{x_t} = \mu_t\left(-Z_t\frac{\varphi}{1+\varphi}x_t^{-\frac{1}{1+\varphi}} + 1 - \eta_t\right) + \beta_{t+1}(1+r_{t+1})\mu_{t+1}\eta_t, \tag{48}$$

$$1 = (1+r_t)\mu_t\eta_{t-1}x_{t-1}, \tag{49}$$

$$(1+r_t)\eta_{t-1}x_{t-1} = Z_t x_t^{\frac{\varphi}{1+\varphi}} - (1-\eta_t)x_t. \tag{50}$$

Shifting (49) by one period and using it with (50) and (46) yields:

$$c_{u,t} = (1+r_t)\eta_{t-1}x_{t-1} = x_t\frac{1-\eta_t}{1+2\varphi}, \qquad \frac{c_{e,t}}{c_{u,t}} = 1+2\varphi. \tag{51}$$

We also deduce that the aggregate consumption $C_t^{HA} := c_{e,t}+c_{u,t}$ verifies: $C_t^{HA} = \frac{1+\varphi}{1/2+\varphi}(1-\eta_t)x_t$. Using the resource constraint stating that in the absence of public spending, we have: $C_t^{HA} = Z_t L_t$, or using the previous expression of C_t^{HA} and the expressions in (46):

$$x_t = \left(\frac{1+\varphi}{1/2+\varphi}\right)^{-(1+\varphi)}(1-\eta_t)^{-(1+\varphi)}Z_t^{1+\varphi}. \tag{52}$$

This gives in turn aggregate consumption:

$$C_t^{HA} = \left(\frac{1/2+\varphi}{1+\varphi}\right)^{\varphi}(1-\eta_t)^{-\varphi}\,Z_t^{1+\varphi}. \tag{53}$$

Steady-state interest rate. At the steady state, $Z_t = 1$ and equation (51) readily implies: $1+r = \frac{1+(1+\beta)\varphi}{1+2\varphi}\times\frac{1}{\beta} < \frac{1}{\beta}$: Credit constraints are binding at the steady state.

Path of the instruments. We can recover the path of τ_t^L, from the definition $x_t = w_t^{1+\varphi} = Z_t^{1+\varphi}(1-\tau_t^L)^{1+\varphi}$ and from the expression (52). One finds $\tau_t^L = \frac{1}{2}\frac{1-\beta_t}{1+\varphi(1+\beta_t)}$. The dynamics of the public debt to GDP ratio is defined by $\frac{B_t}{Y_t} = \frac{a_{e,t}}{Z_t x_t^{\frac{\varphi}{1+\varphi}}} = \frac{\eta_t x_t}{Z_t x_t^{\frac{\varphi}{1+\varphi}}} = \frac{\eta_t}{Z_t}x_t^{\frac{1}{1+\varphi}}$, or $\frac{B_t}{Y_t} = \frac{1/2+\varphi}{1+\varphi}\frac{\beta_t}{1+\varphi(1+\beta_t)}$. The path of post tax real interest rate is, from equations (51) and (52):

$$1+r_t = \frac{1}{1+2\varphi}\frac{1+\varphi(1+\beta_{t-1})}{\beta_{t-1}}\left(\frac{1+\varphi(1+\beta_{t-1})}{1+\varphi(1+\beta_t)}\frac{1+\beta_t}{1+\beta_{t-1}}\right)^{\varphi}\frac{Z_t^{1+\varphi}}{Z_{t-1}^{1+\varphi}}.$$

Expressions of the MVCC and DFW. The MVCC uses the expression of the Lagrange multiplier on the credit constraint of unemployed agents: $\nu_t = c_{u,t}^{-1} - \beta_t(1+r_{t+1})\left(c_{e,t+1} - \frac{l_{e,t+1}^{1/\varphi+1}}{1+1/\varphi}\right)^{-1}$. With (46), (51), and (52), we have: $\frac{\nu_t}{c_{u,t}^{-1}} = 1 - \frac{1}{(1+2\varphi)^2}\frac{1-\eta_{t+1}}{\frac{1}{1+\varphi}\frac{1}{1+\beta_{t+1}}}\frac{1-\eta_t}{\eta_t/\beta_t}$. Since $MVCC_t = \left(1-\frac{\nu_t}{c_{u,t}^{-1}}\right)^{-1}$, we find the expression (15) of the main text. Since $\beta_t \in (0,1)$, $MVCC_t > 1$.

The discount factor wedge (DFW) is defined as: $DFW_t = \frac{1}{\beta_t(1+r_{t+1}^{HA})}\frac{C_{t+1}^{HA} - \frac{l_{e,t+1}^{1+1/\varphi}}{1+1/\varphi}}{C_t^{HA} - \frac{l_{e,t}^{1+1/\varphi}}{1+1/\varphi}}$ (since $L_t^{HA} = l_{e,t}$). With (39), (46), (51)–(53), we obtain after some algebra the expression (16).

Relationship between MVCC and DFW. We have the following result.

Result 1. We assume the steady-state value of the discount factor is positive: $\beta > 0$. We have the following results regarding the comparison between MVCC and DFW.

1. The steady-state values of MVCC and DFW are equal to each other iff $\varphi = 0$ or $\beta = 1$,

2. The log deviations of MVCC and DFW are proportional to each other iff $\varphi = 0$ or $\beta = 1$.

Proof. We start with the steady-state values. We have from (15) and (16) that $MVCC = DFW$ iff $\frac{1+\varphi(1+\beta)}{1+2\varphi} = 1$, or $\varphi(1-\beta) = 0$. This proves the first point.

For log-deviations, we have: $\widehat{MVCC}_t = -\frac{\varphi\beta}{1+\varphi(1+\beta)}(\widehat{\beta_{t+1}} + \widehat{\beta}_t)$, and:

$$\widehat{DFW}_t = -\left(\frac{\varphi\beta}{1+\varphi(1+\beta)} - \frac{\varphi\beta}{2(1+\varphi)+\varphi(1+\beta)}\right)\widehat{\beta_{t+1}} - \frac{\varphi\beta}{2(1+\varphi)+\varphi(1+\beta)}\widehat{\beta}_t.$$

Thus, $\widehat{MVCC}_t$ and $\widehat{\beta_t^{wedge}}$ are proportional when $\varphi\beta = 0$ or when (assuming $\varphi, \beta > 0$) $\frac{1}{1+\varphi(1+\beta)} - \frac{1}{2(1+\varphi)+\varphi(1+\beta)} = \frac{1}{2(1+\varphi)+\varphi(1+\beta)}$,which corresponds to $\beta = 1$. $\square$

Optimal allocation in the RA economy In the RA economy, the planner can implement the first-best allocation, as the Euler equation only pins down the interest rate. For the sake of comparison with the HA economy, we assume that the RA economy is composed of a homogeneous population of size 2 endowed with a average productivity of $\frac{1}{2}$—which is the average productivity in the HA economy. We denote by C_t^{RA} and L_t^{RA} the aggregate consumption and labor supply. Note that C_t^{RA} is twice the individual consumption, while L_t^{RA} is the individual labor supply. The planner's program writes then as:

$$\max_{(C_t^{RA}, L_t^{RA})} 2\sum_{t=0}^{\infty} \Xi_t \log\left(\frac{C_t^{RA}}{2} - \frac{L_t^{RA,1+1/\varphi}}{1+1/\varphi}\right), \quad \text{s.t. } C_t^{RA} \qquad = Z_t L_t^{RA}.$$

Denoting by μ_t^{RA} the Lagrangian multiplier on the resource constraint, the FOCs are:

$$\left(\frac{C_t^{RA}}{2} - \frac{L_t^{RA,1+1/\varphi}}{1+1/\varphi}\right)^{-1} = \mu_t^{RA}, \qquad 2L_t^{RA,1/\varphi}\left(\frac{C_t^{RA}}{2} - \frac{L_t^{RA,1+1/\varphi}}{1+1/\varphi}\right)^{-1} = Z_t\mu_t^{RA},$$

which imply $L_t^{RA,1/\varphi} = \frac{Z_t}{2}$ or with the resource constraint: $C_t^{RA} = \frac{1}{2^\varphi} Z_t^{\varphi+1}$. Using the expression of C_t^{HA} in (53), we deduce $\frac{C_t^{HA}}{C_t^{RA}}$ of Proposition 1.

B Proof of Lemma 1

With constant MVCC, combining (14) and employed agents' Euler equation implies:

$$U_c(c_{u,t}, 0) = MVCC \times \beta_t R_{t+1} U_c(c_{e,t+1}, l_{e,t+1}),$$
$$U_c(c_{e,t}, l_{e,t}) = \beta_t R_{t+1} U_c(c_{u,t+1}, 0),$$

or $\frac{U_c(c_{e,t},l_{e,t})}{U_c(c_{u,t},0)} = \frac{1}{MVCC} \frac{1}{\frac{U_c(c_{e,t+1},l_{e,t+1})}{U_c(c_{u,t+1},0)}}$. Because (i) the model's equations are identical in every period, (ii) only current technology Z_t enters production at time t, and (iii) the two agent types e, u at time t carry preference parameters $(\beta_t,\, \beta_{t-1})$, the date-t equilibrium conditions form a stationary system, whose solution yields time-homogeneous policy functions $(c_{e,t}, c_{u,t}, l_{e,t}) = (c_e(Z_t, \beta_t, \beta_{t-1}), c_u(Z_t, \beta_t, \beta_{t-1}), l_e(Z_t, \beta_t, \beta_{t-1}))$.

We denote $m(Z_t, \beta_t, \beta_{t-1}) := \frac{U_c(c_{e,t}, l_{e,t})}{U_c(c_{u,t}, 0)}$, verifying: $m(Z_{2t}, \beta_{2t}, \beta_{2t-1}) = m(Z_{2t+2}, \beta_{2t+2}, \beta_{2t+1})$ and $m(Z_{2t-1}, \beta_{2t-1}, \beta_{2t-2}) = m(Z_{2t+1}, \beta_{2t+1}, \beta_{2t})$. Thus, $m(Z_{2t}, \beta_{2t}, \beta_{2t-1}) = m(Z_0, \beta_0, \beta_{-1})$ and $m(Z_{2t+1}, \beta_{2t+1}, \beta_{2t}) = m(Z_1, \beta_1, \beta_0)$. Since the limits of $(Z_t)_{t\geq 0}$ and $(\beta_t)_{t\geq 0}$ exist, m is constant.

C Derivation of the wage-Phillips curve

There is a continuum of unions of size 1 indexed by k and each union k supplies L_{kt} hours of labor with nominal wage $\hat{W}_{kt}$. Union-specific labor supplies are then aggregated into aggregate labor supply by a competitive technology featuring a constant elasticity of substitution ε_W:

$$L_t = \left(\int_k L_{kt}^{\frac{\varepsilon_W - 1}{\varepsilon_W}} dk \right)^{\frac{\varepsilon_W}{\varepsilon_W - 1}}. \tag{54}$$

The competitive aggregator demands the union labor supplies $(L_{kt})_k$ that minimize the total labor cost $\int_k \hat{W}_{kt} L_{k,t} dk$ subject to the aggregation constraint (54), where $\hat{W}_{kt}$ is the bargained nominal wage of the members of union k. The demand for labor of union k depends on the total labor cost paid by the firm $\tilde{W}_{kt}$: $L_{kt} = \left(\frac{\tilde{W}_{kt}}{\tilde{W}_t}\right)^{-\varepsilon_W}$, where $\tilde{W}_t = \left(\int_k \tilde{W}_{kt}^{1-\varepsilon_W} dk\right)^{\frac{1}{1-\varepsilon_W}}$ is the total nominal wage index. Total labor demand can be expressed as:

$$L_{kt} = \left(\frac{\hat{W}_{kt}}{\hat{W}_t} \right)^{-\varepsilon_W} L_t, \tag{55}$$

where $\hat{W}_t = \left(\int_k \hat{W}_{kt}^{1-\varepsilon_W} dk\right)^{\frac{1}{1-\varepsilon_W}}$ is the bargained nominal wage index. Each union k sets its wage $\hat{W}_{kt}$ so as to maximize the intertemporal welfare of its members subject to fulfilling the demand of equation (55). Due to the presence of quadratic utility costs related to the adjustment of the nominal wage, $\frac{\psi_W}{2}(\hat{W}_{kt}/\hat{W}_{kt-1} - 1)^2 dk$, the objective of union k is thus:

$$\max_{(\hat{W}_{ks})_s} \mathbb{E}_t \sum_{s=t}^{\infty} \beta^s \int_i \left(u(c_{i,s}) - v(l_{i,s}) - \frac{\psi_W}{2} \left(\frac{\hat{W}_{ks}}{\hat{W}_{ks-1}} - 1 \right)^2 \right) \ell(di),$$

subject to (55) and where $c_{i,t}$ and $l_{i,t}$ are the consumption and labor supply of agent i. The FOC with respect to W_{kt} thus writes as:

$$\pi_t^W(\pi_t^W + 1) = \frac{\hat{W}_{kt}}{\psi_W} \int_i \left(u'(c_{i,t}) \frac{\partial c_{i,t}}{\partial \hat{W}_{kt}} - v'(l_{i,t}) \frac{\partial l_{i,t}}{\partial \hat{W}_{kt}} \right) \ell(di) + \beta \mathbb{E}_t \left[\pi_{t+1}^W(\pi_{t+1}^W + 1) \right], \tag{56}$$

where the wage inflation rate is denoted by: $\pi_t^W = \frac{\hat{W}_{k,t}}{\hat{W}_{k,t-1}} - 1$. The labor supply l_{it} of agent i is the sum of her hours l_{ikt} supplied to union k, summed over all unions: $l_{it} = \int_k l_{ikt} dk$. Each union is assumed to request uniform number of hours: $l_{ikt} = L_{kt}$. We thus have from (55):

$$\hat{W}_{kt} \frac{\partial l_{i,t}}{\partial \hat{W}_{kt}} = \hat{W}_{kt} \frac{\partial \left(\int_k \left(\frac{\hat{W}_{kt}}{\hat{W}_t}\right)^{-\varepsilon_W} L_t dk\right)}{\partial \hat{W}_{kt}} = -\varepsilon_W L_{kt}. \tag{57}$$

To compute the derivative of consumption $\frac{\partial c_{i,t}}{\partial \hat{W}_{kt}}$, it should observed that it is equal to the derivative of its net total income, $(1-\tau_t^W)\hat{W}_{kt}y_{i,t}l_{i,t}/P_t$, where τ_t^W is the labor tax. Formally:

$$\hat{W}_{kt}\frac{\partial c_{i,t}}{\partial \hat{W}_{kt}} = (1-\varepsilon_W)(1-\tau_t^W)\hat{W}_{kt}y_{i,t}l_{i,t}/P_t \tag{58}$$

We focus on the symmetric equilibrium $\hat{W}_{kt} = \hat{W}_t$, hence $l_{it} = L_t$. Combining (56) with (57) and (58) yields the Phillips curve for wage inflation of equation (20).

D Ramsey program for HA models

D.1 The HA economy with all instruments

As in the RA case, we express the Ramsey program in post-tax terms. We begin with the general case, in which all instruments are available to the planner: $\mathcal{I}_f = (\tau_t^L, \tau_t^S, \tau_t^E, \tau_t^K, B_t, \pi_t^P, \pi_t^W, w_t, r_t, L_t, (c_{i,t}, a_{i,t}, \nu_{i,t})_i)_{t\geq 0}$. We turn to missing tools below.

$$\max_{\mathcal{I}_f}\sum_{t=0}^{\infty}\beta^t\int_i \omega(y_{i,t})\left(u(c_{i,t})-v(L_t)\right)\ell(di) - \frac{\psi_W}{2}(\pi_t^W)^2, \tag{59}$$

$$\beta^t\mu_t\colon G_t + (1+r_t)\int_i a_{i,t-1}\ell(di) + w_tL_t + T_t \leq \Big(1-\frac{\psi_P}{2}(\pi_t^P)^2\Big)Z_tL_t + \int_i a_{i,t}\ell(di), \tag{60}$$

$$\text{for all } i\in\mathcal{I}\colon\ c_{i,t} + a_{i,t} = (1+r_t)a_{i,t-1} + w_ty_{i,t}L_t, \tag{61}$$

$$a_{i,t} \geq -\overline{a}, \nu_{i,t}(a_{i,t}+\overline{a}) = 0,\ \nu_{i,t}\geq 0, \tag{62}$$

$$\beta^t\lambda_{i,t}\colon\quad u'(c_{i,t}) = \beta\mathbb{E}_t\Big[(1+r_{t+1})u'(c_{i,t+1})\Big] + \nu_{i,t}, \tag{63}$$

$$\beta^t\gamma_{W,t}\colon \pi_t^W(1+\pi_t^W) = \frac{\varepsilon_W}{\psi_W}\Big(v'(L_t) - \frac{\varepsilon_W-1}{\varepsilon_W}\frac{w_t}{1-\tau_t^L}\int_i y_{i,t}u'(c_{i,t})\ell(di)\Big)L_t + \beta\pi_{t+1}^W(1+\pi_{t+1}^W), \tag{64}$$

$$\beta^t\gamma_{P,t}\colon \pi_t^P(1+\pi_t^P) = \frac{\varepsilon_P-1}{\psi_P}\Big(\frac{w_t}{Z_t(1-\tau_t^L)(1-\tau_t^W)(1-\tau_t^E)} - 1\Big) + \beta\pi_{t+1}^P(1+\pi_{t+1}^P)\frac{Z_{t+1}L_{t+1}}{Z_tL_t}, \tag{65}$$

$$\beta^t\Lambda_t\colon (1+\pi_t^W)\frac{w_{t-1}}{(1-\tau_{t-1}^L)(1-\tau_{t-1}^W)} = \frac{w_t}{(1-\tau_t^L)(1-\tau_t^W)}(1+\pi_t^P), \tag{66}$$

$$\Xi_0\colon (1+\pi_0^P)r_0 = (1-\tau_0^K)(i_{-1}-\pi_0^P), \tag{67}$$

where we specify the associated Lagrange multiplier at the beginning of the line. The constraint (67) on the capital tax is explicit, for date 0 only. As for $t\geq 1$, capital tax τ_t^K and nominal interest rate i_{t-1} are redundant the constraint has been removed from the program for $t\geq 1$.

We write the Lagrangian with all constraints and factorize it following LeGrand and Ragot (2022a). In all FOCs of the planner, we take the derivatives of $c_{i,t}$ as a function of the relevant variables. We thus use the SVL, $\psi_{i,t} := \frac{\partial \mathcal{L}}{\partial c_{i,t}}$, defined in (35) and $\hat{\psi}_{i,t} := \psi_{i,t} - \mu_t$, equal to the SVL of agent i net of the cost of the resource for the planner. As discussed in LeGrand and Ragot (2025), if the government had a complete set of tools, it would set $\hat{\psi}_{i,t} = 0$, for all i and all $t\geq 0$. The FOCs are ($1_{t=0} = 1$ if $t=0$, 0 otherwise).

$$(\pi_t^W)\ 0 = -\psi_W\pi_t^W - (\gamma_{W,t}-\gamma_{W,t-1})(2\pi_t^W+1) + \Lambda_t\frac{w_{t-1}}{(1-\tau_{t-1}^L)(1-\tau_{t-1}^W)}, \tag{68}$$

$$(\pi_t^P)\ 0 = (\gamma_{P,t} - \gamma_{P,t-1})(2\pi_t^P + 1) + \mu_t \psi_P \pi_t^P + \frac{\Lambda_t}{Z_t L_t} \frac{w_t}{(1-\tau_t^L)(1-\tau_t^W)} - \Xi_0(r_0 + 1 - \tau_0^K)1_{t=0}, \tag{69}$$

$$(a_{i,t})\ \hat{\psi}_{i,t} = \beta(1+r_{t+1})\hat{\psi}_{i,t+1} \text{ for unconstrained agents, } \lambda_{i,t} = 0 \text{ otherwise,} \tag{70}$$

$$(r_t)\ 0 = \int_i a_{i,t-1}\hat{\psi}_{i,t}\ell(di) + \int_i \lambda_{i,t-1}u'(c_{i,t})\ell(di) + \Xi_0(1+\pi_0^P)1_{t=0}, \tag{71}$$

$$and (w_t)\ 0 = \int_i y_{i,t}\left(\hat{\psi}_{i,t} - \gamma_{W,t}\frac{\varepsilon_W - 1}{\psi_W}\frac{1}{1-\tau_t^L}u'(c_{i,t})\right)\ell(di) + \frac{1}{L_t(1-\tau_t^L)(1-\tau_t^W)}\left(\frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{L_t}{1-\tau_t^E} - \Lambda_t(1+\pi_t^P) + \beta\Lambda_{t+1}(1+\pi_{t+1}^W)\right), \tag{72}$$

$$(L_t)\ v'(L_t) = w_t \int_i y_i \hat{\psi}_{i,t}\ell(di) + \mu_t\Big(1 - \frac{\psi_P}{2}(\pi_t^P)^2\Big)Z_t + \frac{\varepsilon_W}{\psi_W}\gamma_{W,t}\left(v''(L_t)L_t + v'(L_t) - \frac{\varepsilon_W - 1}{\psi_W}\frac{1}{1-\tau_t^L}\int_i y_{i,t}u'(c_{i,t})\ell(di)\right) - (\gamma_{P,t} - \gamma_{P,t-1})\pi_t^P(1+\pi_t^P)Z_t + \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\left(\frac{w_t}{(1-\tau^W)(1-\tau_t^L)(1-\tau_t^E)} - Z_t\right), \tag{73}$$

$$(\tfrac{1}{1-\tau_t^W})\ 0 = \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{1}{1-\tau_t^E}L_t - \Lambda_t(1+\pi_t^P) + \beta\mathbb{E}_t\left[\Lambda_{t+1}(1+\pi_{t+1}^W)\right], \tag{74}$$

$$(\tfrac{1}{1-\tau_t^E})\ 0 = \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{w_t}{(1-\tau^W)(1-\tau_t^L)}L_t, \tag{75}$$

$$(\tfrac{1}{1-\tau_t^L})\ 0 = \gamma_{W,t}\frac{\varepsilon_W - 1}{\psi_W}\int_i y_{i,t}u'(c_{i,t})\ell(di) - \frac{1}{L_t(1-\tau_t^W)}\left(\frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{L_t}{1-\tau_t^E} - \Lambda_t(1+\pi_t^P) + \beta\mathbb{E}_t\left[\Lambda_{t+1}(1+\pi_{t+1}^W)\right]\right), \tag{76}$$

$$(\tau_1^K)\ 0 = \Xi_1. \tag{77}$$

D.2 Proof of Proposition 2

With all instruments, (74)–(76) yield $\gamma_{W,t} = \gamma_{P,t} = 0$. In words, wage and price Phillips curves are not constraints of the planner's program anymore. Consider an allocation $(\tau_t^W, \tau_t^L, B_t, \pi_t^P, \pi_t^W, w_t, r_t, L_t, (c_{i,t}, a_{i,t}, \nu_{i,t})_i)_{t\geq 0}$ with non-zero inflation rates (for a set T of time indices: $\pi_t^P \neq 0$ and $\pi_t^W \neq 0$ for $t \in T$, with $(1+\pi_t^W)\frac{w_{t-1}}{(1-\tau_{t-1}^W)(1-\tau_{t-1}^L)} = \frac{w_t}{(1-\tau_t^W)(1-\tau_t^L)}(1+\pi_t^P)$). Note that tax rate τ^E plays no role, since Phillips curves are not constraints any more. Consider the allocation $(\tilde{\tau}_t^W, \tau_t^L, B_t, \pi_t^P, \tilde{\pi}_t^W, w_t, r_t, L_t, (c_{i,t}, a_{i,t}, \nu_{i,t})_i)_{t\geq 0}$, differing only along the inflation rate $\tilde{\pi}^W$ and tax rate $\tilde{\tau}^W$. We define: $\tilde{\pi}_t^W = 0$ for all t, $\tilde{\tau}_0^W = 0$ and $1 - \tilde{\tau}_t^W = (1 - \tilde{\tau}_{t-1}^W)\frac{1-\tau_{t-1}^L}{1-\tau_t^L}\frac{w_t}{w_{t-1}}(1+\pi_t^P)$ for $t \geq 1$. This allocation is feasible and implies a strictly larger welfare than the initial one (because of the zero wage inflation). We thus deduce that for any optimal allocation, $\pi_t^W = 0$. The FOC (68) on π^W implies $\Lambda_t = 0$, which in turn gives using the FOC (69) on π^P that $\pi_t^P = 0$.

D.3 The HA economy with missing instruments

When some instruments from $\{(\tau_t^E, \tau_t^W, \tau_t^L)_t, \tau_0^K\}$ are missing, the corresponding Ramsey FOCs is dropped and replaced by an equality stating the missing instrument is set to its steady-state value. All other FOCs are identical to their counterpart in the full-instrument case.

E Characterization of the Ramsey allocation in the RA case

E.1 First-best allocation

The first-best allocation is simply characterized by: $\max_{L_t} u(Z_tL_t - G_t) - v(L_t)$, or:

$$Z_t u'(Z_tL_t - G_t) = v'(L_t). \tag{78}$$

At the steady state with $u'(c) = c^{-\sigma}$ and $v'(L) = \chi^{-1}L^{1/\varphi}$, we have $\chi(L - G_t)^{-\sigma} = L^{1/\varphi}$ or with $g := G/Y = G/L$: $\chi(1-g)^{-\sigma} = L^{1/\varphi+\sigma}$.

E.2 FOCs with all tools

Using the resource constraint instead of the government budget, the Ramsey program is:

$$\max_{\left(\tau_t^E,\tau_t^W,\tau_t^L,B_t,\pi_t^P,\pi_t^W,w_t,r_t,L_t,c_t,a_t\right)_{t\geq 0}} \sum_{t=0}^{\infty} \beta^t \left(u(c_t) - v(L_t)\right) - \frac{\psi_W}{2}(\pi_t^W)^2, \tag{79}$$

$$G_t + c_t \leq \Big(1 - \frac{\psi_P}{2}(\pi_t^P)^2\Big) Z_tL_t, \tag{80}$$

$$c_t + a_t = (1+r_t)a_{t-1} + w_tL_t, \tag{81}$$

$$u'(c_t) = \beta(1+r_{t+1})u'(c_{t+1}), \tag{82}$$

$$\pi_t^W(\pi_t^W+1) = \frac{\varepsilon_W}{\psi_W}\Big(v'(L_t) - \frac{\varepsilon_W - 1}{\varepsilon_W}\frac{w_t}{1-\tau_t^L}u'(c_t)\Big)L_t + \beta\pi_{t+1}^W(\pi_{t+1}^W+1), \tag{83}$$

$$\pi_t^P(1+\pi_t^P) = \frac{\varepsilon_P - 1}{\psi_P}\Big(\frac{1}{Z_t}\frac{w_t}{(1-\tau_t^W)(1-\tau_t^L)(1-\tau_t^E)} - 1\Big) + \beta\pi_{t+1}^P(1+\pi_{t+1}^P)\frac{Z_{t+1}L_{t+1}}{Z_tL_t}, \tag{84}$$

$$(1+\pi_t^W)\frac{w_{t-1}}{(1-\tau_{t-1}^W)(1-\tau_{t-1}^L)} = \frac{w_t}{(1-\tau_t^W)(1-\tau_t^L)}(1+\pi_t^P), \tag{85}$$

where we have used the financial market clearing condition $a_t = B_t$. Observe that $(a_t)_t$ and $(r_t)_t$ only play a role in equations (81) and (82) and are thus determined by the allocation $(w_t, L_t, c_t)_{t\geq 0}$—independently of which fiscal instrument is available.

More precisely, $(r_t)_{t\geq 1}$ is pinned down by the Euler equation from $(c_t)_t$. Then public debt $(B_t)_t$ (equal to savings $(a_t)_t$) is deduced from the budget constraint (81): for all $t \geq 0$, $B_t = \sum_{s=t+1}^{\infty} \frac{c_s - w_sL_s}{\prod_{\tau=t+1}^{s}(1+r_\tau)}$. The date-0 interest rate (or the capital tax rate) adjusts to balance the date-0 constraint (B_{-1} is given): $1 + r_0 = \frac{c_0 - w_0L_0 + B_0}{B_{-1}}$.

We can thus drop equations (81) and (82) from the constraints of the Ramsey program, as well as $(a_t)_t$ and $(r_t)_t$ from the planner's instruments. It is then apparent that the tax τ^L and the wage w only play a role in the Ramsey program through $\frac{w}{1-\tau^L}$, meaning that both instruments are redundant. We will thus drop the tax τ^L from planner's instrument set.

We denote by $\beta^t\mu_t$, $\beta^t\gamma_t^W$, $\beta^t\gamma_t^P$, and $\beta^t\Lambda_t$ the Lagrange multipliers on the resource constraint (80), the wage and price Phillips curves (83)–(84), and the price-wage inflation relationship (85), respectively. We define the SVL ψ_t in the context of the RA economy as:

$$\psi_t := \frac{d\mathcal{L}}{dc_t} = u'(c_t) - \frac{\varepsilon_W - 1}{\psi_W}\gamma_{W,t}\frac{w_t}{1-\tau_t^L}L_tu''(c_t), \tag{86}$$

whose expression is much simpler than in the HA case because the Euler equation has been dropped from the constraints of the Ramsey program. The expressions of the Lagrangian and the SVL hold regardless of the set of available labor taxes.

When all instruments are available (but τ^L, which is redundant with w), we deduce the following set of FOCs. We report for each FOC the relevant instrument at the start of the line.

$$(\pi_t^W)\ 0 = -\psi_W \pi_t^W - (\gamma_{W,t} - \gamma_{W,t-1})(2\pi_t^W + 1) + \Lambda_t \frac{w_{t-1}}{(1-\tau_{t-1}^L)(1-\tau_{t-1}^W)}, \tag{87}$$

$$(\pi_t^P)\ 0 = -(\gamma_{P,t} - \gamma_{P,t-1})(2\pi_t^P + 1) - \mu_t \psi_P \pi_t^P - \frac{\Lambda_t}{Z_t L_t} \frac{w_t}{(1-\tau_t^L)(1-\tau_t^W)}, \tag{88}$$

$$(r_t)\ 0 = \psi_t - \mu_t, \tag{89}$$

$$\begin{aligned}(w_t)\ 0 = &-\frac{\varepsilon_W - 1}{\psi_W}\gamma_{W,t}\frac{1}{1-\tau_t^L}u'(c_t) \\ &+ \frac{1}{L_t}\frac{1}{(1-\tau_t^L)(1-\tau_t^W)}\left(\frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{L_t}{1-\tau_t^E} - \Lambda_t(1+\pi_t^P) + \beta\Lambda_{t+1}(1+\pi_{t+1}^W)\right),\end{aligned} \tag{90}$$

$$\begin{aligned}(L_t)\ v'(L_t) = &\ \mu_t\Big(1 - \frac{\psi_P}{2}(\pi_t^P)^2\Big)Z_t + \frac{\varepsilon_W}{\psi_W}\gamma_{W,t}\Big(v''(L_t)L_t + v'(L_t) - \frac{\varepsilon_W - 1}{\varepsilon_W}\frac{w_t}{1-\tau_t^L}u'(c_t)\Big) \\ &- (\gamma_{P,t} - \gamma_{P,t-1})\pi_t^P(1+\pi_t^P)Z_t + \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\left(\frac{w_t}{(1-\tau_t^W)(1-\tau_t^L)(1-\tau_t^E)} - Z_t\right),\end{aligned} \tag{91}$$

$$(\tfrac{1}{1-\tau_t^W})\ 0 = \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{1}{1-\tau_t^E}L_t - \Lambda_t(1+\pi_t^P) + \beta\mathbb{E}_t\left[\Lambda_{t+1}(1+\pi_{t+1}^W)\right], \tag{92}$$

$$(\tfrac{1}{1-\tau_t^E})\ 0 = \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{w_t}{(1-\tau^W)(1-\tau_t^L)}L_t. \tag{93}$$

E.3 Analysis when all instruments are available

The analysis follows the same steps as in the HA case. The FOCs with respect to taxes τ^W, τ^E, wage w and inflation rates π^W, π^P imply $\gamma_{P,t} = \gamma_{W,t} = 0$. Then any allocation with non-zero wage inflation can be replaced by a feasible allocation with zero wage inflation and strictly larger welfare. The FOCs on π^W and π^P then yield $\Lambda_t = 0$ and $\pi_t^P = 0$.

The FOCs (89)–(91) with respect to r_t and L_t imply, with (86): $\psi_t = u'(c_t) = \mu_t$ and $v'(L_t) = Z_t u'(c_t)$, which, with $c_t = Z_t L_t - G_t$, corresponds to the first-best allocation of (78). Combining zero inflation $\pi_t^P = \pi_t^W = 0$ with Phillips curves (83)–(84) and equation (85) we can recover the taxes τ_t^E, τ_t^W, and the ratio $\frac{w_t}{1-\tau_t^L}$ as a function of $\frac{w_0}{(1-\tau_0^W)(1-\tau_0^L)}$ and Z_0.

E.4 Analysis some labor tax instruments are missing

When some labor tax instruments are missing, FOC (92) or (93) (or both) may not hold—but others do—and the outcome depends on the type of the shock. For a Z-shock, inflation rates generally differ from zero, the extent to which depending on the missing fiscal instrument. For a β-shock, all labor tax instruments can remain at their steady state values, which implements the first-best allocation (and zero inflation).

E.5 Analysis the capital tax is missing

When the capital tax is missing, the interest rate r_0 (or equivalently the tax τ_0^K) cannot adjust to balance the date-0 government budget constraint, $1 + r_0 = \frac{c_0 - w_0 L_0 + B_0}{B_{-1}}$. However, since τ^L

and w are redundant, w_0 will balance this budget constraint, while τ_0^L ensures that FOC (90) holds. The absence of the capital tax breaks the substitutability of w and τ^L – at date 0 only. The planner still implements the first-best allocation with zero price-wage inflation.

F The truncation method

We decompose the presentation of truncation method into four steps: (i) solving the full Bewley model and aggregating it to obtain the *truncated model*; (ii) solve the Ramsey program in this truncated model; (iii) using the inverse optimal-approach at the steady state to compute the SWF weights; (iv) computing the dynamics of the Ramsey model.

Aggregating the Bewley model. Constructing the truncated model requires to solve the Bewley model at the steady state and then express the solution in terms of truncated histories rather than individual agents.

In the first step, we compute the steady-state solution of the model of Section 3 for a given fiscal policy. Using standard methods such as EGM, we obtain the steady-state wealth distribution, $\Lambda : \mathbb{R}_+ \times \mathcal{Y} \to \mathbb{R}_+$, as well as policy functions (defined over $\mathbb{R}_+ \times \mathcal{Y}$), denoted by g_a, g_c, g_l and g_ν for savings, consumption, labor, and the Lagrange multiplier ν.

Second, to construct the truncated model, we consider a set of truncated histories $\mathcal{H}$, the associated transition matrix $(\pi_{h\tilde{h}})_{h,\tilde{h}\in\mathcal{H}}$, and the corresponding vectors of history sizes (S_h). The construction of the truncated model aims at attributing to each history $h \in \mathcal{H}$ an allocation that verifies budget constraints and FOCs at the truncated-history level. Consider an history $h = (y_{h,N_h-1}, \ldots, y_{h,0})$. To construct the distribution over asset choices and histories (and not productivity level only), we We start from the distribution $\Lambda(\cdot, y_{h,N_h-1})$ and apply the policy rule $g_a(\cdot, y_{h,N_h-2})$ to obtain the distribution of agents with history $(y_{h,N_h-1}, y_{h,N_h-2})$. We then proceed recursively by applying the policy rules corresponding to the following productivity levels of h and derive the steady-state wealth distribution of agents with history h – denoted as $\Lambda(\cdot, h)$. This distribution allows us to aggregate the steady-state model. The mass of agents with history $h \in \mathcal{H}$ is $S_h = \int_0^\infty \Lambda(da, h)$. The per-capita consumption c_h, beginning-of-period saving $\tilde{a}_h$, end-of-period saving a_h, and Lagrange multiplier value can be defined as follows:

$$z_h := \frac{1}{S_t}\int_0^\infty g_z(a, y_{h,0})\Lambda(da, h), \text{ for } z = c, a, l, \nu, \qquad \tilde{a}_h := \frac{1}{S_t}\int_0^\infty a\Lambda(da, h). \tag{94}$$

We define the set of credit constrained histories $\mathcal{C}_\mathcal{H}$ as the histories in $\mathcal{H}$ such that: the measure of credit-constrained histories is positive and as close as possible to the measure of credit-constrained agents in the Bewley model; and the credit-constrained histories have the largest ν_h.

From the individual budget constraint, we construct history-specific budget constraints:

$$c_{t,h} + a_{t,h}. = w_t y_0^h L_t + (1 + r_t)\tilde{a}_{t,h}, \tag{95}$$

We also define an history-specific aggregation parameter: $\xi_h^u := \frac{\int_0^\infty u\left(g_c(a,y_{h,0})\right)\Lambda(da,h)}{u(c_h)}$, such that the aggregate period utility of agents having a history h is the period utility of the aggregate consumption and labor multiplied by ξ_h^u. This parameter captures the interaction between the non-linearity of the function u and the heterogeneity within h.

We similarly define history-specific Euler-equation parameters ξ_h^E:

$$\xi_h^E u'(c_h) = \beta(1+r)\left[\sum_{h'\in\mathcal{H}} \Pi_{hh'}\xi_{h'}^E u'(c_{h'})\right] + \nu_h, \tag{96}$$

that guarantee that Euler equations hold for truncated histories.

The allocation $(c_h, l_h, a_h, \tilde{a}_h, \nu_h)_h$ given by equations (94), the budget constraint (95), the Euler equation (96) characterize together with the set of credit-constrained histories $\mathcal{C}_\mathcal{H}$ and the parameters $(\xi_h^u)_h$ the truncated model for a given fiscal policy. Every history h in the truncated model acts a "representative agent" with their own budget constraint and their own Euler equation. The history-wise allocation is a solution of the truncated model (with parameters ξ_h^u and ξ_h^E). Although the distinction between ξ_h^u and ξ_h^E are conceptually important, it less so from a quantitative standpoint. For this reason, in the remainder, we consider only ξ_h^E.

Ramsey problem. We now use the truncation to solve the Ramsey program. See LeGrand and Ragot (2023) for the ability of the method to compute optimal policies.

We express the Ramsey program with given SWF weights (ω_h) and given within-heterogeneity parameters $(\xi_h^u, \xi_h^E)_h$, and then derive the FOCs. We then compute the SWF weights for which our target fiscal policy is an optimal choice of the Ramsey planner—which is the inverse optimal approach in our HA setting. The Ramsey problem can be expressed as follows:

$$\max_{\left(\tau_t^L,\tau_t^S,\tau_t^E,\tau_t^K,B_t,\pi_t^P,\pi_t^W,w_t,r_t,L_t,(c_{i,t},a_{i,t},\nu_{i,t})_i\right)_{t\geq 0}} \sum_{t=0}^{\infty}\beta^t\left[\sum_{h\in\mathcal{H}}\Big(S_h\xi_h^E u(c_{t,h}) - v\left(L_t\right)\Big) - \frac{\psi_W}{2}(\pi_t^W)^2\right] \tag{97}$$

$$\mu_t\colon\ G_t + (1+r_t)\sum_{h\in\mathcal{H}} S_h\tilde{a}_{t,h} + w_tL_t \leq \Big(1-\frac{\psi_P}{2}(\pi_t^P)^2\Big)Z_tL_t + \sum_{h\in\mathcal{H}} S_h a_{t,h}, \tag{98}$$

$$\text{for all } h\in\mathcal{H}\colon\ c_{t,h} + a_{t,h} = w_t y_0^h L_t + (1+r_t)\tilde{a}_{t,h}, \tag{99}$$

$$\lambda_{h,t}\colon\quad \xi_h^E u'(c_{t,h}) = \beta(1+r_{t+1})\sum_{h'\in\mathcal{H}}\Pi_{hh'}\xi_{h'}^E u'(c_{t+1,h'})\Big] + \nu_{t,h}, \tag{100}$$

$$a_{t,h}\geq 0,\ \nu_{t,h}(a_{t,h}+\bar{a}) = 0,\ \nu_{t,h}\geq 0,\ c_{t,h}\geq 0, \tag{101}$$

$$\tilde{a}_{t,h} = \sum_{\tilde{h}\in\mathcal{H}}\Pi_{\tilde{h}h}\frac{S_{\tilde{h}}}{S_h}a_{t-1,\tilde{h}}, \tag{102}$$

$$\gamma_{W,t}\colon\ \pi_t^W(1+\pi_t^W) = \frac{\varepsilon_W L_t}{\psi_W}\bigg(v'(L_t) - \frac{(\varepsilon_W-1)w_t}{\varepsilon_W(1-\tau_t^L)}\sum_{h\in\mathcal{H}} S_h y_0^h\xi_h^E u'(c_{h,t})\bigg) + \beta\pi_{t+1}^W(1+\pi_{t+1}^W), \tag{103}$$

$$\gamma_{P,t}\colon\ \pi_t^P(1+\pi_t^P) = \frac{\varepsilon_P-1}{\psi_P}\Big(\frac{w_t}{Z_t(1-\tau_t^W)(1-\tau_t^L)(1-\tau_t^E)} - 1\Big) + \beta\pi_{t+1}^P(1+\pi_{t+1}^P)\frac{Z_{t+1}L_{t+1}}{Z_tL_t}, \tag{104}$$

$$\Lambda_t\colon\ (1+\pi_t^W)\frac{w_{t-1}}{(1-\tau_{t-1}^L)(1-\tau_{t-1}^W)} = \frac{w_t}{(1-\tau_t^L)(1-\tau_t^W)}(1+\pi_t^P), \tag{105}$$

$$\Xi_1\colon\ (1+\pi_0^P)r_0 = (1-\tau_0^K)(i_{-1}-\pi_0^P). \tag{106}$$

FOCs of the planner. We define at the bin level $\hat{\psi}_{h,t} := \psi_{h,t} - \mu_t$ and:

$$\psi_{h,t} := \omega_{h,t}\xi_t^h u'(c_{h,t}) - \Big(\lambda_{h,t} - (1+r_t)\tilde{\lambda}_{h,t}\Big)\xi_{h,t}^E u''(c_{h,t}) - \frac{\varepsilon_W-1}{\psi_W}\gamma_{W,t}\frac{w_t y_{h,t}L_t}{1-\tau_t^L}\xi_t^h u''(c_{h,t}).$$

Similarly to $\tilde{a}$, we also define $\tilde{\lambda}_{t,h} := \frac{1}{S_{t,h}} \sum_{\tilde{h}\in\mathcal{H}} S_{t-1,\tilde{h}} \Pi_{\tilde{h}h} \lambda_{t-1,\tilde{h}}$, which the per-capita average value of the Lagrange multiplier in the previous period. We finally define any per capita variable $x_{h,t}$, the bin level quantity: $\bar{x}_{h,t} := S_h x_{h,t}$ (e.g., $\bar{c}_{h,t}$ for total consumption in bin h).

$$
\begin{aligned}
\bar{\hat{\psi}}_{h,t} &= -S_h\mu_t + \bar{\omega}_{h,t}\xi^E_{h,t}u'(c_{h,t}) - (\bar{\lambda}_{h,t} - (1+r_t)\bar{\tilde{\lambda}}_{h,t})\xi^E_{h,t}u''(c_{h,t}) - \frac{\varepsilon_W - 1}{\psi_W}\gamma_{W,t}\frac{w_t y_{h,t} L_t}{1-\tau^L_t} S_h \xi^E_{h,t} u''(c_{h,t}),\\
\bar{\tilde{\lambda}}_{t,h} &= \sum_{\tilde{h}\in\mathcal{H}} \Pi_{\tilde{h}h}\bar{\lambda}_{t-1,\tilde{h}},\\
\bar{\hat{\psi}}_{h,t} &= S_h(1+r_{t+1})\sum_{h'\in\mathcal{H}} \frac{\Pi_{hh'}}{S_{h'}}\bar{\hat{\psi}}_{h',t+1}, \text{for } h \notin \mathcal{C}_{\mathcal{H}},\\
\bar{\lambda}_{t,h} &= 0, \text{for } h \in \mathcal{C}_{\mathcal{H}},\\
0 &= \psi_W \pi^W_t + (\gamma_{W,t} - \gamma_{W,t-1})(2\pi^W_t + 1) - \Lambda_t \frac{w_{t-1}}{(1-\tau^L_{t-1})(1-\tau^W_{t-1})},\\
0 &= -v'(L_t) + \mu_t\Big(1 - \frac{\psi_P}{2}(\pi^P_t)^2\Big)Z_t + \frac{\varepsilon_W}{\psi_W}\gamma_{W,t}\left(v''(L_t)L_t + v'(L_t)\right)\\
&\quad - (\gamma_{P,t} - \gamma_{P,t-1})\pi^P_t(1+\pi^P_t)Z_t + \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\left(\frac{w_t}{(1-\tau^L)(1-\tau^E_t)(1-\tau^W_t)} - Z_t\right)\\
&\quad - \frac{w_t}{L_t}\frac{1}{(1-\tau^L_t)(1-\tau^W_t)}\left(\frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{1}{1-\tau^E_t}L_t - \Lambda_t(1+\pi^P_t) + \beta\Lambda_{t+1}(1+\pi^W_{t+1})\right),\\
0 &= \sum_{h\in\mathcal{H}} y_h\left(\bar{\hat{\psi}}_{h,t} - \gamma_{W,t}\frac{\varepsilon_W - 1}{\psi_W}\frac{1}{1-\tau^L_t}S_h\xi^E_{h,t}u'(c_{h,t})\right)\\
&\quad + \frac{1}{L_t}\frac{1}{(1-\tau^L_t)(1-\tau^W_t)}\left(\frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{1}{1-\tau^E_t}L_t - \Lambda_t(1+\pi^P_t) + \beta\Lambda_{t+1}(1+\pi^W_{t+1})\right),\\
0 &= \sum_{h\in\mathcal{H}}\left(\tilde{a}_{h,t}\bar{\hat{\psi}}_{h,t} + \bar{\tilde{\lambda}}_{h,t}\xi^E_{h,t}u'(c_{h,t})\right),\\
0 &= \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{1}{1-\tau^E_t}L_t - \Lambda_t(1+\pi^P_t) + \beta\Lambda_{t+1}(1+\pi^W_{t+1}),\\
0 &= \gamma_{W,t}\frac{\varepsilon_W - 1}{\psi_W}\sum_{h\in\mathcal{H}} y_h S_h u'(c_{h,t}) - \frac{1}{L_t(1-\tau^W_t)}\left(\frac{\varepsilon_P - 1}{\psi_P}\frac{\gamma_{P,t}L_t}{1-\tau^E_t} - \Lambda_t(1+\pi^P_t) + \beta\Lambda_{t+1}(1+\pi^W_{t+1})\right),\\
0 &= \frac{\varepsilon_P - 1}{\psi_P}\gamma_{P,t}\frac{w_t}{(1-\tau^L)(1-\tau^W_t)}L_t.
\end{aligned}
$$

Matrix representation of the steady state. When all fiscal tools are available, $Z = 1$, inflation rates are zero: $\pi^P = \pi^W = 0$, and $\gamma_P = \gamma_W = \Lambda = 0$. We consider a given indexing of histories over $\mathcal{H}$ of cardinal N_{tot} (total number of histories). We denote with a bold letter the N_{tot}-vector associated to a given variable: e.g., $\boldsymbol{S} = (S_h)_{h\in\mathcal{H}}$ is the vector of history sizes. Similarly, $\boldsymbol{a}$, $\boldsymbol{c}$, $\boldsymbol{l}$, and $\boldsymbol{\nu}$ are the vectors of end-of-period wealth, consumption, labor supply, and Lagrange multipliers, respectively. These vectors can be derived from the steady-state equilibrium of the Bewley model. The vector of bin level variables is denoted as $\bar{\boldsymbol{x}} := S \circ x$ ($\circ$ is the Hadamard product). We also define $\boldsymbol{I}$ as the $(N_{tot} \times N_{tot})$-identity matrix, $\boldsymbol{\Pi}$ as the transition matrix across histories, $\boldsymbol{P}$ as the diagonal matrix having 1 on the diagonal at h if h is not credit-constrained (i.e., $h \in \mathcal{C}_{\mathcal{H}}$), and 0 otherwise, and $\boldsymbol{D_x}$ the $N_{tot} \times N_{tot}$-matrix with

$\boldsymbol{x} \in \mathbb{R}^{N_{tot}}$ on the diagonal. The steady state can be characterized by the following equations:

$$\bar{\boldsymbol{c}} + \bar{\boldsymbol{a}} = (1+r)\boldsymbol{\Pi}^\top \bar{\boldsymbol{a}} + wL\bar{\boldsymbol{y}}, \tag{107}$$

$$\boldsymbol{\xi}^E \circ u'(\boldsymbol{c}) = \beta(1+r)\boldsymbol{\Pi}(\boldsymbol{\xi}^E \circ u'(\boldsymbol{c})) + \boldsymbol{\nu}, \tag{108}$$

$$v'(L) = w(\boldsymbol{S} \circ \boldsymbol{y})^\top u'(\boldsymbol{c}), \tag{109}$$

$$\bar{\tilde{\boldsymbol{\lambda}}} = \boldsymbol{\Pi}^\top \bar{\boldsymbol{\lambda}}, \tag{110}$$

$$\bar{\boldsymbol{\psi}} = -\mu \boldsymbol{S} + \boldsymbol{D}_{\boldsymbol{\xi}^{u,0} \circ u'(\boldsymbol{c})} \bar{\boldsymbol{\omega}} - \boldsymbol{D}_{\boldsymbol{\xi}^E \circ u''(\boldsymbol{c})}(\boldsymbol{I} - (1+r)\boldsymbol{\Pi}^\top)\bar{\boldsymbol{\lambda}}, \tag{111}$$

$$\boldsymbol{P}\bar{\boldsymbol{\psi}} = \beta(1+r)\boldsymbol{P}(\boldsymbol{S} \circ \boldsymbol{\Pi} \circ (1./\boldsymbol{S}))\bar{\boldsymbol{\psi}}, \tag{112}$$

$$(\boldsymbol{I} - \boldsymbol{P})\bar{\boldsymbol{\lambda}} = 0, \tag{113}$$

$$v'(L) = \mu, \tag{114}$$

$$\boldsymbol{y}^\top \bar{\boldsymbol{\psi}} = 0, \tag{115}$$

$$\tilde{\boldsymbol{a}}^\top \bar{\boldsymbol{\psi}} = -\left(\boldsymbol{\xi}^{u,E} \circ u'(\boldsymbol{c})\right)^\top \boldsymbol{\Pi}^\top \bar{\boldsymbol{\lambda}}. \tag{116}$$

Steady-state allocation. The inverse optimal approach starts from an observed fiscal system, computes the associated Bewley allocation and determines the SWF weights that guarantee that the observed fiscal system is indeed a solution of a Ramsey problem.

The allocation $\boldsymbol{c}, \boldsymbol{\nu}, L, \boldsymbol{a}, \boldsymbol{y}$ and prices w, r are computed with the aggregation of the Bewley model; $\boldsymbol{\Pi}$ and $\boldsymbol{S}$ from the set $\mathcal{H}$ of truncated histories. The Euler equation (108) gives $\boldsymbol{\xi}^E$:

$$u'(\boldsymbol{c}) \circ \boldsymbol{\xi}^E = (\boldsymbol{I} - \beta(1+r)\boldsymbol{\Pi})^{-1}\boldsymbol{\nu}. \tag{117}$$

We thus need to compute $\bar{\boldsymbol{\psi}}$ and $\bar{\boldsymbol{\lambda}}$ as a function of $\bar{\boldsymbol{\omega}}$ (μ is directly given by (114)) and then deduce the restrictions implies by the FOCs on $\bar{\boldsymbol{\omega}}$. Combining (111) and (112) yields:

$$\boldsymbol{M}_1 \bar{\boldsymbol{\lambda}}_c = \boldsymbol{M}_0(-\boldsymbol{S}v'(L) + \boldsymbol{D}_{\boldsymbol{\xi}^{u,0} \circ u'(\boldsymbol{c})} \bar{\boldsymbol{\omega}}),$$

where: $\boldsymbol{M}_0 = \boldsymbol{P}(\boldsymbol{I} - \beta(1+r)(\boldsymbol{S} \circ \boldsymbol{\Pi} \circ (1./\boldsymbol{S})))$, and $\boldsymbol{M}_1 = \boldsymbol{M}_0 \boldsymbol{D}_{\boldsymbol{\xi}^E \circ u''(\boldsymbol{c})}(\boldsymbol{I} - (1+r)\boldsymbol{\Pi}^\top)$ ($\boldsymbol{M}$ typically denoting a $N_{tot} \times N_{tot}$-matrix). Using (113), we deduce:

$$\bar{\boldsymbol{\lambda}} = \boldsymbol{x}_2 + \boldsymbol{M}_2 \bar{\boldsymbol{\omega}},$$

where: $\boldsymbol{x}_2 = -(\boldsymbol{I} - \boldsymbol{P} + \boldsymbol{M}_1)^{-1}\boldsymbol{M}_0 \boldsymbol{S} v'(L)$, and $\boldsymbol{M}_2 = (\boldsymbol{I} - \boldsymbol{P} + \boldsymbol{M}_1)^{-1}\boldsymbol{M}_0 \boldsymbol{D}_{\boldsymbol{\xi}^{u,0} \circ u'(\boldsymbol{c})}$ ($\boldsymbol{x}$ typically denoting a N_{tot}-vector). We thus deduce from (111):

$$\bar{\boldsymbol{\psi}} = \boldsymbol{x}_3 + \boldsymbol{M}_3 \bar{\boldsymbol{\omega}},$$

where: $\boldsymbol{x}_3 = -v'(L)\boldsymbol{S} - \boldsymbol{D}_{\boldsymbol{\xi}^E \circ u''(\boldsymbol{c})}(\boldsymbol{I} - (1+r)\boldsymbol{\Pi}^\top)\boldsymbol{x}_2$, and $\boldsymbol{M}_3 = \boldsymbol{D}_{\boldsymbol{\xi}^{u,0} \circ u'(\boldsymbol{c})} - \boldsymbol{D}_{\boldsymbol{\xi}^E \circ u''(\boldsymbol{c})}(\boldsymbol{I} - (1+r)\boldsymbol{\Pi}^\top)\boldsymbol{M}_2$. Finally, FOCs (115) and (116) imply:

$$\boldsymbol{x}_4^\top \bar{\boldsymbol{\omega}} = \kappa_4, \quad \boldsymbol{x}_5^\top \bar{\boldsymbol{\omega}} = \kappa_5, \tag{118}$$

$$\text{where: } \boldsymbol{x}_4^\top = \boldsymbol{y}^\top \boldsymbol{M}_3, \quad \boldsymbol{x}_5^\top = \tilde{\boldsymbol{a}}^\top \boldsymbol{M}_3 + \left(\boldsymbol{\xi}^{u,E} \circ u'(\boldsymbol{c})\right)^\top \boldsymbol{\Pi}^\top \boldsymbol{M}_2,$$

$$\kappa_4 = -\boldsymbol{y}^\top \boldsymbol{x}_3, \quad \kappa_5 = -\tilde{\boldsymbol{a}}^\top \boldsymbol{x}_3 - \left(\boldsymbol{\xi}^{u,E} \circ u'(\boldsymbol{c})\right)^\top \boldsymbol{\Pi}^\top \boldsymbol{x}_2.$$

Our resolution implies that the weights are restricted by (118) and the normalization $\mathbf{1}^\top \bar{\boldsymbol{\omega}} = 1$. To tackle underdeterminacy, we select the weights respecting the three constraints which have the lowest variance.

Dynamics. The difficult part is the derivation of the Ramsey program is to compute the steady-state allocation. The dynamics equations are given by the FOCs of the Ramsey planner. As there is a finite number of equations (the number of which is determined by the number of bins), we can rely on standard solvers, such as Dyanre to compute the IRFs.

G The dynamics for other shocks

G.1 Constant capital tax

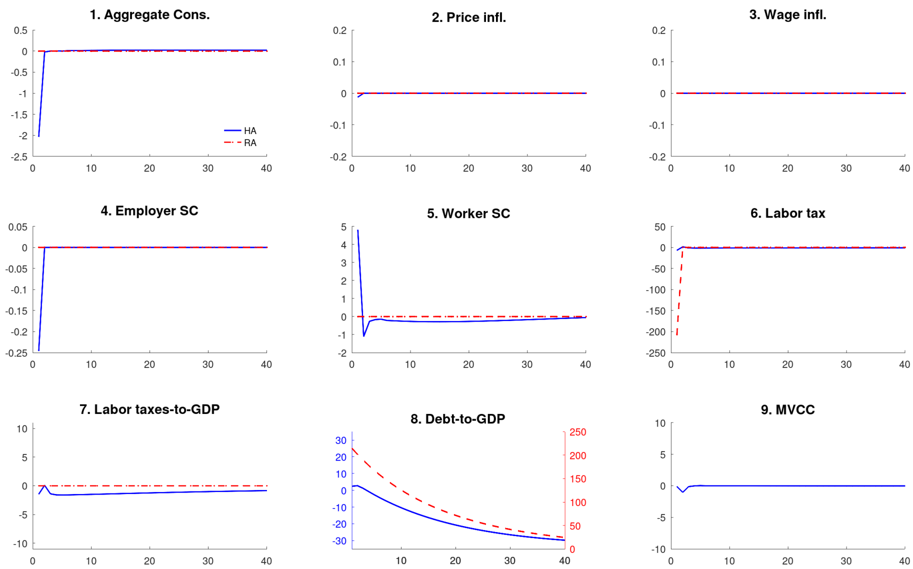

Figure 4: Dynamics of the economy when the capital tax τ^K is constant, and other tools are time-varying, following discount factor shock. The HA economy is represented in blue and the RA one in red. All variables are expressed in relative deviations from their steady-state values, except for tax and inflation rates which are presented in level deviations from their steady-state values.

G.2 Public spending shock

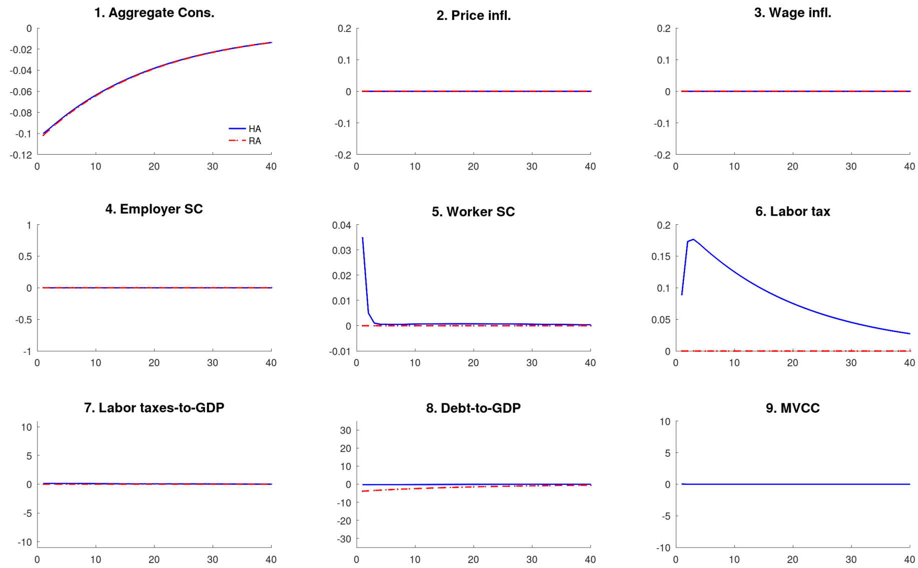

Figure 5: Dynamics of the economy when all instruments are available, after a public spending shock. The Heterogeneous-Agent economy (HA) is in blue and the Representative Agent (RA) is in red. Variables are in percentage proportional change, except tax rates and inflation rates which are in percentage level change.

G.3 Idiosyncratic uncertainty shock

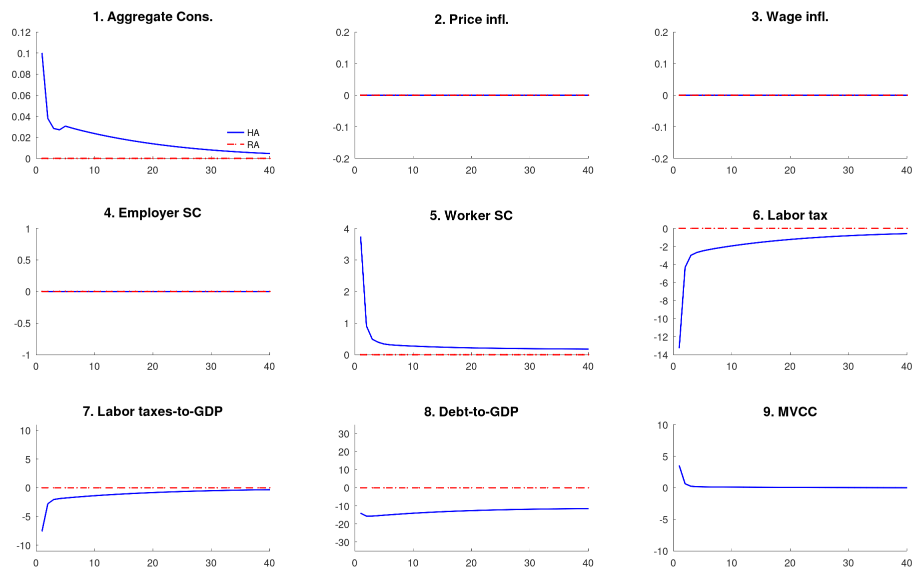

Figure 6: Dynamics of the economy when all instruments are available, after an idiosyncratic uncertainty shock. See the 5.5 for a description of the shock. The Heterogeneous-Agent economy (HA) is in blue and the Representative Agent (RA) is in red. Variables are in percentage proportional change, except tax rates and inflation rates which are in percentage level change.