Economic Theory Bulletin (2021) 9:225–245
https://doi.org/10.1007/s40505-021-00207-x

RESEARCH ARTICLE

Wealth and income inequality in a monetary economy

Yoichi Gokan[1] · Stephen J. Turnovsky[2]

Received: 19 July 2021 / Accepted: 29 July 2021 / Published online: 19 August 2021

Abstract
In contrast to the standard aggregate monetary model which suggests that money growth is super-neutral in the long run with respect to real aggregate quantities, we find that the super-neutrality of money does not extend to inequality measures. Two alternative scenarios to illustrate the impact of money on inequality are considered, enabling us to identify the channels whereby monetary policy impacts various inequality measures. Three striking results emerge from the formal model. First, the effects of money growth on income inequality and wealth inequality contrast sharply. Second, money growth impacts the long-run distribution of capital only as long as it accompanies some other real shock, such as an increase in productivity. Third, the flexibility of labor supply is critical in determining the distributional consequences of monetary policy. The model is sufficiently flexible to reconcile the mixed empirical data on the correlation between inflation and inequality.

This paper has benefited from seminar presentations at Kinki University, Kwansei Gakuin University and Osaka University as well as from presentation at the 2018 SAET conference in Taipei. We also thank Taro Fukui, Koichi Futagami, Kazuki Hiraga, Keiichi Hori, Takeshi Hoshikawa, Hirokazu Ishise, Akira Kamiguchi, Tetsu Kawakami, Kazuo Mino, Ryu-ichiro Murota, Masao Oda, Toshihiro Okada, and Katsunori Yamada for constructive and valuable suggestions. The editorial suggestions of an Associate Editor are also gratefully acknowledged. Yoichi Gokan would like to acknowledge the financial support from the JSPS KAKENHI Project (No.19K01564). Stephen Turnovsky wishes to acknowledge the Van Voorhis endowment at the University of Washington for its financial support. Much of the work on this paper was done while Yoichi Gokan was visiting the University of Washington.

✉ Stephen J. Turnovsky
sturn@uw.edu

Yoichi Gokan
y-gokan@ec.ritsumei.ac.jp

[1] Faculty of Economics, Ritsumeikan University, 1-1-1, Noji-higashi, Kusatsu, Shiga, Japan

[2] Department of Economics, University of Washington, Seattle, WA 98195-3330, USA

1 Introduction

This paper addresses one of the classic questions in monetary theory, that pertaining to the (super)-neutrality of money. Assuming rational intertemporal optimizing agents, Sidauski (1967) established the long-run "super-neutrality of money", meaning that the steady-state capital stock, output, and consumption are all determined independently of the constant money growth rate. This finding is contrary to the "Mundell-Tobin effect" which, based on an arbitrary savings function, suggested that monetary policy would affect the real interest rate, and via the subsequent portfolio adjustment, determine real capital intensity.[1]

Sidrauski's model was based on strong assumptions, including inelastic labor supply, leading many economists to check the robustness of this proposition. For example, Fischer (1979) found that the money growth rate may boost the rate of capital accumulation along a transitional path but not in steady state. Danthine et al. (1987) showed that the introduction of uncertainty causes super-neutrality to break down, although the observed Mundell-Tobin effect is quantitatively insignificant. Using an overlapping generations framework, Weil (1981) and Marini and van der Ploeg (1988) showed that super-neutrality fails to hold, because of the effect of intergenerational redistribution. In addition to the mixed results of the theoretical literature, there is empirical evidence supporting the super-neutrality of money, although it too is mixed; see e.g. Kormendi and Meguire (1984), Geweke (1986), King and Watson (1997) and Serletis and Koustas (1998).

Most of the literature investigating the long-run consequences of sustained money growth focuses on the aggregate effects. But the impact of inflation is unequally shared among heterogeneous agents, and it is important to address the distributional consequences of monetary policy and its associated inflation. The objective of this paper is to investigate this aspect in an economy in which the underlying source of heterogeneity is agents' initial endowments of capital, which is then introduced into the basic Sidrauski model, extended to allow for flexible labor supply. Summing over the heterogeneous individuals yields a macro equilibrium in which money is super-neutral with respect to the long-run *aggregate* measures of real activity. But despite this, the long-run *distributions* of wealth, income, consumption, and (in most cases) capital across the individuals are impacted by changes in the money growth rate. Thus, even under conditions most favorable to the long-run super-neutrality of money at the macro level, it does not extend to the distribution across individuals.

To highlight the distributional consequences of inflation, we consider two scenarios. In the first, the economy is initially in steady state and experiences a constant sustained increase in the money growth rate. With money being super-neutral in the aggregate, the aggregate capital stock, which is the driving force of the dynamics, remains fixed, and the only response is the instantaneous drop in the real money stock stemming from the rise in the nominal interest rate. As a result, the capital stock becomes a bigger component of aggregate wealth. Since capital is shown to

[1] See Mundell (1963) and Tobin (1965).

be less equally distributed across individuals than is money, the increase in its relative importance causes an increase in wealth inequality. Moreover, with consumption being tied to wealth, this is coupled with an increase in consumption inequality. On the other hand, the response in labor supply leads to a most probable decline in income inequality, while in this case the distribution of capital is unaffected.

In the second scenario, the increase in the money growth rate accompanies a *contemporaneous* productivity increase, reflecting, for example, a situation in which the government finances an increase in public infrastructure by printing money. The resulting increase in the capital stock occurs gradually, generating transitional dynamics. We decompose the resulting changes in the various inequality measures into two components: (1) reflecting the productivity increase and (2) due to the associated increase in the money growth rate. Changes in the real money stock stemming from the nominal monetary expansion exert two offsetting effects on the distribution of capital, with their relative importance varying along the transition and also with the flexibility of labor supply.

The framework employed to investigate the inequality is the "representative consumer theory of distribution" (RCTD); see Caselli and Ventura (2000). This assumes complete markets and homogeneous preferences, in which case for certain key sources of heterogeneity, including initial endowments, one can exploit the aggregation procedures due to Gorman (1959).[2]

Empirical evidence suggests that income inequality does not seem to be neutral with respect to inflation, although the nature of the relationship is unclear. For example, Romer and Romer (1999) and Albanesi (2007) suggest a strong positive link, while Thalassinos et al. (2012) and Coibion et al. (2017) find a negative relationship. In part, these diverse results reflect different data sets and alternative inflation-generating mechanisms. While a basic calibration of the model is directed toward advanced economies, for which the inflation-inequality relationship tends to be inverse, by varying the flexibility of labor supply, the model can generate a positive relationship between inflation and income inequality, thereby illustrating the model's flexibility in explaining this tradeoff.

We wish to stress that the motivation for this paper is to determine the extent to which the long-run super-neutrality of money that has played such a prominent role in macroeconomic theory is applicable to distributional measures. For this purpose the Sidrauski model with its focus on long-run aggregate super-neutrality and flexible prices, is a natural benchmark. In addition the RCTD approach, despite its strong assumptions, being a natural extension of the representative consumer model upon which Sidrauski (1967) and other papers are based, serves as an appropriate framework.

But we should also stress that our objective and the perspective it offers to the inflation-inequality relationship contrasts sharply with much of the current literature.

[2] Other examples of this approach include Chatterjee (1994), Sorger (2002), Maliar and Maliar (2003) and García-Peñalosa and Turnovsky (2011). Much of the literature focuses on the impact of fiscal policy on inequality; the present paper can be viewed as an extension of this literature to address the consequences of monetary policy.

First, much of it employs versions of New Keynesian models which incorporate price rigidities that afford an active role to monetary policy, thereby ruling out super-neutrality at the aggregate level.[3] Also, instead of complete markets that characterize the RCTD approach, much of the literature assumes incomplete markets, drawing heavily on the seminal work of Bewley (1987) and Aiyagari (1994).[4] A key characteristic of this approach is that individual agents are subject to idiosyncratic shocks that are the underlying source of inequality, rather than differential wealth endowments as in the present setup.

While we focus primarily on income inequality, our analysis also has implications for the differential responses of wealth and consumption inequality. In this respect it is related to a literature that compares the responses of different inequality measures. This literature suggests a wide range of relative responses, depending upon, the specific inequality measure and the framework employed.[5]

2 Analytical framework

This section sets out the analytical framework, which is an adaptation of García-Peñalosa and Turnovsky (2011), to include the role of money and monetary policy.

2.1 Firms

The economy comprises a single representative firm that produces an aggregate good in accordance with the standard neoclassical production function

$$Y = F(K, L), \quad F_K > 0, \quad F_{KK} < 0, \quad F_L > 0, \quad F_{LL} < 0, \quad \text{and} \quad F_{KL} > 0, \tag{1}$$

where Y, K and L denote per capita output, capital stock, and labor supply. This good can be either consumed or accumulated as capital. Profit maximization implies that the return to capital, r, and the real wage rate, w, are determined by the respective marginal products of capital and labor:

$$r = F_K(K, L)[\equiv r(K, L)] \text{and} w = F_L(K, L)[\equiv w(K, L)]. \tag{2}$$

[3] Notable is the recent contribution by Kaplan et al. (2018) that examines the impact of monetary policy on wealth inequality generated by the HANK model, showing how its transmission mechanism enables it to generate realistic distributions of wealth inequality. Several other papers focus on the impact of inflation on wealth inequality. For example, Doepke and Schneider (2006) document how unanticipated inflation causes a shift in wealth across sectors. Gabaix et al. (2016) show how the upper tail of the income distribution can be replicated by a Pareto distribution having a fat tail.

[4] For an extensive discussion of this approach see Heathcote et al. (2009).

[5] See e,g. Meyer and Sullivan (2013), Camera and Chien (2014), Ragot (2014) and Chang et al. (2020).

2.2 Heterogeneous households

The total population in the economy consists of a constant number, N, of heterogeneous agents, indexed by i. There are two types of assets: real capital, and nominal money. Individual i owns $K_i(t)$ units of capital, so that the total amount of capital in the economy at time t is $K^T(t) = \int_0^N K_i(t)di$, with the average per-capita capital stock $K(t) = (1/N)K^T(t)$ and the relative share of capital owned by the individual: $k_i(t) = K_i(t)/K(t)$. Analogously, the amount of nominal money held by individual i is $M_i(t)$, with the total money stock being $M^T(t) = \int_0^N M_i(t)di$, and the average amount of nominal stock per capita being $M(t) = (1/N)M^T(t)$. Letting $P(t)$ denote the price level, the amount of wealth owned by individual i at time t is $A_i(t) = K_i(t) + M_i(t)\big/P(t)$. Thus the total wealth and average per capita wealth in the economy are $A^T(t) = \int_0^N A_i(t)di$, and $A(t) = (1/N)A^T(t)$, respectively, with the relative share of wealth owned by individual i being $a_i(t) = A_i(t)\big/A(t)$.

As the economy transitions, the evolution of the relative shares $k_i(t)$, $a_i(t)$ trace out the distributions of capital and wealth, the means of which are both one, and standard deviations, which serve as convenient measures of inequality, of $\sigma_k(t)$, $\sigma_a(t)$, respectively. With the initial distribution of capital endowments being predetermined, and capital being accumulated gradually, $\sigma_k(0) = \sigma_{k,0}$ is predetermined, and is the underlying source of the heterogeneity. At the same time, while the initial endowments of nominal money supply are also predetermined, $\sigma_a(0)$ is endogenous as a result of the initial jump in the price level following any structural or policy change, as discussed in Sect. 4.1.

Each individual is also endowed with one unit of time that can be allocated either to leisure, $l_i(t)$, or to labor, $1 - l_i(t) = L_i(t)$, so that the average economy-wide labor supply and leisure can be expressed as $L = 1 - l = 1 - \frac{1}{N}\int_0^N l_i di$. The agent maximizes lifetime utility, assumed to be a constant elasticity function of consumption, $C_i(t)$, leisure, $l_i(t)$, real money balances, $m_i(t)\left[= M_i(t)/\mathrm{P}(t)\right]$, and multiplicatively separable in real government expenditure, G.[6]

$$\Omega_i \equiv \frac{1}{\gamma}\int_0^\infty \left[\left(C_i(t)l_i(t)^\beta m_i(t)^\eta\right)^\gamma \cdot h(G)\right]e^{-\rho t}dt \quad -\infty < \gamma < 1,\ \beta,\eta > 0,\ 1 > \gamma(1+\beta+\eta) \tag{3}$$

The constant elasticity utility function, (3) is chosen for two reasons. First, it is multiplicatively separable in real money balances, and consequently will generate long-run super-neutrality in the aggregate variables.[7] Second, it possesses the

[6] The first inequality in (3) is required for the intertemporal elasticity of substitution (IES), $1/(1-\gamma)$, to be positive. The last inequality guarantees the concavity of utility function with respect to the choice variables.

[7] The super-neutrality of money depends critically upon the form of the utility function. If labor supply is inelastic, as in Sidrauski (1967) and Fischer (1979), long-run super-neutrality is ensured without further restrictions. With elastic labor supply it requires multiplicative separability of real money balances, as is assumed here. If money balances are additively separable, money becomes super-neutral during the transition, as well as in the steady state.

homogeneity properties necessary to apply Gorman (1959) aggregation, enabling us to derive closed-form expressions for the distributional measures.

The optimization is performed subject to the agent's wealth accumulation constraint

$$\begin{aligned}\dot{K}_i(t) + \dot{m}_i(t) = \left[\left(1-\tau_K\right)r(t) - \delta\right]K_i(t) - \pi(t)m_i(t) \\ + \left(1-\tau_W\right)w(t)\left(1-l_i(t)\right) - \left(1+\tau_C\right)C_i(t)+T_i(t),\end{aligned} \tag{4}$$

where δ denotes the (constant) rate of capital depreciation, $\pi(t)$ denotes the rate of inflation, τ_K, τ_w, τ_C and T_i are respectively tax rates on capital income, labor income, consumption, and lump-sum taxes/transfers that the agent takes as given. For convenience, we omit the time index t whenever possible. Carrying out the optimization yields the following standard first order conditions:

$$C_i^{\gamma-1} l_i^{\beta\gamma} m_i^{\eta\gamma} = \lambda_i \tag{5a}$$

$$\beta \frac{C_i}{l_i} = \left(\frac{1-\tau_W}{1+\tau_C}\right) w(K,l) \tag{5b}$$

$$\eta \frac{C_i}{m_i} = \left(\frac{(1-\tau_K)r(K,l) - \delta + \pi}{1+\tau_C}\right) \tag{5c}$$

$$\rho - \frac{\dot{\lambda}_i}{\lambda_i} = (1-\tau_K)r(K,l) - \delta \tag{5d}$$

where λ_i is agent i's shadow value of wealth. Using $l = 1 - L$, enables us to express both the wage rate, w, and interest rate, r, as functions of average leisure, l, rather than average employment.

Using (5b), (5c), and the definition of wealth, $A_i(t) \equiv K_i(t) + M_i(t)/P(t)$, the agent's wealth accumulation constraint (4) can be rewritten as

$$\frac{\dot{A}_i}{A_i} = \left(1-\tau_K\right)r(K,l) - \delta + \left(1-\tau_W\right)\frac{w(K,L)}{A_i}\left(1 - \frac{1+\beta+\eta}{\beta}\right) + \frac{T_i}{A_i}. \tag{6}$$

2.3 Government

The key issue we focus on is monetary policy, which we specify in terms of maintaining a constant nominal growth rate of money $\dot{M}(t)/M(t) = \theta$. Assuming that the instruments of fiscal policy, τ_K, τ_W, τ_C, and G, together with the money growth rate, θ, are fixed over time, then along the transitional path as the tax base is changing, the government finances its expenditures by endogenously varying lump-sum transfers in accordance with.

$$T = \tau_K r(K,l)K + \tau_W w(K,l)(1-l) + \tau_C C + (\theta - \pi)m - G. \tag{7}$$

To abstract from any arbitrary distributional effects arising from lump-sum transfers, we assume that they are distributed to agents in proportion to their share of wealth, A_i/A so that $T_i/A_i = T/A$ holds.

3 Macroeconomic equilibrium

We define the economy-wide averages $C = \frac{1}{N}\int_0^N C_i di$ and$m = \frac{1}{N}\int_0^N m_i di$.[8] A key consequence of the optimality conditions (5a) and (5b) is that since (1) all agents face the same real wage, and the same rates of return on capital and money, and (2) leisure and real balances of an agent i are linear functions of the consumption of the agent i, they imply

$$\frac{C_i(t)}{C(t)} = \frac{m_i(t)}{m(t)} = \frac{l_i(t)}{l(t)} \equiv v_i \tag{8a}$$

so that agent i's share of the three averages maintains the same constant value over time. Equation (8a) further implies that all agents choose the same growth rates for consumption, leisure, and real money balances (although levels differ):

$$\frac{\dot{C}_i(t)}{C_i(t)} = \frac{\dot{C}(t)}{C(t)};\ \frac{\dot{m}_i(t)}{m_i(t)} = \frac{\dot{m}(t)}{m(t)};\ \frac{\dot{l}_i(t)}{l_i(t)} = \frac{\dot{l}(t)}{l(t)} \tag{8b}$$

which in turn implies that the aggregates grow at the same respective rates.

To derive the macroeconomic equilibrium, we proceed as follows. First, summing (5b) over individuals and using (2) we may write $C = (1-\tau_W)(1+\tau_C)^{-1}\beta^{-1}F_L(K,L)l \equiv C(K,L)$. With this notation, the macroeconomic equilibrium can be summarized by the following dynamic equations:

$$\frac{\dot{l}}{l} = \frac{1}{\Delta}\left[(1-\tau_K)F_K(K,L) - \delta - \rho + \eta\gamma\frac{\dot{m}}{m} - (1-\gamma)\frac{s}{\varepsilon}\frac{\dot{K}}{K}\right] \tag{9a}$$

$$\dot{K} = F(K,L) - C(K,L) - \delta K - G, \tag{9b}$$

$$\frac{\dot{m}}{m} = \theta - \eta(1+\tau_C)\frac{C(K,L)}{m} + (1-\tau_K)F_K(K,L) - \delta \tag{9c}$$

together with $L = 1 - l$, $\dot{L} = -\dot{l}$ and where $s \equiv KF_K/Y$ denotes capital's share of output, $\varepsilon \equiv F_K F_L/FF_{KL}$ is the elasticity of substitution in production, and$\Delta \equiv (1-\gamma)\frac{s}{\varepsilon}\frac{l}{1-l} + 1 - \gamma(1+\beta) > 0$. As long as the production function $F(K,L)$

[8] We use the terms economy-wide "aggregates" and "averages" interchangeably.

is a general constant returns to scale function, both s and ε are functions of the capital-labor ratioK/L.[9]

Equations (9a)–(9c) determine the joint dynamics of average (aggregate) leisure, l, capital, K, and real money balances, m. From these variables, the dynamics of all other aggregate variables follow. These equations are essentially equivalent to the aggregate dynamic system as spelled out by Fischer (1979), for example, though modified to endogenize labor supply. The key observation is that the aggregate equilibrium evolves independently of wealth and income distributions. This is a manifestation of the RCTD, and reflects the homothetic preferences specified in (3). On the other hand, through the labor-leisure choice and its interaction with the evolution of real money balances as indicated by (9c), the time paths for capital and output depend upon the money growth rate, θ, so that the super-neutrality of money does not in general apply during the transition.

4 Local aggregate dynamics

Since the dynamics of the aggregate quantities impact the dynamics of the distributions of wealth and income, we must first consider the dynamics of the former. To do so we linearize Eqs. (9a)–(9c) around its steady state, set out as (A.1a)–(A.1d), along with the resulting linearized system, (A.2), in the Online Appendix. There we show that under plausible conditions the local dynamic system has one negative eigenvalue μ(< 0). It is also apparent from (9) that the money growth rate impinges on the transitional paths of the real variables (K, l) through the intertemporal elasticity of substitution as reflected in γ. If $\gamma = 0$, so that the utility function is logarithmic, the dynamics of (K, l) decouple, and proceed independently of monetary policy. In that case money becomes super-neutral with respect to real activity along the transitional path, as well as in steady state.

With $l(0)$ and $m(0)$ free to jump instantaneously (the latter through a jump in $P(0)$), while $K(t)$ evolves gradually from its initial value, K_0, the stable equilibrium paths for K, l and m are:

$$K(t) = K^* + \left(K_0 - K^*\right)e^{\mu t} \tag{10a}$$

$$l(t) = l^* + \underbrace{\frac{\mu - a_{22}}{a_{21}}}_{+}(K(t) - K^*) \tag{10b}$$

[9] Equation (9a) is derived by combining (8b), the time derivatives of (5b) and (5c), together with $\dot{C}$. Equation (9b) is goods market equilibrium obtained by aggregating the individual accumulation Eqs. (4) and combining with (7). Equation (9c) is derived by utilizing (8a) in (5b) and the accumulation equation for real money balances $\dot{m}/m = \theta - \pi$. With l, K, m, L, determined by (9), the inflation rate is obtained from $\pi = \eta(1 + \tau_C)C(K, L)/m + (1 - \tau_K)F_K(K, L) - \delta$.

$$m(t) = m^* + \underbrace{\frac{a_{31}(a_{22} - \mu) - a_{21}a_{32}}{a_{21}(\theta + \rho - \mu)}}_{+}(K(t) - K^*) \tag{10c}$$

where the elements a_{ij} are defined in the Appendix. There it is shown that while the sign of $\mu - a_{22}$ is in principle ambiguous, it is most likely negative, especially if we restrict attention to the Cobb–Douglas production function . In that case, if the economy experiences an expansion in the aggregate capital stock ($K_0 < K^*$), following initial jumps, average leisure,$l(t)$, and real balances,$m(t)$, will both increase monotonically to their respective steady-state values, l^* and m^*, during the subsequent transition. As will be evident below, the evolution of $l(t)$ is critical in determining how the distributions of wealth and capital converge to their respective steady-states.

5 Distributions of wealth and income

5.1 Dynamics of relative wealth

To determine the dynamics of individual i's relative wealth, $a_i(t) \equiv A_i(t)/A(t)$, we aggregate (6) over the i agents to obtain a corresponding expression for the evolution of $A(t)$, which we then combine with the individual wealth dynamics in (6). Omitting details, the resulting evolution of agent i's relative wealth, $a_i(t)$ is:

$$\dot{a}_i = \left(1 - \tau_\omega\right)\frac{w(K, L)}{A}\left[1 - v_i l\left(\frac{1 + \beta + \eta}{\beta}\right) - \left(1 - \frac{1 + \beta + \eta}{\beta} l\right)a_i\right] \tag{11}$$

where in deriving (11) we incorporate the assumption $T_i/A_i = T/A$, and (8a) that agent i' s share in the average $l_i/l \equiv v_i$ remains constant over time. By focusing on the stationary solution to (11) when$\dot{a}_i = 0$, we determine the constant, v_i, and obtain (where * denotes steady state)

$$\frac{l_i}{l} = v_i = 1 + \left(1 - \frac{\beta}{1 + \beta + \eta}\frac{1}{l^*}\right)\left(a_i^* - 1\right) \tag{12}$$

Two key sources of dynamics drive the dynamics of relative wealth, (11), in the neighborhood of steady state. The first is that of aggregate leisure $l(t)$, as it evolves according to (10b); the second is the internal dynamics of $a_i(t)$, the nature of which depends upon the coefficient of a_i in (11) in the neighborhood of steady state. Using (9b) we can show that a sufficient condition for

$$l^* > \frac{\beta}{1 + \beta + \eta} \equiv \upsilon \tag{13}$$

is that the total amount of private consumption expenditure, inclusive of the consumption tax, $(1 + \tau_C)[F(K^*, L) - \delta K^* - G]$, exceeds the after-tax labor income $(1 - \tau_W)w^*L^*$, a condition that is strongly supported by empirical evidence, as well as by the calibration reported in Table 1. In that case (12) implies that the greater an agent's steady-state relative wealth, the more leisure he consumes and the less labor he supplies. This reflects the fact that wealthier agents have a lower marginal utility of wealth and empirical evidence in support of this negative relationship between wealth and labor supply (given the wage rate) is available from a variety of sources; see e.g. MaCurdy (1981), Holtz-Eakin et al. (1993) and Coronado and Perozek (2003).

To analyze the local dynamics of relative wealth, we linearize (11) around the steady-state values K^*, L^*, l^*, l_i^* and a_i^*. Given (13), the bounded solution for agent i's relative wealth, $a_i(t)$, is

$$a_i(t) - 1 = \frac{\alpha(t)}{\alpha(0)}(a_i(0) - 1) \tag{14}$$

where

$$\alpha(t) \equiv 1 + \left(\frac{(1-\tau_W)F_L(K^*, L^*)}{A^*}\left[1 - \frac{l(t)}{l^*}\right]\right) \bullet \left(\frac{(1-\tau_W)F_L(K^*, L^*)}{A^*}\left[\frac{l^*}{\upsilon} - 1\right] - \mu \right)^{-1} \tag{14$'$}$$

For notational convenience we may write (14′) as $\alpha(t) \equiv 1 + \chi(m^*, t)$, where $\chi(m^*, t) > 0$, $\chi_m(m^*, t) < 0$, $\chi_t(m^*, t) < 0$, and $\alpha(0) \equiv 1 + \chi(m^*)$, $\chi'(m^*) < 0$.

However, $a_i(0)$, being a function of $P(0)$, is endogenous. Using (12) and (14), we can express $a_i(0)$ in terms of the agent's initial predetermined relative endowment of capital $k_{i,0}$. To do so, we first solve for the individual's relative holdings of the two assets in terms of his relative wealth:

$$\frac{m_i(t)}{m(t)} - 1 = \left(1 - \frac{\upsilon}{l^*}\right)\frac{1}{\alpha(t)}\left[a_i(t) - 1\right] \tag{15a}$$

$$k_i(t) - 1 = \omega(t)\left[a_i(t) - 1\right] \tag{15b}$$

where[10]

$$\omega(t) \equiv \left[1 + \frac{m(t)}{K(t)\alpha(t)}\left(\alpha(t) - 1 + \frac{\upsilon}{l^*}\right)\right] \tag{16}$$

As $t \to \infty$, $l(t) \to l^*$, implying $\alpha(t) \to 1$, and (16) converges to the steady state

$$\omega^* = 1 + \frac{m^*}{K^*}\frac{\upsilon}{l^*} \tag{16$'$}$$

Then, setting $t = 0$ in (15b) determines $(a_i(0) - 1)$ in terms of $(k_{i,0} - 1)$

[10] If $K(t)$ is increasing, which we assume and view as being the normal case, $l(t) < l^*$ and (14') implies $\alpha(t) > 1$, in which case $\omega(t) > 0$. It is also likely to hold if $K(t)$ is subject to a moderate decline. But if $K(t)$ is subject to a dramatic decline, then it is possible for $\omega(t) < 0$ at the initial stages of the transition, but to become positive as steady state is approached.

Table 1 Basic parameters

Production function	$Y = AK^{s^*}L^{1-s^*}$
Production parameters	$s^* = 0.36, A = 1.5, \delta = 0.07$
Taste parameters	$\beta = 1.75, \eta = 0.10, \rho = 0.04$
Fiscal policy	$\tau_K = 0.276, \tau_\omega = 0.224, \tau = 0.08, G/Y = 0.19$
Monetary policy (growth rate)	$\theta = 0.05$
Initial distribution of capital	$\sigma_{k,0} = 1$

$$a_i(0) - 1 = \omega(0)^{-1}(k_{i,0} - 1) \tag{17}$$

From (14) to (16), it is seen that $\alpha(t)$ and $\omega(t)$ are the critical determinants of the evolution of relative wealth and its components; $\alpha(t)$ determines how the agent's total relative wealth evolves in response to the changing equilibrium employment and the factor returns it generates, while $\omega(t)$ determines the agent's allocation of wealth between capital and real money stock. Comparing Eqs. (15a) and (15b) we see that a relatively wealthy agent, for whom $a_i > 1$, will hold relatively more capital and relatively less money; i.e. $k_i - 1 > a_i - 1 > m_i/m - 1 > 0$. The opposite applies to a relatively poor agent having below average wealth. Thus the distribution of capital across agents is more unequal than that of money. This is a reflection of the assumption that all agents derive identical utility from holding money, while simultaneously, subject to differential endowments of capital.

Equation (14) shows how, beginning from his initial relative wealth at time 0, the evolution of the relative wealth of agent i depends critically upon $\alpha(t)$. This in turn is driven by $l(t)/l^*$, which reflects the adjustment of the aggregate labor supply during the transition, and the fact that wealth takes time to accumulate.[11] This is seen most directly, by rewriting (14′) in the form:

$$\frac{\alpha(t) - 1}{\alpha(0) - 1} = \frac{l^* - l(t)}{l^* - l(0)} \tag{18a}$$

Thus, if the economy is experiencing an expansion in the aggregate capital stock, which generates an increase in average leisure in accordance with (10b), $\dot{\alpha}(t) < 0$, so that wealth inequality will also be declining. As $l(t)$ converges to the steady state, l^*, $\alpha(t)$ converges to $\alpha^* \equiv 1$.

In contrast, Eq. (16) highlights how the money growth rate, θ, impacts the ratio of the agent's relative capital holdings to his relative wealth, and ultimately the various inequality measures. Using the relationship $\alpha(t) = 1 + \chi(m^*, t)$, we may write (16) as

[11] If $l(0) = l^*$, so that labor supply adjusts instantaneously to its new steady state, $\alpha(0) = 1$ and $a_i(t) = a_i(0)$, remaining unchanged during the transition.

$$\omega(t) \equiv \left[1 + \frac{m(t)}{K(t)\alpha(t)}\left(\chi(m^*, t) + \frac{\upsilon}{l^*}\right)\right] \tag{18b}$$

It is clear that the change in the monetary growth rate, θ, impacts $\omega(t)$ via two channels. First, at the instant it is implemented, an increase in θ causes an initial increase in the price level, $P(0)$, resulting in reduced real money balances at that instant, $m(0)$, leading to a reduction in $\omega(0)$. At the same time, an increase in θ reduces steady-state real money balances,m^* (see (A.1c)), which raises χ and hence, ω, thereby increasing the relative share of capital held by the relatively wealthy $((a_i(t) > 1)$.

5.2 Dynamics of relative income

In considering income distribution, it is important to distinguish between agent $i's$ relative *before-tax* income, y_i, and his *after-tax* income, y_i^a, defined respectively by[12]

$$y_i = \frac{rK_i + w(1 - l_i)}{rK + w(1 - l)} \tag{19a}$$

$$y_i^a = \frac{(1 - \tau_K)rK_i + (1 - \tau_W)w(1 - l_i)}{(1 - \tau_K)rK + (1 - \tau_W)w(1 - l)} \tag{19b}$$

Using the relationships set out in Sect. 5.1, these expressions may be written in the form

$$y_i(t) - 1 = \varphi(t)[k_i(t) - 1] \tag{20a}$$

$$y_i^a(t) - 1 = \psi(t)[k_i(t) - 1] \tag{20b}$$

where

$$\varphi(t) \equiv s(t) - (1 - s(t))\frac{l(t)}{1 - l(t)}\left[1 - \frac{\upsilon}{l^*}\right]\frac{1}{\omega(t)\alpha(t)}$$

$$\psi(t) = \varphi(t) + \frac{\tau_W - \tau_K}{\left(1 - \tau_K\right)s(t) + \left(1 - \tau_W\right)(1 - s(t))} \bullet [1 - \varphi(t)].$$

Equations (20a) and (20b) highlight how the agent's relative income is driven by (1) his relative capital stock, and (2) the factor income this generates, before and after taxes, $\varphi(t)$ and $\psi(t)$, respectively. Consider first the factor-income element for before-tax income inequality, $\varphi(t)$. This measure has two components, the share of

[12] The after-tax income measure ignores the direct distributional impacts of lump-sum transfers, since these are arbitrary.

capital income, $s(t)$, and an adjustment reflected in the second term—"the leisure equalization effect"—which captures the fact that more (less) wealthy agents supply less (more) labor.[13] In the case of after-tax relative income, we can readily verify $\psi(t) < \varphi(t)$ if and only if $\tau_W < \tau_K$. That is, the agent's post-tax relative income is less than his pre-tax relative income if and only if τ_K exceeds τ_W.

5.3 Wealth and income inequality

We can now compute indexes of inequality. Because of the linearity of (14), (15a, 15b), (20a), and (20b) across agents, we can immediately derive the standard deviations of the relative wealth, capital, and income across agents (coefficients of variation) which serve as convenient measures of inequality. Following this procedure, the coefficients of variation of wealth and capital at time t are[14]

$$\sigma_a(t) = \frac{\alpha(t)}{\alpha(0)}\sigma_a(0) = \frac{\alpha(t)}{\omega(0)\alpha(0)}\sigma_{k,0} \tag{21a}$$

$$\sigma_k(t) = \omega(t)\sigma_a(t) = \frac{\omega(t)\alpha(t)}{\omega(0)\alpha(0)}\sigma_{k,0} \tag{21b}$$

which converge in steady state to

$$\sigma_a^* = \frac{1}{\omega(0)\alpha(0)}\sigma_{k,0} \tag{21a$'$}$$

$$\sigma_k^* = \omega^*\sigma_a^* = \frac{\omega^*}{\omega(0)\alpha(0)}\sigma_{k,0} \tag{21b$'$}$$

From (20a) and (20b) we may express the corresponding coefficients of variation of before-tax and after-tax income as follows:

$$\sigma_y(t) = \varphi(t) \cdot \sigma_k(t) \tag{22a}$$

$$\sigma_y^a(t) = \psi(t) \cdot \sigma_k(t) \tag{22b}$$

which correspondingly converge to $\sigma_y^* = \varphi^* \cdot \sigma_k^*$, and $(\sigma_y^a)^* = \psi^*\sigma_k^*$, respectively.

If labor supply is fixed, $\varphi(t) = s(t)$ and thus, $\sigma_y(t) = s(t)\sigma_k(t)$.[15] However, if labor supply is endogenous, wealthier agents supply less labor. This response mitigates

[13] These expressions are analogous to those obtained by García-Peñalosa and Turnovsky (2011). The main difference from the earlier expressions is that the relative importance of the adjustment of leisure, incorporated in the second term, takes account of the relative importance of real money balances in overall wealth, reflected in $\omega(t)$.

[14] A critical consequence of the "representative consumer theory of distribution" that is being adopted here is that the distributions of all quantities, $\sigma_a(t), \sigma_k(t)$ are tied to the given initial distribution of capital endowments, $\sigma_{k,0}$.

[15] With labor supply fixed $l_i = l = \bar{l}$ say, in which case $\varphi(t) = s(t)$ immediately follows.

the effect of capital inequality on income inequality and accordingly, the case of endogenous labor implies $\sigma_y(t) < s(t)\sigma_k(t)$. In that case, if the labor response effect dominates, in principle, there is the potential for $\varphi(t)$ in (20a) and (22a) to become negative. That would imply that agents having above average wealth have below average income. However, as a practical matter this can be ruled out and henceforth we shall assume $\varphi > 0$.[16]

5.4 Distribution of consumption (and welfare)

Some empirical studies, because of data limitations, also use observations on consumption inequality, which in any event is of its own independent interest. Combining (8a) and (12), we obtain:

$$c_i - 1 \equiv \frac{C_i}{C} - 1 = \left(1 - \frac{\upsilon}{l^*}\right)(a_i^* - 1) \tag{23}$$

Now summing this over the agents, we find that the coefficient of variation of consumption is

$$\sigma_c = \left(1 - \frac{\upsilon}{l^*}\right)\sigma_a^* = \left(1 - \frac{\upsilon}{l^*}\right)\frac{1}{\omega^*}\sigma_k^* \tag{24}$$

Thus, consumption inequality remains constant over time and is a constant fraction of steady-state wealth inequality. Moreover, because individuals' relative consumption, leisure, and real money balances all satisfy the same constant ratio given in (8a), and since these variables are determinants of welfare one can establish that welfare inequality across agents, measured in terms of units of wealth, is also constant and given by the expression in (24).

6 Inequality measures and the long-run super-neutrality of money

We turn now to the main issue, namely the extent to which the money growth rate impacts the various long-run measures of inequality. We assume that the economy is initially in steady state and shall consider two scenarios. In the first, the only change is an increase in the money growth rate, θ. In the second, starting from an initial steady state, there is a real shock, in the form of an increase in productivity, that is accompanied by a *contemporaneous* permanent increase in the money growth rate.

At time 0 the economy is initially in steady-state equilibrium, with all the aggregate quantities at their respective steady-state levels, $K_0, l_0, L_0, C_0, m_0, A_0$. Because of the super-neutrality of money at the aggregate level, K_0, l_0, L_0, C_0 are independent

[16] In simplified versions of the model that abstract from money, it can be ruled out analytically. In the present setup this will be so as long as $\upsilon < l^* < \upsilon\left[1 + (1+\eta)s^*/\beta\right]$, a condition that is met in all plausible parameterizations of the model.

of the initial monetary growth rate, θ_0. Corresponding to these aggregate quantities, (14) implies $\alpha_0 = 1$, and (16) implies

$$\omega_0 = 1 + \frac{m_0}{K_0}\frac{\upsilon}{l_0} > 1 \tag{25}$$

With this notation, the initial pre-shock distributions of wealth, pre-tax income, and consumption can be expressed in terms of the predetermined distribution of capital, $\sigma_{k,0}$:

$$\sigma_{a,0} = (\omega_0)^{-1}\sigma_{k,0} < \sigma_{k,0} \tag{26a}$$

$$\sigma_{y,0} = \varphi_0\sigma_{k,0} \text{ where } \varphi_0 = s_0 - (1 - s_0)\left(\frac{l_0 - \upsilon}{1 - l_0}\right)\frac{1}{\omega_0} \tag{26b}$$

$$\sigma_{c,0} = \left(1 - \frac{\upsilon}{l_0}\right)\frac{1}{\omega_0}\sigma_{k,0} \tag{26c}$$

Table 1 lists key parameters used to calibrate the model, while Table 2 reports the corresponding steady-state values of key aggregate variables together with several inequality measures. The specified values of the underlying parameters are all based on the relevant empirical evidence and equilibrium conditions and are justified in detail in an expanded version of this paper.[17] At this point we want to draw attention to the following ordering among the three inequality measures, $\sigma_{c,0} < \sigma_{y,0} < \sigma_{a,0}$, which is entirely consistent with the observed empirical evidence.[18]

6.1 Increase in monetary growth rate alone

Suppose the money growth rate increases from θ_0 to θ_1. Because of the super-neutrality of money at the aggregate level, the steady-state Eqs. (10a) and (10b) imply that K^* and l^* remain unchanged at their respective initial equilibrium values, $K^* = K_0$, $l^* = l_0$. Since the driving force behind the dynamics is the evolution of the capital stock, and since that remains fixed, (10a) and (10b) imply that $l(0)$ also remains unchanged at its initial steady-state level l_0. Since there are no dynamics in $K(t)$, there are no dynamics in $l(t)$. With $K(t)$ and $l(t)$ fixed over time, it follows from (9c) and (10c) that $m(t)$ jumps instantaneously to its new steady state, so that

$$\frac{m^*}{m_0} = \frac{m(0)}{m_0} = \frac{\theta_0 + \rho}{\theta_1 + \rho} < 1 \tag{27}$$

[17] The expanded version of the paper also conducts extensive numerical simulations of the model's transitional dynamics.

[18] $\sigma_{k,0}$ is set arbitrarily at 1. To our knowledge there is no available evidence determining whether $\sigma_{k,0} \gtreqless \sigma_{a,0}$.

Table 2 Initial steady-state responses

	k	y	c	l	m	a	σ_k	σ_a	σ_y	σ_c
Benchmark										
$\theta = 0.05, A = 1.5$	2.105	0.888	0.571	0.710	0.685	2.790	1.000	0.780	0.195	0.105
$\theta = 0.06, A = 1.5$	2.105	0.888	0.571	0.710	0.617	2.722	1.000	0.798	0.191	0.108

Hence (14′) implies $\alpha(t) = 1$ for all t, while in addition

$$\omega(t) = 1 + \frac{m(0)}{K_0}\frac{v}{l^*} = \omega(0) \text{ for all } t, \text{ so that } \omega^* = \omega(0) < \omega_0 \tag{28}$$

Recalling (21a′) and (21b′) we see that following the increase in the money growth rate, capital stock and wealth inequality immediately converge to their new steady-states

$$\sigma_k^* = \sigma_{k,0} \tag{29a}$$

$$\sigma_a^* = \frac{1}{\omega(0)}\sigma_{k,0} > \frac{1}{\omega_0}\sigma_{k,0} \tag{29b}$$

Thus we see that the steady-state distribution of capital remains at its initial pre-shock level, and is therefore independent of the money growth rate. In contrast, long-run wealth inequality will increase with the money growth rate. Intuitively, this is because the increase in the monetary growth rate reduces the proportion of real money balances in wealth, increasing the relative importance of capital. Since wealthier individuals hold relatively more capital, this leads to an increase in wealth inequality.

Turning now to income inequality, again there are no transitional dynamics. Recalling (20a) and (26b), the long-run impact of the increase in the monetary growth rate on income inequality is

$$\frac{\sigma_y^*}{\sigma_{y,0}} = \frac{\varphi^*}{\varphi_0} \text{ where } \frac{\varphi^*}{\varphi_0} = \frac{s^* - (1-s^*)\left(\frac{l^*-v}{1-l^*}\right)\frac{1}{\omega^*}}{s^* - (1-s^*)\left(\frac{l^*-v}{1-l^*}\right)\frac{1}{\omega_0}} < 1 \tag{30}$$

Thus, since an increase in the money growth decreases ω^*, with $\varphi > 0$, it reduces pre-tax income inequality. The intuition for this result is seen in Eq. (12). Since the increase in money growth rate increases wealth inequality, wealthier people respond by increasing their leisure, thereby reducing their labor supply and wage income. Since the distribution of income from capital remains independent of the money growth rate, the relative income of wealthier agents declines, reducing pre-tax income inequality.[19]

[19] Post-tax income inequality will also decline if and only if $(1-s^*)(\tau_K - \tau_W) + (1-\tau_W) > 0$, which is certainly met if $\tau_K > \tau_W$. However, it is also possible for post-tax income inequal-

Finally, dividing (24) by (26c) implies $\sigma_c^*/\sigma_{c,0} = \omega_0/\omega^* > 1$ so that increasing the money growth rate increases consumption inequality. This follows directly from the fact that consumption inequality is directly tied to wealth inequality.[20] We may summarize these results by the proposition:

Proposition 1 *Suppose the economy is initially in steady state. An increase in the money growth rate alone, with no other change, will be super-neutral with respect to the asymptotic distribution of capital. However, it will increase wealth inequality and consumption inequality, but reduce pre-tax income inequality, and almost certainly post-tax income inequality, as well.*

6.2 Increase in monetary growth rate accompanying an increase in productivity

To illustrate the impact of the monetary growth rate on the gradual adjustment in the economy we now assume that at time 0, the economy experiences an increase in total factor productivity accompanied by an increase in the monetary growth rate from θ_0 to θ_1. As an example, this may reflect a situation in which the government invests in public infrastructure, financed by printing money. The productivity increase leads to a long-run gradual increase in $K(t)$ from K_0 to K^*, so that $K_0 < K(t) < K^*$. The long-run response of leisure depends upon the elasticity of substitution. For example, in the case of a Cobb–Douglas production function, $l(t)$ can be shown to adjust as follows: $l(0) < l(t) < l_0 < l^*$. That is, on impact, $l(t)$ immediately declines from its initial steady-state value, l_0, to $l(0)$, after which it increases during the transition back to beyond its original steady-state equilibrium value.[21] Both the new aggregate steady state and distributional steady states are reached gradually. Because of the super-neutrality of money at the aggregate level, the initial and steady-state values, K_0, K^* and l_0, l^* are independent of the monetary growth rate or its change. In contrast, the real stock of money, $m(t)$ responds to both the productivity increase and the money growth rate.

Appendix B spells out the changes in the various steady-state inequality measures, indicating the channels whereby the productivity increase and money growth rate impinge on the distributional measures.[22] There it is seen that the increase in

Footnote 19 (continued)
ity to increase, while pre-tax income inequality declines and would occur in the extreme case that $\tau_W > [1 + \tau_K(1 - s^*)]/(2 - s^*)$.

[20] The direct link between consumption inequality and wealth inequality contrasts with the findings of Camera and Chien (2014). This illustrates the point that the distributional implications of monetary policy are sensitive to the underlying framework upon which they are based.

[21] See Turnovsky and García-Peñalosa (2008). They abstract from government expenditure in which case they find $l^* = l_0$. Introducing government expenditure forces $l^* > l_0$ for a sustainable steady-state equilibrium to obtain.

[22] We should note, however, that for reasons discussed at length by Atolia et al. (2012), the *steady-state* responses in the inequality measures stemming from a productivity increase are all path-dependent. This is because the long-run accumulation of assets that it generates depends upon the savings behavior during the transition, which in turn depends upon the time horizon over which the underlying structural

productivity, holding the real money supply constant, reduces the inequality of capital holdings. This finding is consistent with the early result obtained by Turnovsky and García-Peñalosa (2008) that abstracted entirely from money. The intuition is identical. The increase in productivity raises the long-run real wage, while the long-run return to capital remains unchanged, in accordance with (10a). Since wealthier agents supply less labor, instead enjoying more leisure and consumption, they save relatively less, and over time wealth inequality declines.

Equation (A.6b) also highlights the fact that with the accumulation of capital and the transition that this involves, the accompanying increase in the money growth rate now does impact the steady-state distribution of capital. This relationship indicates how the interaction depends upon the slope of the stable path followed by real money supply, (10c) relative to their steady-state changes. A sufficient condition to ensure that $\sigma_k^* < \sigma_{k,0}$ is that the change in the capital stock during the transition exceeds that of the real money balances, the extreme case of this being where real money balances remain constant over time. But increasing the money growth rate increases the ratio $m^*/m(0)$ during the transition, and if sufficient may lead to $\sigma_k^* > \sigma_{k,0}$. But this effect can occur only if the money growth accompanies an increase in capital that occurs over time. In the absence of this, (A.6b) reduces to zero, and money would be super neutral with respect to the distribution of capital, as in Proposition 1.

A second issue is that the increase in money growth, while almost certainly increasing wealth inequality, will most likely reduce income inequality. This is because as wealth inequality increases, wealthier people respond by increasing their leisure, thereby reducing their labor supply and wage income. Whether or not capital inequality increases, income inequality is more likely to decline, although in the extreme case where labor is supplied inelastically and the growth in real money supply during the transition exceeds of capital income inequality may in fact increase. The main insights from this shock can be summarized by the proposition:

Proposition 2 *Suppose the economy has a Cobb–Douglas technology and is initially in steady state, when it experiences an increase in productivity that is accompanied by a permanent increase in the money growth rate. While the long-run responses in capital, output, leisure, and consumption are independent of the accompanying change in the monetary growth rate, money is not super-neutral with respect to various inequality measures, including capital. It will lead to an immediate increase in wealth inequality, which moderates over time, but nevertheless increases in the long run, as well as an increase in consumption inequality. The impact on income inequality depends in part on what happens to capital inequality, but is more likely to decline.*[23]

Footnote 22 (continued)

change takes place. Since this aspect is not the focus of our analysis, we maintain the prevalent assumption that all changes are fully implemented at the initial time 0.

[23] The increase in consumption inequality coupled with the probable decline in income inequality is contrary to the empirical patterns identified by Meyer and Sullivan (2013). But it should be recalled that

7 Conclusion

This paper has studied the impact of inflation on various measures of inequality in a monetary economy. To do so we have modified the standard Sidrauski model to include elastic labor supply, and a utility function that ensures money growth is super-neutral in the long run with respect to real aggregate activity. We find that the super-neutrality of money does not extend to most distributional measures. To illustrate the impact of money on inequality we have considered two scenarios.

The first assumes that the economy, initially in steady state, is subject to a permanent sustained increase in the money growth rate. With money being super-neutral with respect to the real aggregate variables, there are no transitional dynamics. The aggregate capital stock and labor supply remain unchanged, as do the corresponding factor returns. The only response is an instantaneous reduction of real money balances. With the aggregate capital stock unchanged, capital assumes a larger share of aggregate wealth, and being more unequally distributed across agents, this implies an increase in wealth inequality. This in turn leads to a relative increase in leisure by the affluent, who supply less labor, leading to a decline in income inequality.

In the other scenario, the increase in the monetary growth rate accompanies a gradual increase in the aggregate capital stock, resulting from a concurrent real shock, such as a productivity increase. The accompanying increase in the monetary growth rate impacts the long-run distributions of wealth and capital in two distinct, but offsetting, ways. The first is through the reduction in real money balances at the time of the monetary expansion. This is sustained over the subsequent transition and contributes to an increase in the evolving wealth inequality. But at the same time, the increase in the monetary growth rate tends to reduce the growth of wealth inequality over time, offsetting the first effect. The money growth rate impinges on income inequality through two channels: (1) its impact on the growth of wealth inequality and (2) its impact on the factor returns associated with the capital.

Having identified the channels whereby inflation impacts the various inequality measures, to obtain further insight we have calibrated the model to reflect an advanced economy. In this case, we find that the first effect of the money growth rate on wealth inequality, noted above, dominates the second equalizing effect, and on balance, wealth inequality increases. In the case of capital inequality, the opposite tends to be true, although the relative importance of the two effects changes with inflation and the impact on the distribution of capital tend to be relatively small. Thus, capital inequality declines while the monetary growth rate and its increase remain moderate, it may increase for high rates of inflation. In the case of income inequality, one key influence is what we have called the "equalizing effect of leisure", which reflects the fact that more affluent agents choose more leisure and supply less labor. This effect is sufficiently strong, at least in advanced economies, to

Footnote 23 (continued)
our dynamic response pertains to just one specific shock while the data reflect responses to a variety of shocks, having diverse distributional consequences.

dominate the increase due to wealth inequality, so that on balance income inequality tends to decline.

Three striking results emerge from the implications of the formal model together with the numerical calibrations, the latter discussed in detail in the expanded version of this paper. First, the money growth rate in fact has an imperceptible effect on the time paths of the real aggregates, output, capital, and labor, so that the superneutrality of money holds as a good approximation along the transition, as well as in steady state. Second is the sharply contrasting effects of money growth on income inequality versus wealth inequality. Finally, the flexibility of labor supply is a critical element in determining the consequences of monetary policy for income inequality. By reducing the utility of leisure, our model has the flexibility to generate a positive relationship between income inequality and inflation often characteristic of less affluent economies.

Finally, we should note that the present paper has expressed monetary policy in terms of the traditional fixed nominal money growth rate advocated by Milton Friedman, so that an increase of which generates a correspondingly higher equilibrium inflation rate. However, much of contemporary monetary policy is expressed in terms of central banks controlling the nominal interest rate in response to the inflation rate and real GDP, by following some kind of Taylor rule. Clearly to examine how alternative ways of conducting monetary policy affect various measures of inequality merits serious study, as well as other frameworks in which prices are characterized by varying degrees of flexibility.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40505-021-00207-x.

References

Aiyagari, S.R.: Uninisured idiosyncratic risk and aggregate saving. Q. J. Econ. **109**, 659–684 (1994)

Albanesi, S.: Inflation and inequality. J. Monet. Econ. **54**, 1088–1114 (2007)

Atolia, M., Chatterjee, S., Turnovsky, S.J.: Growth and inequality: dependence on the time path of productivity increases (and other structural changes). J. Econ. Dyn. Control **36**, 331–348 (2012)

Bewley, T.F.: Stationary monetary equilibrium with a continuum of independently fluctuating consumers. In: Hildenbrand, W., Mas-Collel, A. (eds.) Contributions in Mathematical Economics in Honor of Gerard Debreu, North-Holland, Amsterdam (1987)

Camera, G., Chien, Y.: Understanding the distributional impact of long-run inflation. J. Money Credit Bank. **46**, 1137–1170 (2014)

Caselli, F., Ventura, J.: A representative theory of distribution. Am. Econ. Rev. **90**, 909–926 (2000)

Chang, J.-J., Lin, H.-Y., Savitski, D.W., Tsai, H.-F.: Inflation and inequality in a growing economy with cash and credit goods. Macroecon. Dyn. (2020) **(forthcoming)**

Chatterjee, S.: Transitional dynamics and the distribution of wealth in a neoclassical growth model. J. Public Econ. **54**, 97–119 (1994)

Coibion, O., Gorodnichenko, Y., Kueng, L., Silva, J.: Innocent bystanders? Monetary policy and inequality. J. Monet. Econ. **88**, 70–89 (2017)

Coronado, J.L., Perozek, M.: Wealth effects and the consumption of leisure: retirement decisions during the stock market boom of the 1990s, Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series, 2003–20 (2003)

Danthine, J.-P., Donaldson, J.B., Smith, L.: On the superneutrality of money in a stochastic dynamic macroeconomic model. J. Monet. Econ. **20**, 475–499 (1987)

Doepke, M., Schneider, M.: Inflation and the redistribution of nominal wealth. J. Polit. Econ. **114**, 1079–1097 (2006)
Fischer, S.: Capital accumulation on the transition path in a monetary optimizing model. Econometrica **47**, 1433–1439 (1979)
Gabaix, X., Lasry, J.-M., Lions, P.-L., Moll, B.: The dynamics of inequality. Econometrica **84**, 2071–2111 (2016)
Garcia-Peñalosa, C., Turnovsky, S.J.: Taxation and income distribution dynamics in a neoclassical growth model. J. Money Credit Bank. **43**, 1543–1577 (2011)
Geweke, J.F.: The Superneutrality of money in the United States: an interpretation of the evidence. Econometrica **54**, 1–21 (1986)
Gorman, W.M.: Separable utility and aggregation. Econometrica **27**, 469–481 (1959)
Heathcote, J.K., Storesletten, and G.L. Violante, : Quantitative macroeconomics with heterogeneous households. Annu. Rev. Econ. **1**, 319–354 (2009)
Holtz-Eakin, D., Joulfaian, D., Rosen, H.S.: The Carnegie conjecture: some empirical evidence. Q. J. Econ. **108**, 413–435 (1993)
Kaplan, G., Moll, B., Violante, G.L.: Monetary policy according to HANK. Am. Econ. Rev. **108**, 697–743 (2018)
King, R.G., Watson, M.W.: Testing long-run neutrality. Fed. Reserve Bank Richmond Econ. q. **83**(3), 69–101 (1997)
Kormendi, R.C., Meguire, P.G.: Cross-regime evidence of macroeconomic rationality. J. Polit. Econ. **92**, 875–908 (1984)
MaCurdy, T.: An empirical model of labor supply in a life cycle setting. J. Polit. Econ. **89**, 1059–1085 (1981)
Maliar, L., Maliar, S.: The representative consumer in the neoclassical growth model with idiosyncratic shocks. Rev. Econ. Dyn. **6**, 362–380 (2003)
Marini, G., van der Ploeg, F.: Monetary and fiscal policy in an optimizing model with capital accumulation and finite lives. Economic Journal **98**, 772–786 (1988)
Meyer, B.D., Sullivan, X.: Consumption and income inequality and the Great Recession. Am. Econ. Rev. Papers Proc. **103**, 176–183 (2013)
Mundell, R.A.: Inflation and real interest. J. Polit. Econ. **71**, 280–283 (1963)
Ragot, X.: The case for financial approach to money demand. J. Monet. Econ. **62**, 94–107 (2014)
Romer, C.D., Romer, D.H.: Monetary policy and the well-being of the poor. Fed. Reserve Bank Kansas City Econ. Rev. First Quart. 21–49 (1999)
Serletis, A., Koustas, Z.: International evidence on the neutrality of money. J. Money Credit Bank. **30**, 1–25 (1998)
Sidrauski, M.: Rational choice and pattern of growth in a monetary economy. Am. Econ. Rev. **57**, 534–544 (1967)
Sorger, G.: On the long-run distribution of capital in the Ramsey model. J. Econ. Theory **105**, 226–243 (2002)
Thalassinos, E., Uğurlu, E., Muratoğlu, Y.: Income inequality and inflation in the EU. Eur. Res. Stud. **15**, 127–140 (2012)
Tobin, J.: Money and economic growth. Econometrica **33**, 671–684 (1965)
Turnovsky, S.J., Garcia-Peñalosa, C.: Distributional dynamics in a neoclassical growth model: the role of elastic labor supply. J. Econ. Dyn. Control **32**, 1399–1431 (2008)
Weil, P.: Is money net wealth? Int. Econ. Rev. **32**, 37–53 (1981)