Zero liquidity and concentrated redistribution in a New Keynesian model*

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Abstract

The *zero-liquidity* assumption — households cannot borrow and assets are in zero net supply — simplifies heterogeneous-agent models by eliminating the asset distribution as an aggregate state. I show that it creates a peculiar response to concentrated redistribution in a New Keynesian model. A transfer Δ distributed among a fraction ε of households reduces period-0 output by Δ/ε. Thus, output can remain depressed as Δ vanishes and can approach zero. If a positive fraction of transfer-paying households can borrow and their constraints are locally slack, the output loss vanishes with Δ. This fragility warrants caution in highly concentrated transfer experiments.

JEL codes: E12, E21

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1 Introduction

Incomplete-market heterogeneous-agent models become particularly tractable under the *zero-liquidity assumption*: households cannot borrow, and the asset is in zero net

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supply, so every household holds zero assets in equilibrium. The equilibrium distribution of asset holdings — a potentially complicated aggregate state — is therefore degenerate and time-invariant. This assumption has been used to derive asset-pricing and aggregation results (Krusell, Mukoyama, and Smith, 2011; Werning, 2015) and to obtain tractable heterogeneous-agent New Keynesian (HANK) models (Ravn and Sterk, 2017, 2021; Challe, 2020; Broer, Hansen, Krusell, and Öberg, 2020). Its widespread use makes it important to understand the restrictions that it places on equilibrium responses.[1]

This paper shows that zero liquidity can generate a peculiar response to concentrated redistribution in a simple New Keynesian model. I consider a one-time redistribution shock that collects an aggregate amount Δ from a fraction $1 - \varepsilon$ of households and transfers it to the remaining fraction ε. Under zero liquidity, in the maximal-output equilibrium, the period-0 output contracts by Δ/ε from the steady state value. Consequently, a redistribution whose aggregate size vanishes can have a non-vanishing contractionary effect on output: as Δ and ε converge to zero, the redistribution vanishes in the aggregate sense, although the output loss, Δ/ε, need not vanish.

The mechanism follows from asset-market clearing. The recipients of the temporary transfer have an incentive to save. Under the zero-liquidity assumption, however, positive saving is impossible in equilibrium. Output — and hence the before-transfer income common to all households — must fall until the recipients are willing to hold zero assets. In equilibrium, their after-transfer income is restored exactly to its no-shock level, so output falls by the transfer per recipient. Concentrating a vanishing aggregate transfer among a sufficiently small group can therefore produce a substantial contraction.

[1]An alternative route to tractability is to derive explicit aggregation results under additional assumptions on preferences and shocks (Braun and Nakajima, 2012; Acharya and Dogra, 2020).

This result is fragile to positive borrowing capacity. If any fixed positive fraction of transfer-paying households can borrow and their borrowing constraints are locally slack, their additional borrowing partially accommodates the recipients' desired saving. The output loss then converges to zero as the aggregate redistribution vanishes. Zero-liquidity HANK models should therefore be used cautiously for experiments that temporarily raise the income of a very small group, such as a large positive idiosyncratic income shock or a targeted tax cut. The resulting contraction may reflect the zero-liquidity assumption rather than a robust implication of economies with limited but positive borrowing capacity.

2 Model

Time is discrete and indexed by $t = 0, 1, \ldots$. There is a unit measure of households, indexed by $i \in [0, 1]$, that have access to an asset market. Households have identical preferences and identical before-transfer incomes. They differ in the realization of the redistribution shock in $t = 0$. Once the redistribution shock is realized at the beginning of $t = 0$, there is no uncertainty. The model below is, except for the redistribution shock, a special case of the model in Auclert, Rognlie, and Straub (2024): monetary policy fixes the real interest rate; households' labor supply is demand-determined and households take their work hours and incomes as exogenous.

Household i's utility from a strictly positive consumption sequence, $\{c_t(i)\}_{t=0}^{\infty}$ is given by $\sum_{t=0}^{\infty} \beta^t \ln c_t(i)$. The period-$t$ budget constraint for household i is $c_t(i) + a_{t+1}(i) = y_t - \tau_t(i) + r a_t(i)$. All households begin with zero assets, $a_0(i) = 0$, receive the same before-transfer income, y_t, for all t, and face the constant gross real interest rate, $r = 1/\beta$. The redistribution shock, $\tau_t(i)$, is nonzero only in period $t = 0$ and equals zero thereafter. The period-0 redistribution shock satisfies:

$$\tau_0(i) = \begin{cases} \Delta/(1-\varepsilon), & \text{for } i \in [0, 1-\varepsilon) \\ -\Delta/\varepsilon, & \text{for } i \in [1-\varepsilon, 1] \end{cases} \tag{1}$$

where $\Delta > 0$ denotes the total amount of transfer and $\varepsilon \in (0,1)$ denotes the fraction of households who receive the transfer. The ratio Δ/ε is thus the transfer per recipient. The shock is purely redistributive because $\int_0^1 \tau_0(i)di = 0$.

The borrowing constraint for household i in period t is given by:

$$a_{t+1}(i) \geq \begin{cases} -\bar{b}, & \text{for } i \in [0, \omega) \\ 0, & \text{for } i \in [\omega, 1] \end{cases} \tag{2}$$

where $\omega \in [0, 1-\varepsilon]$ denotes the fraction of households who can borrow, and where $\bar{b} > 0$ denotes their borrowing limit. The zero-liquidity assumption corresponds to the case where $\omega = 0$.

An equilibrium is $\{y_t, (c_t(i), a_{t+1}(i))_{i\in[0,1]}\}_{t=0}^{\infty}$ such that, given $\{y_t\}$ and $\{\tau_t(i)\}$, each household's allocation solves its optimization problem and, for every t, $\int_0^1 c_t(i)di = y_t$ and $\int_0^1 a_{t+1}(i)di = 0$. The steady-state output, $\overline{y}$, is exogenously specified and not determined endogenously in the present model.[2] The choice of the steady-state output does not affect the qualitative results. Among equilibria satisfying $y_t = \overline{y}$ for every $t \geq 1$, I select the equilibrium with the largest period-0 output.[3]

[2] To understand why, let us set $\Delta = 0$. Then the model becomes a representative-agent New Keynesian model, and the equilibrium here reduces to the dynamic IS equation, which combines the Euler equation and the resource constraint. It does not by itself determine the steady-state output level.

[3] Restricting $y_t = \overline{y}$ after the shock dissipates follows the standard practice in the New Keynesian literature. In the present model, selecting the maximal-output equilibrium is equivalent to the criterion used in Krusell, Mukoyama, and Smith (2011) and Werning (2015), which requires the Euler equation to hold with equality for households with the strongest saving motive.

3 Equilibrium characterization

Suppose $\Delta < \overline{y}/4$. Let $\underline{\varepsilon}(\Delta/\overline{y})$ and $\overline{\varepsilon}(\Delta/\overline{y})$ be two distinct solutions to $\varepsilon(1-\varepsilon) = \Delta/\overline{y}$ with $\underline{\varepsilon}(\Delta/\overline{y}) < \overline{\varepsilon}(\Delta/\overline{y})$. It follows that $\lim_{\Delta\downarrow 0} \underline{\varepsilon}(\Delta/\overline{y}) = 0$ and $\lim_{\Delta\downarrow 0} \Delta/\underline{\varepsilon}(\Delta/\overline{y}) = \overline{y}$.

Without the redistribution shock, an obvious equilibrium exists: all households consume $\overline{y}$ and save exactly zero in every period, and output is constant at $\overline{y}$. With the redistribution shock, the following proposition characterizes an equilibrium:

Proposition 1 *Suppose $\Delta < \overline{y}/4$. Fix any $\varepsilon \in \mathcal{E}(\Delta) := (\underline{\varepsilon}(\Delta/\overline{y}), \overline{\varepsilon}(\Delta/\overline{y}))$ and $\omega \in [0, 1-\varepsilon]$. Then the following equilibrium exists: (a) for all $t \geq 1$, $y_t = \overline{y}$, $c_t(i) = c_{t+1}(i)$, and $a_t(i) = a_{t+1}(i)$ for all i; (b) $a_1(i) = -\min\left\{\overline{b}, -\beta(y_0 - \Delta/(1-\varepsilon) - \overline{y})\right\}$ for all $i < \omega$, $a_1(i) = 0$ for all $i \in [\omega, 1-\varepsilon)$, and $a_1(i) = \beta(y_0 + \Delta/\varepsilon - \overline{y})$ for $i \geq 1-\varepsilon$; and (c) y_0 solves*

$$\varepsilon\beta\left(y_0 + \frac{\Delta}{\varepsilon} - \overline{y}\right) = \omega \min\left\{\overline{b}, -\beta\left(y_0 - \frac{\Delta}{1-\varepsilon} - \overline{y}\right)\right\}, \tag{3}$$

and $c_0(i) > 0$ is obtained from the budget constraint for each i.

Condition (a) describes equilibrium from period 1 onward. Because $y_t = \overline{y}$ and $\beta r = 1$, every household keeps consumption and assets constant. Period-0 asset-market clearing then ensures market clearing thereafter. Condition (b) describes the saving decision of individual households. The log utility implies that the households' marginal propensity to save is β in the absence of a binding borrowing constraint. Hence, each recipient household saves $\beta(y_0+\Delta/\varepsilon-\overline{y})$; each transfer-paying household who can borrow borrows the minimum of $-\beta(y_0 - \Delta/(1-\varepsilon) - \overline{y})$ and $\overline{b}$; and the remaining transfer-paying households save zero. Condition (c) aggregates saving and borrowing on the two sides of equation (3). Finally, the restrictions on Δ and ε ensure strictly positive consumption.

The following two corollaries are the main results of the present paper.

Corollary 1 (Output under the zero-liquidity assumption) *Under the assumptions of Proposition 1 and the zero-liquidity condition ($\omega = 0$), the period-0 output is given by $y_0 = \overline{y} - \Delta/\varepsilon$. For a given Δ, the contractionary effect increases as ε shrinks toward $\underline{\varepsilon}(\Delta/\overline{y})$. For any sequence $\{(\Delta_n, \varepsilon_n)\}$ with $\Delta_n \downarrow 0$, $\varepsilon_n \in \mathcal{E}(\Delta_n)$ for all n, and $\lim_n \Delta_n/\varepsilon_n = \overline{y}$, the output loss converges to $\overline{y}$, implying $y_0 \to 0$. If instead $\{\varepsilon_n\}$ is such that $\lim_n \Delta_n/\varepsilon_n = 0$, the output loss converges to zero.*

Under the zero-liquidity assumption, equation (3) implies $y_0 = \overline{y} - \Delta/\varepsilon$. The output loss equals the transfer per recipient, Δ/ε, which may remain large even when total redistribution vanishes.

Corollary 2 (Output under a less stringent borrowing constraint) *In addition to the assumptions of Proposition 1, assume that $\overline{b} > 0$, $\omega \in (0, 1-\varepsilon]$, and $\omega\overline{b} \geq \beta\Delta$. Then, the period-0 output is given by $y_0 = \overline{y} - \{\Delta/(\varepsilon + \omega)\}(1 - \omega/(1-\varepsilon))$. Hence, if $\omega = 1 - \varepsilon$, the shock has no effect on output, i.e., $y_0 = \overline{y}$. For fixed ω and $\overline{b}$, the period-0 output converges to $\overline{y}$ along any sequence satisfying $\Delta_n \downarrow 0$, $\varepsilon_n \in \mathcal{E}(\Delta_n)$, and $\omega < 1 - \varepsilon_n$ for all n.*

Under the condition $\beta\Delta \leq \omega\overline{b}$, the unconstrained borrowing of each household $i < \omega$, $\beta\Delta/(\varepsilon + \omega)$, is strictly less than the borrowing limit for any $\varepsilon > 0$, and their borrowing constraints are slack. Then, a decline in y_0 not only decreases the left-hand side of equation (3) by lowering the saving incentives of the recipients, but also increases the right-hand side by increasing the borrowing of the households $i < \omega$. Therefore, the required income adjustment to clear the asset market is smaller than under the zero-liquidity assumption. As a result, a vanishingly small shock has only a vanishingly small effect on output. The borrowers' ability to respond to the shock is crucial for this result. Note that ω need not be fixed to obtain this result. Even if $\omega_n \downarrow 0$, the contractionary effect disappears provided that $\Delta_n/\omega_n \to 0$ and $\overline{b}$ is fixed.

4 Conclusion

Zero liquidity can make aggregate output highly sensitive to concentrated redistribution: in the maximal-output equilibrium, the output loss equals the transfer per recipient and may remain large as total redistribution vanishes. This result disappears when a positive measure of transfer-paying households can borrow subject to locally slack constraints.

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