Banks, the Government, and Money Creation

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Abstract

We examine how private money creation by banks and fiat money creation by the government jointly affect real output. Fiat money derives its value from the government's taxation authority, but banks are essential for tax collection and thus for sustaining both forms of money. Four main results emerge. First, money – regardless of form – functions as a multiplier on the economy's capital endowment, amplifying investment and output. Second, without interbank loan trading, only total money creation matters – not its composition – so the supply of fiat money is irrelevant. Third, with interbank loan trading, fiat money matters, and private and fiat money become complements, with higher bank capital enhancing the creation of both. Finally, the analysis rationalizes quantitative easing and government subsidies for banks' asset purchases, showing that these interventions can be at least partially self-financing.

JEL: E42, E51, E58, G21, G28

Keywords: Bank capital, Private money, Fiat money, Interbank trading, Policy intervention

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1 Introduction

Money has occupied a prominent place in macroeconomics for a long time. The connection between money and real economic output (e.g., Friedman and Schwartz (1963)) as well as the mediating role of banks in economies lubricated by money as a medium of exchange (e.g., Bagehot (1873), Hicks (1969), and Keynes (1936, 1973)) are issues with a hoary tradition of deep research. This research has explored the potential importance of the quantity of money and the role of central banks in regulating it (e.g., Friedman (1961, 1970) and Lucas (2006)). It has also illuminated the causal linkages between monetary aggregates and real output. A related strand of research in microeconomics has focused on the channels through which banks and other intermediaries improve the efficiency with which money flows from savers to investors in real projects in the face of informational frictions (e.g., Allen (1990), Diamond (1984), and Ramakrishnan and Thakor (1984)). However, the bridge that *connects* these two strands of research – with microfoundations for the existence of money as well as banks – is somewhat sparsely populated, and this is what we seek to explore in this paper. In particular, we develop a model in which banks and different types of money emerge endogenously, and examine their effect on real output. We also analyze central bank policy in this environment and the potential role of government intervention in boosting real output.

We address four questions. First, what role does money play in affecting real output? This question has been actively debated, with new Keynesian models of monetary policy asserting that output, prices, and interest rates can be determined without reference to the quantity of money (e.g., Woodford (2003)), whereas others argue that money predicts output fluctuations (e.g., Nelson (2002)). Our analysis introduces new nuance by examining how banks endogenously shape the money-output linkage.

Second, does the *mix* of money matter in how money affects real output? Money consists of both fiat money issued by the government and private money created by banks through lending (e.g., Gross and Siebenbrunner (2019)). We examine whether these two forms of money interact as complements or substitutes, and whether their relative shares influence real economic activity.

There is growing recognition that bank capital matters for monetary policy (e.g., Gambacorta and Shin (2018)). Our third question is therefore: Given the centrality of banks in money creation, how does bank capital affect aggregate money creation and hence economic output through the monetary channel?

Since money is a created object, monetary policy – particularly the determination of the quantity of money and its response to economic conditions – is an important objective of the central bank. In this regard, there has been much recent interest in unconventional monetary policy, including quantitative easing (QE); see, for example, Gagnon, Raskin, Remache, and Sack (2011) and Swanson (2011). While the focus of this literature is mainly on how monetary policy needs to tackle financial crises to buoy economic output during such periods, our fourth question examines a different issue: Is there a role for central banks or governments to intervene in money creation to improve upon the laissez-faire equilibrium during *normal times*?

Model Sketch & Central Idea: The economy, populated by risk-neutral agents, operates across three dates. A single numéraire good serves as both investible capital and a consumption good. Firms invest labor and capital in production at date 0. Investments are partly funded with bank loans, which are made with "deposits" *unbacked* by goods at date 0. That is, banks create deposits in the process of lending,[1] and this is private money creation by banks. The date-1 production output is random due to uncertainty, and it is stored until date 2 for consumption. Banks have an advantage in safeguarding this output.[2] The key friction is lack of pledgeability, so agents honor contracts only if that is to their *ex post* interest. Specifically, firms repay loans and banks safeguard deposits only if it is *ex post* incentive compatible for them to do so. Banks are endowed with an immutable amount of initial equity capital, and capital is scarce.

For bank-created private money to be an acceptable means of payment, its value must be backed by *future* access to consumption goods. So a bank's private money creation at date 0 is constrained by the

[1]The creation of deposits through the lending process is an observation that has a long tradition going back to Hahn (1920), Keynes (1931), Rogers (1929), Schumpeter (1954), and Wicksell (1907). In his contribution to the 1931 Macmillan Committee, Keynes wrote (on p. 34): "It is not unnatural to think of deposits of a bank as being created by the public through the deposits of cash representing either savings or amounts which are not for the time being required to meet expenditures. But the bulk of the deposits arise out of the action of the banks themselves, for by granting loans, allowing money to be drawn on an overdraft or purchasing securities, a bank creates a credit in its books which is the equivalent of a deposit." In the modern context, banks are viewed as financial intermediaries that create digital purchasing power for their customers (e.g., Jakab and Kumhof (2019)). This is also widely recognized by policymakers in the context of modern banking. Mervyn King (Governor of the Bank of England, 2003-2013) notes: "When banks extend loans to their customers, they create [private] money by crediting their customers' accounts." Adair Turner (Chairman of the UK Financial Services Authority, 2008-2013) notes: "Banks do not, as too many textbooks still suggest, take deposits of existing money from savers and lend it out to borrowers: they create credit and [private] money *ex nihilo* – extending a loan to the borrower and simultaneously crediting the borrower's money account."

[2]Output stored as a deposit by the bank does not lose value, while it depreciates in value (through theft, spoilage, etc.) if not deposited in the bank. This is not only consistent with the historical origins of banks, but also of contemporary relevance. One reason why central banks like the ECB were able to offer negative interest rates on deposits by banks with the central bank is that safekeeping of valuables is costly and there are economies of scale, so central banks have an advantage. Modern banks also provide a host of safeguarding services to customers for storage of valuable documents, gold, jewelry, cash, etc.

quantity of goods it can credibly commit to store at date 1. When a firm's date-1 production output is low, the value of the bank's loan and hence its capital decline. This violates the incentive compatibility (IC) condition for the bank to safeguard deposits at date 1 for another period and not abscond with them. Consequently, in this low-output state, the borrower will not deposit output with the bank at date 1. Anticipating this, the bank's date-0 private money loses value, reducing its money creation. We permit banks to engage in loan trading at date 1. Trading allows the low-capital bank to sell its impaired loan to a high-capital bank (whose borrower has a high output) that can credibly commit to safeguarding and thus attract deposits at date 1. Thus, trading enhances the value of private money, enabling higher aggregate money creation by banks.

In addition to private money created by banks, there is also fiat money created by the government. This money is backed by the taxing authority of the government. Specifically, the government taxes firms' output, collecting these taxes in consumption goods at date 2. Due to the non-pledgeability friction, output is within the reach of the government for taxation only if it resides in bank deposit accounts. That is, a firm may evade tax by not depositing its output with the bank at date 1. Thus, banks play a central role in tax collection and consequently support fiat money creation.

Since money in this model represents a claim on the consumption good, one can think of this as money under a "commodity standard." That is, despite our reference to government-created money as "fiat money" – typically viewed as currency that carries no promise of either present or future convertibility into gold, silver or anything else of intrinsic value (e.g., Rolnick and Weber (1997)) – we are thinking of fiat money as having value because it is backed by the government's ability to collect the consumption good via taxation. However, identifying the monetary standard (commodity or fiat money) is not always clearcut. Bordo and Kydland (1996) argue that all standards – including the "fiat money" standard – are really commodity standards because people believe that money will be convertible to a valued commodity or consumption good in the future. Moreover, as noted by Calomiris (1988) and others, even unbacked fiat money is implicitly backed.[3] Others have noted that even fiat currencies need backing through credible fiscal support from the government, and that the ultimate backing for the value of money is the fiscal sustainability of the consolidated public sector, consisting of the central bank and fiscal authorities (e.g., Bolt et al. (2024), Curdia and Woodford (2011), Reis

[3]These papers note that money's value aligns more closely with a real-bills type backing theory than with the quantity theory.

(2013), and Sims (1994)). We will thus refer to the two types of money in our model as fiat money (government-created) and private money (bank-created).[4] Given our clarification above, we trust this avoids any semantic kerfuffle on the appropriate labels.

Results: Our analysis generates four main results, each corresponding to one of the research questions stated earlier. First, money – regardless of how it is created – functions as a multiplier on the economy's capital endowment, amplifying investment and output. This result is consistent with the theoretical implications in Nelson (2002), and the empirical evidence in Favara and Giordani (2009), Feldstein and Stock (1993), and Rudebusch and Svensson (2002). What is different about our analysis is that it endogenizes not only money, but also the existence of banks as creators of private money that interacts with fiat money.

Second, when banks cannot trade loans in the secondary market, only *total* money creation matters for real output, not its composition of fiat and private money. In this case, the quantity of fiat money does not matter because private money can perfectly substitute for it. While loan trading is a fairly old practice, organized secondary markets for loan trading developed in the U.S. only in the second half of the 20th century. Thus, while we model the no-trading case as a theoretical benchmark, it does have historical relevance.

Third, with interbank loan trading, the quantity of fiat money matters, and private and fiat money now become complements. This is consistent with the evidence in Rolnick and Weber (1997) and Reis (2013). Moreover, we also find that higher bank capital leads to higher quantities of both private and fiat money. This is a new prediction that awaits empirical verification.[5] Our analysis focuses on the case in which bank capital is scarce, though we also discuss the implications of bounteous bank capital.

Finally, we find that the laissez-faire money creation equilibrium is inefficient. State-dependent government intervention can enhance money creation and boost real output. In some cases, the optimal policy involves government loan purchases as in QE. In others, it requires subsidizing a fraction of banks that purchase loans. While the existing literature has rationalized QE and government subsidies during crises and economic downturns, our analysis reveals a striking implication – such interventions may be

[4] Bank-created money can include "fountain pen money" (Tobin (1963)), as well as the creation of digital purchasing power for bank customers.

[5] Thakor and Yu (2024) provide limited evidence on the relative magnitudes of bank-created and fiat money. They document that during 2001-2020, 92% of U.S. bank deposits were due to private money creation, with fiat money accounting for only 8%. Bank-created money accounted for 57% of GDP on average annually.

optimal even in normal times, not just during stress periods.

Literature: In addition to the earlier-discussed papers on money creation, our paper is related to several strands of the literature. The literature on the monetarist approach to banking, reviewed in Lagos, Rocheteau, and Wright (2017), is highly relevant (e.g., Bullard and Smith (2003), Gu, Mattesini, Monnet, and Wright (2013), and He, Huang, and Wright (2005, 2008)). Lack of commitment renders non-intermediated transactions infeasible. This literature shows how money arises endogenously to cope with such frictions. Bank liabilities emerge as an acceptable means of payment to facilitate transactions because banks are assumed to be entities that can be trusted to keep their promise.[6] We do not assume banks are trustworthy, i.e., lack of commitment applies to banks as well in our model. The trustworthiness of banks arises *endogenously* in our analysis and hinges on bank capital. In this setting, loan trading and government intervention *enhance the collective commitment power of the banking system* in money creation.

Our paper is also related to the literature on why banks exist and what services they provide (e.g., Allen (1990), Boyd and Prescott (1986), Bryant (1980), Coval and Thakor (2005), Diamond (1984), Diamond and Dybvig (1983), Millon and Thakor (1985), and Ramakrishnan and Thakor (1984)). In contrast to these papers, our model is devoid of informational frictions or risk sharing considerations, and we examine a *raison d'etre* for banks that differs from the usual credit screening and moral hazard attenuation theories. Specifically, we rationalize banks based on their safekeeping expertise and ability to create private money. Thus, our paper is related to the "financing-via-money-creation" literature (e.g., Disyatat (2011), Jakab and Kumhof (2019), and McLeay, Radia, and Thomas (2014)). The paper most closely related in this strand is Donaldson, Piacentino, and Thakor (2018), which models an agrarian economy to endogenize banks as private money creators. Our paper differs significantly in that we focus on the role of uncertainty and the interaction between private and fiat money, with an analysis of the potential for loan trading and government intervention to enhance output.

The literature on bank capital (e.g., Allen, Carletti, and Marquez (2011), Berger and Bouwman (2013), Gambacorta and Shin (2018), Mehran and Thakor (2011), and Peek and Rosengren (2000)) is relevant as well. Our paper highlights a novel role of bank capital in facilitating the creation of both private and fiat money.

[6] Thakor and Merton (2025) develop a theory in which the funding cost advantage of banks makes them more trusted lenders than non-banks.

Our paper contributes to the trading inefficiency literature, which typically examines inefficient trades in crises (e.g., Acharya, Gromb, and Yorulmazer (2012)). We do not focus on crises *per se*, but characterize *two-sided* trading inefficiency even in non-crisis states. Specifically, while trading enables high-capital banks to fill the depository service vacuum created by capital-impaired banks, the competitive market price is either too high or too low relative to the social optimum.

Finally, our analysis provides a novel rationale for central bank intervention. Existing studies of central bank intervention either focus on monetary policy (e.g., Greenbaum, Thakor, and Boot (2025) and Stein (2012)) or its role as a lender of last resort (LOLR) in crises to facilitate efficient liquidity transfers (e.g., Acharya, Gromb, and Yorulmazer (2012)), prevent contagion (e.g., Allen and Gale (2000) and Acharya and Thakor (2016)) or enhance welfare (e.g., Allen and Gale (1998)).[7] Central bank intervention in our model is *not* intended to prevent inefficient bank liquidations or fire-sale spirals as in the literature (e.g., Choi and Yorulmazer (2023)). Rather, it aims to bring the loan trading price to a level that leads to the optimal *collective* provision of depository services by the banking system, thereby increasing money creation.

Structure: Section 2 develops the model. Section 3 provides a benchmark analysis with no loan trading. Section 4 analyzes the effect of loan trading on money creation. Section 5 studies government intervention and central bank loan purchases, discusses policy implications, and delineates empirical predictions. Section 6 concludes. Proofs are in Appendices A and B.

2 Model

2.1 Agents and Technologies

Time is discrete with three dates, $t \in \{0, 1, 2\}$, and the economy has three types of agents: banks, firms, and workers. There is a continuum of regions with unit mass. Each region contains one bank, one firm, and a continuum of workers with a large aggregate mass – the exact meaning of "large" will be clarified shortly. There is a single real good, which serves as the numéraire and is used for both consumption and production. All agents are risk-neutral, and the risk-free interest rate is zero. The main friction in this economy is a lack of pledgeability of future output to settle contracts.

[7] In others, governments unfreeze markets afflicted with adverse selection (e.g., Philippon and Skreta (2012) and Tirole (2012)).

All agents consume at $t = 2$. Each firm is endowed with e units of the good at $t = 0$, and each bank receives an exogenous endowment of e^{b} units at $t = 1$. Each worker ("he") has no endowment of the good but is endowed with one unit of labor, which he can supply at $t = 0$ at a constant marginal cost of one.

The firm's technology is governed by the Leontief production function

$$\tilde{y} = \tilde{A} \cdot \min\{\alpha g, \ell\}, \tag{1}$$

where (i) $\alpha > 0$ is a constant, (ii) g and ℓ are date-0 good and labor inputs, respectively, and (iii) $\tilde{A} \in \{A_{\mathrm{H}}, A_{\mathrm{L}}\}$, with $A_{\mathrm{H}} > 1 > A_{\mathrm{L}} > 0$, $\Pr(\tilde{A} = A_{\mathrm{H}}) = \theta \in (0, 1)$, and $\Pr(\tilde{A} = A_{\mathrm{L}}) = 1 - \theta$. The firm hires a mass ℓ of workers in its region, so labor input is ℓ, given a worker's unit labor supply. The regional labor force is large enough that the firm's labor demand is always met at the reservation wage $w = 1$, which equals the marginal cost of labor. The firm's date-1 output in goods, $\tilde{y}$, is non-pledgeable. Output shocks ($\tilde{A}$) are independently and identically distributed (i.i.d.) across regions. No one (including the firm) knows $\tilde{A}$ at $t = 0$, but its realization – A_{H} or A_{L} – becomes public at $t = 1$, when the firm collects the corresponding output, $\tilde{y} = y_{\mathrm{H}}$ or y_{L}. Since all consumption occurs at $t = 2$, the date-1 output must be kept safely. Banks offer superior safekeeping: privately-held output depreciates at a rate $\delta \in (0, 1)$, whereas output deposited in a bank does not depreciate.[8]

2.2 Contracts, Taxes, and Money Creation

There are three types of bilateral contracts: loan, labor, and deposit contracts. Loan contracts are between banks and firms. A firm borrowing B from its regional bank at $t = 0$ repays B_j^{f} (determined in the analysis) at $t = 1$ when its realized output shock is A_j, with $j \in \{\mathrm{H}, \mathrm{L}\}$. Banks may trade these loans at $t = 1$ if the secondary loan market is open; see Section 2.5.

When a bank makes a loan of B to a firm at $t = 0$, it simultaneously creates an offsetting deposit liability of B on its books. We refer to this as private money created by the bank in the process of

[8] The most straightforward interpretation of δ is that it reflects a safeguarding service offered by the bank when theft is possible. This is consistent both with the historical origins of banks as goldsmiths with safekeeping expertise and their contemporary role in providing vault, wealth management and trust services (e.g., He, Huang, and Wright (2005, 2008)). More broadly, we can think of δ as the value of all of the bank's depository services, as in Merton and Thakor (2019). For empirical estimates of this value, see Fixler and Zieschang (1992).

lending, which is *unbacked* by any physical numéraire at the time when it is created.[9] That is, the bank finances its lending with private money recorded as a deposit liability. Specifically, the loan involves the bank crediting the firm's (deposit) account with B. When the firm pays workers through the bank, the firm's account is debited and the workers' (deposit) accounts are credited.

Labor contracts are between firms and workers. As explained earlier, the large supply of workers in a region allows the firm to set the unit wage for each hired worker at $w = 1$, in exchange for one unit of labor. Given the firm's labor demand ℓ, its total wage payments are $w\ell = \ell$, consisting of three parts. The first is a payment in goods not invested in production, $\max\{e - g, 0\} \equiv (e - g)^+$. The second is bank-created private money B, transferred from the firm's account to the workers' accounts. The third is fiat money N, to be introduced below. Together, these three parts satisfy the identity $\ell = (e - g)^+ + B + N$.

The government issues fiat money at $t = 0$ that represents its liability. Fiat money is backed by tax revenues collected at $t = 2$ in the form of the numéraire good.[10] Taxes are levied only on firms – specifically on their output, y_{H} or y_{L} – and loan interest payments are not tax deductible. No taxes are imposed on bank earnings or workers' wages. These simplifying assumptions are innocuous and can be relaxed without qualitatively affecting the analysis. The tax rate $\tau \in [0, 1]$ is taken as exogenous.

Banks are central to tax collection. Due to the lack of pledgeability, the government cannot rely on firms' promises to pay taxes. Taxes can only be collected when output is deposited in a bank, placing it within reach of the tax authority. If a firm bypasses the bank at $t = 1$, the government cannot trace and tax that firm's output. Thus, taxation effectively reduces the firm's valuation of banking from δ to $\delta - \tau$, since using the bank precludes tax evasion. It is therefore optimal for the government to set $\tau < \delta$; otherwise, no taxes can be collected.

Fiat money is fully backed by tax revenues, so it is risk-free – the amount issued, N, is capped by the tax revenue. Since fiat money represents government liabilities, it may also be interpreted as government bonds. Since it is a government-issued claim that is not interest bearing, we refer to it as fiat money.[11] At $t = 0$, the unit mass of firms is uniformly endowed with fiat money, each receiving N,

[9] In other words, the bank extends a loan with "money created out of thin air."

[10] As discussed in the Introduction, fiat currencies need backing through credible fiscal support by the government. Thus, even though we refer to this as "fiat money," one can think of this as a commodity standard.

[11] Technically, there is little difference between government bonds and fiat money – other than denominations and the fact that fiat money pays no interest – since both are liabilities of the *same* government (see Greenbaum, Thakor, and Boot (2025)). As we acknowledge in the Introduction, this view of fiat money departs from the usual view that fiat money

which they use to pay workers as noted above. Conceptually, this resembles a tax rebate or credit, as the endowment is backed by the firm's own future tax payment.

In sum, both the government and banks create money, and for related reasons in our model. Fiat money enables firms to pledge part of their future output (up to the tax rate τ) to pay workers. Its credibility derives from the government's taxation authority, which underlies workers' acceptance of it as payment. Banks create private money by enforcing loan repayment, using their depository services as inducement for firms to deposit output in banks and thus repay loans, as the analysis below shows. Since tax collection relies on banking, banks are central to the creation of both fiat and private money.

We define total money creation relative to the economy's initial capital endowment e as

$$\Lambda \equiv \frac{B+N}{e}, \tag{2}$$

where the numerator is the sum of private (B) and fiat (N) money.

2.3 Deposits by Firms and Workers

At $t=0$, workers in each region allocate wages as follows: (i) deposit $(e-g)^+$ units of the numéraire good into the regional bank for safekeeping; (ii) hold bank money B in deposit accounts, entitling them to withdraw an equivalent amount of goods at $t=1$; and (iii) retain fiat money N outside the bank to purchase goods at $t=2$. At $t=1$, workers decide whether to withdraw deposits in (i) and (ii) or roll them over to $t=2$.

The private money B that workers receive at $t=0$ is merely a digital credit in their bank accounts, unbacked by goods or fiat money in the vault of the bank at the time of payment. For workers to accept this as a credible form of payment, they must believe the bank will remain solvent and pay depositors the promised numéraire good upon withdrawal. This credibility hinges on firms repaying their loans at $t=1$. If the firm fails to repay its loan with output at $t=1$, the bank will lack the resources to meet its depository obligations.

Firms do not deposit goods in banks at $t=0$, as goods not used to pay wages are more productively

has no intrinsic value and derives its worth solely from agents' beliefs or from legal tender laws requiring its use in settling contracts. Thus, this is similar to a commodity monetary standard, but one in which government-issued money is backed by the consumption good rather than gold or silver.

invested in production. At $t = 1$, a firm decides whether to deposit its output in the regional bank. Since the pledgeability friction also applies to banks, the bank will honor its repayment obligation at $t = 2$ only if it is in its *ex post* interest to do so. Consequently, at $t = 1$, the firm's deposit decision and the workers' withdrawal or rollover decision (described earlier) are predicated on whether the bank's IC condition for depository safekeeping holds at $t = 1$.

We assume that an agent borrowing with a debt contract cannot subsequently issue new debt of higher seniority. This limited-debt-enforceability assumption is in line with Hart and Moore (1995) and is an *ex ante* efficient feature of debt contracts in our model, as we shall see in Section 4.

2.4 Interactions Among Players

Figure 1 depicts the interactions among regional agents and the government.

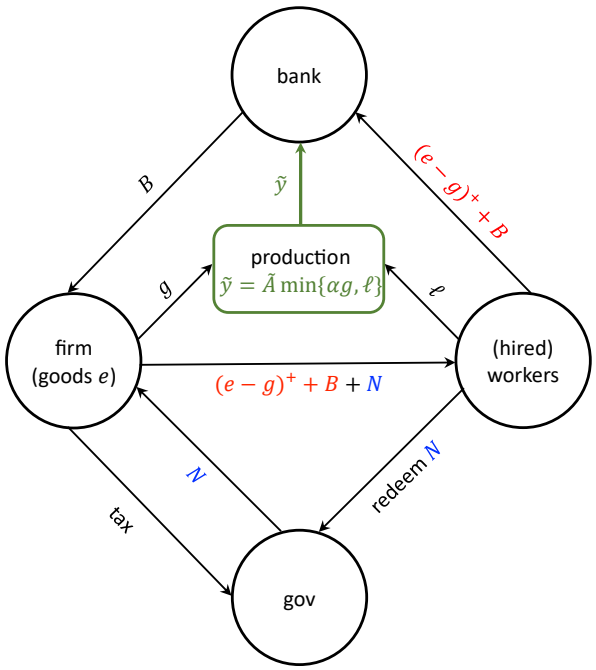


Figure 1: Interactions

In each region: (i) the large labor supply, and the consequent volume of workers' deposits, result in the expected gross return on deposits from date t to $t + 1$ being one; and (ii) as in Rocheteau, Wright, and Zhang (2018), loan terms are bilaterally negotiated between bank and firm. Greater firm bargaining power leads to a lower loan rate. To simplify, we assume the firm holds all bargaining

power, so the expected gross loan rate is one.[12] Given these assumptions, firms capture all production surplus. The competitive equilibrium is characterized by firms maximizing their objectives, subject to binding participation constraints for banks and workers. We formalize the firm's problem in Section 3, where we solve the model.

2.5 Trading

Since output shocks across firms are i.i.d., the Law of Large Numbers implies a fraction θ of firms experience $\tilde{A} = A_{\mathrm{H}}$ (good shock), and a fraction $1-\theta$ experience $\tilde{A} = A_{\mathrm{L}}$ (bad shock). For a firm with a good shock, we say its regional bank also has a good shock. Similarly, if the firm has a bad shock, so does its regional bank.

Loan trading may occur at $t = 1$, after shocks are realized in all regions. Banks interact in an over-the-counter market, modeled using a one-shot random search model. The buyer/seller ratio (market tightness), $n = \frac{\theta}{1-\theta}$, determines the probability of matching. For tractability, we follow the monetary economics literature (e.g., Kiyotaki and Wright (1993)) and use a common specification of the meeting technology

$$\mu(n) = \frac{\lambda n}{1+n} = \lambda\theta \tag{3}$$

to parameterize the probability that a seller meets a buyer. The probability that a buyer matches with a seller is $\frac{\mu(n)}{n} = \lambda(1-\theta)$. A higher λ indicates greater trading efficiency. When specifying these, we label banks with good shocks as buyers and those with bad shocks as sellers; this will emerge endogenously in the analysis.

After a buyer and a seller are matched, they negotiate the loan price p via Nash bargaining, with β as the buyer's bargaining power and $1-\beta$ as the seller's. The Hosios condition is assumed to hold (Hosios (1990)), stating that a bank's bargaining power is commensurate with its contribution to matching.[13] Specifically, a buyer's bargaining power equals the elasticity of $\mu(n)$ with respect to market tightness n, i.e., $\beta = \frac{n\mu'(n)}{\mu(n)} = 1-\theta$; a seller's bargaining power is $1-\beta = \theta$. The price p, paid

[12] All results remain qualitatively unchanged under any division of bargaining power between bank and firm.

[13] We adopt the Hosios condition because it ensures that bargaining weights for buyers and sellers are efficiently determined. Thus, any remaining inefficiencies, such as an imbalance in the mass of buyers and sellers relative to the social optimum as shown in the analysis, are not due to arbitrary bargaining weights.

in the numéraire good, is observable only to trading counterparties (buyer and seller), not the firm, due to price opaqueness in over-the-counter markets.

2.6 Model Summary and Parametric Assumptions

The timeline in Table 1 summarizes the model.

Table 1: Sequence of Events

$t = 0$	• The government issues fiat money and endows firms with an amount N. • In each region, the bank lends B to the firm by crediting its deposit account. • The firm allocates labor and some goods to production, paying workers with uninvested goods, bank money B, and fiat money N. • Hired workers supply labor and deposit received goods in the regional bank. The bank debits B from the firm's account and credits it to the workers' accounts.
$t = 1$	• Each firm, upon realizing its output, chooses whether to repay its loan and deposit the output in the regional bank or default and privately keep the output. • Banks accept new deposits from firms, roll over maturing deposits or repay withdrawing depositors, and trade loans. • Workers withdraw or roll over deposits, including goods deposited at $t = 0$ and bank money B.
$t = 2$	• Banks repay depositors and consume. • Firms that deposited output at $t = 1$ collect repayment, pay taxes, and consume; firms that kept output privately evade taxes and consume. • Workers receive repayments on rolled-over deposits, redeem fiat money for goods, and consume.

Assumption 1. The firm's technology is sufficiently productive that, even without money, its production yields a positive NPV in equilibrium:

$$\theta(1-\tau)A_{\mathrm{H}} + (1-\theta)(1-\delta)A_{\mathrm{L}} > 1 + \frac{1}{\alpha}. \tag{4}$$

Assumption 2. The net benefit of banking to the firm is moderate:

$$\delta[\theta A_{\mathrm{H}} + (1-\theta)A_{\mathrm{L}}] < 1. \tag{5}$$

This ensures that firms' IC constraints for using banking and repaying loans endogenously limit borrowing. As a result, part of worker wages must be paid with uninvested goods, so not all goods are allocated to production, leaving room for trade to improve efficiency.

Assumption 3. Banks have moderate capital endowments, $e^{\mathrm{b}} \in [\underline{e}^{\mathrm{b}}, \bar{e}^{\mathrm{b}})$, where

$$\underline{e}^{\mathrm{b}} = \frac{\alpha e}{1+\alpha(1-\delta\theta A_{\mathrm{H}})}\left[\frac{1+(1-2\delta)\theta A_{\mathrm{H}}}{\delta\theta+(1-\delta)(1-\theta)} - (1-\delta\theta A_{\mathrm{H}})\right], \tag{6}$$

$$\bar{e}^{\mathrm{b}} = \frac{\alpha e(1-\delta)\delta^{-1}}{1+\alpha\{1-\delta[\theta A_{\mathrm{H}}+(1-\theta)A_{\mathrm{L}}]\}}\left[1+(1-\delta)A_{\mathrm{L}} + \frac{\delta^2\theta(A_{\mathrm{H}}-A_{\mathrm{L}})}{1-\delta}\right]. \tag{7}$$

This ensures that, without loan trading, firms deposit output only after a good shock, while bypassing banks after a bad shock.

3 Benchmark: No Loan Trading

In the benchmark without loan trading ($\lambda = 0$ in (3)), we consider two candidate equilibria: (i) equilibrium-H, where firms deposit date-1 output only after a good shock ($\tilde{A} = A_{\mathrm{H}}$); and (ii) equilibrium-HL, where they deposit after either shock ($\tilde{A} = A_{\mathrm{H}}$ or A_{L}). A firm deposits in its regional bank only if the bank has sufficient capital because only then is its IC constraint for safekeeping satisfied. Once deposited, the firm forfeits its option to default, as the bank can invoke "banker's setoff" to seize the deposits as repayment.[14] We show that while equilibrium-HL enables greater money creation, only equilibrium-H prevails with limited bank capital.

Equilibrium-H: We show that the bank's IC constraint for safekeeping holds when $\tilde{A} = A_{\mathrm{H}}$ (output y_{H}) but not when $\tilde{A} = A_{\mathrm{L}}$ (output y_{L}), so the firm deposits y_{H} and repays its loan when $\tilde{A} = A_{\mathrm{H}}$, but strategically defaults when $\tilde{A} = A_{\mathrm{L}}$. Upon default, the firm privately keeps y_{L}, losing δy_{L} to depreciation, and the bank receives nothing ($B^{\mathrm{f}}_{\mathrm{L}} = 0$). The repayment after the good shock for a loan of size B is thus $B^{\mathrm{f}}_{\mathrm{H}} = \frac{B}{\theta}$.

[14] While early Italian banking featured deposit contracts both with and without banker's setoff, the setoff clause is now standard.

As explained in Section 2.4, the competitive equilibrium solves the firm's problem:

$$\max_{g,\ell,B} \ [\theta(1-\tau)A_{\mathrm{H}} + (1-\theta)(1-\delta)A_{\mathrm{L}}] \cdot \min\{\alpha g, \ell\} - B \tag{8}$$

$$\text{s.t. } (\delta - \tau)A_{\mathrm{H}} \cdot \min\{\alpha g, \ell\} \geq \frac{B}{\theta}, \tag{9}$$

$$g + \ell = e + B + N, \tag{10}$$

$$N \leq \tau\theta A_{\mathrm{H}} \cdot \min\{\alpha g, \ell\}, \tag{11}$$

$$\frac{e^{\mathrm{b}}_{\mathrm{H}}}{D_{\mathrm{H}}} \geq \frac{1-\delta}{\delta}, \tag{12}$$

$$\frac{e^{\mathrm{b}}_{\mathrm{L}}}{D_{\mathrm{L}}} < \frac{1-\delta}{\delta}. \tag{13}$$

The objective function (8) is the firm's expected date-2 consumption. With probability θ, a good shock yields output $y_{\mathrm{H}} = A_{\mathrm{H}} \cdot \min\{\alpha g, \ell\}$, which is deposited in the bank at date 1, retains full value by date 2, but is taxed at rate τ. With probability $1-\theta$, a bad shock yields $y_{\mathrm{L}} = A_{\mathrm{L}} \cdot \min\{\alpha g, \ell\}$, which the firm keeps privately; it depreciates at rate δ, but avoids taxation. The firm's expected loan repayment is B.

Condition (9) is the firm's IC constraint to deposit y_{H} and repay its loan after a good shock. The left-hand side (LHS) is the *net* benefit from banking, and the right-hand side (RHS) is the cost to the firm from accessing the bank's services, namely that it must repay the loan when it deposits y_{H}.

The budget constraint (10) equates the firm's capital investment g and labor input ℓ with regional resources, consisting of the firm's endowment e, bank money B, and fiat money N. Condition (11) caps N by the date-2 tax revenue. A θ fraction of firms produce y_{H}, deposit it, and pay taxes; the rest bypass banking and evade taxes. Tax revenue is thus $\tau\theta y_{\mathrm{H}}$. Firms are uniformly endowed with fiat money at $t = 0$, each receiving N.

The bank's IC constraint for safekeeping after a good shock is given by (12). There, $e^{\mathrm{b}}_{\mathrm{H}}$ denotes the bank's capital after receiving loan repayment and rolling over worker deposits, which may differ from its capital endowment e^{b}. Its corresponding liability is D_{H}.[15] If the bank absconds, the goods in its possession, $e^{\mathrm{b}}_{\mathrm{H}} + D_{\mathrm{H}}$, depreciate at rate δ, yielding a date-2 payoff of $(1-\delta)(e^{\mathrm{b}}_{\mathrm{H}} + D_{\mathrm{H}})$.[16] If it does

[15] The proof of Proposition 1 explicitly computes $e^{\mathrm{b}}_{\mathrm{H}}$ and D_{H}.

[16] The banker absconding with deposits and the bank's equity can alternatively be interpreted as being analogous to the banker misusing depositor funds for personal benefit, as in Calomiris and Kahn (1991), and declaring bankruptcy. Doing so causes the banker to incur a cost, which represents a loss of a portion of the equity. Empirical estimates show

not abscond, the bank repays D_{H} to depositors,[17] and retains $e^{\mathrm{b}}_{\mathrm{H}}$. The IC constraint (12) ensures the bank prefers not to abscond: $(1-\delta)(e^{\mathrm{b}}_{\mathrm{H}} + D_{\mathrm{H}}) \leq e^{\mathrm{b}}_{\mathrm{H}}$. After a bad shock, this condition fails, as shown in (13), where $e^{\mathrm{b}}_{\mathrm{L}}$ and D_{L} are the bank's remaining capital and liability, respectively.

Our main result for the benchmark analysis is stated below.

Proposition 1 (Benchmark Equilibrium)**.** *Suppose each bank's capital endowment is moderate,* $e^{\mathrm{b}} \in [\underline{e}^{\mathrm{b}}, \bar{e}^{\mathrm{b}})$.

1. *Let* $A_{\mathrm{ben}} \equiv \theta A_{\mathrm{H}}$. *The prevailing equilibrium in the benchmark economy is equilibrium-H, given by*

$$\begin{cases} B = \dfrac{(\delta-\tau)A_{\mathrm{ben}}\alpha e}{1+\alpha(1-\delta A_{\mathrm{ben}})} \\ N = \dfrac{\tau A_{\mathrm{ben}}\alpha e}{1+\alpha(1-\delta A_{\mathrm{ben}})} \\ \Lambda = \dfrac{\delta A_{\mathrm{ben}}\alpha}{1+\alpha(1-\delta A_{\mathrm{ben}})} \\ g = \dfrac{e}{1+\alpha(1-\delta A_{\mathrm{ben}})} \\ \ell = \dfrac{\alpha e}{1+\alpha(1-\delta A_{\mathrm{ben}})}. \end{cases} \tag{14}$$

2. *Fiat money issuance is irrelevant for the economy's outcome:* Λ, g, ℓ *and* y_j $\forall j \in \{\mathrm{H}, \mathrm{L}\}$ *are the same as in an economy with no taxation and no fiat money.*

3. *While fiat money issuance leaves total money creation* Λ *unchanged, it crowds out bank money one-for-one in that each unit of fiat money displaces a unit of bank money, making them perfect substitutes.*

A few remarks are in order. First, only equilibrium-H is supported in the benchmark. The bank's capital endowment e^{b} is sufficient for its IC constraint for safekeeping to hold after a good shock ($e^{\mathrm{b}} \geq \underline{e}^{\mathrm{b}}$, from (6)), but insufficient for it to also hold after a bad shock ($e^{\mathrm{b}} < \bar{e}^{\mathrm{b}}$, from (7)). A bad shock erodes the bank's capital, leaving it with too little skin in the game to credibly provide depository services. Anticipating this, firms bypass banking in the bad state, rendering equilibrium-HL infeasible.

If, instead, bank capital were plenteous enough to support equilibrium-HL, firms would deposit output with banks in both states. We characterize this equilibrium in Appendix A and show that it

that such bankruptcy costs for banks are quite significant; see, for example, Bennett and Unal (2015).

[17] Goods that the bank does not abscond with are publicly observable and thus pledgeable, enabling depositors to enforce repayment.

leads to greater total money creation and higher firm output than equilibrium-H.

Second, using (14), it can be shown that firm output y_j is linearly increasing in total money creation Λ:

$$y_j = \frac{A_j \alpha}{1+\alpha}(1+\Lambda)e \quad \forall j \in \{\mathrm{H}, \mathrm{L}\}. \tag{15}$$

This yields an interesting interpretation of money's real effect – with total money creation Λ, an economy with capital endowment e and money produces the same output as an economy with endowment $(1+\Lambda)e$ but *no* money. That is, money functions as a multiplier on the endowment, effectively scaling it by a factor of $1+\Lambda$.[18] While the underlying mechanisms differ, the implication that greater money creation boosts output has a Keynesian flavor.

Third, (15) shows that output depends on *total* money creation, not its division between fiat and private money. This raises a natural question: in the absence of trading, does fiat money matter? To address this, consider a counterfactual, tax-free economy ($\tau = 0$), where no fiat money is issued and all money is privately created by banks. It can be shown that the equilibrium in that setting is given by

$$\begin{cases} B = \dfrac{\delta A_{\text{ben}} \alpha e}{1+\alpha(1-\delta A_{\text{ben}})} \\ N = 0 \\ \Lambda = \dfrac{\delta A_{\text{ben}} \alpha}{1+\alpha(1-\delta A_{\text{ben}})} \\ g = \dfrac{e}{1+\alpha(1-\delta A_{\text{ben}})} \\ \ell = \dfrac{\alpha e}{1+\alpha(1-\delta A_{\text{ben}})}. \end{cases} \tag{16}$$

Note that Λ, g, and ℓ are identical to those in (14), so both y_{H} and y_{L} remain unchanged. The only difference lies in money composition: in the tax-free economy, all money is private, but B in (16) equals $B+N$ in (14). Total money creation Λ thus remains the same, implying that fiat money is *irrelevant* in the no-trading benchmark.

The intuition is as follows. Firms bypass banking in the bad state, so y_{L} cannot back either form of money. While y_{H} supports money creation, diverting more of y_{H} to fiat money creation (via a higher

[18] Without money, output would be $y_j = \frac{A_j \alpha}{1+\alpha} e$.

tax rate τ) lowers the value of banking to firms by exactly τ, thereby reducing what is available for private money creation. This creates a zero-sum tradeoff – fiat money issuance crowds out private money creation one-for-one, with *no* net increase in total money.

This perfect substitution is also reflected in $\frac{B}{N} = \frac{\delta-\tau}{\tau}$ from (14): the ratio of private to fiat money equals the firm's *net* valuation of banking $(\delta - \tau)$ relative to the government's taxing power (τ).[19] This implies a higher share of private money and less fiat money in a low-tax economy, with the reverse holding in a high-tax economy.

An implication of the analysis in this section is that the equilibrium in the no-trading benchmark is inefficient – money creation is lower than what it would be if the bank had sufficient capital to preserve its depository safekeeping incentive after a bad shock. That is, bank capital scarcity has real effects via the money creation channel.

4 Analysis with Loan Trading

In this section, we show that interbank loan trading can attenuate the low-money-creation inefficiency of the no-trading equilibrium. At $t = 1$, a fraction θ of firms experience good shocks, and the remaining $1 - \theta$ have bad shocks. These banks can now trade with each other. Suppose the buying bank's firm has high output y_{H} and the selling bank's firm has low output y_{L}, so the buyer/seller ratio is $n = \frac{\theta}{1-\theta}$. Trading works as follows. Once matched, the buyer and seller negotiate a price p, based on their relative bargaining powers. As described in Section 2.5, p is paid in goods and not observable to the firm. The seller receives p and transfers its loan to the buyer, which then negotiates with the firm whose loan it acquired. Although the selling bank's firm refuses to deposit y_{L} with its original bank, it is willing to deposit with the buying bank to access safekeeping. Trading thus allows the buyer to share its spare safekeeping capacity with the seller, improving the banking system's *collective* intermediation capacity. For this to work, however, the buyer's IC constraint for safekeeping must *continue* to hold after trading – a condition that, as we will show, is not always guaranteed.

The price p must ensure trade is feasible. If p is too high, it erodes the buyer's post-trading capital,

[19] In equilibrium, the government maximizes fiat money issuance, so the constraint (11), $N \leq \tau\theta y_{\mathrm{H}}$, binds. Taxation lowers the value the firm attaches to banking by τ per unit of deposited output, reducing private money creation by exactly the same amount. To fully offset this reduction, the government issues the maximum feasible amount of fiat money, leaving total money creation unchanged.

violating its safekeeping incentive (shown later) and breaking the trade. As a result, firms with bad shocks are excluded from banking services at $t = 1$, limiting bank money creation at $t = 0$. This reduces output, tax revenue, and hence fiat money issuance. Thus, the price at which loans are traded is *not* a pure transfer – it impacts welfare by influencing *both* forms of money creation.

To see how trading affects the equilibrium, consider two banks, B1 and B2. Suppose B1's ability to provide depository safekeeping is impaired at $t = 1$ because its borrower suffers a bad shock, and the resulting capital depletion erodes B1's safekeeping incentive. Consequently, B1's borrower avoids banking with B1. Bank B2 can then approach this borrower and offer: "If you deposit y_{L} with me, I will ask you to repay me $(\delta - \tau)y_{\mathrm{L}}$ as settlement of the loan you took from B1." Since $(\delta - \tau)y_{\mathrm{L}}$ is exactly the firm's *net* benefit from banking at $t = 1$, the firm is indifferent between using or avoiding banking, and we assume it deposits with B2. This arrangement cuts the original lender, B1, out of the picture entirely and is equivalent to B1 selling the loan to B2 at a price $p = 0$. Anticipating this *ex post* "exploitation," B1 lends less to the firm at $t = 0$, reducing bank money creation *ex ante*. Since this effect applies to all banks at $t = 0$, aggregate bank money creation declines.

This situation of the original lender being strategically bypassed is avoided with the boilerplate clause introduced in Section 2.3, which prevents a firm from issuing more senior debt after borrowing. This ensures that B2 can profit from having B1's borrower deposit with it only by buying the loan from B1.[20] The price p is determined through bargaining and is no longer zero.[21]

Loan Price: The buyer and seller bargain over $(\delta-\tau)y_{\mathrm{L}}$, the loan repayment the buyer can extract from the seller's firm, as previously explained. The buyer's surplus from trade is $(\delta - \tau)y_{\mathrm{L}} - p$, while the seller's surplus is p. The price p is determined by a Nash bargaining solution that splits $(\delta - \tau)y_{\mathrm{L}}$:

$$\max_{p} \ [(\delta - \tau)y_{\mathrm{L}} - p]^{\beta} p^{1-\beta}, \tag{17}$$

where $\beta = 1 - \theta$ is the buyer's bargaining power. The solution is

$$p = \theta(\delta - \tau)y_{\mathrm{L}}. \tag{18}$$

[20] Our discussion here also reveals that this restriction is welfare enhancing.

[21] In Donaldson, Piacentino, and Thakor (2018), the possibility of trading deters the firm from borrowing from one bank and depositing with another to avoid loan repayment. But trading never occurs in equilibrium in their model because the very threat of interbank trading prevents the firm from attempting to escape its original lender. This logic applies in our setting as well when the firm has high output y_{H}.

A higher θ (more buyers) decreases the buyer's bargaining power and therefore increases p.

Equilibrium Characterization: Consider an arbitrary bank's date-0 problem with its regional firm. The bank charges a loan repayment $B_{\mathrm{H}}^{\mathrm{f}}$ (conditional on a good shock) to satisfy its participation constraint:

$$\theta B_{\mathrm{H}}^{\mathrm{f}} + (1-\theta)\lambda\theta p = B. \tag{19}$$

Following a good shock (probability θ), the firm deposits its output y_{H} with its regional bank, enabling the bank to enforce full repayment of $B_{\mathrm{H}}^{\mathrm{f}}$. After a bad shock (probability $1-\theta$), the bank attempts to sell the loan. The probability of finding a buyer is $\mu(n) = \frac{\lambda n}{1+n} = \lambda\theta$ and, conditional on matching, the loan trades at price p. The bank therefore expects to recover $\lambda\theta p$ from the loan sale.

As shown later, trade occurs only if $\theta \leq \theta^*$, where θ^* is endogenously determined. Using (18) and (19), we obtain $B_{\mathrm{H}}^{\mathrm{f}} = \frac{B}{\theta} - \lambda\theta(1-\theta)(\delta-\tau)A_{\mathrm{L}} \cdot \min\{\alpha g, \ell\}$.

Equilibrium in this trading economy is again characterized by solving the firm's problem at date 0:

$$\max_{g,\ell,B} \ \left\{\theta(1-\tau)A_{\mathrm{H}} + (1-\theta)[\lambda\theta(1-\tau) + (1-\lambda\theta)(1-\delta)]A_{\mathrm{L}}\right\} \cdot \min\{\alpha g, \ell\} - B \tag{20}$$

$$\text{s.t. } (\delta-\tau)A_{\mathrm{H}} \cdot \min\{\alpha g, \ell\} \geq \frac{B}{\theta} - \lambda\theta(1-\theta)(\delta-\tau)A_{\mathrm{L}} \cdot \min\{\alpha g, \ell\}, \tag{21}$$

$$N \leq \tau\theta[A_{\mathrm{H}} + \lambda(1-\theta)A_{\mathrm{L}}] \cdot \min\{\alpha g, \ell\}, \tag{22}$$

$$\frac{e_{\mathrm{buy}}^{\mathrm{b}}}{D_{\mathrm{buy}}} \geq \frac{1-\delta}{\delta}, \tag{23}$$

and the (same) budget constraint (10).

The objective function (20) differs from that in the no-trading benchmark under equilibrium-H, (8), in only one respect. There, the output $A_{\mathrm{L}} \cdot \min\{\alpha g, \ell\}$ after a bad shock is not deposited with the regional bank and depreciates at rate δ between dates 1 and 2. With trading, which occurs with probability $\lambda\theta$, the output is deposited with the buying bank, thereby preserving its value but incurring taxation. With probability $1-\lambda\theta$, trade breaks down, the output remains outside the banking system, experiencing depreciation but avoiding taxation.[22]

Condition (21) is the firm's IC constraint to deposit output, and thus repay its loan, after a good

[22] If $\lambda = 0$, interbank loan trading is closed, and (20) coincides with (8).

shock. Its interpretation mirrors that of (9), except a lower loan repayment (the RHS) in (21) due to trading.

Condition (22) is the government's budget constraint for fiat money issuance, paralleling (11) in the no-trading benchmark. The key difference is that trading enables firms hit by bad shocks to deposit their output y_{L} with buying banks, making it taxable. Absent trading, y_{L} remains outside the banking system and untaxed. Specifically, among the $1-\theta$ mass of firms with bad shocks, a fraction $\lambda\theta$ are matched in trade and deposit y_{L}, generating additional tax revenue of $\tau(1-\theta)(\lambda\theta)y_{\mathrm{L}} = \tau(1-\theta)(\lambda\theta)A_{\mathrm{L}} \cdot \min\{\alpha g, \ell\}$.

The buyer's post-trading IC constraint for safekeeping is given by (23), where $e^{\mathrm{b}}_{\mathrm{buy}}$ and D_{buy} denote its post-trading capital and liability, respectively. This mirrors (12). Trading is feasible only if the buyer can *continue* to safeguard deposits after acquiring the loan. This assures the seller's firm that it can safely deposit its output y_{L} with the buyer, enabling the buyer to extract $(\delta-\tau)y_{\mathrm{L}}$ and pay p out of it to acquire the loan. As shown below, (23) holds only when $\theta \leq \theta^*$ (i.e., p is sufficiently low). We now have:

Proposition 2 (Trading Equilibrium)**.** *Let* $A_{\mathrm{trade}} \equiv \theta A_{\mathrm{H}} + \lambda\theta^2(1-\theta)A_{\mathrm{L}}$.

1. *There exists a unique* θ^* *such that trading occurs only when* $\theta \leq \theta^*$*, in which case the equilibrium is given by*

$$\begin{cases} B = \dfrac{(\delta-\tau)A_{\mathrm{trade}}\alpha e}{1+\alpha\left[1-\delta A_{\mathrm{trade}}-\tau\lambda\theta(1-\theta)^2A_{\mathrm{L}}\right]} \\ N = \dfrac{\tau\theta[A_{\mathrm{H}}+\lambda(1-\theta)A_{\mathrm{L}}]\alpha e}{1+\alpha\left[1-\delta A_{\mathrm{trade}}-\tau\lambda\theta(1-\theta)^2A_{\mathrm{L}}\right]} \\ \Lambda = \dfrac{\left[\delta A_{\mathrm{trade}}+\tau\lambda\theta(1-\theta)^2A_{\mathrm{L}}\right]\alpha}{1+\alpha\left[1-\delta A_{\mathrm{trade}}-\tau\lambda\theta(1-\theta)^2A_{\mathrm{L}}\right]} \\ g = \dfrac{e}{1+\alpha\left[1-\delta A_{\mathrm{trade}}-\tau\lambda\theta(1-\theta)^2A_{\mathrm{L}}\right]} \\ \ell = \dfrac{\alpha e}{1+\alpha\left[1-\delta A_{\mathrm{trade}}-\tau\lambda\theta(1-\theta)^2A_{\mathrm{L}}\right]}. \end{cases} \tag{24}$$

2. *Fiat money issuance enhances overall money creation, which in turn raises output:* Λ*,* g*,* ℓ*, and* y_j $\forall j \in \{\mathrm{H},\mathrm{L}\}$ *are all higher than in an economy with no taxation and no fiat money.*

3. *If* $\theta > \theta^*$*, no trading occurs, and the equilibrium corresponds to equilibrium-H in the no-trading benchmark, as given by* (14).

4. *A higher bank capital endowment raises the likelihood of trading,* $\frac{\partial \theta^*}{\partial e^{\mathrm{b}}} > 0$*, thereby benefiting money creation and firm production.*

The intuition and implications of this proposition can be understood as follows. First, the expressions for B, N, Λ, g, and ℓ in the trading equilibrium (24) mirror those in the no-trading benchmark (14), with the important difference that trading brings the output after a bad shock, y_{L}, back into the banking system for both private and fiat money creation. *Effective* firm productivity is boosted from $A_{\mathrm{ben}} = \theta A_{\mathrm{H}}$ without trading to $A_{\mathrm{trade}} = \theta A_{\mathrm{H}} + \lambda\theta^2(1-\theta)A_{\mathrm{L}}$ with trading. This is because trading enables the bank to sell its impaired loan to another bank with spare safekeeping capacity, enhancing bank lending and private money creation. Moreover, fiat money creation also increases because the government can now tax y_{L}, as reflected in the additional denominator term, $-\tau\lambda\theta(1-\theta)^2 A_{\mathrm{L}}$, in (24). Both effects raise equilibrium quantities – all expressions in (24) exceed their counterparts in (14). Loan trading gives rise to a feedback loop. By permitting taxation on y_{L}, it enables more fiat money to be created. This allows firms to invest more goods in production at $t = 0$, leading to higher output. This, in turn, supports more bank lending and greater private money creation, further raising output and tax revenue, and thus fueling additional fiat money issuance. This self-reinforcing cycle underpins the complementarity between private and fiat money under trading.

Second, the above argument suggests that, unlike in the no-trading benchmark, fiat money becomes relevant when trading is allowed. To see this more directly, consider a tax-free economy ($\tau = 0$) as a counterfactual. In that case, no fiat money is issued, and the trading equilibrium is given by

$$\begin{cases} B = \dfrac{\delta A_{\mathrm{trade}} \alpha e}{1 + \alpha(1 - \delta A_{\mathrm{trade}})} \\ N = 0 \\ \Lambda = \dfrac{\delta A_{\mathrm{trade}} \alpha}{1 + \alpha(1 - \delta A_{\mathrm{trade}})} \\ g = \dfrac{e}{1 + \alpha(1 - \delta A_{\mathrm{trade}})} \\ \ell = \dfrac{\alpha e}{1 + \alpha(1 - \delta A_{\mathrm{trade}})}. \end{cases} \tag{25}$$

Note that Λ is higher in (24) than in (25). This means that with trading, more money is created in total with taxation than without. This is also evident from $B + N$ in (24) exceeding B in (25). Greater total money creation enables more investment – g and ℓ are both higher in (24) – leading to higher

output y_j $\forall j \in \{\mathrm{H}, \mathrm{L}\}$ under trading.

The reason why fiat money matters with loan trading is twofold. One is that trading enables contracting on the low output, y_{L}, and the other is that the government is more effective in monetizing y_{L} than banks. Absent taxation and fiat money, the portion of y_{L} that supports bank-created money is determined by the loan price $p = \theta\delta y_{\mathrm{L}}$,[23] This price is paid in goods by the buying bank, which leads to an increase in the selling bank's money creation relative to the no-trading benchmark. With taxation and fiat money, the low output y_{L} supports even more money creation. While the selling bank can capture only a fraction θ of the surplus via bargaining, the government can tax the *entire* output y_{L} once it is deposited in the buying bank, and collect τy_{L} in taxes. The remaining $(\delta - \tau)y_{\mathrm{L}}$ is split between the buying and selling banks, with the selling bank receiving $\theta(\delta - \tau)y_{\mathrm{L}}$ for private money creation. So, the total money created from y_{L} is $\tau y_{\mathrm{L}} + \theta(\delta - \tau)y_{\mathrm{L}} > \theta\delta y_{\mathrm{L}}$.[24]

Although private money and fiat money are now complements, they are also partial substitutes. However, the substitutability is no longer one-for-one as in the no-trading benchmark. This is evident from the fact that $\frac{B}{N} < \frac{\delta-\tau}{\tau}$ in (24), implying that a unit decline in private money is offset by *more than one* unit of fiat money. By contrast, recall that $\frac{B}{N} = \frac{\delta-\tau}{\tau}$ in (14), implying a one-for-one substitutability as in the no-trading benchmark.

Lastly, the condition $\theta \leq \theta^*$ requires that enough banks experience bad shocks for trade to occur.[25] When $\theta > \theta^*$, the buyer/seller ratio $n = \frac{\theta}{1-\theta}$ is relatively high, weakening each buyer's bargaining power and raising the price p. If p becomes too high, the buyer's capital gain from trade cannot offset the resulting increase in its liability since, after trading, the seller's firm deposits output with the buyer, further increasing its liability. The proof of Proposition 2 shows that the buyer's post-trading capital ratio $\frac{e^{\mathrm{b}}_{\mathrm{buy}}}{D_{\mathrm{buy}}}$ is strictly decreasing in n, and thus in θ, so (23) fails when $\theta > \theta^*$. Anticipating this, the selling bank's firm does not deposit output with the buying bank. Without this deposit, the buyer cannot enforce loan repayment and thus refuses to purchase the loan. Trade breaks down.[26] This has

[23] This follows from setting $\tau = 0$ in (18). Note that $p = \theta\delta y_{\mathrm{L}}$ is the seller's share of the trade surplus.

[24] This is tantamount to the government possessing full bargaining power over the buying bank. In the special case in which $\theta = 1$, the seller would also possess full bargaining power, so bank-created money related to y_{L} would be $\tau y_{\mathrm{L}} + (\delta - \tau)y_{\mathrm{L}} = \delta y_{\mathrm{L}}$, once again making fiat money irrelevant.

[25] The proof of Proposition 2 shows that θ^* is determined by (B8).

[26] A subtle issue here concerns bargaining. Knowing that trade breakdown results in a complete loss of surplus $(\delta-\tau)y_{\mathrm{L}}$, why would the seller, despite its strong bargaining power, not agree to a lower price to preserve the buyer's incentive and sustain trade? The proof of Proposition 2 explains why this does not happen. Since the actual trading price is unobservable to the firm, the seller can exploit the firm's belief: conditional on the firm *believing* that the negotiated price is low enough to preserve the buyer's incentive (so the firm deposits output with the buyer), the seller can push the buyer to accept a price actually too high to satisfy the buyer's IC condition, but not high enough to cause the buyer to

the striking implication that trade requires enough aggregate "bad luck" (low θ), so that buyers have sufficient bargaining power to maintain incentives to provide safekeeping services for deposits of sellers' firms.[27]

A higher capital endowment e^{b} gives the buyer more skin in the game relative to its post-trading liability, making (23) more likely to hold. Therefore, trade remains viable over a wider range of θ (higher θ^*). This suggests that bank capital enhances money creation and real production by promoting asset market trading.[28]

5 Government Intervention, Policy Implications, and Empirical Predictions

A simple rationale emerges for government intervention in our analysis because, as explained below, the laissez-faire loan price in the trading equilibrium is not welfare-maximizing. Specifically, two inefficiencies arise, both leading to reduced money creation and lower output than would be achieved under the welfare-maximizing loan price.

5.1 Inefficiency when $\theta < \theta^*$

In this case, an excess of loan sellers relative to buyers at $t = 1$ drives down the loan price. Sellers receive little from trade, while buyers earn more than needed to preserve their post-trading safekeeping incentives. Anticipating that a bad shock will force them to sell loans at a low price, banks reduce lending at $t = 0$. This lowers private money creation and real output. The resulting decline in output also reduces tax revenue, limiting fiat money issuance. The government can mitigate this inefficiency, arising from the buyer-seller imbalance, by committing to purchase a fraction of the loans for sale. This raises the loan price at $t = 1$, which in turn augments bank money creation at $t = 0$ and ultimately increases fiat money issuance via the tax channel. The mechanism resembles QE, in which the central bank buys Treasury bonds and MBS from banks. As in QE, this policy expands the money supply –

walk away. The firm is exploited. So, when $\theta > \theta^*$, the firm's belief that the seller would renegotiate to preserve trade is not rational, and trade does not arise in equilibrium.

[27] For any $\theta \leq \theta^*$, the buyer – with relatively strong bargaining power – has no incentive to deviate and pay more than p, and the seller has no incentive to accept less. Therefore, the firm's belief that the actual trading price is p is correct.

[28] This mechanism is new to the loan trading literature but aligns with the evidence in Berger, Zhang, and Zhao (2021).

both private and fiat money – and stimulates investment.

Suppose the government offers to purchase loans at a price $p_{\rm g}$, inducing a fraction ζ of sellers to sell directly to it. This leaves $(1-\zeta)(1-\theta)$ as the mass of selling banks in the market. Consequently, the buyer/seller ratio becomes $n = \frac{\theta}{(1-\zeta)(1-\theta)}$, which is higher than the ratio in the absence of intervention. This increases each remaining seller's chance of finding a buyer, $\mu(n) = \frac{\lambda n}{1+n} = \frac{\lambda\theta}{1-\zeta(1-\theta)}$, where $\mu(n)$ is increasing in ζ. The intervention also improves the seller's bargaining position. The seller's share of the surplus, $1-\beta = \frac{n}{1+n} = \frac{\theta}{1-\zeta(1-\theta)}$, likewise increases with ζ. The post-intervention market price becomes $p = \frac{\theta}{1-\zeta(1-\theta)}(\delta-\tau)y_{\rm L}$. In equilibrium, the marginal seller is indifferent between selling to the government and staying in the market, so

$$p_{\rm g} = \mu(n)p = \lambda\left[\frac{\theta}{1-\zeta(1-\theta)}\right]^2(\delta-\tau)y_{\rm L}. \tag{26}$$

There is a positive relationship between $p_{\rm g}$ and ζ. When more sellers participate in the government's program (larger ζ), the bargaining position of those who remain in the market is strengthened, which enhances their outside (market) option. To maintain indifference, the government must raise its offer (higher $p_{\rm g}$) accordingly.

A portion of the government's tax revenue now funds the intervention, so not all of it backs fiat money issuance. The amount of fiat money, N, will be determined as part of the government's optimization problem examined later. We assume the government can commit at $t=0$ to the date-1 intervention described above. Given this commitment and a fiat money issuance of N, it can be shown that the total money creation is[29]

$$\Lambda = \frac{(1+\alpha)\left(1+\frac{N}{e}\right)}{1+\alpha\left[1-(\delta-\tau)\widehat{A}_{\rm trade}\right]} - 1, \tag{27}$$

where $\widehat{A}_{\rm trade} \equiv \theta A_{\rm H} + \lambda(1-\theta)\left[\frac{\theta}{1-\zeta(1-\theta)}\right]^2 A_{\rm L}$, which increases with ζ. Thus, a more aggressive

[29] The other quantities are

$$\begin{cases} B = \dfrac{(\delta-\tau)\widehat{A}_{\rm trade}\alpha(e+N)}{1+\alpha\left[1-(\delta-\tau)\widehat{A}_{\rm trade}\right]} \\ g = \dfrac{e+N}{1+\alpha\left[1-(\delta-\tau)\widehat{A}_{\rm trade}\right]} \\ \ell = \dfrac{\alpha(e+N)}{1+\alpha\left[1-(\delta-\tau)\widehat{A}_{\rm trade}\right]}. \end{cases}$$

intervention (higher ζ) raises $\widehat{A}_{\text{trade}}$, thereby increasing Λ.

As in (15), firm output is given by $y_j = \frac{A_j \alpha}{1+\alpha}(1+\Lambda)e \ \forall j \in \{\text{H}, \text{L}\}$. Thus, maximizing output is equivalent to maximizing total money creation Λ. The government's problem at $t = 0$ can be stated as:

$$\max_{N,\zeta} \ \Lambda$$
$$\text{s.t. } N + \zeta(1-\theta)\lambda \left[\frac{\theta}{1-\zeta(1-\theta)}\right]^2 (\delta - \tau) y_{\text{L}} \leq \tau \left\{\theta y_{\text{H}} + (1-\theta)\left[\zeta + (1-\zeta)\frac{\lambda\theta}{1-\zeta(1-\theta)}\right] y_{\text{L}}\right\}. \tag{28}$$

The government's budget constraint (28) reflects how tax revenue is collected and allocated. Given the offer in (26), purchasing a ζ fraction of loans costs $\zeta(1-\theta)p_{\text{g}} = \zeta(1-\theta)\lambda\left[\frac{\theta}{1-\zeta(1-\theta)}\right]^2(\delta-\tau)y_{\text{L}}$, which, along with fiat money issuance N, makes up the LHS. This total expenditure is financed from tax revenue, which appears on the RHS, and has two parts. First, a mass θ of firms produce high output y_{H}, which is deposited in their regional banks and thus fully taxable. Second, the remaining firms, with mass $1-\theta$, produce low output y_{L}. A fraction ζ of these firms sell to the government, making their output taxable. The remaining fraction $1-\zeta$ trade in the market; their output becomes taxable with probability $\mu(n) = \frac{\lambda\theta}{1-\zeta(1-\theta)}$, which equals the likelihood that their loan is sold and deposited in a buying bank.

Some remarks on the budget constraint are useful. While a higher ζ increases government spending on intervention *ceteris paribus*, it also contributes to money creation, firm output, and thus tax revenue. The size of the government's budget is therefore *endogenous* – both shaped by and shaping its policy choices (N and ζ). Indeed, increasing ζ may not tighten the constraint but rather expand fiscal capacity, permitting greater fiat money issuance. This leads to:

Proposition 3 (Government Loan Purchase)**.** *When the tax rate is sufficiently high, the government's commitment to purchase loans for sale* ($\zeta > 0$) *strictly increases total money creation and firm output relative to the laissez-faire with* $\zeta = 0$.

The endogeneity of the intervention budget implies that QE is, at least partly, self-financing. This novel implication of the analysis means that government intervention in the market via (targeted) asset purchases can contribute to enhanced output and higher welfare even outside financial crises.

5.2 Inefficiency when $\theta > \theta^*$

In this case, an excess of banks that are loan buyers relative to banks that are loan sellers at $t = 1$ drives the loan price so high that buyers would violate their IC constraint for safekeeping if they were to pay that price. As a result, trade collapses at $t = 1$. This inefficiency reduces private money creation at $t = 0$, leading to lower output and diminished tax revenue, thereby constraining the government's capacity to issue fiat money.

The government can address this inefficiency by subsidizing loan buyers. This approach has been frequently employed during financial crises. For example, during the 2007-09 crisis, the Federal Reserve and the U.S. Treasury provided support to J.P. Morgan Chase in its acquisition of Bear Stearns. Similarly, in the 1980s, the FDIC facilitated purchases of failing S&Ls by offering assistance to solvent banks as inducement to purchase. What is novel in our analysis is the implication that such interventions may be warranted even *outside* of crisis periods, as a tool to enhance money creation and real output.

While providing asset buyers a subsidy to resuscitate trading seems intuitively plausible, our analysis suggests the nuance that the simple solution of subsidizing *all* buyers is unlikely to be optimal due to the shadow costs of the government intervention. A better alternative is for the government to subsidize only a fraction $\gamma \in (0, 1)$ of buyers, choosing γ high enough to lower the buyer/seller ratio enough to revive trading. Since all buyers are ex ante identical, the identity of those that are subsidized is irrelevant. What matters is that the recipients of the subsidies are publicly recognized, so the $1 - \gamma$ fraction of buyers that are not subsidized cannot trade since all agents know that their post-trading IC constraint for safekeeping will not be satisfied. The exclusion of these potential buyers improves the bargaining power of the fraction γ of buyers that are subsidized, which then lowers the government subsidy that needs to be provided to them.

Specifically, in choosing γ, the government faces the following tradeoff. A lower γ leads to fewer buyers, which means a lower buyer/seller ratio. This increases each remaining buyer's bargaining power, and reduces the loan price, thereby lowering the subsidy to be provided to each remaining buyer to restore its post-trading IC condition. However, reducing the mass of buyers also reduces the odds of each seller meeting a buyer, so it lowers the probability of trade. The government's problem is to choose γ to optimally balance this tradeoff.

5.3 Policy Implications

Our analysis takes the bank's initial capital endowment e^{b} as given. Proposition 2 shows that a higher e^{b} leads to greater money creation and higher output. Our analysis thus highlights a new role for bank capital, namely that it enhances money creation. That is, bank capital can increase aggregate money creation through a previously unrecognized channel. The regulatory policy implication is that to stimulate lending and increase economic output, regulators should focus on bank capital. This contrasts with the standard approach of flooding banks with liquidity (reserves of loanable funds) to stimulate more lending via the bank lending channel. Our analysis shows that lending by banks depends on loan demand and bank capital. Indeed, the empirical evidence shows that just infusing the banking system with more liquidity does not necessarily lead to more bank lending (e.g., De Haan, Holton, and van den End (2019), Peek and Rosengren (1995), and Thakor (1996)).

Second, bank capital scarcity introduces distortions in our model that are not limited to the empirically-documented decrease in bank lending when banks suffer negative shocks to capital (e.g., Peek and Rosengren (1997)). Specifically, this scarcity also dampens money creation and leads to inefficient utilization of the financial intermediation services that banks can potentially offer. More plenteous bank capital would diminish these inefficiencies, but the policy-relevant question is: where would this capital come from? One approach would be for the government to directly purchase equity in banks, with the appropriate corporate governance guardrails to cope with moral hazard (e.g., Mücke, Pelizzon, Pezone, and Thakor (2024)). But this may run into government resource constraints as well as political headwind, especially during non-crisis periods. Another approach is to intertemporally refurbish bank capital levels via regulatory dividend restrictions, since most bank capital accumulation occurs through retained earnings (e.g., Uluc and Wieladek (2018)). It would be Panglossian to presume that such capital-building would eliminate the bank capital scarcity problem, but this policy implication about the benefit of building up higher bank capital levels runs counter to the usual argument by bankers that higher capital requirements (or dividend restrictions) will lead to reduced economic output.

The third implication is that, even when the credit market is not frozen and there is no financial crisis, central bank interventions can improve the efficiency of the laissez-faire equilibrium. This intervention is state-dependent and takes one of two forms, either asset purchases as in QE or selec-

tive subsidization of potential asset buyers.[30] Thus, there is a welfare-enhancing role for government intervention even when informational frictions are absent. Moreover, since the intervention elevates economic output, the intervention budget is endogenous.

Finally, the complementarity of bank-created money and fiat money highlighted by our analysis points to the potential welfare losses that may be associated with denying banks the ability to create private money. Such proposals have been discussed quite a bit lately. For example, in June 2018, Swiss citizens voted on a referendum to prevent commercial banks from creating money in the process of lending. The initiative, also known as *Vollgeld*, proposed to give Switzerland's central bank, The Swiss National Bank, the exclusive authority to create money. Although the referendum was rejected by the voters, similar proposals have been made in connection with central bank digital currency.[31] Our analysis shows that because banks create money in response to loan demand, the quantity of private money they create naturally reflects economic conditions and also enables efficient utilization of the financial services banks are experts in providing. It would be dubious at best to assume that a central bank could be omniscient enough to replicate or improve upon such market signals.

5.4 Empirical Predictions

Our analysis yields numerous empirical predictions. First, the aggregate amount of money in the economy affects economic output. This is consistent with the empirical evidence in Feldstein and Stock (1993) and Stock and Watson (1989). However, a direct causal test of this prediction is likely to be challenging. This is because changes in the money supply and changes in economic output are both likely to be induced by overlapping factors. Thus, one would need an exogenous shock to the money supply that is not a direct shock to economic output itself. One possibility is a shock akin to the Japanese stock market shock used by Peek and Rosengren (1997), i.e., a shock to the capital ratios of Japanese banks operating branches in the U.S. that is engendered by an event in a distant geography with no direct ramification for the U.S. economy. If the prediction of our theory is supported by the data, this should lead to a reduction in the private money created by banks, a diminished total money supply, and lower economic output.

[30] One caveat with QE is that it may introduce distortions not captured by our analysis (e.g., Liu, Mian, and Sufi (2022) and Rosengren (2015)). In particular, Song and Thakor (2025) show that one such distortion is that QE generates a "soft budget constraint" problem in banks' continuation financing, a problem exacerbated by higher bank capital.

[31] See, for example, Thakor (2019).

Second, although our analysis does not consider non-bank lenders, it has a novel implication for the segmentation of the credit market between banks and non-depository lenders that do not create private money. An increase in the tax rate reduces the value of the bank's depository services but does not affect the value of credit extended by non-banks. Thus, our model implies that an increase in the tax rate should lead to banks losing market share to non-banks. To the best of our knowledge, this implication has yet to be confronted with the data.

6 Conclusion

We have developed a theory in which there is a rich interaction between endogenously-arising private money, fiat money and banks. This interaction is mediated by bank capital, interbank loan trading and the government's taxation on output. Central bank intervention is welfare enhancing even outside of crisis. Moreover, the budget for this intervention is endogenous and it may be partially self-financing.

A key to the model is the inseparability of bank lending from bank deposit creation. Moreover, in our model, banks are not just *users* of the fiat money or liquidity created by the central bank – they are *co-creators* of it, with their private money creation complementing government-created liquidity. This has direct implications for narrow bank proposals in which banks accept cash deposits but do not lend or create private money, as well as other proposals in which banks lend but are prohibited from creating private money.

Given the centrality of banks in money creation process that our analysis highlights, an interesting question is how banks will adapt in form and function if digital currencies (like stable coins) get more traction in terms of government adoption. And what will this portend for the role of (or even the need for) the central bank? These are promising normative questions for future research to explore.

Appendix A: Candidate Equilibrium-HL in the No-Trading Benchmark

In this equilibrium, the firm deposits y_{L} at $t = 1$ after a bad shock, as well as y_{H} after a good shock. This requires: (i) loan repayment after the bad shock is renegotiated to restore the firm's IC constraint to deposit y_{L}; and (ii) the bank's IC constraint for safekeeping holds after the bad shock. Consider (i), assuming (ii) holds. The bank can seize at most $(\delta - \tau)y_{\mathrm{L}}$, the firm's *net* benefit from depositing after the bad shock. Repayment must therefore be reduced to this level. The bank has no reason to accept less, so repayment is set exactly to $(\delta - \tau)y_{\mathrm{L}}$. Consequently, repayment after the good shock falls from $\frac{B}{\theta}$ in equilibrium-H to $\frac{B}{\theta} - \frac{1-\theta}{\theta}(\delta - \tau)y_{\mathrm{L}} = \frac{B}{\theta} - \frac{1-\theta}{\theta}(\delta - \tau)A_{\mathrm{L}} \cdot \min\{\alpha g, \ell\}$ in equilibrium-HL.

Equilibrium-HL is characterized by solving the firm's maximization problem:

$$\max_{g,\ell,B} \ (1-\tau)[\theta A_{\mathrm{H}} + (1-\theta)A_{\mathrm{L}}] \cdot \min\{\alpha g, \ell\} - B \tag{A1}$$

$$\text{s.t. } (\delta - \tau)A_{\mathrm{H}} \cdot \min\{\alpha g, \ell\} \geq \frac{B}{\theta} - \frac{1-\theta}{\theta}(\delta - \tau)A_{\mathrm{L}} \cdot \min\{\alpha g, \ell\}, \tag{A2}$$

$$\frac{e_j^{\mathrm{b}}}{D_j} \geq \frac{1-\delta}{\delta} \quad \forall j \in \{\mathrm{H}, \mathrm{L}\}, \tag{A3}$$

and the (same) budget constraints (10) and (11).

The objective function (A1) differs from (8) in that output is now deposited in the bank even after the bad shock, preserving its value but subjecting it to taxation. Comparing (A2) with the corresponding IC constraint (9) in equilibrium-H, the reduced loan repayment after the good shock, $\frac{1-\theta}{\theta}(\delta - \tau)A_{\mathrm{L}} \cdot \min\{\alpha g, \ell\}$, strengthens the firm's repayment incentive *ceteris paribus*. The bank's IC constraint for safekeeping, (A3), holds regardless of the shock.

Let $\widehat{A}_{\mathrm{ben}} \equiv \theta A_{\mathrm{H}} + (1-\theta)A_{\mathrm{L}}$. The solutions are[32]

$$\begin{cases} B = \dfrac{(\delta - \tau)\widehat{A}_{\mathrm{ben}}\alpha e}{1 + \alpha(1 - \delta\widehat{A}_{\mathrm{ben}})} \\ N = \dfrac{\tau\widehat{A}_{\mathrm{ben}}\alpha e}{1 + \alpha(1 - \delta\widehat{A}_{\mathrm{ben}})} \\ \Lambda = \dfrac{\delta\widehat{A}_{\mathrm{ben}}\alpha}{1 + \alpha(1 - \delta\widehat{A}_{\mathrm{ben}})} \\ g = \dfrac{e}{1 + \alpha(1 - \delta\widehat{A}_{\mathrm{ben}})} \\ \ell = \dfrac{\alpha e}{1 + \alpha(1 - \delta\widehat{A}_{\mathrm{ben}})}. \end{cases} \tag{A4}$$

Expressions in (A4) mirror those in equilibrium-H ((14)), except that the *effective* firm productivity there, $A_{\mathrm{ben}} = \theta A_{\mathrm{H}}$, increases to $\widehat{A}_{\mathrm{ben}} = \theta A_{\mathrm{H}} + (1-\theta)A_{\mathrm{L}}$. Since $\widehat{A}_{\mathrm{ben}} > A_{\mathrm{ben}}$, B, N, Λ, g, and ℓ are all higher in equilibrium-HL. With firms also depositing output after the bad shock, the bank's ability to enforce repayment

[32] The firm's problem here is solved analogously to that in equilibrium-H (see the proof of Proposition 1), so we omit the details.

improves, allowing it to create more private money. Firms can then allocate more goods to production. The resulting increase in output boosts tax revenue, allowing the government to issue more fiat money. Essentially, when firms utilize banking in more *ex post* states, both bank and fiat money creation increase *ex ante*.

Appendix B: Proofs of Results

Proof of Proposition 1. First, we solve the firm's problem in (8) – (13). We have $\alpha g = \ell$, due to Leontief production. Using (10) and $\alpha g = \ell$, we can rewrite the objective function (8) as

$$\begin{aligned}&[\theta(1-\tau)A_{\mathrm{H}} + (1-\theta)(1-\delta)A_{\mathrm{L}}](\alpha g) - (1+\alpha)g + e + N \\ &= \big\{[\theta(1-\tau)A_{\mathrm{H}} + (1-\theta)(1-\delta)A_{\mathrm{L}}]\alpha - (1+\alpha)\big\}\frac{e+B+N}{1+\alpha} + e + N,\end{aligned} \tag{B1}$$

which is strictly increasing in B and N, due to condition (4). So, B and N are maximal at the optimum and, hence, (9) and (11) are binding. Solving (9), (10) and $\alpha g = \ell$ jointly, we have

$$\begin{cases} B = \dfrac{(\delta-\tau)A_{\mathrm{ben}}\alpha(e+N)}{1+\alpha\big[1-(\delta-\tau)A_{\mathrm{ben}}\big]} \\ g = \dfrac{e+N}{1+\alpha\big[1-(\delta-\tau)A_{\mathrm{ben}}\big]} \\ \ell = \dfrac{\alpha(e+N)}{1+\alpha\big[1-(\delta-\tau)A_{\mathrm{ben}}\big]}. \end{cases} \tag{B2}$$

From the binding condition (11), we have $N = \frac{\tau\theta A_{\mathrm{H}}\alpha(e+N)}{1+\alpha[1-(\delta-\tau)A_{\mathrm{ben}}]}$, which yields $N = \frac{\tau A_{\mathrm{ben}}\alpha e}{1+\alpha(1-\delta A_{\mathrm{ben}})}$. Substituting this into (B2) gives the equilibrium expressions in (14). Condition (5) ensures $\delta A_{\mathrm{ben}} < 1$, so $g < e$: some wage payments (specifically, $e-g$) are made in goods.

Next, we examine conditions for (12) and (13) to hold to support equilibrium-H. To analyze (12), we compute $e^{\mathrm{b}}_{\mathrm{H}}$ and D_{H}. For the deposits $e-g+B$ made by workers at $t=0$, the bank repays $e-g+B^{\mathrm{w}}_j$ at $t=1$ when the region's output shock is $\tilde{A} = A_j$, $j \in \{\mathrm{H},\mathrm{L}\}$. When $\tilde{A} = A_{\mathrm{L}}$, the firm does not deposit its output and defaults on its loan. Consequently, the bank can repay at most $e-g+e^{\mathrm{b}}$, exhausting its capital endowment e^{b}. That is, even if the bank uses all of its capital, it cannot fully meet its deposit obligations after the bad shock, implying $B^{\mathrm{w}}_{\mathrm{L}} = e^{\mathrm{b}}$. This also means $e^{\mathrm{b}}_{\mathrm{L}} = 0$, i.e., no capital remains in the bank after the bad shock, so condition (13) holds.

The workers' (binding) participation constraint for deposit making is

$$\theta(e-g+B^{\mathrm{w}}_{\mathrm{H}}) + (1-\theta)(1-\delta)(e-g+e^{\mathrm{b}}) = e-g+B \quad\Rightarrow\quad B^{\mathrm{w}}_{\mathrm{H}} = \frac{B}{\theta} - \frac{1-\theta}{\theta}[(1-\delta)e^{\mathrm{b}} - \delta(e-g)]. \tag{B3}$$

Since the bank's IC constraint fails after the bad shock, workers withdraw and privately keep $e-g+e^{\mathrm{b}}$ (the amount the bank can repay them) between dates 1 and 2. As a result, they consume $(1-\delta)(e-g+e^{\mathrm{b}})$ at $t=2$. After a good shock, workers receive $e-g+B^{\mathrm{w}}_{\mathrm{H}}$ in goods from the bank at $t=1$. This is rolled over (since the

bank's IC constraint for safekeeping holds in that state), yielding $e - g + B_{\rm H}^{\rm w}$ at $t = 2$.

When $\tilde{A} = A_{\rm H}$, the bank's liability $D_{\rm H}$ consists of: (i) the firm's deposit, $y_{\rm H} - \frac{B}{\theta}$, after repaying $\frac{B}{\theta}$ from output $y_{\rm H}$, and (ii) workers' deposits that are rolled over, $e - g + B_{\rm H}^{\rm w}$. Thus, $D_{\rm H} = \left(y_{\rm H} - \frac{B}{\theta}\right) + (e - g + B_{\rm H}^{\rm w}) = y_{\rm H} + e - g - \frac{1-\theta}{\theta}[(1-\delta)e^{\rm b} - \delta(e-g)]$. The bank's remaining capital $e_{\rm H}^{\rm b}$ consists of: (i) its intact endowment $e^{\rm b}$, and (ii) the residual from the firm's loan repayment after settling workers' deposits, $\frac{B}{\theta} - B_{\rm H}^{\rm w}$. So, $e_{\rm H}^{\rm b} = e^{\rm b} + \frac{B}{\theta} - B_{\rm H}^{\rm w} = e^{\rm b} + \frac{1-\theta}{\theta}[(1-\delta)e^{\rm b} - \delta(e-g)]$.

Substituting expressions for $D_{\rm H}$ and $e_{\rm H}^{\rm b}$ into (12):

$$\frac{e^{\rm b} + \frac{1-\theta}{\theta}[(1-\delta)e^{\rm b} - \delta(e-g)]}{y_{\rm H} + e - g - \frac{1-\theta}{\theta}[(1-\delta)e^{\rm b} - \delta(e-g)]} \geq \frac{1-\delta}{\delta} \quad \Rightarrow \quad e^{\rm b} \geq \underline{e}^{\rm b}, \tag{B4}$$

where $\underline{e}^{\rm b}$ is given by (6).

Lastly, we show that equilibrium-HL is not supported, i.e., the bank's IC constraint (A3) fails for $j = {\rm L}$: $\frac{e_{\rm L}^{\rm b}}{D_{\rm L}} < \frac{1-\delta}{\delta}$. Suppose $\frac{e_{\rm L}^{\rm b}}{D_{\rm L}} \geq \frac{1-\delta}{\delta}$, so equilibrium-HL exists, in which the bank seizes $\delta y_{\rm L}$ from the firm after the bad shock. It follows from $\frac{e_{\rm L}^{\rm b}}{D_{\rm L}} \geq \frac{1-\delta}{\delta}$ that $e_{\rm L}^{\rm b} > 0$, implying workers are fully repaid even after the bad shock. Their deposits are thus risk-free, and the full repayment $e - g + B$ at $t = 1$ is rolled over to $t = 2$ regardless of the shock. The bank's remaining capital consists of: (i) its endowment $e^{\rm b}$, and (ii) the residual from the firm's loan repayment after settling workers' deposits, $\delta y_{\rm L} - B$. So, $e_{\rm L}^{\rm b} = e^{\rm b} - (B - \delta y_{\rm L})$. To have $e_{\rm L}^{\rm b} > 0$, we need $e^{\rm b} > B - \delta y_{\rm L} = \frac{\delta\theta(A_{\rm H} - A_{\rm L})\alpha e}{1+\alpha\{1-\delta[\theta A_{\rm H} + (1-\theta)A_{\rm L}]\}}$. The bank's date-1 liability $D_{\rm L}$ consists of: (i) the firm's deposit, $y_{\rm L} - \delta y_{\rm L}$, after repaying $\delta y_{\rm L}$ to the bank, and (ii) deposits rolled over by workers, $e - g + B$. So, $D_{\rm L} = y_{\rm L} + e - g + (B - \delta y_{\rm L})$.

Substituting expressions for $D_{\rm L}$ and $e_{\rm L}^{\rm b}$ into (A3):

$$\frac{e^{\rm b} - (B - \delta y_{\rm L})}{y_{\rm L} + e - g + (B - \delta y_{\rm L})} \geq \frac{1-\delta}{\delta} \quad \Rightarrow \quad e^{\rm b} \geq \bar{e}^{\rm b}, \tag{B5}$$

with $\bar{e}^{\rm b}$ given by (7). The earlier condition, $e^{\rm b} > \frac{\delta\theta(A_{\rm H} - A_{\rm L})\alpha e}{1+\alpha\{1-\delta[\theta A_{\rm H} + (1-\theta)A_{\rm L}]\}}$, holds if $\bar{e}^{\rm b} > \frac{\delta\theta(A_{\rm H} - A_{\rm L})\alpha e}{1+\alpha\{1-\delta[\theta A_{\rm H} + (1-\theta)A_{\rm L}]\}}$; this holds if $1 + (1-\delta)A_{\rm L} > 0$ (clearly true). Given $e^{\rm b} < \bar{e}^{\rm b}$, (A3) is violated for $j = {\rm L}$: equilibrium-HL is not supported. ■

Proof of Proposition 2. First, we solve the firm's problem in (20) – (23). We have $\alpha g = \ell$, due to Leontief production. Using (10) and $\alpha g = \ell$, we can rewrite the objective function (20) as

$$\begin{aligned} &\left\{\theta(1-\tau)A_{\rm H} + (1-\theta)[\lambda\theta(1-\tau) + (1-\lambda\theta)(1-\delta)]A_{\rm L}\right\}(\alpha g) - (1+\alpha)g + e + N \\ &= \left[\left\{\theta(1-\tau)A_{\rm H} + (1-\theta)[\lambda\theta(1-\tau) + (1-\lambda\theta)(1-\delta)]A_{\rm L}\right\}\alpha - (1+\alpha)\right]\frac{e + B + N}{1+\alpha} + e + N, \end{aligned} \tag{B6}$$

which is strictly increasing in B and N, due to condition (4). So, B and N are maximal at the optimum and,

hence, (21) and (22) are binding. Solving (10), (21) and $\alpha g = \ell$ jointly (assuming (23) holds), we have

$$\begin{cases} B = \dfrac{(\delta-\tau)A_{\text{trade}}\alpha(e+N)}{1+\alpha\left[1-(\delta-\tau)A_{\text{trade}}\right]} \\ g = \dfrac{e+N}{1+\alpha\left[1-(\delta-\tau)A_{\text{trade}}\right]} \\ \ell = \dfrac{\alpha(e+N)}{1+\alpha\left[1-(\delta-\tau)A_{\text{trade}}\right]}. \end{cases} \tag{B7}$$

From the binding condition (22), we have $N = \frac{\tau\theta[A_{\text{H}}+\lambda(1-\theta)A_{\text{L}}]\alpha(e+N)}{1+\alpha[1-(\delta-\tau)A_{\text{trade}}]}$, which yields $N = \frac{\tau\theta[A_{\text{H}}+\lambda(1-\theta)A_{\text{L}}]\alpha e}{1+\alpha[1-\delta A_{\text{trade}}-\tau\lambda\theta(1-\theta)^2A_{\text{L}}]}$. Substituting this into (B7) gives the equilibrium expressions in (24). Condition (5) ensures $\delta A_{\text{trade}} + \tau\lambda\theta(1-\theta)^2 A_{\text{L}} < 1$, so $g < e$: some wage payments (specifically, $e-g$) are made in goods. The result that B, N, Λ, g, and ℓ are higher under trading than in equilibrium-H without trading follows directly from comparing (24) with (14), noting that $A_{\text{trade}} > A_{\text{ben}}$.

Next, we examine (23). Compute the buyer's post-trading capital and liability, $e^{\text{b}}_{\text{buy}}$ and D_{buy}. Compared to a bank's capital after the good shock under equilibrium-H in the no-trading benchmark (derived in the proof of Proposition 1), $e^{\text{b}}_{\text{H}} = e^{\text{b}} + \frac{1-\theta}{\theta}[(1-\delta)e^{\text{b}} - \delta(e-g)]$, trading increases the buyer's capital by $(\delta-\tau)y_{\text{L}} - p = (1-\theta)(\delta-\tau)y_{\text{L}}$, where we substitute p using (18). This term represents the buyer's surplus from trade. So, $e^{\text{b}}_{\text{buy}} = e^{\text{b}} + \frac{1-\theta}{\theta}[(1-\delta)e^{\text{b}} - \delta(e-g)] + (1-\theta)(\delta-\tau)y_{\text{L}}$. Compared to a bank's liability after the good shock in equilibrium-H (also derived in the proof of Proposition 1), $D_{\text{H}} = y_{\text{H}} + e - g - \frac{1-\theta}{\theta}[(1-\delta)e^{\text{b}} - \delta(e-g)]$, D_{buy} increases by $y_{\text{L}} - (\delta-\tau)y_{\text{L}}$, which is the seller firm's deposit in the buying bank after trading.

Substituting expressions for $e^{\text{b}}_{\text{buy}}$ and D_{buy} into (23), we can rewrite it as

$$\frac{e^{\text{b}} + \frac{1-\theta}{\theta}[(1-\delta)e^{\text{b}} - \delta(e-g)] + (1-\theta)(\delta-\tau)y_{\text{L}}}{y_{\text{H}} + e - g - \frac{1-\theta}{\theta}[(1-\delta)e^{\text{b}} - \delta(e-g)] + (1-\delta+\tau)y_{\text{L}}} \geq \frac{1-\delta}{\delta}. \tag{B8}$$

The LHS of (B8) is monotonically decreasing in θ, so for a given e^{b}, there exists a unique cutoff θ^* such that (B8) binds. Therefore, this IC condition holds for $\theta \leq \theta^*$, but fails for $\theta > \theta^*$. Moreover, since the LHS is strictly increasing in e^{b}, it follows that θ^* is strictly increasing in e^{b}.

Finally, we address the point related to bargaining when $\theta > \theta^*$ (see footnote 26): if trade would otherwise break down and both parties receive nothing, why would the seller not accept a lower price to restore the buyer's post-trading IC condition and thereby sustain trade? Suppose the firm *believes* that the negotiated price between the buyer and seller (unobservable to the firm) is no higher than $p(\theta^*)$, where $p(\theta^*)$ is determined by the binding condition in (B8), rewritten as

$$\frac{e^{\text{b}}_{\text{H}} + (\delta-\tau)y_{\text{L}} - p(\theta^*)}{D_{\text{H}} + (1-\delta+\tau)y_{\text{L}}} = \frac{1-\delta}{\delta} \quad \Rightarrow \quad (1-\delta)\left[e^{\text{b}}_{\text{H}} + D_{\text{H}} + y_{\text{L}} - p(\theta^*)\right] = e^{\text{b}}_{\text{H}} + (\delta-\tau)y_{\text{L}} - p(\theta^*) > e^{\text{b}}_{\text{H}}. \tag{B9}$$

Here, $e^{\text{b}}_{\text{H}} = e^{\text{b}} + \frac{1-\theta}{\theta}[(1-\delta)e^{\text{b}} - \delta(e-g)]$ and $D_{\text{H}} = y_{\text{H}} + e - g - \frac{1-\theta}{\theta}[(1-\delta)e^{\text{b}} - \delta(e-g)]$ are the buyer's pre-trading capital and liability, respectively. Given its belief, the firm is willing to deposit its output y_{L} with the buyer, expecting safekeeping. But the seller will instead offer a price $p^{\text{neg}} > p(\theta^*)$ that the buyer is willing to

accept, because doing so yields a higher payoff than rejecting the trade (in which case the buyer's payoff would equal its pre-trading capital $e_{\mathrm{H}}^{\mathrm{b}}$). Specifically, the buyer is indifferent at a cutoff price $\tilde{p}$ that satisfies

$$(1-\delta)(e_{\mathrm{H}}^{\mathrm{b}} + D_{\mathrm{H}} + y_{\mathrm{L}} - \tilde{p}) = e_{\mathrm{H}}^{\mathrm{b}}. \tag{B10}$$

Comparing this with the condition defining $p(\theta^*)$, it is clear $\tilde{p} > p(\theta^*)$. The seller can profitably offer a price $p^{\mathrm{neg}} \in \big(p(\theta^*), \tilde{p}\big)$, which the buyer will accept. However, this violates the buyer's post-trading IC constraint, invalidating the firm's belief. Thus, trade is infeasible in equilibrium when $\theta > \theta^*$. ■

Proof of Proposition 3. From the relation between y_j and Λ, $y_j = \frac{A_j\alpha}{1+\alpha}(1+\Lambda)e$, and the expression of Λ in (27), we have $y_j = \frac{A_j\alpha(e+N)}{1+\alpha[1-(\delta-\tau)\widehat{A}_{\mathrm{trade}}]}$ $\forall j \in \{\mathrm{H}, \mathrm{L}\}$. Substituting this into (28), we can rewrite the government's budget constraint as

$$\begin{aligned}&\frac{N}{e+N}\frac{1+\alpha[1-(\delta-\tau)\widehat{A}_{\mathrm{trade}}]}{\alpha} + \zeta(1-\theta)\lambda\left[\frac{\theta}{1-\zeta(1-\theta)}\right]^2(\delta-\tau)A_{\mathrm{L}} \\ &\leq \tau\left\{\theta A_{\mathrm{H}} + (1-\theta)\left[\zeta + (1-\zeta)\frac{\lambda\theta}{1-\zeta(1-\theta)}\right]A_{\mathrm{L}}\right\}.\end{aligned} \tag{B11}$$

The budget constraint must be binding at the optimum: otherwise, the government could slightly increase fiat issuance N, thereby expanding total money creation and improving outcomes. From the binding (B11), we have

$$\begin{aligned}&1 + \frac{N}{e} \\ &= \frac{1+\alpha[1-(\delta-\tau)\widehat{A}_{\mathrm{trade}}]}{1+\alpha[1-(\delta-\tau)\widehat{A}_{\mathrm{trade}}] - \alpha\left(\tau\left\{\theta A_{\mathrm{H}} + (1-\theta)\left[\zeta + (1-\zeta)\frac{\lambda\theta}{1-\zeta(1-\theta)}\right]A_{\mathrm{L}}\right\} - \zeta(1-\theta)\lambda\left[\frac{\theta}{1-\zeta(1-\theta)}\right]^2(\delta-\tau)A_{\mathrm{L}}\right)}.\end{aligned} \tag{B12}$$

Substituting this into the objective function, we can rewrite the government's problem as

$$\min_{\zeta}\ [1-(\delta-\tau)\widehat{A}_{\mathrm{trade}}] - \left(\tau\left\{\theta A_{\mathrm{H}} + (1-\theta)\left[\zeta + (1-\zeta)\frac{\lambda\theta}{1-\zeta(1-\theta)}\right]A_{\mathrm{L}}\right\} - \zeta(1-\theta)\lambda\left[\frac{\theta}{1-\zeta(1-\theta)}\right]^2(\delta-\tau)A_{\mathrm{L}}\right). \tag{B13}$$

Differentiate it with respect to ζ (omitting the constant coefficient $(1-\theta)A_{\mathrm{L}}$):

$$-2\lambda(\delta-\tau)\frac{1-\theta}{1-\zeta(1-\theta)}\left(\frac{\theta}{1-\zeta(1-\theta)}\right)^2 - \tau\left[1-\lambda\left(\frac{\theta}{1-\zeta(1-\theta)}\right)^2\right] + \lambda(\delta-\tau)\frac{1+\zeta(1-\theta)}{1-\zeta(1-\theta)}\left(\frac{\theta}{1-\zeta(1-\theta)}\right)^2. \tag{B14}$$

Evaluating this first-order derivative at $\zeta = 0$ yields $-2\lambda(\delta-\tau)(1-\theta)\theta^2 - \tau(1-\lambda\theta^2) + \lambda(\delta-\tau)\theta^2$. This is negative when $\tau > \max\left\{\frac{\lambda\delta\theta^2(2\theta-1)}{1-2\lambda(1-\theta)\theta^2}, 0\right\}$, implying that the optimum solution must involve some $\zeta > 0$. ■

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