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Authors	David Andolfatto
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Federal Reserve Bank of St. Louis, Research Division, P.O. Box 442, St. Louis, MO 63166

Hot Money for a Cold Economy

David Andolfatto
Federal Reserve Bank of St. Louis

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Abstract

What is the theoretical justification for taxing unspent money transfers in a recession? To examine this question, I study a model economy where fiat money is necessary as a medium of exchange and, incidentally, serves as a store of value. This latter property is shown to open the door to business cycles and depressions driven entirely by speculation. Unconditional money transfers do not guarantee escape from a psychologically-induced depression. I demonstrate how money transfers subject to a short expiration date do eliminate speculative equilibria. This *hot money* policy compares favorably to negative interest rate policy because the latter taxes all money savings whereas the former only threatens to tax gifted money.

JEL codes: B1, B2, E3, E4, E5, E6
Keywords: Money, hoarding, depression, sunspot equilibria.

1 Introduction

The proposition that money, as a *medium of exchange,* facilitates commercial activity, is hardly disputed. It is sometimes asserted, however, that money as a *store of value* might have the exact opposite effect. That is, because money is a safe asset, people are predisposed to save it as the economic outlook darkens. And while the accumulation of precautionary wealth may be rational at the individual level, a communal act of money-hoarding could conceivably spawn the depression people initially only feared. Keynes (1936) labeled this idea the *paradox of thrift.* The prospect of "aggregate demand failure" in monetary economies was a central message in his *General Theory.*[1]

[1] Kocherlakota (1998) highlights the role of money in facilitating intertemporal exchange when credit histories are absent. Kiyotaki and Moore (2002) demonstrate how monetary exchange overcomes the problem of limited commitment in credit markets. Bryant (2005) shows how fiat money can generate self-fulfilling depressions.

The traditional policy prescribed for a collapse of private demand is some form of government stimulus. The recommended policy interventions typically involve either direct purchases of goods from the private sector and recruitment into the public service, or tax cuts and cash transfers to households and businesses. While the first option should, in principle, be the most effective, it is not always the most practical. In particular, it may not be obvious where the government should direct its spending. Moreover, even when projects can be identified, they may not be available in "shovel ready" form. For these and other reasons, tax cuts and outright cash transfers to individuals may be preferred since, it seems reasonable to assume that people know best where to direct their purchasing power.

There is, however, potential problem with policies designed to transfer money to households in a deep recession. In particular, if economic conditions are expected to remain depressed, then households and businesses seem as likely to save their money transfer as they are to spend it. The precautionary saving motive would in this case defeat the purpose of the intervention. Such a concern was very much on the mind of Irving Fisher who in 1933 promoted the idea of *stamp scrip* to Congress for the purpose of

> ...[unleashing] a force on which the ultimate cure of the depression really depends. I refer to the credit currency of the land which is now so tragically bottled up and has hitherto baffled the most heroic efforts at rescue. It has simply refused to be rescued - refused with an apparently insane perversity. Fisher (1933).

The stamp scrip described by Fisher (1933) is a proposal to tax money (scrip) as a store of value.[2] The tax renders the money "hot" as in a "hot potato" that people are eager to dispose of. Its purpose is to generate a *coordinated* private sector expenditure designed to "kick-start" a depressed economy, primarily by motivating firms to hire the workers necessary to meet the expected rush of orders. The intervention is meant to be temporary–once individual decision-makers coordinate on a higher level and broader scope of economic activity, it can be removed. As such, the incentives the program engenders is similar to a negative interest rate policy, with two important differences. First, the tax applies only to the transfer and not on all existing money balances. Second, the tax is only a threat; that is, it need not be applied if the money is spent. Once the transfer is spent by a buyer, it converts into regular money for the seller. Apart from this last property, hot money resembles an everyday gift card with a short expiration date.

Most applications of stamp scrip appear to be experiments in local currency issuance. Fisher (1933) cites a number of anecdotes, but had little hard evidence to

[2]The idea is attributed to Silvio Gessel; see Champ (2008) and also to Pierre-Joseph Proudhon; see Ferreira (2011).

appeal to. There have been a few modern efforts to employ hot money at a national scale, though the sums involved appear relatively small in size. Hsieh, Shimizutani and Hori (2010) study the effects of a Japanese program that distributed 20,000 yen (about $200) to over 30 million people in 2009. These six-month expiry coupons had to be spent in the recipient's local community. The authors report that the program had a significant and *lasting* impact on the purchases of durable goods, but not on non-durable goods and services. Kan, Peng and Wang (2017) evaluate the 2009 Taiwan Shopping Voucher Program and find that it had its intended effects and that these were comparable to those reported in other types of fiscal stimulus programs.

The purpose of this paper is to explore the theoretical rationale for a hot money policy. I am particularly interested in the following questions. First, what needs to be true for a hot money policy to have any potential economic benefit. This is an important question for policymakers since, as with any policy, success of any intervention depends on the problem being diagnosed correctly. Second, under what circumstances is hot money preferable to more conventional forms of fiscal stimulus payments. I am aware of no existing literature that investigates the theory of hot money. Perhaps this is because the intuition underlying its appeal seems sufficiently straightforward. Nevertheless, I believe it is useful to lay out the elements of a theory–first, to understand clearly why the mechanism works and second, to identify potential unintended consequences.

The model I develop below displays the phenomenon of "aggregate demand failure," consistent with Keynes (1936). This is important because hot money (or indeed, any fiscal stimulus) hardly makes sense otherwise. Formally, the model gives rise to multiple, Pareto-ranked equilibria, similar in spirit to Azariadis (1981), Farmer and Guo (1994) and Bryant (2005), among others. The model consists of workers and entrepreneurs who are randomly matched in pairwise meetings in each period. Individuals are anonymous so that private credit arrangements are impractical. The perishable output produced by a match is not valued by the worker, who is assumed to value output produced elsewhere in the economy. Workers must therefore be compensated with implicit claims against the output produced outside of the firm that employs them. In the model (as in reality), these claims take the form of money that the entrepreneur (lacking access to credit) must accumulate for the purpose of financing payroll. The hiring decisions (whether to spend money on payroll) made by entrepreneurs depend on the entrepreneur's forecast money revenue. If sales are projected not to materialize, the entrepreneur rationally economizes on her cash balances. Since labor in this event earns no income, aggregate demand fails to materialize. Collectively, these decisions lead to a depression as the outcome of a self-fulfilling prophecy.

I demonstrate below the existence of a stationary sunspot equilibrium when money takes its normal durable form. In depressions, entrepreneurs "hoard" their money, and money-hoarding causes employment and output to collapse. I demonstrate how a well-designed hot money policy eliminates the incentive to hoard money, thereby eliminating the existence of sunspot equilibria.[3] The unique stationary (not quite Nash) equilibrium is the full employment outcome. That is, the theory suggests that if a hot money contingency policy is put in place, if it is clearly communicated and is credible, then it need not ever be used. The mere threat of the intervention is sufficient, in theory, to discourage coordination failure. Of course, one should expect that in practice, demonstrations of the policy are likely to be necessary at first to build the desired credibility.

2 A simple model

2.1 The environment

The economy is populated by a continuum of infinitely-lived households. There are two types of households: *entrepreneurs* and *workers*. Each type has a unit mass.

Let $t = 0, 1, ..., \infty$ denote time. Each period is divided into two stages: a *production stage* and a *reward stage*. At the beginning of each period, entrepreneurs and workers are matched at random in pairwise unions that last only through the production stage. At the end of the production stage, entrepreneurs and workers are again randomly matched in different pairwise unions, that last only through the reward stage. This matching process repeats anew at the beginning of each period. Because individuals will almost never meet again, reciprocal trading arrangements are not feasible.

Workers are endowed with a unit of time in each production stage. Their time is indivisible and has two possible uses. First, it can be used in a home-production activity that generates $v > 0$ units of non-storable and non-transferable output. Alternatively, it can be devoted toward the production of a non-storable and transferable good $y > v$. The technology for producing the transferable good is possessed by entrepreneurs. Thus, the production of good y requires the joint effort of entrepreneur and worker in an establishment I call a *firm*.

I assume that the output produced by a firm is not valued as a form of consumption by the worker involved in manufacturing it. Instead, the worker wants to consume the products other firms. In their role as consumers, workers travel to various firm locations according to the random matching process described above. This structure captures the real-world property that most of what we consume is not produced by our own labor. It also implies that a firm is not in a position to reward its workers directly with its produce–the worker does not value it and is not in a position to dispose of it easily on the market for goods (it is the entrepreneur who services

[3] The analysis below formalizes the conjecture described in Andolfatto (2020).

customers as they arrive to the firm's location). This structure of specialized wants and abilities is important because it implies the need for a high degree of cooperation if the multilateral gains to trade available to members of the community are to be realized. In particular, workers must be willing to expend labor in the hope that their efforts will be rewarded by other members of society with whom they have no existing relationships.

For simplicity, I assume that both entrepreneurs and workers have linear preferences. For the entrepreneur,

$$\sum_{t=0}^{\infty} \beta^t e_t \tag{1}$$

where e_t denotes the consumption of the good produced by her firm and $0 < \beta < 1$. Workers have preferences given by,

$$\sum_{t=0}^{\infty} \beta^t \left[w_t + v(1 - n_t) \right] \tag{2}$$

where $n_t \in \{0, 1\}$ denotes labor supply and w_t is understood to mean consumption of any good not produced by the worker's place of employment.

2.2 Optimality

The efficient allocation is simple to characterize: given $y > v$, efficiency entails setting $n_t = 1$ for workers and for all $t \geq 0$. I assume that the match surplus $y - v$ is shared according to a simple rule that assigns a fraction $0 < \theta < 1$ of the surplus to the worker. A worker's real wage is in this case given by $w = v + \theta(\alpha - v)$, or

$$w = \theta y + (1 - \theta) v \tag{3}$$

To be clear, a firm in a given match produces y units of output with $\pi = (1-\theta)(y-v)$ units of this output consumed by the firm's entrepreneur and the remaining $w = \theta y + (1 - \theta) v$ units of output handed over to the visiting worker (in his role as a consumer in the reward stage).

Let E^* and W^* denote the value to an entrepreneur and worker from participating in cooperative exchange. From (1) and (2), with $n_t = 1$ for all $t \geq 0$, we have

$$(1 - \beta) E^* = \pi \tag{4}$$

$$(1 - \beta) W^* = w \tag{5}$$

The respective payoffs from operating in autarky are,

$$(1 - \beta) E^a = 0 \tag{6}$$

$$(1 - \beta) W^a = v \tag{7}$$

2.3 Implementation with social credit

If everyone in society could be relied upon to act cooperatively, we could end the analysis here. Suppose, however, that individuals cannot automatically be relied on to honor their obligations. It is known that in these types of settings, individuals may nevertheless be induced to behave cooperatively if society stands ready to reward cooperative acts (personal sacrifices made for the benefit of the broader community). In what follows, I assume that the worst punishment that can be imposed on an individual for noncompliance behavior is economic ostracism. An ostracized individual generates their autarkic payoff as defined in (6) and (7).

In this section, I assume that individual trading histories constitute public information. Kocherlakota (1998) appropriately labels this database "societal memory." In the present context, it is sufficient in period t for a worker to know how his employer behaved in the reward stage of period $t-1$ and for an entrepreneur to know how the consumer behaved (as a worker) in the production stage of period t. The proposed "tit-for-tat" strategy profile is as follows. For the worker, newly matched in production stage with an entrepreneur at date t,

$$n_t = \begin{cases} 1 & \text{if} \quad h_{t-1}^2 \geq w \\ 0 & \text{if} \quad h_{t-1}^2 < w \end{cases} \tag{8}$$

where h_{t-1}^2 represents the entrepreneur's gift to *some other consumer/worker* who visited her firm in the second stage of the previous period, and where w is defined by (3). I assume that all workers cooperate in the first move of the game, i.e., $n_0 = 1$. For the entrepreneur, newly matched with a consumer in the reward stage of date t,

$$w_t = \begin{cases} w & \text{if} \quad h_t^1 = 1 \\ 0 & \text{if} \quad h_t^1 = 0 \end{cases} \tag{9}$$

where h_t^1 denotes the consumer's employment record *at some other firm* in the production stage of date t. I will say that these strategy profiles constitute an *equilibrium* if each individual finds the recommended action sequentially-rational at every date, conditional on all others playing (8)-(9).

Suppose that all individuals play strategies (8) and (9). For a worker in the production stage, sequential-rationality requires $w + \beta W^* \geq v + \beta V^a$.[4] Since $0 < \theta < 1$, condition (3) implies $w > v$, so that worker-cooperation is sequentially-rational. Next, consider an entrepreneur in the reward stage of a period. Sequential-rationality requires $\pi + \beta E^* \geq y + \beta E^a$ or, after some algebraic manipulation,

$$\left(\frac{\beta}{1-\beta}\right)(1-\theta)(y-v) \geq y \tag{10}$$

[4] I assume that if defection is profitable in the current period, it remains profitable in all future periods.

Condition (10) will hold for a wide range of parameter values and, in particular, if β sufficiently is close to unity (i.e., if entrepreneurs are sufficiently patient).

Not surprisingly, autarky is also an equilibrium here. To see this, imagine that all individuals play autarkic strategies: workers consume their home production v and entrepreneurs, producing nothing, offer nothing for visiting consumers. An individual worker defecting in this scenario must expect to give up v in exchange for nothing. It is not even feasible for an individual entrepreneur to defect from autarky, since she has no output.

2.4 Limited information and money

The strategies described above rely on individuals having access to a databank of the personal trading histories of all individuals in society. This information structure may not be a bad approximation for smaller societies. For larger social networks, however, the phenomenon of having to deal with "strangers" is likely to arise. To capture this effect, I assume that societal memory is absent. In this case, realizing the multilateral gains to trade requires the use of an alternative record-keeping technology.

One such technology entails the use of private debt. In the present context, it is conceivable for each firm to pay its workers in coupons representing claims against its own production. While workers here do not value the output they helped to produce, there is nothing in principle to prevent workers from exchanging these claims with each other on a financial market. In what follows, I assume that privately-issued debt of this form is too easily counterfeited to operate at the scale that is needed. One could imagine the existence of other types of frictions making a system of multiple currencies unwieldy to manage relative to an alternative record-keeping system, like fiat a money system (e.g., Ostroy, 1973, Townsend, 1987, Bigoni, Camera and Casari, 2019). Below, I assume that the best feasible record-keeping technology is limited to money accounts in a central incorruptible ledger, and that the transfer of money credit across accounts is costless and secure.

Assume that each entrepreneur is given one dollar at $t = 0$ and that money is indivisible.[5] The money supply is kept constant forever. The idea here is that the monetary token might serve as a sufficient statistic, credibly signalling an historical sacrifice made by its owner on behalf of the community (Kocherlakota, 1998). This of course assumes that money cannot be counterfeited or stolen, so that the only way to acquire it (apart from the initial injection) is to make the requisite sacrifice of goods or labor.

In what follows, I assume that the individual in possession of money moves first.

[5]Since the model features indivisible goods and indivisible money, it belongs to the class of so-called "first generation" money search models introduced by Kiyotaki and Wright (1993) which, in turn, built on Jones (1976).

The timing of events is as follows. In the production stage, the entrepreneur makes the worker an offer ($1) or not. The worker accepts or rejects the offer. In the reward stage, the consumer makes the firm an offer ($1) or not. The firm accepts or rejects the offer.

Consider the following strategy profiles. For the worker, newly matched in the production stage with an entrepreneur at date t,

$$n_t = \begin{cases} 1 & \text{if} \quad o_t^1 = \$1 \\ 0 & \text{if} \quad o_t^1 = \$0 \end{cases} \tag{11}$$

where $o_t^1 \in \{\$0, \$1\}$ represents the entrepreneur's production stage wage payment.[6] For the entrepreneur, newly matched with a consumer in the reward stage of date t,

$$w_t = \begin{cases} w & \text{if} \quad o_t^2 = \$1 \\ 0 & \text{if} \quad o_t^2 = \$0 \end{cases} \tag{12}$$

where $o_t^2 \in \{\$0, \$1\}$ denotes the consumer's reward stage money payment. Strategy profiles (11) and (12) are meant to correspond as closely as possible to (8) and (9), respectively, to demonstrate the role of money as "societal memory." I now demonstrate that the strategy profiles (11) and (12) constitute an equilibrium and that, if individuals follow this prescribed play, they will possess the necessary money balances to make their respective wage and price offers when the time comes.

To demonstrate that the play described above is an equilibrium, we have to show that each individual has no incentive to defect conditional on believing that all others are following the prescribed equilibrium play. Consider first an entrepreneur entering the production stage with one dollar. A defection here means not making a wage offer to her worker, choosing instead to hold the dollar into the next period. But her situation at date $t+1$ is exactly the same as it was at date t. If she continues to defect, her payoff is autarky. If she reverts to cooperative play at date $t+1$, she loses one period of surplus. Both of these outcomes is dominated by cooperative play from the start. Now consider the worker in the production stage. Defection here means declining the wage offer and consuming home production. The worker carries zero money balances into $t+1$ and again faces the same choice. If he continues to defect, his payoff is autarky. If he reverts to cooperative play, he loses one period of surplus. Both of these outcomes is dominated by cooperative play from the start.

Next, consider a worker entering the reward stage with one dollar which, according to equilibrium play, he is supposed to spend on goods. Defection in this case means foregoing consumption w at date t and carrying the dollar into date $t+1$. Returning to cooperative play at $t+1$ means carrying an extra dollar forever at the expense of foregoing consumption in one period. Hence, a one-shot defection in this form does not pay. Alternatively, the worker could use the extra dollar to forego work *and* enjoy

[6] I assume here that one can only make a positive monetary offer if one is in possession of money.

consumption at date $t+1$. This latter defection generates a date $t+1$ flow payoff of $v+w$ instead of the equilibrium payoff w. In this case, the defection is effectively trading off w at date t for v at date $t+1$. Such an action cannot pay since $w > v$ (and also because of discounting). Finally, consider an entrepreneur entering the reward stage in period t with zero money balances (the case in the proposed equilibrium). Defection in this case means zero sales (output is consumed by the entrepreneur), which implies that the entrepreneur will enter period $t+1$ with zero money balances and the inability to hire labor. Cooperative play in this case is sequentially-rational if condition (10) holds.

As in the social credit economy studied above, there is another equilibrium that corresponds to autarky. To see this, assume that all share the initial belief that money has no exchange value. In this case, it makes no sense to defect from autarky–that is, to make a contribution to society–in exchange for worthless "paper."

3 A hot and cold economy

Achieving the multilateral gains to trade available in this model economy requires a considerable degree of coordination. People must be willing to make sacrifices to specific individuals (workers to firms and firms to consumers) absent any prospect of mutual reciprocation. Essentially, people have to trust that others will, for the most part, behave cooperatively. In a monetary economy, cooperative play means making sacrifices of goods and labor in exchange for intrinsically worthless tokens that society chooses to label *money*.

As mentioned above, a central idea in economics revolves around the question of whether decentralized economic systems are stable in the sense of possessing "natural" mean-reverting forces that keep an economy operating at, or close to, its potential–at least, over the long run. This type of stability is often just *assumed* in economic models. This assumption presumably reflects the belief that real-world economies are stable in this sense.

Keynes (1936) was of a very different mind. It is clear that he believed that an economy possessed no natural mean-reverting forces. Prolonged slumps, like the Great Depression he was living through at the time, were obviously possible. The passage by Fisher (1933) quoted in the introduction suggests that his American counterpart felt the same way. While Keynes (1936) did not possess the tools of game theory at the time, it seems not too much of a stretch to interpret his view of the Great Depression as constituting a type of "equilibrium." In Chapter 18 of the *General Theory*, for example, he writes:

> *In particular, it is an outstanding characteristic of the economic system in which we live that, whilst it is subject to severe fluctuations in respect*

of output and employment, it is not violently unstable. Indeed it seems capable of remaining in a chronic condition of subnormal activity for a considerable period without any marked tendency either towards recovery or towards complete collapse.

Moreover, he felt that an important coordinating force in decentralized systems originates from a market psychology that he labeled "animal spirits."

A question one could ask is whether the model economy described above is capable of displaying the properties Keynes (1936) believed to be characteristic of decentralized economic systems. As it turns out, we can answer this question in the affirmative. Consider a set of parameters satisfying (10). Then we know that the cooperative outcome can be implemented as a Nash equilibrium (using either societal memory or money). And, of course, autarky is also an equilibrium outcome. Because there is more than one equilibrium outcome, it is known that there exist a continuum of equilibria where the economy fluctuates stochastically between cooperative and non-cooperative outcomes, which one may reasonably interpret as economic booms and busts driven by Keynesian "animal spirits" (Howitt and MacAfee, 1992).

3.1 Sunspot equilibrium

In what follows, I invoke the concept of "sunspot" equilibrium (Cass and Shell, 1983). Specifically, imagine there exists an extraneous variable (a "sunspot") that blinks on and off over random intervals of time. The sunspot is observed by everyone at the beginning of each period. Let $0 \leq \sigma \leq 1$ denote the probability that a sunspot is off at any given date. Note that the sunspot here is simply a theoretical device to coordinate expectations and behavior. In reality, it may correspond to some unsubstantiated news or rumors concerning the health of the economy that here will ultimately become self-fulfilling prophecies.[7] If the sunspot remains on, equilibrium play is as described above. If the sunspot blinks off, entrepreneurs do not make their production-stage offers to workers–and workers, having no money, do not make their reward-stage offers to firms.

The idea captured here is that suddenly, and for no apparent reason, entrepreneurs turn bearish and forecast a decline in the demand for their product. As a result, they curtail employment/production and instead "hoard" their money balances. Workers, having no money wages, generate no demand for firm output, which only serves to confirm the initial bearish sentiment. The next period begins with each entrepreneur holding a dollar, *representing precautionary saving rather than earned revenue*. What

[7] There are other more realistic (and complicated) ways to model expectation formation. Howitt and MacAfee (1992), for example, ask the question of how people can be expected to coordinate their expectations in this manner. They show that it is possible for this to occur through learning and that learning dynamics do not materially affect their conclusions.

transpires next depends on the realization of the sunspot variable. There is the possibility of a prolonged depression, even if σ is small. But when the sunspot blinks on, animal spirits now drive entrepreneurs in a bullish direction. They begin to spend money on labor, which generates the consumer income necessary to generate the demand for firm output. This economy displays cyclical fluctuations, at times prolonged booms and slumps, for no fundamental reason. The cycle that materializes is driven *entirely by speculation*.

Let me now derive the payoffs associated with the behavior described above and then check whether it constitutes an equilibrium. Note that the behavior described above implies that entrepreneurs always enter a period holding money. Consider the value to an entrepreneur entering a period when the sunspot is on E^h and off E^l. Let $E \equiv (1-\sigma)E^h + \sigma E^l$. Then,

$$\begin{aligned} E^h &= \pi + \beta E & (13) \\ E^l &= \beta E & (14) \end{aligned}$$

so that

$$(1-\beta)E = (1-\sigma)\pi \qquad (15)$$

Similarly, for workers. Let $W \equiv (1-\sigma)W^h + \sigma W^l$. Then,

$$\begin{aligned} W^h &= w + \beta W & (16) \\ W^l &= v + \beta W & (17) \end{aligned}$$

so that

$$(1-\beta)W = (1-\sigma)w + \sigma v \qquad (18)$$

We need to check that prescribed behavior is sequentially rational for entrepreneurs and workers in each stage of each period and for each state (i.e., sunspot on or off). For the case in which the sunspot is on, the check on sequential rationality follows what has already been explained in Section 2.4. The only minor difference pertains to the entrepreneur in the reward stage. As before, the entrepreneur defects by refusing to sell output, choosing to consume it herself. Her immediate reward is y, but this comes at the cost of entering the next period with no money. Reverting to cooperative play in this case is not possible–the entrepreneur has condemned herself to a future of autarky. Sequential-rationality requires $E^h \geq y + \beta E$ or, after some algebraic manipulation,

$$(1-\theta)(y-v)\left[1 + (1-\sigma)\left(\frac{\beta}{1-\beta}\right)\right] \geq y \qquad (19)$$

Condition (19) corresponds to (10) when $\sigma = 0$ and will hold for β sufficiently close to unity.

Consider next a period in which the sunspot is turned off. The prescribed behavior in this case is non-cooperative play, reverting to cooperative play the next time the sunspot turns on.

Here, I introduce a refinement of the Nash equilibrium solution concept that I believe is reasonable in the present context (and also necessary, as I will explain below). In particular, when the sunspot turns off, assume that each individual believes that the counterparty they are presently matched with plays cooperatively with probability $0 \leq \psi \leq 1$. This specification nests the Nash construct when $\psi = 0$.[8]

Now, consider the entrepreneur. The entrepreneur defects by making her worker a wage offer. This defection will not pay if,

$$E^l \geq (1-\psi)E^l + \psi\left[(1-\psi)\left(y+\beta E^a\right) + \psi(\pi + \beta E)\right] \equiv \lambda(\psi) \tag{20}$$

That is, with probability $(1-\psi)$, the worker is expected to play noncooperatively. In this case, the entrepreneur hoards her money, generating payoff E^l. With complementary probability, the worker accepts the wage offer and output is produced. However, the entrepreneur anticipates meeting a willing buyer only with probability ψ. If the buyer is willing, she shares the surplus in exchange for money. With probability $(1-\psi)$ she anticipates not meeting a willing buyer. In this case, she consumes her own output and, failing to generate money revenue, lives forever more in autarky.

The payoff to defecting from non-cooperative play $\lambda(\psi)$ is quadratic in ψ. The equation $E^l = \lambda(\psi_0)$ has two solutions, one of which is $\psi_0 = 0$. But there is another solution $0 < \psi_0 < 1$ satisfying this condition as well. In fact, we can solve for this non-zero critical probability as,

$$\psi_0 = \frac{\beta E - y}{\pi + \beta E - y} < 1 \tag{21}$$

Lemma 1 $E^l = \lambda(0) < \lambda(1) = E^h$. *There exists a critical value* $0 < \psi_0 < 1$ *satisfying* $\lambda(\psi_0) = E^l$, *with* $E^l \geq \lambda(\psi)$ *for any* $0 \leq \psi \leq \psi_0$.

The intuition for Lemma 1 is that if cooperative play is expected with sufficiently low probability, the entrepreneur is taking a very large risk by playing cooperatively of not having sales materialize in the reward stage. A failure to replenish money balances here dooms the entrepreneur to perpetual autarky. However, if the entrepreneur is (for some reason) sufficiently optimistic about generating sales, she is willing to take the risk. If all entrepreneurs are endowed with the same optimistic beliefs $\psi > \psi_0$, a depression cannot occur in equilibrium.[9]

[8] One could interpret ψ as an off-equilibrium "tremble" similar to Selten (1975), but my concept here is distinct in that I do not restrict attention to arbitrarily small ψ.

[9] Here we see how a community made up of individuals who simply refuse to think the worst of their neighbors is unlikely ever to fall into a pyschologically-induced depression.

Next, consider the worker when presented with a wage offer. The worker defects by accepting the offer and then spending earned income. This defection will not pay if,

$$W^l \geq (1-\psi)\,(-v+\beta\hat{W}) + \psi(w+\beta W) \equiv \alpha(\psi) \tag{22}$$

That is, with probability $(1-\psi)$, the worker anticipates not having the opportunity to spend his money. In this case, he carries his money into the next period, which generates payoff $\hat{W} = v + \beta W$. That is, the best the worker can do with the money he carries over is to use it to take a holiday (engage in home production) and then spend his saved dollar in the reward stage should an opportunity arise. The worker anticipates meeting an open retail establishment with probability ψ, in which case he spends his money for goods w.

The payoff to defecting from non-cooperative play $\alpha(\psi)$ here is increasing and linear in ψ. We can, in this case, solve for a unique ψ_1 satisfying $W^l = \alpha(\psi_1)$. In particular, using $W^l = v + \beta W$ and (22), we can derive

$$\psi_1 = \frac{(1-\beta)\,W + v}{(1-\beta)\,W + w} \tag{23}$$

Lemma 2 $\alpha(0) < W^l < \alpha(1) = W^h$. *There exists a critical value* $0 < \psi_1 < 1$ *satisfying* $\alpha(\psi_1) = W^l$, *with* $W^l \geq \alpha(\psi)$ *for any* $0 \leq \psi \leq \psi_1$.

The intuition behind Lemma 1 applies to Lemma 2 as well. In this environment, money is ultimately valued as a means for acquiring goods. As long as workers are sufficiently pessimistic ($\psi \leq \psi_1$) about the future value of money, they reject their normal money-wage offer in a depression state. Note from (23), however, that the likelihood of this being true for workers depends on the value of home production v relative to what they expect to be able to buy on the market w with their time/money (essentially, their real wage). If the gap between v and w is large–that is, if the return to market work strongly dominates home production–then ψ_1 will be small.[10]

To conclude this section, the conventional sunspot Nash equilibrium concept can be thought of as assuming $\psi = 0$. That is, when things go dark (sunspot blinks off), *everyone* thinks the worse of everyone else in the sense that all expect non-cooperative play to be the norm in a depression. The analysis here suggests that self-fulfilling business cycles (and depressions, in particular) are possible if even people ascribe some probability to meeting cooperative players in a depression. Technically, the condition needed here is

$$\psi \leq \min\{\psi_0, \psi_1\} \tag{24}$$

[10] This could be construed as a theory of economic development. That is, underdeveloped economies (w close to v) are more prone to self-fulfilling development traps. Note, this argument relies on my refined Nash concept.

So, it appears that as long as conditions (19) and (24) are satisfied, the expectations-induced boom-bust cycle described above constitutes a sunspot equilibrium. If we were to simulate this economy for a low but positive value for σ, an econometrician would observe a booming economy most of the time, but one that fell into depression on occasion. Moreover, the depression would have no obvious "trigger." An econometrician would observe firms hoarding money, followed by a collapse in employment and output. It would not be unreasonable to infer that "money hoarding caused the depression." And, indeed, while there is an element of truth to this interpretation, it is not entirely correct. After all, exactly the same possibility exists in the social-credit economy described earlier. The more fundamental problem has to do with the propensity of an economy to coordinate on suboptimal behavior. Money, in this economy, simply serves as a record-keeping object, much as personal trading histories serve as the necessary records in a credit economy. But if this is the case, then what can monetary policy do to potentially eliminate depressions? I turn to this question next.

4 Monetary policies

The question I investigate next is whether monetary policy can be designed in a manner that *eliminates* the possibility of depression. There are many types of monetary/fiscal policies that one could consider. Below, I begin by describing the optimal monetary policy for this environment. As we shall see, the optimal policy embeds a hot money option. I then demonstrate that conventional "helicopter money" cannot be relied on to eliminate sunspot equilibria.

4.1 Hot money

In most investigations of money and monetary policy, theory treats initial money holdings as an endowment. In this section, I assume instead that, starting at date $t = 0$, each entrepreneur is offered a zero-interest dollar loan callable at the beginning of any future period $t > 0$. This money loan is formally equivalent to an initial endowment if the loan is never called. In what follows, I assume that the loan is called at the beginning of period t if (i) the sunspot blinks off and (ii) if the entrepeneur does not use the money to finance her regular payroll. If the loan is called, it is never renewed.

I label the monetary policy just described "hot money" because there are some states of the world in which money acquires a "hot potato" property that induces individuals to dispose of it rapidly.[11] One can think of "cold money" as describing the standard case in which the money supply is injected as a transfer in the initial

[11] The technology to program money with an expiry date is already available and, indeed, the

period and then left to circulate. One can easily check that by replacing cold money with hot money, the cooperative outcome remains implementable as an equilibrium. The question is whether hot money improves the stability properties of the economy, in particular, by ruling out the possibility of sunspot equilibria. The relevant state to consider is when the sunspot blinks off. Is it still an equilibrium–in the sense defined above–for individuals to coordinate on noncooperative play?

Consider first the entrepreneur. The prescribed behavior is non-cooperative play. Given hot monetary policy, this strategy implies $E^l = E^a (= 0)$. That is, if the entrepreneur does not spend her money, no labor is hired, no output is produced, no sales revenue is generated *and* hot money balances evaporate. The expected value of defecting is now given by,

$$\hat{\lambda}(\psi) \equiv (1-\psi)E^a + \psi\left[(1-\psi)\left(y+\beta E^a\right) + \psi(\pi + \beta E)\right] \tag{25}$$

That is, the entrepreneur expects non-cooperative play from the worker with probability $(1-\psi)$, in which case the entrepreneur receives the autarkic payoff. With probability $\psi(1-\psi)$, the worker accepts the wage offer, but the entrepreneur finds no market for her goods. The continuation value here is autarky as well, since money revenue is zero. And finally, with probability ψ^2 cooperative play is reciprocated in both the production and reward stage. Since $E^a = 0$, we have $\hat{\lambda}(\psi) = \psi(1-\psi)y + \psi(\pi + \beta E) \geq 0 = E^a$. In other words, only in the special case $\psi = 0$ does the entrepreneur find it (weakly) sequentially-rational to play non-cooperatively when the sunspot blinks off.

Next, consider the worker matched with the defecting entrepreneur. Because the hot money spent by the entrepreneur turns into cold money for the worker, the sequential-rationality condition is exactly as it is written in condition (22). The implication then is that the sunspot equilibrium exists for any $\psi \leq \min\{0, \psi_1\}$; which is to say, only when $\psi = 0$.

Thus, strictly speaking, hot money does not eliminate the sunspot equilibrium, when equilibrium is defined in the conventional Nash sense ($\psi = 0$). Nevertheless, it remains true that in the hot money regime, entrepreneurs only *weakly* prefer to play non-cooperatively in the depression state. Literally, they have to believe that *everyone* else is playing non-cooperatively. This equilibrium is arguably "unstable" in the sense that if entrepreneurs believe that even an arbitrarily small but positive measure ($\psi > 0$) of individuals will play cooperatively when they are not supposed to, then the sunspot equilibrium collapses. I argue that this generalization of Nash makes sense in the present context, since entrepreneurs literally have nothing to lose by spending hot money and so, it makes sense that they do. Of course, if all individuals reason in this manner, then only the cooperative equilibrium is possible. Hot money can eliminate self-fulfilling depressions.

policy is presently used in the Supplemental Nutrition Assistance Program (SNAP), where unused credits expire after 365 days.

4.2 Helicopter money

In this section, I invoke the conventional assumption that initial money balances constitute an endowment. Consider a countercylical monetary policy that injects new money into the economy when it is in recession, removing it when the economy emerges from recession. Specifically, when the sunspot blinks off, the monetary authority transfers $1 to each entrepreneur's bank account and when the sunspot blinks on, the monetary authority removes $1 from each entrepreneur's bank account. I assume that negative balances are permitted, but that if an entrepreneur incurs a negative balance, she is forced to default and so goes out of business (receives the autarkic payoff). In this way, entrepreneurs are motivated to pay their taxes when they come due.[12]

The question I ask is not whether such a policy *can* eliminate depressions, but whether such a policy *necessarily* eliminates depressions. To demonstrate that such a policy does not necessarily eliminate depressions, I describe how a sunspot equilibrium continues to be an equilibrium even when such a policy is in place.

The argument is very simple. The proposed strategy profile for entrepreneurs is modified as follows: keep the $1 transfer in the depression state and use it to pay the $1 tax when the economy transitions to the normal state. All other aspects of worker and entrepreneur behavior are as described above. The entrepreneur in this case clearly has no incentive to spend the transfer. After all, she already has the money necessary to hire labor. If she uses her money to hire labor to produce output that is not expected to sell, she is out $1 and forced to consume her own inventory. True, she now has the $1 transfer money available, but it will not be enough money to finance payroll *and* fulfil her tax obligation when it comes due.

A natural objection here is that the policy just described is flawed. In particular, rather than tax the money back as one would a loan, why not let it circulate forever as "helicopter money?" As it turns out, helicopter money will not work here. Entrepreneurs are still motivated to hoard their money transfer–not to pay taxes–but to pay for the higher nominal costs of production once the depression ends. To put it another way, a lump-sum injection of cash to entrepreneurs is neutral in this environment. Once the economy transitions from depression, the nominal wage and price level will simply rise in proportion to the increase in the money supply circulating in the economy.

[12] Alternatively, one can think of the new money injection as a zero-interest loan that comes due when economic conditions improve.

4.3 Hot and cold money policy

In describing the optimal monetary policy in Section 4.1 above, I assumed that design could proceed with *carte blanche*. In reality, policymakers will have to take as given that an existing supply of money is already in circulation.

Let us reconsider the policy design question taking as given that at $t = 0$, entrepreneurs are each in possession of a \$1 monetary token. Consider a monetary policy that offers each entrepreneur \$1 in hot money at the beginning of any period in which the sunspot blinks off. Recall that this hot money credit turns into regular money once it is spent. While policy could permit this new money to circulate forever, let me restrict attention to economies in which the money supply remains constant in the long-run. This requires that a lump-sum \$1 tax on entrepreneurs is needed in every period following the period in which hot money is injected. Entrepreneurs who cannot pay their tax obligations are forced out of business.

As before, entrepreneurs are strongly motivated to spend their hot money. The only question is whether they will, in equilibrium, end up spending \$1 or \$2 on the labor they want to hire. Because of the structure of policy, entrepreneurs anticipate having to pay \$1 in future taxes (once the economy recovers). It seems clear, therefore, that they will only offer their worker the \$1 wage they are accustomed to. That is, they will only finance their regular payroll. Owing to the incentives already described above, workers will accept the \$1 knowing they will be able to spend it at some firm in the reward stage of the period.

It is clear that a depression cannot be part of an equilibrium when the hot money option is in place. Entrepreneurs *will* spend hot money *en masse*. The aggregate expenditure on labor will provide workers with the money they need to buy the output that is produced. The only "rational" expectation in this case is to expect full employment in every period.

5 Conclusion

Hot money policy is best thought of as a contingency plan designed to address a specific macroeconomic problem. The problem is an aggregate demand shortfall generated by a broad private sector pessimism that feeds on, and reinforces itself. The goal of the policy is to generate a coordinated private-sector spending spree to boost employment and output and, in so doing, lift the cloud of pessimism taxing economic activity. The policy has an advantage over government spending programs because it leaves the private sector in control of deciding where the money should be spent. The policy also has an advantage over standard cash stimulus payments in that it incentivizes spending over precautionary saving, which could be a blunt the force of stimulus if money-hoarding is likely.

This paper was motivated, in part, by a concern over whether world economies presently afflicted by the COVID-19 pandemic can be expected to recover at a reasonable pace without government assistance once the health crisis passes. In the United States, the unemployment rate rose from 3.5 percent in February 2020 to a Depression-era level 14.7 percent in April 2020. Much of the increase in unemployment took the form of workers on temporary layoff, so there is some reason to be optimistic that the labor market might recover rapidly if health risks dissipates quickly. If health risks remain elevated for an extended period of time, then the transition will take much longer. However, the hot money policy I describe above is not the appropriate tool to employ if this turns out to be the case. That is, the factor inhibiting production in this case is "real" so that standard income-support programs designed to spread the cost of the shock across members of the community seem perfectly appropriate.

Instead, the concern is if the economy stalls for no apparent reason once the health crisis has passed. It is not implausible that the air of uncertainty stubbornly lingers, leading households to accumulate safe assets and firms to delay capital expenditures. While diagnosis is always problematic, one would expect to see the telltale signs emerge–low inflation and downward pressure on bond yields, in particular. Even if such an event in improbable, it is not inconceivable–after all, it has happened in the past. And so it seems wise for policymakers to be prepared to have an insurance policy ready for just such an event. The hot money policy described above provides this insurance. Having a hot money policy in place makes sense even if it is unlikely ever to be used. Indeed, its mere existence could help keep private sector expectations coordinated on economic fundamentals and away from the guessing games characteristic of decentralized systems where individual decisions are subject to strategic complementarities characteristic of modern economies with intricate supply-chain and credit networks (Cooper and John, 1988) .

There is perhaps one more reason to promote hot money policy. When interest rates on safe assets are close to zero, central banks often feel constrained by a *zero lower bound* or ZLB. This constraint is determined more by political rather than economic factors, but either way, it presents a significant obstacle for monetary policy, especially in some jurisdictions.[13] The usual way for monetary policy to provide stimulus against faltering aggregate demand is to lower short term interest rates sharply and, ideally, temporarily. In a low interest rate environment, such a policy may require lowering the monetary policy rate below zero (so-called, *negative interest rate policy*, or NIRP). In a depressed economic state, NIRP could conceivably work to promote a coordinated private sector spending effort since a negative interest rate is effectively a tax on saving. A hot money policy can also be thought of as NIRP, but with the advantage of having the tax apply to the gifted transfer only, as opposed to *all* deposit savings. This latter property should serve to make hot money politically

[13] See Andolfatto (2019).

more palatable.

Finally, while the specific design of the hot money program can be worked out by central bank and treasury officials, along with input from the broader community, the trigger should likely be placed in the hands of the legislative authority. In the United States, the power to trigger the policy would in this case reside with Congress and the executive branch of government. This is in contrast to the type of automatic stabilizers that are instead triggered by economic conditions. While the latter design could work as well, the policy may have a better chance of overcoming political hurdles if politicians can be assured that the ultimate power to implement the policy resides directly with elected representatives.

6 References

1. Andolfatto, David (2019). "Is the ZLB an Economic or Legal Constraint," *Macromania*, March 27, 2019. http://andolfatto.blogspot.com/2019/03/is-zlb-economic-or-legal-constraint.html

2. Andolfatto, David (2020). "Hot Money Credits to Kickstart a Stalled Economy?," *On the Economy Blog*, Federal Reserve Bank of St. Louis, May 29, 2020.

3. Azariadis, Costas (1981). "Self-Fulfilling Prophecies," *Journal of Economic Theory*, 25 (December): 380-96.

4. Bigoni, Maria, Gabriele Camera, and Marco Casari (2019). "Partners or Strangers? Cooperation, Monetary Trade and the Choice of Scale of Operation," *American Economic Journal: Microeconomics*, 11(2): 1-34.

5. Bryant, John (2005). "Fiat Money and Coordination: A 'Perverse' Coexistence of Private Notes and Fiat Money," *Eastern Economic Journal*, 31(3): 377-381.

6. Cass, David and Karl Shell (1983). Do Sunspots Matter? *Journal of Political Economy*, 91: 193-227.

7. Champ, Bruce (2008). "Stamp Scrip: Money People Paid to Use," *Federal Reserve Bank of Cleveland Economic Commentary*, April.

8. Cooper, Russell and Andrew John (1988). "Coordinating Coordination Failures," *Quarterly Journal of Economics*, 103(3): 441-463.

9. Farmer, Roger and Jang-Ting Guo (1994). "Real Business Cycles and the Animal Spirits Hypothesis," *Journal of Economic Theory*, 63(1): 42-72.

10. Ferreira, Nathalie (2011). "Crédit et Monnaie Sociale Chez P.J. Proudhon (1809-1865)," *Revue de Philosophie Économique*, 12: 91-116.

11. Fisher, Irving (1933). *Stamp Scrip*, New York; Adelphi Company; Publishers.

12. Howitt, Peter and Preston MacAfee (1992). "Animal Spirits," *The American Economic Review*, 82(3): 493-507.

13. Hsieh, Chang-Tai, Satoshi Shimizutani and Masahiro Hori (2010). "Did Japan's shopping coupon program increase spending?" *Journal of Public Economics*, 94: 523-529.

14. Jones, Robert A. (1976). "The Origin and Development of Exchange Media," *Journal of Political Economy*, 84(4): 757-776.

15. Kan, Kamhon, Shin-Kun Peng and Ping Wang (2017). "Understanding Consumption Behavior: Evidence From Consumers' Reaction to Shopping Vouchers," *American Economic Journal: Economic Policy*, 9(1): 137-153.

16. Keynes, John M. (1936). *The General Theory of Employment, Interest and Money*, New York: Harcourt, Brace.

17. Kiyotaki, Nobuhiro and John Moore (2002). "Evil is the Root of All Money," *American Economic Review*, 92(2), Papers and Proceedings of the One Hundred Fourteenth Annual Meeting of the American Economic Association, 62-66.

18. Kiyotaki, Nobuhiro and Randall Wright (1993). "A Search-Theoretic Approach to Monetary Economics," *American Economic Review*, 83(1): 63-77.

19. Kocherlakota, Narayana (1998). "The Technological Role of Fiat Money," *Federal Reserve Bank of Minneapolis Quarterly Review*, 22(3): 2-10.

20. Ostroy, Joseph (1973). "The Informational Efficiency of Monetary Exchange," *American Economic Review*, 63(4): 597-610.

21. Selten, Reinhard (1975). "A Reexamination of the Perfectness Concept for Equilibrium Points in Extensive Games," *International Journal of Game Theory*, 4 (1): 25–55.

22. Townsend, Robert (1987). "Economic Organization with Limited Communication," *American Economic Review*, 77(5): 954-970.