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RESEARCH ARTICLE

The tax-foundation theory of fiat money

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Abstract Throughout modern history governments have tried to promote the general acceptance of their unbacked paper currencies. One of the most common devices has been legal tender laws that have assured the acceptance of these currencies as tax payments. Economic theory has largely ignored this mechanism, except for the static models of Starr (Econometrica 42:45–54, 1974; Econ Theory 21:455–474, 2003). I provide the first dynamic model of this mechanism, thus showing explicitly the medium of exchange role of money, accounting for expectations about the government's survival, and enabling more realistic taxation systems. I show that a stable government can promote its currency by refusing to accept other objects in tax payments. While this mechanism has similarities to convertibility, it differs from it on a critical aspect: with this mechanism the government can often keep its favorite money in circulation even while increasing its quantity and thus causing it to decrease in value. This opens the door for a successful inflationary policy.

Keywords Fiat money · Taxes · Legal tender · Inflation

JEL Classification E42

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Abbreviations
AW Aiyagari and Wallace (1997)
LW Li and Wright (1998)

1 Introduction

The circulation of inconvertible, intrinsically useless money is a fundamental puzzle in monetary theory. Standard models attribute it to self-fulfilling expectations. The non-monetary equilibrium in these models can be eliminated by a government. The government can force agents to accept money in trade (Lotz and Rocheteau 2002; Selgin 2003). It can accept money in its own trade and thus induce private agents to do the same (Aiyagari and Wallace 1997; Li and Wright 1998; Waller and Curtis 2003). Such mechanisms, however, are rare in reality. Legal tender laws do not force money on spot transactions[1] and many governments sell only postal stamps.

This note explores an alternative mechanism of government intervention. The government chooses which objects to accept in tax payments. This affects their potential to circulate as media of exchange. This mechanism is highly realistic and has been prominent in the history of paper money. It was the foundation of influential inconvertible paper moneys whose descendents rule today.[2] Every modern legal tender law includes this mechanism.

Economic theorists, however, have largely ignored this mechanism. Succinctly named *the tax-foundation theory* by Ellis (1934, p. 11), it was supported by Smith (1776), Lerner (1947) and Goodhart (1998) among others.[3] Its only formal models are Starr (1974, 2003).[4] The former is a Walrasian model with a cash-in-advance constraint while the latter is a trading post model. Both models are static, with agents taxed with probability one. It may be argued that static models only show that money has value but not that it is a medium of exchange. They cannot consider inflation and expectations about the future viability of the government. They do not account for tax deferment, tax evasion and tax exemption.

In order to address these concerns I provide the first dynamic model of the tax-foundation theory. I use a monetary search model, in which the monetary object is received in one period and later spent in shopping (i.e., it is a medium of exchange). The theory is sustainable even if taxes are not paid by everyone in every period, but not if agents expect the government to collapse. I also explore the relation of the theory to convertibility. While there are strong similarities, with this mechanism the government's ability to sustain the money's circulation may be unharmed by excessive money printing. This can explain the "success" of numerous hyperinflations—where money lost value but kept circulating while raising seigniorage revenue.

[1] These laws only settle pre-existing obligations resulting from a contract or a tax law. Spot transactions are not included. See http://www.federalreserve.gov/generalinfo/faq/faqcur.htm#2. Also see Goldberg (2010).

[2] Goldberg (2009) explains the mechanism's invention in the West in 1690.

[3] Forstater (2006) surveys the history of economic thought on this theory.

[4] Lerner's idea has been used as a technical device in other static monetary models that investigated other issues. See a discussion in Dubey and Geanakoplos (2003).

There are similar theories. Knapp's (1905) state/chartal theory of money includes the tax-foundation theory among many ways in which the government must support the money. The tax-backing theory (e.g., Smith 1985) and the fiscal theory of the price level focus on the price level *given* that money circulates. In contrast, I ask whether money circulates at all, and this is determined more by the object used to pay taxes than the tax rate. I emphasize this by not allowing public deficits. The legal restrictions theory argues that money exists only because the government prevents markets from eliminating it, while the tax-foundation theory argues that markets are too weak to create money (Cowen and Kroszner 1994, pp. 148–9).

I present the model in Sect. 2, discuss policy in Sect. 3, and conclude in Sect. 4.

2 The model

Among the variety of search models I use the Trejos and Wright (1995) variant rather than the more popular Lagos and Wright (2005) framework. There are three reasons for this. First, the tax-foundation mechanism is closely related to convertibility. The only search models that explore something similar to convertibility are Trejos–Wright adaptations as in Aiyagari and Wallace (1997) and Li and Wright (1998) (henceforth AW and LW, respectively). LW even argue that convertibility is analogous to the tax-foundation mechanism. By using the same framework I create a controlled experiment. Specifically, the model is as similar as possible to LW. Second, one might get the impression that the tax-foundation mechanism works only in "special" environments that are either at least partly Walrasian (Starr 1974, Lagos–Wright) or static (Starr 1974, 2003). For a *first* dynamic model of this theory, it is better to use a model which is entirely non-Walrasian. This will put the tax-foundation theory on equal methodological footing with competing theories. Finally, while the Lagos–Wright framework provides a more tractable environment for policy analysis, the Trejos–Wright environment is more appropriate to address a most fundamental question in the pure theory of money.[5]

2.1 Environment

Time is continuous. A continuum $[0, 1]$ of infinitely lived agents are randomly matched in pairs according to a Poisson arrival rate α. They cannot commit to future actions and there is strong anonymity in the matching process.[6] A fraction $p \in (0, 1)$ of them are private agents. Each one derives utility $u(q) \geq 0$ from consuming a quantity q of some goods, with $u(0) = 0$, $u'(q) > 0$, and $u''(q) < 0$ for all $q > 0$. The agent can produce one type of good, which it does not consume. Production of q units of a good involves disutility q. Agents can produce if and only if they hold nothing. That is, production is independent of previous consumption. This unusual assumption allows

[5] For example, Aliprantis et al. (2007) show that money may fail to be essential in the original Lagos–Wright formulation.

[6] In the sense of Aliprantis et al. (2007).

agents who were just taxed to resume market activities. Goods are perishable.[7] The probability that a private agent consumes the good of its trading partner is $x > 0$. The conditional probability that the converse holds too is $y \geq 0$. As in LW, αx is normalized to 1. The discount rate is $r > 0$.

The only durable objects are indivisible one-dollar bills, which have a storage cost $c > 0$ per bill and a fixed supply $M \in [0, \min(1 - p, p))$.[8] A fraction m of private agents are initially endowed with one bill each and are called *private buyers*. The other private agents hold nothing and are called *sellers*.

The rest of the randomly matched agents are *potential government buyers*. They can neither produce nor store anything. This assumption, starkly different from AW and LW, emphasizes that the tax-foundation mechanism can succeed even if the government is parasitic and cannot credibly promise convertibility. Some of the potential government buyers hold one bill each. Such a *government buyer* receives a taste shock when it meets a seller. With probability x it wants to consume the seller's good. It offers money but *does not* force the seller to trade. If the money is accepted, the government buyer consumes and becomes a potential government buyer, waiting to get another bill as described below.

Trejos–Wright models have complete randomness in all meetings. However, real-life taxation is not completely random. People know when they are going to be taxed and thus they have enough time to prepare for a tax payment (e.g., get the proper medium of payment). Some taxes can be completely, and legally, avoided by eschewing certain activities. Therefore, taxation here is not completely random.[9] *Tax collectors* form another class of government agents. They operate outside of the matching process. They are idle during trade meetings and operate right after them (as in Shi 2005). They can identify agents who just produced, say because these sellers show signs of exhaustion.

Tax law in the economy states the following: (i) Only current income is taxed. (ii) An agent who just sold is taxed with probability $\tau \in [0, 1)$. (iii) The size of the tax payment is the entire new income. (iv) Tax collectors cannot reject tax payments in dollar bills. (v) Tax collectors choose whether to accept a tax payment in real goods. (vi) Agents whose payment is rejected face a non-monetary punishment $P > 0$.

Agents know that only a sale makes them eligible for taxation. They can choose never to be exposed to the tax, or to make a sale only if it leaves them prepared for the tax collector's visit (say, sell for bills but avoid barter). Some randomness ($\tau < 1$) must remain for analytical tractability.[10] It is also useful in approximating tax evasion, tax exemption, tax deferment, and the fact that income taxes are not paid after every single sale. The only existing models of this theory have $\tau = 1$ (Starr 1974, 2003).

Sections (iv) and (v) of the tax law specified above are a real-life legal tender law. Explicitly, the law imposes an obligation only on tax collectors, and it says nothing about objects other than dollars. This silence regarding other objects means that tax

[7] This rules out commodity money. A version with commodity money is in Goldberg (2010).

[8] The assumption $M < 1 - p$ will allow the government to hold all the money if private agents reject it (as in AW). The assumption $M < p$ will be useful in establishing a monetary equilibrium.

[9] A version with completely random taxation is in Goldberg (2010).

[10] With $\tau = 1$, production would have been incentive-compatible only by taxing a fraction of one's income.

collectors do not have to accept them. You cannot force the IRS to accept your car as a tax payment.

Tax proceeds are given to potential government buyers, with each buyer getting one bill at most. Then trade meetings resume. The government has a balanced budget because taxation precedes consumption for every dollar bill spent by government buyers.

2.2 Strategies

Barter makes a seller eligible for taxation so the seller might avoid it even if there is a double coincidence of wants. Let Π_0 be the probability that a random seller agrees to barter. Let Π_1 be the probability that a random seller accepts money. Let the probabilities π_0 and π_1 be the stationary best responses of a maximizing seller who is offered a good it consumes, and a bill, respectively. Let T indicate whether tax collectors accept real goods ($T = 1$) or not ($T = 0$). Assume that in meetings between sellers the bargaining power is equal, so both sides produce the efficient q^* which satisfies $u'(q^*) = 1$. The quantity that may be produced for the tax collector after barter is also assumed to be q^*. In buyer-seller meetings the buyers make take-it-or-leave-it offers. The quantity produced in all other matches is Q. If V_0 and V_1 are the stationary value functions of sellers and private buyers respectively, then

$$\begin{aligned} rV_0 = {} & p(1-m)y\Pi_0 \max_{\pi_0} \pi_0 \left\{u(q^*) - q^* + \tau[T(-q^*) + (1-T)(-P)]\right\} \\ & + M \max_{\pi_1} \pi_1[-q + (1-\tau)(V_1 - V_0)], \end{aligned} \tag{1}$$

$$rV_1 = -c + p(1-m)\Pi_1[u(Q) + V_0 - V_1]. \tag{2}$$

In (1) a seller might meet one of the other $p(1-m)$ sellers. If both want to trade, then later with probability τ the seller meets a tax collector. If the latter agrees to accept goods then the seller produces. Otherwise, the seller faces the punishment P. Choosing $\pi_0 = 0$ can ensure non-exposure to P. If the seller meets any buyer (public or private), it chooses whether to accept a bill. If it does, then it produces and gets \$1. With probability $1-\tau$, this \$1 is *not* taxed away, so the seller becomes a buyer. In (2) a buyer pays the storage cost of money and it can buy if it meets a seller who accepts money.

2.3 Equilibrium

I focus on symmetric, pure strategy, non-autarkic equilibria. Sellers might accept money and refuse barter (*pure monetary* equilibrium), accept money and barter (*monetary* equilibrium), or barter and reject money (*non-monetary* equilibrium). Assumption 1 ensures that barter has a fair chance.

Assumption 1 $\tau < u(q^*)/q^* - 1$.

The first result is that if all objects are tax-receivable, money may not circulate at all.

Proposition 1 *If all objects are tax-receivable, then:* (i) *the non-monetary equilibrium exists,* (ii) *two monetary equilibria exist for some parameter values, and* (iii) *there is no pure monetary equilibrium.*

Proof (i) Set $T = \Pi_0 = 1$ and $\Pi_1 = 0$ in (1) and (2). Then $\pi_1 = 0$, while Assumption 1 implies $\pi_0 = 1$. (ii) Set $T = \Pi_0 = \Pi_1 = 1$. Then $m = M(1-\tau)/p$. The bargaining rule implies $q = (1-\tau)(V_1 - V_0)$, so $q = (1-\tau)\frac{[p-M(1-\tau)]\{u(q)-y[u(q^*)-q^*]\}-c}{r+[p-M(1-\tau)](1-y\tau)}$. As in LW, the concavity of the utility function results in two solutions. $\pi_1 = 1$ iff $q > 0$. (iii) Assumption 1 implies $\pi_0 = 1$ even if money is accepted. □

As usual, fiat money's circulation depends on both its intrinsic properties and agents' beliefs. It will not circulate if c is too high.

3 Policy

The government can promote the use of money. Moreover, this ability is unrelated to the quantity of money.

3.1 Promoting money

The government may be able to affect existence of equilibria by discriminating between various objects. It can make the dollar bill the only tax-receivable object. It then needs to determine the punishment for those not paying taxes in bills.

Proposition 2 *The government can guarantee the existence of two pure monetary equilibria, and that no other equilibria exist, iff* $\tau > 0$ *and c is small enough.*

Proof Set $P > [u(q^*) - q^*]/\tau$ and $T = 0$. This implies $\pi_0 = 0$ so there is no barter. This rules out the non-monetary and monetary equilibria. Setting $\Pi_1 = 1$ results in $q = (1-\tau)\frac{[p-M(1-\tau)]u(q)-c}{p-M(1-\tau)+r}$. $\pi_1 = 1$ iff $q > 0$. □

The lower the probability of meeting tax collectors in the future, the higher the minimal punishment needs to be. The mechanism does not work if agents expect the tax collectors receiving that money to disappear soon ($\tau = 0$). Indeed, numerous fiat moneys have failed when their issuing regime was expected to disappear in a revolution or a war.

Unlike convertibility, where the issuer commits to provide gold for paper money, in the tax-foundation mechanism the government does not give anything useful for paper money. However, it does give something *harmful* if one does *not* have paper money on Tax Day. Paper money buys immunity from punishment. It is implicitly convertible into immunity. While anyone in real life can issue convertible money, only a government can operate the tax-foundation mechanism. Close to convertibility are models of government sales (AW and LW). In both these models and the current one, more interaction with the government implies more exogenous pro-money behavior, which inspires circulation. The difference is that here the government collects taxes, which is clearly more significant in reality than government sales in the marketplace.

The theory does not critically depend on government involvement in trade or monitoring of trade: The government does not convert money into real goods, it does not directly force agents to use money in their own trade (barter is legal), and it does not force sellers to accept money from government buyers. In fact, these buyers only serve here the technical purpose of returning the taxed money to the economy.

As in AW, it is easy to show that the pure monetary equilibria have lower welfare than the monetary equilibrium, but they could be better than the non-monetary equilibrium. In the pure monetary equilibria, sellers forgo barter opportunities and this reduces welfare, but the use of money can increase trade compared with the non-monetary equilibrium.

3.2 Quantity of money

Consider an economy identical to the one above, only that the money supply is XM one-dollar bills and each buyer is endowed with X one-dollar bills, for $X \in \{2, 3, 4, \ldots\}$. This economy can be thought of as the result of an unexpected once and for all transfer of $\$(X-1)$ to each buyer in the above-mentioned economy. For $i = 1, 2, 3, \ldots, X$, let b_i be the probability that a seller meets a buyer who offers $\$i$, let q_i be the quantity demanded by such a buyer, let Q_i be the quantity produced in all other matches for $\$i$, let Π_i be the probability that a random seller accepts a payment i, let π_i be the best response of a seller who is offered a payment i, and let V_i be the value function of an agent holding $\$i$. Then

$$rV_0 = p(1-m)y\Pi_0 \max_{\pi_0} \pi_0\{u(q^*) - q^* + \tau[T(-q^*) + (1-T)(-P)]\} + \sum_{i=1}^{X} b_i \max_{\pi_i} \pi_i[-q_i + (1-\tau)(V_i - V_0)], \tag{3}$$

$$rV_i = -ic + p(1-m)\max\{\Pi_k[u(Q_k) + V_{i-k} - V_i]\}_{k=1}^{i}, \quad \text{for } i = 1, 2, \ldots, X. \tag{4}$$

In (3) a seller can meet buyers who hold up to $\$X$. Each one of them has a favorite offer of $\$i$. If taxed, the seller still pays the *entire* income, in accordance with the tax law. In (4) the buyer might meet different types of sellers. Some might accept only small payments because of money's storage cost. Others might accept only large payments (e.g., if all prices are even it is useless to hold one dollar). Subject to the sellers' willingness, the buyer chooses how much to pay.

Proposition 3 *The government can guarantee the existence of two pure monetary equilibria, and that no other types of equilibria exist, iff* $\tau > 0$ *and* c *is small enough.*

Proof As before, set $P > [u(q^*) - q^*]/\tau$ and $T = 0$ to eliminate barter. Setting $\Pi_i = 0 \, \forall i = 1, 2, \ldots, X-1$, and $\Pi_X = 1$, results in $\pi_i = 0 \;\; \forall \, i = 1, 2, \ldots, X-1$, and $q = (1-\tau)\frac{[p - M(1-\tau)]u(q) - Xc}{p - M(1-\tau) + r}.\pi_X = 1$ iff $q > 0$. □

The difference from Proposition 2 is that c is multiplied by X. Buyers spend X times more money in each trade. If c is very small (as in real-life paper money) and $X$is not

too large (think of anything other than Germany in 1923), then the extra storage cost affects bargaining only slightly. Output barely changes and prices are almost exactly X times their former value. Money is almost neutral. Even these minor real changes are gone if the government replaces every bundle of X one-dollar bills with a single X-dollar bill.

Guaranteeing the circulation of money is therefore just as easy with more money than with less money. A proportional monetary transfer is neutral not only in terms of allocations, but also in the strength of the pure monetary equilibria and the policy's viability. In contrast, excessive printing of convertible money (where each bill is a promise to a gold coin), might lead to collapse because of loss of trust. The tax-foundation mechanism is similar to convertibility in its ability to guarantee *circulation*, but it cannot guarantee the *value* of money because it allows a discretionary money supply. The government can print money at will, causing higher prices, higher nominal incomes—and thus *higher nominal tax obligations*. The price of immunity is indexed to the money supply, and so the money's acceptability is sustained. While some see this "indeterminacy" of the price level as a fatal flaw for a theory of money (Ellis 1934; Klein 1974), governments have realized its blessing: they can guarantee that their money circulates (as with convertibility), even though they can print more of it at will. They can have their cake and eat it too. Therefore, this "indeterminacy" of the price level is a reason to understand the tax-foundation theory rather than ignore it.

4 Conclusion

In the real world there is more to government-issued fiat money than intrinsic uselessness and inconvertibility. Its acceptance in tax payments is guaranteed. Generally, no other objects can be forced on the tax authority. I prove in an otherwise standard dynamic, decentralized economy that receivability for taxes can make an object the general medium of exchange.

The tax-foundation mechanism may be the ideal way to promote the government's money. Its assurance that money can have some use is similar to convertibility but its circulation is robust to inflation. It is cheaper than other pro-money policies: No need to obtain and store gold, monitor market transactions, or search for illegal moneys. Given that the government collects taxes in any case, it can promote its money by accepting only that money.

The working paper (Goldberg 2010) allows the government's money to compete with commodity money, other token moneys, and inside money.[11] The theory still works, with some limits. A legal tender object may not circulate (e.g., a US dollar coin) because it is not the unique legal tender, or because tax collectors choose to accept also inside money (which is convertible to legal tender money). I also allow completely random taxation, explain in detail what legal tender means, and show the theory's conformity with history. I also show that agents can reduce money holdings to the minimum needed to pay taxes and conduct the rest of their trade in other ways. It has

[11] In a model without a legal tender law, Williamson (2004) shows that fiat money is displaced in transactions by private inside money.

been argued that in reality it is this minimal money demand that prevents an immediate abandonment of money when its issuer initiates hyperinflation (Bruno 1993, p. 8). Future work with more sophisticated models will need to calculate how this critical demand affects the rate of inflation. Future work can also use the tax-foundation theory to explain the coexistence of fiat money with interest-bearing, default-free assets. One reason that T-Bills do not circulate as currency may be the fact that they are not accepted in tax payments.[12]

References

Aiyagari, S.R., Wallace, N.: Government transaction policy, the medium of exchange, and welfare. J Econ Theory **74**, 1–18 (1997)

Aliprantis, C.D., Camera, G., Puzzello, D.: Contagion equilibria in a monetary model. Econometrica **75**, 277–282 (2007)

Bruno, M.: Crisis, Stabilization, and Economic Reform. Oxford: Clarendon Press (1993)

Camera, G., Noussair, C., Tucker, S.: Rate-of-return dominance and efficiency in an experimental economy. Econ Theory **22**, 629–660 (2003)

Cowen, T., Kroszner, R.: Explorations in the New Monetary Economics. Cambridge: Blackwell (1994)

Dubey, P., Geanakoplos, J.: Inside and outside fiat money, gains to trade, and IS-LM. Econ Theory **21**, 347–397 (2003)

Ellis, H.S.: German Monetary Theory: 1905–1933. Cambridge: Harvard University Press (1934)

Forstater, M.: Tax-driven money: additional evidence from the history of economic thought, economic history, and economic policy. In: Setterfield, M. (ed.) Complexity, Endogenous Money, and Macroeconomic Theory, pp. 202–220. Cheltenham: Edward Elgar (2006)

Goldberg, D.: The Massachusetts paper money of 1690. J Econ Hist **69**, 1092–1106 (2009)

Goldberg, D.: The tax-foundation theory of fiat money. Working paper 2009-05, Department of Economics, Bar Ilan University. http://www.biu.ac.il/soc/ec/wp/2009-05.pdf (2010)

Goodhart, C.A.E.: The two concepts of money: implications for the analysis of optimal currency areas. Eur J Polit Econ **14**, 407–432 (1998)

Klein, B.: The competitive supply of money. J Money Credit Bank **6**, 423–453 (1974)

Knapp, G.F.: The State Theory of Money. English edn. Macmillan, London (1905 [1924])

Lagos, R., Wright, R.: A unified framework for monetary theory and policy analysis. J Polit Econ **113**, 463–484 (2005)

Lerner, A.P.: Money as a creature of the state. Am Econ Rev **37**, 312–317 (1947)

Li, Y., Wright, R.: Government transactions policy, media of exchange and prices. J Econ Theory **81**, 290–313 (1998)

Lotz, S., Rocheteau, G.: On the launching of a new currency. J Money Credit Bank **34**, 563–588 (2002)

Selgin, G.A.: Adaptive learning and the transition to fiat money. Econ J **113**, 147–165 (2003)

Shi, S.: Nominal bonds and interest rates. Int Econ Rev **46**, 579–612 (2005)

Smith, A.: The Wealth of Nations. William Benton, Chicago (1776 [1952])

Smith, B.D.: Some colonial evidence on two theories of money: Maryland and the Carolinas. J Polit Econ **93**, 1178–1211 (1985)

Starr, R.M.: The price of money in a pure exchange monetary economy with taxation. Econometrica **42**, 45–54 (1974)

Starr, R.M.: Why is there money? Endogenous derivation of 'money' as the most liquid asset: a class of examples. Econ Theory **21**, 455–474 (2003)

Trejos, A, Wright, R.: Search, bargaining, money, and prices. J Polit Econ **103**, 118–141 (1995)

Waller, C.J., Curtis, E.S.: Currency restrictions, government transaction policies and currency exchange. Econ Theory **21**, 19–42 (2003)

Williamson, S.D.: Limited participation, private money, and credit in a spatial model of money. Econ Theory **24**, 857–875 (2004)

[12] Camera et al. (2003) offer additional reasons based on experimental data.