BANKNOTES AND ECONOMIC GROWTH

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ABSTRACT

Modern paper currency contributes little to productive investment. This shortcoming is not inherent to paper money. It stems from the fact that currency today is monopolistically supplied by public monetary authorities that are poor intermediaries. Commercial banknotes, in contrast, support efficient intermediation. The holding of private banknotes promotes economic growth just as the holding of private bank deposits does. We demonstrate this advantage in an endogenous growth model, and use the model to simulate, for a sample of developing countries, steady-state growth rate gains from various degrees of banknote deregulation. The simulated gains are large compared to those from conventional forms of financial liberalization.

Keywords: Endogenous growth, economic development, financial repression, fiat money, currency.

JEL Codes: E5, G2, O1, O4

Historically local banks of issue have played an important role not only in habituating the populace to the use of financial instruments and institutions, but also in the development of small-scale local industry and agriculture. Conceivably this can be done by means of deposit money, but in relatively primitive conditions ... where laborers and entrepreneurs alike have but little sophistication in the use of modern financial instruments, there is much to be said for local banks of issue (Rondo Cameron 1967, p. 319).

Introduction

Paper money forms a far from trivial part of the world's money stock. As of 2004, international balances of paper money, excluding sums held by banks, were worth $3.2 trillion. A disproportionate share of this paper circulates among poor persons. The official currency stocks of many less-developed countries exceed 10 percent of their GDP (Jefferson and O'Connell 2004, Figures 1 and 2). Allowing for unrecorded holdings of foreign paper currency would raise these values still further, and might increase them substantially in some cases.

Modern research on money's role in economic growth treats the presence of so much paper money as a cause for regret. Money, this research argues, promotes growth largely (though not solely) by serving as a vehicle for productive financial intermediation (Levine 1997). This contribution is especially crucial in developing economies, where markets for non-monetary financial assets are small or nonexistent (Fry 1995, pp. 4-5). But money holdings fuel efficient intermediation only when they serve as a basis for productive private-sector lending. In practice, this is taken to mean that money contributes most to economic growth when it consists, not of paper currency, but of the transferable deposit credits of commercial banks. Bank regulations are accordingly considered to be financially "repressive" when they amount to a "tax" on such deposits that reduces their attractiveness both absolutely and relative to paper money. (High required reserve ratios and deposit and loan rate ceilings are the most commonly-cited instances of such repressive regulations.) The scope for financial development or "deepening" in poorer nations is in turn assumed to be limited by the imperfect substitutability of deposits for paper money.

But is heavy reliance upon paper money necessarily a barrier to financial development and economic growth? Here we argue that it is not. Drawing on both theory and historical experience, we argue that the low productivity of paper money today rests, not upon any inherent shortcoming of paper currency relative to deposits, but on the fact that the former medium is today supplied almost exclusively by public monetary authorities which, for reasons to be considered below, happen to be inefficient intermediaries. We argue that *private* paper money, consisting of redeemable notes issued by commercial banks and backed by the same general assets that presently back bank deposits, is no less capable of promoting growth than bank deposits themselves.[1]

Our perspective suggests that the monopolization of paper currency by public authorities itself constitutes an important, though generally unacknowledged, instance of repressive financial legislation. It follows that prospects for substantial financial development in developing countries might be considerably enhanced by extending the notion of financial liberalization to include reviving commercial banks' ability to supply circulating banknotes. Banknotes, unlike bank deposits, are capable of supplanting a large share of current holdings of official paper money, with corresponding gains to private intermediation.

Our argument begins with a brief review of the historical contribution of commercial banknotes to economic development. We then discuss the difference between such notes and fiat paper money. Next we formally examine, using an endogenous growth model, banknotes' potential contribution to economic growth. A calibration exercise based on our model allows us to draw conclusions regarding the likely magnitude of the growth effects of a banknote revival. We conclude by briefly considering some concerns raised by the possibility of a full-fledged banknote revival.

[1] Although we refer throughout the paper to "commercial banks" and "banknotes," these terms can be understood to include other classes of private financial intermediaries, including non-governmental organizations (NGOs), and any circulating notes issued by them.

Commercial banknotes

Is paper money inherently unproductive? Adam Smith, for one, didn't think so. Although Smith understood that money "is the only part of the circulating capital of a society, of which the maintenance can occasion any diminution in their neat revenue" (1925, p. 272), he regarded not paper money but gold and silver coin as so much unproductive capital or "dead stock." Smith held paper money to be an especially *efficient* exchange medium. He did so, not simply because paper currency can be produced at a lower cost than coin (although this is certainly true), but because in employing it a country may "convert a great part of [its] dead stock into active and productive stock; into stock which produces something to the country" (ibid., p. 304). For Smith, paper money was itself a vehicle for productive bank intermediation.

What accounts for the contrast between Smith's favorable view of paper money and the negative one found in modern writings? The explanation is that the "paper money" Smith had in mind consisted not of fiat money issued by public authorities but of redeemable banknotes issued by commercial banks. In Smith's day, and for many decades afterwards, banknotes made up the bulk of the world's paper money, and were commercial banks' primary source of funds (Schuler 1996, p. 16). Like today's transferable bank deposits, historical banknotes were backed mainly by commercial loans. Already at the time of the appearance of the *Wealth of Nations*, some Scottish banks held metallic reserves equal to less than two percent of their demand liabilities (Cameron 1967, pp. 87-8) – lower than the cash reserve ratios of many of today's least repressed commercial banks. Because the Scottish public itself held very little coin, this low figure meant that almost all of Scotland's money holdings were funding commercial bank lending.

That commercial banknotes promoted economic growth in Scotland and elsewhere appears well-established. "That the trade and industry of Scotland ... have increased very considerably [since the establishment of the first issuing banks] ... and that the banks have

contributed a good deal to this increase, cannot be doubted," Smith himself observed (1925, p. 280). His belief has been seconded by modern economic historians, including Rondo Cameron (Cameron et al. 1967, p. 97), who attributes Scotland's still more rapid economic development from the late-18^{th} to the mid-19^{th} century to "the superiority of its banking system" and especially to the exceptional freedom of note issue Scottish banks enjoyed. That freedom provided Scottish banks "with the means to engage in productive credit creation" at a time when there was little demand for bank deposits.[2]

Cameron's conclusion occurs as part of a survey of the role of banking in industrialization.[3] In summing-up the findings of that survey, Cameron concludes that competitively supplied banknotes were instrumental both in directly reducing the need for less-productive (metallic) monies and in indirectly reducing that need by furthering the progress of deposit banking:

> One obvious determinant of the relative size of the banking sector is the extent to which [commercial] bank liabilities fulfill the role of money.... The use of bank liabilities as money [is] related to the question of freedom of note issue. In almost every case the most rapid expansion of the banking system occurred during the phase when banknotes constituted the most important liabilities of the banks. [Although] deposits subsequently assumed greater importance [they] were most widely used in countries that had previously become accustomed to the note issues of competing independent banks. The public of countries with monopolistic issuing agencies ... did not develop the 'banking habit' to the same degree as did the public in countries in which relative freedom in banking prevailed (Cameron 1967, pp. 305-6).

Fiat money

Despite commercial banknotes' advantages, "monopolistic issuing agencies" became the

[2] Citing Pollard and Ziegler (1992), Levine (1997, p. 709) raises doubts concerning the significance of the Scottish case. But while Pollard and Ziegler (1992, p. 18) claim to reexamine Cameron's conclusions "in light of the research and writing in the last twenty years," they unaccountably overlook Lawrence White's (1984, rev. ed. 1995, and 1991) contributions, which uphold Cameron's position while effectively rebutting many of Pollard and Ziegler's counterarguments.

[3] The countries surveyed are England, Scotland, France, Belgium, Germany, Russia, and Japan. A companion volume (Cameron 1972) looks at Austria, Italy, Spain, Serbia, Japan, and the United States.

norm worldwide. According to Vera Smith (1990, pp. 4-5), this development completed a trend that began in western Europe and the United States, where it had more to do with "a combination of political motives and historical accident" than with "any well-considered economic principle." After an initial phase of often vigorous debate, the superiority of monopoly money "became a dogma which ... was accepted without question or comment in all the later foundations of central banks" (ibid., p. 168).[4]

Today only a few small remnants of former competitive banknote systems survive – in Scotland, Northern Ireland, and Hong Kong – and in all of them circulating banknotes must be entirely or almost entirely backed by claims against a central monetary authority. Few economists, in turn, question the necessity, or at least the desirability, of official currency monopolies. Part of this paper's aim is to encourage them to revisit this issue, by pointing to the substantial toll official currency monopolies take in foregone intermediation opportunities and economic growth – a toll that does not appear to have been taken into consideration in past debates.

Monetary authorities are themselves intermediaries, of course: the funds they acquire by issuing currency (and also by granting deposit credits) are for the most part invested in interest-earning assets. But as intermediaries go they are relatively unproductive. Thus while King and Levine (1993a, b) report a strong positive partial correlation between financial depth (the ratio of broad money to GDP) and the growth rate of real per capita GDP, they find that per capita GDP growth is also strongly correlated with a second measure, BANK, consisting of the ratio of commercial bank credit to total (commercial and central bank) credit. King and Levine estimate, furthermore, that an increase in the value of BANK from 0.52 (the mean value of the poorest quartile of nations) to 0.91 (the mean value of the richest quartile) would increase the poorer nations' annual growth rates by 125

[4] The belief that banknotes were likely to be overissued unless subject to strict regulation also played a part, of course. Concerning this, see below and, for further details, see Schuler (1992).

basis points (Levine, 1997, Tables 1 and 2, pp. 705-06).

The fundamental reason why monetary authorities are poor intermediaries is that their duties, including the prevention of inflation and the rendering of last-resort aid to commercial banks, often run counter to the goal of maximizing the value of their capital. "Policy effectiveness," Kenneth Sullivan (2002) observes, "rather than efficiency of resource utilization or profitability, provides the basis for central bank accountability." Many monetary authorities are not residual claimants, or are subject to laws that "explicitly exclude measures of profit from [their] objectives" (ibid.). Indeed, this lack of a profit motive is, together with their monopoly of paper currency, among the distinguishing features of central banks and other monetary authorities.

Besides not being charged with maximizing the return on capital invested in them, monetary authorities are required, for a variety of fiscal, operational, prudential, or bureaucratic reasons, to confine their investing to a relatively small subset of available assets. This subset almost always excludes loans to non-bank private firms, while often including domestic government securities. Such restrictions appear calculated to undermine investment productivity. As Levine (1997, p. 705) has observed, financial systems that allocate credit to private firms promote more growth than those "that simply funnel credit toward the government or state owned enterprizes."[5] Finally, the low investment productivity of monetary authorities may reflect a tendency, evident in comparing the performance of government-owned and private commercial banks, for public financial institutions to be less efficiently managed than their private-sector counterparts.[6]

The relatively low productivity of investment by public monetary authorities is a fun-

[5] Sleeper (2005) identifies two basic types of central banks. Whereas "type 1" central banks are merely required to limit their involvement in commercial lending, "type 2" central banks – the majority – are prevented as well from lending to their sponsoring governments, and so must invest the bulk of their assets in either foreign exchange or gold.

[6] La Porta et al. (2002) find that government ownership of commercial banks leads, other things equal, to reduced financial development and slower economic growth. Their findings suggest, furthermore, that government-owned banks employ capital in such a way as to actually hinder productivity growth (ibid., p. 267).

damental source of gains from financial liberalization, that is, gains from increasing the ratio of commercial bank liabilities to fiat money (including both fiat paper and central bank deposits). The gains to be had by means of conventional forms of deregulation are, however, limited by the imperfect substitutability, given the existing state of wealth, preferences and technology, of bank deposits for fiat currency: even among the wealthy, and for the mass of smaller retail exchanges especially, paper currency remains competitive relative to both checks and electronic transfers (Markore and Loke 2002), while among the poor paper currency is frequently the *only* accessible (and accepted) financial asset. Official currency monopolies stand in the way of improved intermediation and growth in so far as they deny commercial banks access to a low-tech payment technology that happens to be uniquely appropriate for many transactions.

In taking existing official paper money monopolies for granted, and thereby treating the market for paper currency as off-limits to commercial banks, economists and policymakers have, inadvertently perhaps, closed off a major avenue for financial deepening, depriving poorer nations especially of a vast potential sum of productive capital.

An endogenous growth model with private banknotes

Having established the fundamental difference between fiat money and banknotes, we now proceed to formalize the financially-repressive consequences of banknote suppression using a stylized model of endogenous growth with financial intermediation. Our aim in developing this model, which is based on those of Roubini and Sala-i-Martin (1992, 1995) and Becsi and Wang (1997), among others, is to clarify the channels by which note-issue restrictions are repressive. Doing so allows us to better assess the quantitative significance of such restrictions and the gains to be achieved by their removal.

Basic assumptions and structure of the model

The model economy consists of representative households, financial intermediaries (banks), firms, and a public sector (the government), the last of which is made up of a fis-

cal authority and a central bank. Households own productive capital goods, but firms control the technology that transforms capital into final goods. For reasons not modelled here (e.g., informational asymmetries or savers' desire to "pool" liquidity risk), households rely on banks to lend capital to firms for use in production instead of lending (or otherwise supplying) such capital to firms directly.[7]

To finance their loans of capital, banks supply households with two types of claims, deposits and banknotes, both of which are redeemable in central bank-issued fiat money. Deposits, banknotes and fiat currency are denominated in the monetary unit of account. While we assume throughout our analysis that deposits bear interest at a rate proportional to the return on private-sector production, banknotes are initially assumed to be non-interest-bearing, in accordance with historical experience. (Later we consider the possibility of interest payments on banknotes.) Although they do not bear interest, banknotes are valued by households owing to their usefulness as currency, a medium that is especially useful in certain exchanges. The model captures this medium-of-exchange role of currency by treating it as a direct source of utility. We assume that fiat currency and banknotes are perfect substitutes, so that banks' holdings of fiat money to satisfy reserve requirements on notes are analytically equivalent to fiat money held directly by households.

The fiscal authority sets the government's expenditures, which are financed through lump sum and income taxes on households and by issuing debt to the central bank. The central bank finances its loans to the fiscal authority by issuing fiat money to banks. The demand for fiat money rests on central bank reserve requirements on both deposits and banknotes, on commercial banks' demand for settlement balances, and on bank and household demand for fiat currency balances.

Because we are concerned with long-run growth, we assume perfect certainty on the

[7] For an endogenous growth model in which the role played by banks is explicitly modelled, see Bencivenga and Smith (1991). In their analysis, banking contributes to growth by reducing the aggregate demand for liquid reserves, while keeping a higher portion of available savings productively invested, compared to the alternative of financial autarky (ibid., p. 196).

part of representative agents. The markets for bank loans, bank liabilities and final goods are competitive. We follow Roubini and Sala-i-Martin (1992, 1995)in assuming for convenience that labor is unproductive at the margin. Wages are therefore identically zero, and household income consists solely of interest paid on bank deposits. Real magnitudes are expressed in terms of a single aggregate final or consumer good. Finally, for simplicity's sake, we assume a closed economy with a constant population while setting the price of capital relative to final goods at unity.

Economic behavior and equilibrium

The representative household chooses consumption, saving and asset holdings to maximize discounted utility

$$U = \int_0^\infty e^{-\rho t} \frac{(c^\alpha b^\beta)^{1-\theta}}{1-\theta}\, dt, \quad \theta > 0 \tag{1}$$

subject to its budget constraint and non-negativity constraints on asset holdings,

$$\begin{aligned} \dot{d} + \dot{b} &= [(1-\tau_i)R_d - \pi]d - \pi b - \tau_0 - c, \\ d, b &\geq 0, \end{aligned} \tag{2}$$

and given the path of the interest rate on deposits. Here, ρ is the household's rate of time preference, c is real household consumption of the final good produced by firms, b is the stock of real currency (banknotes) held by households, d is the stock of real bank deposits, R_d is the nominal return on those deposits, π is the inflation rate (the rate of change of the nominal consumer good price), and $\dot{x} \equiv \frac{\partial x}{\partial t}$. The fiscal authority imposes a lump sum tax, τ_0, and a proportional tax rate on nominal interest income, τ_i.[8]

The functional form for instantaneous utility is necessary for balanced growth because it implies that the elasticity of intertemporal substitution, $(\frac{1}{\theta})$, is constant. Both the accumulation constraint and the household's objective function reflect our assumption that

[8] Our assumption that the fiscal authority issues debt only to the central bank is reflected in the absence of such debt in the household's budget constraint in (2). This assumption is not restrictive if we assume Ricardian Equivalence, under which households treat lump sum taxes and government debt as perfect substitutes.

currency, rather than yielding an *explicit* return to households, is a direct source of household utility. The constraint also reflects the fact that, to the extent that inflation is positive, households face capital losses on their holdings of deposits and banknotes. The parameter β measures the value of currency in reducing (implicit) exchange costs. We might equivalently invoke a cash-in-advance constraint, or allow for explicit costs of transacting in the household budget constraint.[9] We assume that deposits do not play an equivalent exchange role, and exclude them from the utility function for this reason.[10]

The solution to the household's optimization problem is a straightforward application of optimal control theory, where $d + b = W$ (real household wealth) is the state variable and c and b are the controls (Roubini and Sala-i-Martin, 1992, pp. 9-11). The necessary conditions for optimization are the Euler equations

$$\gamma \equiv \frac{\dot{c}}{c} = \frac{(1-\tau_i)R_d - \pi - \rho}{q}, \tag{3}$$

and

$$b = \left[\frac{\beta}{\alpha}\frac{1}{(1-\tau_i)R_d}\right]c, \tag{4}$$

where $q \equiv 1 - (1-\theta)(\alpha+\beta) > 0$ for reasonable values of θ, α and β. These conditions, together with the household budget constraint and transversality condition ($\lim_{t\to\infty}\lambda(t)W(t) = 0$, where λ is the co-state variable), define a differential equation system that describes the optimal paths for c, b, and d, taking the time path of R_d as given.

[9] For the "functional" equivalence of money in the utility function, cash in advance, and transactions cost approaches to modelling money in general equilibrium, see Feenstra (1986). Wang and Yip (1992) show conditions for the "qualitative" equivalence of these approaches, under which they yield identical growth-model comparative statics.

[10] We might also allow deposits to be a direct source of utility, without affecting the main results of our analysis, provided that in so doing we continued to treat them as imperfect substitutes for currency. This alternative approach would, among other minor changes, imply a lower equilibrium return on deposits.

Our utility function is identical to that of Roubini and Sala-i-Martin (1992), except that they allow the preference parameter β to depend negatively on "the level of financial development" (p. 12). Their view is that the more sophisticated the financial system, the lower are overall transactions costs, and thus the lower is the marginal utility of money (pp. 8-9).

Condition (3) indicates that consumption growth depends on the real, after-tax return on deposits. Condition (4) is the demand for currency, which is directly proportional to consumption and inversely proportional to the after-tax nominal deposit rate; it implies that households will accumulate currency until the marginal rate of substitution of notes for consumption equals the return on deposits. In this respect, currency resembles any durable good. The Euler equations imply that consumption growth and the currency-to-consumption ratio will be constant in long-run equilibrium provided that the yield on deposits is also constant, as will indeed prove to be the case.

The representative bank maximizes real profits,

$$\Pi^B = (R_l - \pi)k - (R_d - \pi)d + \pi(b - f) - \phi k, \tag{5}$$

subject to the balance sheet constraint

$$k + f = d + b, \tag{6}$$

and the required reserves constraint

$$f = \tau_d d + \tau_b b, \tag{7}$$

where R_l is the nominal rate of return on capital ("loans"), k is the real capital stock deposited by households and intermediated by banks, ϕ represents intermediation costs as a proportion of the capital stock, including an allowance for under-performing loans, f stands for real reserves of central bank-issued fiat money, τ_d is the statutory reserve ratio on deposits, as determined by the central bank, and τ_b is the statutory reserve ratio on banknotes. We constrain both τ_d and τ_b to lie between 0 and 1. We also assume that the central bank pays no interest on reserves.

Equation (5) indicates that, given real returns on capital and deposits, inflation has an ambiguous effect on banks' profits. They pay an inflation tax to the central bank by holding real fiat money reserves, but realize greater profits from float to the extent that they are

able to issue non-interest bearing banknotes not backed by reserves. As nominal consumer (and capital) prices rise, fixed nominal claims command a smaller value of real capital. As seen from the budget constraint in (2), this inflation-based profit comes directly from the household sector.

In general, a bank will choose loans, deposits and banknotes to maximize profits at each point in time (which is equivalent to maximizing its present value in this case), given R_l, R_d and π. However, because currency yields no explicit nominal return, we assume that banks accommodate household demand for currency by supplying notes perfectly elastically. In other words, banks choose k and d to maximize profits, taking the currency-to-deposit ratio, $\kappa \equiv \frac{b}{d}$, as given.

The first order conditions from the bank's optimization problem and the no-profit condition implied by free entry determine the relationship between the rate the bank pays on deposits and what it receives from lending:

$$R_d = (R_l - \phi)[(1 - \tau_d) + (1 - \tau_b)\kappa]. \tag{8}$$

The spread between loan and deposit rates is thus a reflection of intermediation costs, reserve requirements and the household's desired currency ratio.

The representative firm demands capital as an input into production to maximize profits

$$\Pi = y - (R_l - \pi + \delta)k, \tag{9}$$

subject to constant-returns technology:[11]

$$y = A(v)k, \tag{10}$$

where y is output of the final good, δ is the rate of capital depreciation, $A(v)$ is the marginal product of capital, and v is government expenditure as a proportion of the economy's capital stock. We allow government expenditure, as a proportion of the capital stock,

[11] Although the underlying rationale for this 'AK' technology is not important for our purposes, it may help to think of the capital stock as consisting of both physical and human capital, including knowledge and public goods.

to enhance the productivity of private capital but with diminishing returns ($A'(v) > 0$, $A''(v) < 0$). Thus, we assume that the growth contribution of government expenditure is subject to congestion effects (Turnovsky 1996, p. 416, and Barro and Sala-i-Martin 1995, 158-61).

Equation (9) assumes that firms pay banks the true cost, or rental rate, of capital. Taking R_l and π as given, the firm's first order condition is simply

$$R_l - \pi = A(v) - \delta. \tag{11}$$

The lack here of diminishing returns to capital supplies a basis for endogenous long-run growth. This assumption may also serve as a useful approximation for economies characterized by diminishing returns but with very gradual transitions to the steady-state (Barro and Sala-i-Martin 1995, p. 144).

Finally, we assume that the fiscal authority's budget constraint is

$$g = \tau_0 + \tau_i R_d d + \frac{\dot{B}}{P}, \tag{12}$$

where g is real government expenditures, B is nominal government debt (more precisely, loans from the central bank), and P is the nominal price of consumer goods. The central bank finances its loans to the fiscal authority by issuing fiat money: $\dot{B} = \dot{F}$. Although the government's consolidated flow budget constraint is easily obtained by using $\dot{F}$ to eliminate $\dot{B}$ in (12), by accounting separately for each government authority we emphasize the fact that the central bank is itself a financial intermediary, albeit one that is severely constrained in its lending activities.

Using $\frac{F}{P} = f$, we can rewrite (12) as

$$g = \tau_0 + \tau_i R_d d + \dot{f} + f\pi, \tag{12a}$$

which reveals the two components of government seignorage: the issue of real fiat currency and the inflation tax on banks. If we assume further that the central bank sets a

fixed growth rate for nominal reserves, $\frac{\dot{F}}{F} = \mu$, then we have that seignorage is given by $\dot{f} + f\pi = \mu f$, which implies

$$\pi = \mu - \frac{\dot{f}}{f} \ . \tag{12b}$$

We take π to be exogenous, as if it were targeted by the central bank. Because the growth rate of real fiat currency is determined by the behavior of the rest of the economy, nominal money growth μ adjusts endogenously to ensure that (12b) holds.

To allow for a balanced growth path, we assume that the fiscal authority determines its real spending as a given proportion of the aggregate capital stock:

$$g = vk. \tag{13}$$

The government chooses this proportion, as well as income tax rates and the reserve requirements, exogenously. It supplies fiat money to banks to fully meet their demand for reserves. As noted previously, it pays no interest on bank reserves.[12]

In equilibrium, household demand for deposits and banknotes will equal the supply of these assets from banks, the supply of loans from banks will equal the demand for loans (derived from the demand for capital) from firms, and total output will satisfy the demands of households for consumption and asset accumulation, and government expenditures. Also, the demand for bank reserves will equal the supply of fiat money from the central bank. These equilibrium conditions are given by the representative household's Euler equations (3) and (4), its asset accumulation constraint (2), and the profit maximizing conditions of banks (8) and firms (11).

Capital Accumulation

To draw the model's implications for capital accumulation, we combine the budget and

[12] If the central bank paid interest on reserves, the equilibrium spread would be tightened and reserve holdings would be less financially repressive. However, because the public sector is less productive than the private sector, there would still be some opportunity cost of reserve holding.

balance sheet constraints of households, banks and the government, and then use the equilibrium expressions for R_l and R_d to obtain

$$\dot{k} = A(v)k - \delta k - \phi k - c - g. \tag{14}$$

Capital accumulation is thus equal to output less capital consumption less intermediation costs less the consumption of households and the government.

If we replace g with its assumed path based on the exogenous parameter v, equation (14) becomes a first-order differential equation in k:

$$\dot{k} - hk = -c(0)e^{\gamma t}, \tag{15}$$

where $h = A(v) - \delta - \phi - v$ and consumption is that implied by household optimization in (3) given initial value $c(0)$. From (8) and (11), it is evident that the deposit interest rate will be constant in the long-run, and therefore growth will be balanced, only if the banknote-to-deposit ratio κ is constant. Under the maintained assumption of balanced growth, the solution to (15) satisfying the transversality condition of households is:[13]

$$k = (h - \gamma)^{-1}c. \tag{16}$$

Eliminating k using the banking system's balance sheet shows that d is a constant proportion of c under the maintained hypothesis:

$$\frac{c}{d} = [(1 - \tau_d) + (1 - \tau_b)\kappa](h - \gamma). \tag{17}$$

We can now show that the currency-to-deposit ratio and the return on deposits are indeed constant in the balanced growth equilibrium. From (4) and (17), we have that

$$\kappa = \frac{b}{c} \cdot \frac{c}{d} = \left[\frac{\beta}{\alpha}\frac{1}{(1 - \tau_i)R_d}\right][(1 - \tau_d) + (1 - \tau_b)\kappa](h - \gamma). \tag{18}$$

[13] Barro and Sala-i-Martin (1995, pp. 142-43) illustrate the role of the transversality condition in determining the particular solution.

Substituting for the equilibrium value of R_d and solving for κ yields its equilibrium, reduced-form value:

$$\kappa = \left[\frac{\beta/(1-\tau_i)}{\alpha q + \beta(1-\tau_b)}\right]\left[q - (1-\tau_i)(1-\tau_d) + [\rho - vq + \pi(1-q)](R_l - \phi)^{-1}\right]. \quad (19)$$

If v is sufficiently small, κ will be positive. For example, if $q = 1$, an assumption we use in our simulations, a sufficient (but not necessary) condition for the equilibrium currency ratio to be positive is that $\rho > v$. Because the ratio depends only on fixed model parameters (including π, and given that R_l is determined from equation 11), it must be constant in the steady state: currency and deposits grow at the same rate in the long run. Equations (4) and (16) show that both currency and capital are proportional to consumption in the steady state, so all relevant quantities grow at the rate γ in the balanced growth equilibrium.[14] Given an initial value of the capital stock, the model yields closed-form, steady-state solutions for consumption (16), deposits (17), currency (19), their growth rates (3), and the rates of return on deposits (8) and loans (11).

Financial repression

Repressive financial regulations can hamper economic growth in several ways (Roubini and Sala-i-Martin 1995, pp. 279-283). Our model allows for two channels emphasized in most writings on financial repression, including McKinnon (1973) and Shaw (1973): first, regulations can reduce the efficiency with which any *given* amount of saving is invested, as happens when savings are diverted from commercial banks to a central bank that invests funds less productively; second, regulations can reduce the equilibrium *quantity* of saving and investment, as when reserve requirements reduce the private (but not necessarily the *social*) return on savings.

We can isolate the first of these channels by defining private saving as household accumulation of real assets, $S = \dot{d} + \dot{b}$, and by then combining household, bank and government

[14] From the production function, output also grows at this rate in the steady-state. Here as in many endogenous growth models (e.g. Barro and Sala-i-Martin 1995, pp. 142-43) there are no transitional dynamics.

flow budget constraints to obtain

$$\dot{k} = \left[\frac{(1-\tau_d)+(1-\tau_b)\kappa}{1+\kappa}\right] S = S - \left(\frac{\tau_d d + \tau_b b}{W}\right) S. \tag{20}$$

Equation (20) shows that, as reserve requirements on deposits and banknotes are relaxed, banks invest available savings more productively, so that capital accumulation increases as a *proportion* of private saving, promoting more rapid growth.[15]

The above argument hinges on the presumed inefficiency of public intermediaries: were public intermediaries just as efficient as their private counterparts, reserve requirements would not reduce the contribution of private saving to capital accumulation. The second equality in (20) illustrates this argument best. Productive capital accumulation equals household saving less that amount of saving taken by the government through the financial system (the last term in the equation equals $\dot{f}$). Equivalently, private saving is divided between capital accumulation and government consumption. If the central bank were to loan funds from the issue of fiat money, not to the fiscal authority for spending, but to firms for production, the last term in (20) would drop out, and private saving would be fully allocated toward productive capital accumulation.

We can identify the second channel most easily by considering the special case in which there is no demand for currency ($\beta = 0$). In this case, we have, from (8) and (3):

$$\begin{aligned} \frac{\partial R_d}{\partial \tau_d} &= -[R_l - \phi] < 0 \\ \frac{\partial \gamma}{\partial \tau_d} &= \frac{(1-\tau_i)}{q}\frac{\partial R_d}{\partial \tau_d} \\ &= -\frac{(1-\tau_i)}{q}[R_l - \phi] < 0. \end{aligned} \tag{21}$$

So long as deposit rates and growth are positive – an assumption we maintain – an increase in the reserve requirement on deposits lowers the private return to deposits, reducing the incentive to save, and thereby slowing household asset accumulation and growth. This

[15] Compare this result to equations (3) and (3') of Roubini and Sala-i-Martin (1995, p. 282).

channel does not depend on the relative inefficiency of public-sector intermediation, but on the difference between the social and the private return to saving, that is, on a tax distortion.

Banknotes, financial repression and growth

Unlike other models of financial repression and growth, ours allows private banks to supply currency by issuing their own notes, which are assumed to be capable of performing the same medium-of-exchange role as fiat currency. In this section, we highlight the importance of this difference for various government policies. We then turn to the main purpose of this paper: measuring the potential effect of banknote restrictions on growth.

Government spending, income tax, and inflation effects

We begin by considering the effects of an increase in government's share of the capital stock, v. Differentiating (19),(8) and (3), respectively, with respect to v, we have:

$$\frac{\partial \kappa}{\partial v} = \left[\frac{\beta/(1-\tau_i)}{\alpha q + \beta(1-\tau_b)}\right]\left[\frac{[\rho - vq + \pi(1-q)]A'(v)}{(R_l - \phi)^2} - \frac{q}{R_l - \phi}\right] \tag{22a}$$

$$\frac{\partial R_d}{\partial v} = (1-\tau_d)A'(v) + (1-\tau_b)\left[\kappa A'(v) + R_l \frac{\partial \kappa}{\partial v}\right] \tag{22b}$$

$$\frac{\partial \gamma}{\partial v} = \left(\frac{1-\tau_i}{q}\right)\frac{\partial R_d}{\partial v} \tag{22c}$$

In general, the marginal effects of v on deposit rates and growth are ambiguous. However, we can better understand the mechanisms at work if we consider some special cases. Suppose, for example, that currency has no value ($\beta = 0$) and government spending is pure consumption [$A'(v) = 0$]. Then government spending affects neither interest rates nor growth: as g rises, lump sum taxes rise, there being no change in other sources of government finance. The increased lump sum tax results in an equal decline in consumption. Consequently, both capital accumulation (saving) and growth remain unchanged. This is a standard result in the endogenous growth literature (e.g. Turnovsky 1996, p. 409).

Next suppose that government expenditures remain unproductive but that $\beta > 0$, so that currency is valued by households. An increase in v will cause the currency-to-deposit

ratio to *fall* in this case, leading to an unambiguous reduction in deposit rates and to a decline in growth. As v rises, household consumption falls in equilibrium given the capital stock, as seen from equation (16), causing a reduction in the demand for banknotes, *ceteris paribus*. Because banks must accommodate this declining demand, and because deposits (unlike banknotes) are interest bearing and therefore relatively costly to banks as a source of funds, the reduced currency ratio causes the interest rate spread to increase by reducing the deposit rate. The lower deposit rate in turn reduces households' incentive to save, thereby reducing the economy's steady-state rates of capital accumulation and growth. Notice that the reduction in growth in this case is due entirely to price distortions in financial markets. This finding appears to be unique to our model.

An increase in the marginal income tax rate also reduces growth, but through a different channel. Proceeding as before, we find the partial effects of a tax rate change to be

$$\frac{\partial \kappa}{\partial \tau_i} = \left[\frac{\beta/(1-\tau_i)^2}{\alpha q + \beta(1-\tau_b)}\right]\left[q + [\rho - vq + \pi(1-q)](R_l - \phi)^{-1}\right] > 0 \tag{23a}$$

$$\frac{\partial R_d}{\partial \tau_i} = (R_l - \phi)(1-\tau_b)\frac{\partial \kappa}{\partial \tau_i} > 0 \tag{23b}$$

$$\frac{\partial \gamma}{\partial \tau_i} = q^{-1}(R_l - \phi)(1-\tau_d)\left(\frac{\beta}{q\alpha + \beta} - 1\right) < 0 \tag{23c}$$

An increase in the income tax rate *raises* the relative demand for banknotes (when κ is positive), allowing banks to tighten the rate spread by raising deposit rates. However, the direct negative effect of the tax rate on *after-tax* deposit returns offsets the increase in before-tax returns, so that the effect on growth is negative. The negative effect of an income tax in this model is hardly surprising since household income consists of interest earnings only: a tax on labor income would likely induce a smaller distortion on saving behavior. In any event the ability of banks to issue banknotes mitigates the growth distortions of an (interest) income tax.

Finally, although an increase in the rate of inflation appears likely to inhibit growth,

the effect is ambiguous:

$$\frac{\partial \kappa}{\partial \pi} = \left[\frac{\beta/(1-\tau_i)}{\alpha q + \beta(1-\tau_b)}\right]\left[\frac{(R_l - \pi - \phi)(1-q) + vq - \rho}{(R_l - \phi)^2}\right] \tag{24a}$$

$$\frac{\partial R_d}{\partial \pi} = (1-\tau_d) + (1-\tau_b)(\pi\frac{\partial \kappa}{\partial \pi} + \kappa) \tag{24b}$$

$$\frac{\partial \gamma}{\partial \pi} = (1-\tau_i)\frac{\partial R_d}{\partial \pi} - 1 \tag{24c}$$

Even allowing that the effect of inflation on the currency ratio is negative (a sufficient conditions for which is that $\rho > vq$), growth may rise with inflation if the response of the real after-tax deposit rate to inflation is positive. Because banks pay zero nominal interest on banknotes, their real return on outstanding banknotes rises with inflation, *ceteris paribus*. Competition in the industry forces banks to transfer this return to deposit holders through higher deposit rates. If this increase outweighs the negative effects of reserve requirements on deposits and the interest income tax, investment and growth will rise. But observe that this potential growth channel cannot operate when banknotes are prohibited: when $\tau_b = 1$, the growth-rate effect of inflation is unambiguously negative.

The marginal effects of banknote restrictions

Our primary concern is with the growth effects of banknote restrictions. The central bank's reserve requirement on notes, τ_b, measures the severity of such restrictions, and may be likened to a reserve "tax rate" on banknotes. As τ_b rises, the ability of banks to finance intermediation with banknotes declines. For example, when $\tau_b = 1$ (implying a 100% reserve ratio on notes), the public's demand for notes translates into a corresponding demand for bank reserves, with no increase in productive investment. As we've previously noted, we might equivalently suppose that households simply hold fiat currency, completely by-passing banks as providers of exchange media. A 100% reserve requirement on banknotes thus resembles outright prohibition of notes, in so far as it generates a demand for fiat money equal to the former demand for banknotes.[16]

[16] There is in fact a subtle yet important difference between a 100% statutory reserve re-

We obtain the following steady-state multipliers for a marginal change in the degree of banknote prohibition:

$$\frac{\partial \kappa}{\partial \tau_b} = \left[\frac{\beta}{\alpha q + \beta(1-\tau_b)}\right]\kappa > 0, \tag{25a}$$

$$\frac{\partial R_d}{\partial \tau_b} = (R_l - \phi)\left[\frac{\beta(1-\tau_b)}{\alpha q + \beta(1-\tau_b)} - 1\right]\kappa < 0, \quad \text{and} \tag{25b}$$

$$\frac{\partial \gamma}{\partial \tau_b} = \left[\frac{(1-\tau_i)}{q}\right]\frac{\partial R_d}{\partial \tau_b} < 0. \tag{25c}$$

An increase in the effective reserve ratio on banknotes increases intermediation costs – τ_b acts as an implicit tax on banks – thereby increasing the equilibrium interest rate spread by reducing deposit rates. While the resulting decline in R_d raises the quantity of banknotes demanded, it reduces growth, once again, through a price distortion in financial markets. The multiplier clearly illustrates the "banknote" growth channel. Because banknotes can be useful to households despite not bearing interest, they constitute a low-cost source of funds to financial intermediaries. Prohibition eliminates this source of funds. In general, restricting private banknote issue, whether through reserve requirements or outright prohibition, amounts to a financially repressive tax on growth.

Equation (25c) implies that, at the margin, banknote restrictions will have a greater negative effect on growth in economies with high currency-to-deposit ratios, *ceteris paribus*. Such countries are likely to be relatively poor (Jefferson and O'Connell 2004). Our analysis therefore suggests that less-developed countries are among those that stand to benefit most from any given reduction in banknote restrictions.

The model also predicts that the marginal effect of a reduction in the tax on banknotes can be of a similar order of magnitude as a like reduction in the reserve requirement

quirement on banknotes and outright prohibition: When banknotes are prohibited, banks' currency inventories (vault, till, and ATM cash) must themselves consist of fiat money. In contrast, because reserve requirements generally apply to banks' *outstanding* liabilities only, banks subject to a 100% banknote reserve requirement can limit their "tax" burden by continuing to issue and hold inventories of their own notes. This fact largely accounts for the survival – and profitability – of commercial banknotes where such notes, instead of being prohibited, are subject to a 100% reserve requirement.

on bank deposits. The marginal effect of a change in the latter tax is

$$\frac{\partial \gamma}{\partial \tau_d} = \left[\frac{(1-\tau_i)}{q}\right](R_l - \phi)\left[\frac{\beta(1-\tau_b)}{\alpha q + \beta(1-\tau_b)} - 1\right] < 0, \tag{26}$$

which generalizes (21) for the case in which $\beta \neq 0$. The only difference between the multiplier in (25c) and this one is the sensitivity of the former to the currency-deposit ratio. If $\kappa = 1$, then the marginal effects of both reserve requirements are the same. If $\kappa > 1$, a situation not uncommon in developing economies (especially allowing for holdings of foreign currency), then any given percentage reduction in reserve requirements on banknotes will have a *larger* positive effect on growth than a like percentage reduction in reserve requirements on deposits.

Simulating growth under complete and partial banknote liberalization

Because the effects measured in (25) and (26) are responses to *marginal* changes in policy, comparing them misses the very large potential gains from banknote privatization, which arise because banknotes are today prohibited almost everywhere, and are otherwise subject to reserve requirements equal to or closely approaching 100%. To illustrate this growth potential, we calibrate our model to data from a small sample of developing economies: Brazil, Chile, Indonesia, Mexico, the Philippines and South Africa. We then use the model to simulate growth-rates for each of these countries for various counterfactual (and more liberal) banknote regimes.

For each country we assume that the parameters τ_i (the income tax rate) and v (the ratio of government spending to capital) are equal to their average values as implied by annual data over the last 20 years or so. We use the same procedure to arrive at steady-state values for R_l (the nominal loan rate) and π (the inflation rate), and at initial values for R_d (the nominal deposit rate), κ (the currency-deposit ratio) and γ (the growth rate). In keeping with our theory, we define "deposits" broadly so as to include time deposits and money market accounts. We rely on the survey data in Barth et al. for the deposit reserve ratio,

τ_d. (An appendix supplies other data sources and details.) We set all of these parameter values independently of the model.

We then choose the remaining parameter values so that the model's predictions hold under banknote prohibition, with $\tau_b = 1$. We solve equation (8) for ϕ (intermediation costs) given the values of R_l, R_d and τ_d. Under the assumption that $\alpha + \beta = 1$, which we maintain, equation (3) determines either θ (the reciprocal of the representative household's elasticity of intertemporal substitution) or ρ (the household's rate of time preference): the model is not capable of separately identifying each. We consider a range of values for θ to gauge sensitivity, allowing the model to determine ρ for each of these values. We consider log utility ($\theta = 1$) as the benchmark case and, following DeJong and Dave (2007, p. 176), treat θ is 0.5 and 2.5 as lower and upper bounds.[17] Finally, we use equation (19) to derive the value of currency to households, β.

Having thus calibrated all of the model's parameters, we then simulate growth rates for counterfactual circumstances in which banknotes are not prohibited. For example, we set $\tau_b = 0$ in equation (19) to predict the currency-deposit ratio (κ) in the absences of reserve requirements on banknotes. We then use the simulated value of κ to solve equation (8) for the deposit rate R_d. Finally, we use equation (3) to simulate the counterfactual growth rate. We repeat this procedure for various values of $\tau_b < 1$ to measure the effects of partial relaxations of the reserve requirement on note issue.

Table 1 reports the results of this counterfactual exercise for our developing economies. The first row for each country shows the calibrated values of κ, R_d and γ under banknote prohibition (the status quo). Subsequent rows report the simulated quantities for κ, R_d and γ for various values of τ_b. The row corresponding to $\tau_b = 100$ reflects the counterfactual

[17] There is as yet no consensus concerning appropriate values for the elasticity of intertemporal substitution, given both theoretical and econometric difficulties in estimation. Indeed, some estimates in the literature exceed even our rather generous bounds. For recent attempts to estimate and to interpret estimates of this parameter, see Yogo (2004), Gruber (2006), Guvenen (2006), and de la Cruz, et al. (2007).

situation in which banknotes, though no longer prohibited by law, are subject to a 100% reserve requirement. As we've noted, there is a growth gain even in this case because banks can hold their own notes, rather than fiat currency, as cash inventories. We account for this possibility by reducing the deposit reserve ratio (τ_d) by the the percentage of bank reserves held as cash, for all cases save that of prohibition. We take this percentage to be 20% for all countries. All quantities but θ are in percentage terms.

Consider first the benchmark results for the second country, Chile. The calibrated values for the nominal lending rate and the rate of inflation imply that the real lending rate in Chile has been around 15% during the calibration period; this figure is consistent with the estimates of the marginal product of capital for Chile of 10% in Caselli and Feyrer (2006), allowing for a rate of capital depreciation of around 5%. The spread between the lending rate and the 20.13% deposit rate implies a proportional intermediation cost of 5.64%. The currency ratio is 8.57% under prohibition, implying that β is close to 18%. Given that the actual growth rate during the period was 1.9%, $\rho = 1.30\%$ is consistent with the model and within a reasonable range for the rate of time preference.

Suppose that Chile chose to legalize commercial banknotes, without subjecting them to any statutory reserve requirement, and that such notes entirely displaced circulating fiat money. According to our baseline calibration, such a radical reform would lead to a 134 basis-point increase in Chile's steady-state growth rate. This is, evidently, a "large" increase, comparable to the 125 point increase that Levine (1997, p. 706) associates with a change in his and King's BANK variable from its poorest-quartile value to its richest-quartile value. The change reflects both a more productive use of savings embodied in currency holdings and an increase in total savings, the latter stemming from an increase in nominal deposit interest rates from 20.13% to 21.89%, which translates into an increase in real, after tax rates from 3.21% to 4.53%.

As is well known from conventional models of endogenous growth, the smaller is θ (i.e.,

the larger the elasticity of intertemporal substitution), the more household saving will respond to increases in the return to bank deposits. This fact is evident in the table, which shows that the growth gain from removing banknote prohibition rises from 134 to 233 basis points as θ declines from 1.0 to 0.5.[18]

The table also shows substantial (though necessarily smaller) potential gains for Chile if restrictions on banknote issue are relaxed rather than entirely eliminated. A mere move from outright prohibition to a 100% reserve requirement yields a potential growth-rate gain of 19 basis points, while adopting a 50% reserve requirement would still allow growth to increase by as much as 82 basis points. As we've suggested above, the latter result is equivalent to complete elimination of statutory banknote reserve requirements with a 50% conversion of government issued-fiat currency into private banknotes.

The potential gains to Mexico from currency privatization are considerably larger than those for Chile. The benchmark simulation for full deregulation yields a steady-state growth rate increase of 315 basis points. This increase may seem implausibly large, but even the more conservative simulation, with $\theta = 2.50$, yields a gain of 149 basis points. Mexico harbors great potential for growth-rate gains from currency privatization because of its relatively high currency-deposit ratio: the calibrated value of κ there is almost 13%, implying $\beta = 30.28\%$, as compared to only 8.57% ($\beta = 17.88\%$) in Chile.

Currency is almost as important in the Philippines as it is in Mexico. Yet the Philippines' predicted growth-rate gain from complete currency privatization – 131 basis points according to the benchmark simulation – is actually just below Chile's. The explanation lies in the Philippines' real lending rate, which, at just over 7%, is considerably lower than Mexico's rate of 11.64% and less than half of Chile's rate of 15%.

If we suppose that a reasonable range for the annual rate of time preference, ρ, is 1.25% to 3.25%, then we can rule out of consideration all but one simulation for both Brazil

[18] We ignore the simulation results for $\theta = 2.5$ because the implied value of ρ is negative.

and Indonesia. In Indonesia's case, the smaller values of θ imply implausibly large rates of time preference. In Brazil's, larger values of θ yield negative rates of time preference. The remaining specifications predict that full privatization of banknotes in Brazil and Indonesia will increase steady-state growth by 111 and 159 basis points, respectively.

Finally, because the benchmark value of κ and the gross real return on loans are both small for South Africa, it gains relatively little from currency privatization. Yet these gains are hardly trivial: according to our benchmark simulation, full privatization, with zero statutory reserve requirements, would increase South Africa's steady-state growth rate by 54 basis points.

Because the above, projected gains are for annual balanced growth rates, the implied standard-of-living gains are very large. For example, Chile's potential 134 basis point gain from unrestricted banknote issuance would allow its national income to double over 15 years faster than if existing restrictions remain in effect. In 50 years, its income would be almost twice what it would be (given its current growth rate) under the status quo.

To conclude: our simulations yield some strikingly high estimates of potential gains from currency privatization. The estimated potential gains from unrestricted privatization range from 54 to 315 basis points, according to our benchmark simulations with $\theta = 1$; for alternative simulations, with $\theta = .5$ and $\theta = 2.5$, the ranges are 94 to 511 basis points and 24 to 149 basis points, respectively. These estimates are biased upward by our failure to allow, either in our model or in our simulations, for direct finance and non-local lending by commercial banks. They are, on the other hand, conservative in so far as they ignore the substantial use of U.S. dollars and other developed-nation currencies in poorer countries, and the potential gains from privatizing such unofficial currency holdings.

Some practical concerns

Can banknotes compete with fiat money?

The growth gains reported in the previous section are potential gains only, being based

on the assumption that banknotes completely take the place of non-bank holdings of fiat money. Partial currency privatization would yield correspondingly reduced gains. For example, the estimated growth gain from a wholesale banknote liberalization, with $\tau_b = 0$, that only resulted in 50% substitution of banknotes for circulating fiat currency, would be the same as the estimated gain from a partial liberalization, with $\tau_b = 0.5$, leading to 100% substitution of banknotes for fiat money.

But is it reasonable to expect any substantial substitution of banknotes for default-risk free fiat money? Although historical banknotes did manage to take the place of less risky coins, that was so in part because paper was considered more convenient than metal.

That commercial banknotes can thrive in a fiat money system is evidenced by their continued popularity in the few places, like Scotland, where they aren't prohibited. Today Scottish banknotes make up about 95 percent of Scotland's circulating paper money, and do so despite not being legal tender. Emerging-market branches and subsidiaries of present note-issuing banks, including HSBC, the Standard Chartered Bank, and the Royal Bank of Scotland, might draw upon their parent firms' reputations to establish footholds in local currency markets. Established suppliers of travelers checks might likewise find it relatively easy to enter the paper currency business.

Establishing markets for new banknote brands poses a special challenge. Banks can resort to conventional interest payments to create markets for their deposits. This tactic is not suitable for banknotes, because the cost of calculating and making regular interest payments on circulating media is, given the present state of technology, prohibitive (White 1987). Commercial banks might instead compete along non-price dimensions, by making commercial banknotes more appealing to general users and collectors, or by making them especially secure against counterfeiting.[19] Banks can also offer non-interest incentives to

[19] Such improvements would presumably be funded by banks' interest earnings, and would to that extent lower interest payments for depositors. On non-price competition among note-issues, see White and Boudreaux (1998).

persons who accept their notes in lieu of fiat paper. They might, for example, wave or reduce commissions when dispensing their own notes to non-depositors, through ATMs or otherwise.[20] Banks operated by firms that also operate extensive retail chains, like Mexico's Banco Azteca and Banco Wal-Mart, might similarly encourage the use of their notes by offering discounts to retail customers who offer the notes in payment.

While the above options alone might not inspire a wholesale shift from fiat currency to banknotes, an alternative, originally suggested by Huston McCulloch (1986) and Charles Goodhart (1986, 1993), has a far greater potential to do just that: banks could treat their notes like so many small zero-coupon lottery bonds, allowing holders of notes bearing "lucky" (randomly-chosen) serial numbers to redeem them for substantially more than their face value, thereby giving the notes a positive expected rate of return. Though the suggestion may appear farfetched, in many countries lotteries are presently being used with considerable success to market bank deposits. According to Mauro Guillén and Adrian Tschoegl (2002), "lottery-linked" deposit accounts have been especially popular with poorer persons, including many who might otherwise remain "outside the banking system." The success of lottery-linked deposits is all the more impressive in light of the fact that such deposits are generally uninsured, and also in light of the relatively high cost they assign to individual lottery "tickets." In two popular Argentine schemes, for instance, depositors receive one ticket or chance of winning for every $200 or $250 on deposit (ibid., p. 221). Lottery-linked banknotes, in contrast, would themselves serve as tickets, allowing persons to play for as little as the value of the lowest note denomination, and with no apparent cost to themselves save that of occasionally inspecting their note holdings. As Goodhart (1993, p. 273) has observed, "Given that many people seem to appreciate opportunities to engage in gambles with positive skew," such a scheme "could make note holdings considerably more

[20] That present-day note-issuing banks in Scotland and elsewhere offer no discounts in dispensing their own notes is due at least in part to the fact that these notes become subject to a 100-percent marginal reserve requirement upon being placed into circulation.

popular than now."[21]

Banknotes and monetary control

Because currency today makes up a large portion of monetary authorities' outstanding liabilities, any substantial substitution of private banknotes for existing fiat paper will entail an equally substantial shrinking of monetary authorities' real assets, both absolutely and relative to the assets of commercial banks. This possibility may cause some to wonder whether a successful banknote revival might undermine existing mechanisms of monetary control.

In answer it is tempting to refer yet again to historical instances of stable banknote-based currency systems, including those of Scotland and Canada during the nineteenth century.[22] These historical banknote arrangements were, however, based on metallic monetary standards that precluded any danger of price-level indeterminacy. Might that danger arise in arrangements that combined unrestricted banknote issuance with fiat money? The concern here is identical to that occasionally expressed with regard to new forms of electronic money (e.g. Friedman 1999; King 1991). The reply is the same as well, namely, that the lack of any demand for circulating fiat money needn't undermine central banks' ability to regulate nominal spending and inflation.

As Woodford (2000) explains, neither the elimination of statutory reserve requirements, nor the substitution of bank-supplied instruments for public holdings of fiat money would do away with banks' demand for reserves for interbank settlement. Central banks could

[21] Because lottery-linked banknotes are especially likely to appeal to the poor, they might prove valuable in fully realizing the "promise of microfinance" (Murdoch 1999), fulfillment of which has thus far been limited by microfinance agencies' dependence on donated funds: although these agencies have succeeded in showing that poor markets can harbor good loan prospects, they have been relatively unsuccessful in building "the banking habit" in those same markets, that is, in encouraging poor persons to establish deposit accounts. By issuing their own paper notes, lottery-linked or otherwise, microfinance agencies might at last succeed in harnessing the scarce savings available in poorer communities, thereby improving their prospects for becoming self-sustaining.

[22] See Dowd (1992) for various case studies.

therefore continue to conduct monetary policy by targeting overnight (reserve market) lending rates. Indeed, Woodford notes (ibid.), "the complete elimination of the use of [fiat] currency ... would only make monetary control under current operating procedures easier, by making it simpler for the central bank to control the supply of bank reserves" in the face of fluctuations in the public's preferred currency-deposit ratio. Although Woodford's conclusion rests on the assumption that central banks can either (1) "vary the spread between the return on base money and on other financial assets to an arbitrary extent" through changes in the available stock of base money or (2) pay interest on bank reserves, the latter alternative is always feasible, even if the former is not.[23] In short, although the opportunity cost (reckoned in terms of foregone opportunities for efficient intermediation) of centralized monetary control is proportional to the real demand for monetary authorities' liabilities, the effectiveness of monetary control is largely independent of the extent of that demand.

Counterfeiting

Another concern raised by the prospect of a banknote revival is counterfeiting. It is widely believed that commercial banknotes are more likely to be counterfeited than their publicly supplied counterparts, including fiat money. Stephen Williamson expresses this concern in a recent paper that is noteworthy for its explicit recognition of the growth advantages of privately-issued currency. "Bank notes," Williamson observes (2002, p. 47), "support productive investment," whereas "fiat money serves only the medium of exchange function and does nothing to promote private investment." However, "in a world of many private issuers, each...may invest too little in foiling counterfeiters relative to the social optimum" (ibid., p. 55). Consequently "a ban on private money may be necessary to support

[23] Goodhart (1993, pp. 275-6) reaches the same conclusion with specific reference to the hypothetical case of fiat-money-dominating, lottery-linked banknotes. So long as banks remain obliged to convert such notes into legal tender, he writes, that obligation, together with "some constraint on the limit to which the commercial banks could hold a net debt position against the Central Bank, or ... a sufficiently penalty rate on such an excess net debt position," will suffice to preserve monetary authorities' ability to regulate short-term interest rates and the nominal price level.

a stationary equilibrium with monetary exchange" (ibid., p. 49). Like many other writers before him, Williamson cites antebellum U.S. experience, excepting that of New England, in support this view.

But empirical evidence does not support the claim that private banknotes are generally more vulnerable to counterfeiting than central bank notes. Williamson himself recognizes two important examples – New England under the Suffolk System and Canada prior to the establishment of the Bank of Canada – of commercial banknote arrangements in which counterfeiting was not a serious problem. Scottish banknotes were likewise seldom counterfeited, and were throughout the 19th century less frequently counterfeited than Bank of England notes (Coppieters 1955, pp. 64-5). Nor does recent experience suggest that surviving commercial banknotes are substantially more vulnerable to counterfeiting than notes issued by public authorities.[24]

There are also at least two important theoretical reasons for expecting commercial banknotes to be *less* vulnerable to counterfeiting than central bank notes. One has to do with the likelihood of counterfeits being detected. That likelihood, and therefore the risk borne by a counterfeiter, depends on how often notes find their way to legitimate issuers, who are best able to spot fakes. Competitively-supplied notes tend to have relatively short average periods of circulation between redemptions – typically a matter of less than a month – because rival issuers treat them like so many checks.[25] In contrast, central bank currency – and fiat money especially – tends to circulate for many months, if not for several

[24] For example, in 2006 the number of counterfeit Scottish bank notes discovered and removed from circulation amounted to 0.03% of genuine notes in circulation, while the corresponding figure for Bank of England notes was 0.02%. The difference is trivial compared to annual variations in both rates. See http://www.scotbanks.org.uk/banknote_counterfeit.php and http://www.bankofengland.co.uk/banknotes/about/counterfeits.htm.

[25] The average circulation period of a Scottish banknote around 1870 was only 10 or 11 days (Somers 1873, p. 161). In Canada in the 1890s the average period between note redemptions was about one month (Breckenridge 1895, p. 309). The redemption rate for Suffolk System banknotes was similar (U.S. Congress 1897-98, p. 452). Elsewhere in the antebellum U.S. the absence of both branch banking and centralized clearing and collection arrangements stood in the way of routine and expeditious redemption of banknotes, encouraging counterfeiters.

years, before returning to the issuer. This tendency makes it, other things equal, a more tempting target for counterfeiters.[26]

The second reason has to do with externalities and incentives. Because banknotes are redeemable claims, successful counterfeits can exhaust an issuer's reserves, threatening it with failure. No similar threat faces an issuer of fiat money. Instead, costs of successful fiat money counterfeiting are largely borne by the public, in the form of increased taxes (to offset lost seignorage) or reduced real government expenditures. Thus, contrary to Williamson, it is not commercial note issuers but central banks that are most likely to "invest too little in foiling counterfeiters relative to the social optimum."

In brief, it is far from obvious that banknotes are substantially more vulnerable to counterfeiting than fiat money, much less that their vulnerability warrants suppressing them entirely, given the potentially large loss of productive investment and economic growth that such suppression entails.

Default and panics

In arguing that a banknote revival could hasten economic growth, we have put aside the possibility that such a revival might also increase the risk of bank failures and banking panics. In so doing, we adhere to a practice common to many studies of financial liberalization. But that practice is not without its critics (see, for example, Diaz-Alejandro 1985). It is, moreover, widely believed that banknotes are especially likely to be abused if not subject to special regulation.

Our reply, which must necessarily be brief, is that past abuses of the right to issue banknotes have either been limited to one or a very small number of irresponsible banks (as in the 1772 failure of Scotland's Ayr Bank), or have been traceable to regulatory restrictions that artificially limited the capitalization of, and extent of competition among, banks

[26] Williamson (2002, pp. 49-50 and 52) himself recognizes that counterfeits are most likely to be detected upon being presented for redemption. He also thinks it "unlikely that fiat money would in general be more difficult to counterfeit than private money" (ibid., p. 55).

of issue (as in England before 1826, when the six partner rule was in effect, and the antebellum U.S., where most states prohibited branch banking), or have been aided by other misguided regulations (the antebellum U.S. again, thanks to so-called "free banking" laws) (see Dowd 1993, pp. 117-206; Rolnick and Weber 1984; and Selgin 1992). In general the evidence does not support the view that banknotes are inherently more prone to over-issuance or other forms of abuse than bank deposits. It bears recalling, finally, that the historical inclination to subject banknotes to special regulations, from which transferable bank deposits have generally been exempt, was largely founded on two long-since discredited British Currency School beliefs: first, that among bank liabilities circulating notes alone were "money," and, second, that a nation's stock of "money" of all kinds ought to be rigidly linked to its metallic reserves (see Schwartz 1992).

Conclusion

Rondo Cameron observed, with regret, that "legal monopolies of note issue are probably here to stay." That was over four decades ago. Since then, the grip of those monopolies has been considerably weakened, especially by increased opportunities for (fiat) currency substitution, outright dollarization, and new-found enthusiasm for multi-national currency unions (Cohen 1998, Helleiner 2002).

We have posed an argument for relaxing the grip of national currency monopolies still further, by pointing to the substantial boost to economic growth some nations might achieve by sanctioning the revival of a once common form of paper money: competitively-supplied commercial banknotes. We have argued that paper money is as capable of promoting economic growth as transferable bank deposits, and that its apparent inferiority to deposits stems from its being issued exclusively by public monetary authorities that happen to be ineffective financial intermediaries. The costs of public currency monopolies, reckoned in terms of forgone opportunities for productive private-sector intermediation, are large, possibly exceeding those of all other forms of financial repression. This high cost of cur-

rency monopoly warrants reconsideration of the case for restoring commercial banks' right to issue redeemable banknotes, and especially so in light of historical and theoretical evidence suggesting that such a step need pose no threat to, and may even enhance, monetary stability. Such reconsideration is especially important in poorer economies with less-developed financial systems.

In making these claims we do not seek to deny that a banknote revival would also involve substantial costs, including, most obviously, a reduction in governments' seignorage revenues (Fischer 1982). Nor have we attempted to demonstrate that such a revival would satisfy Bencivenga and Smith's (1992) or Roubini and Sala-i-Martin's (1992) notion of "optimal" financial repression. Ours has been the modest goal of emphasizing a *cost* of official currency monopolies overlooked in recent writings on economic and financial development. This cost appears substantial enough to warrant re-opening debate concerning the pros and cons of such monopolies.

Appendix

In calibrating our model's parameters for our counterfactual exercises, we first assume that sample averages represent steady-state values. Our sample averages are based on 1980-2005 annual data from the IMF's *International Financial Statistics* database. The starting value varies across countries according to data availability. For the currency-deposit ratio, we divide currency outside banks (IFS series code 14A) by the sum of demand deposits (series 24), time, saving and foreign currency deposits (series 25) and money market instruments (series 26AA). The income tax rate is government revenues (series 81) divided by GDP (series 99b). The numerator for our ratio of government spending to capital is per capita government consumption (series 91f divided by series 99z) adjusted by the dollar exchange rate (series RF). The denominator consists of capital per worker (in dollars) reported in Table VII of Caselli and Feyrer (2007). Average deposit and lending rates are from IFS series 60L and 60P respectively, while average inflation is calculated from the rate of change of the consumer price index in each country (series 64). Growth rates are from the Beck, Demirguc-Kunt and Levine (2007) database (series *growthsh*), or, if not available from this source, they are the growth rate of real gdp over the sample period. Deposit reserve ratios are from the survey data in Barth *et al.* (2001).

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Table 1. Growth rate simulations

Brazil

	$\theta = 0.5$ ($\rho = 8.25$)				$\theta = 1.0$ ($\rho = 7.00$)				$\theta = 2.5$ ($\rho = 3.25$)			
τ_b	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*
Pro	10.45	21.24	2.50	–	10.45	21.24	2.50	–	10.45	21.24	2.50	–
100	10.45	22.31	4.09	1.59	10.45	22.31	3.29	0.79	10.45	22.31	2.82	0.32
75	9.80	22.96	5.06	2.56	10.12	22.98	3.80	1.30	10.32	22.99	3.02	0.52
50	9.23	23.53	5.92	3.42	9.80	23.61	4.27	1.77	10.18	23.66	3.22	0.72
25	8.72	24.04	6.69	4.19	9.51	24.20	4.71	2.21	10.05	24.31	3.42	0.92
0	8.26	24.50	7.37	4.87	9.23	24.76	5.13	2.63	9.93	24.94	3.61	1.11

Fixed parameters: $\tau_d = 20.00$ under prohibition, $\tau_d = 16.00$ otherwise, $\tau_i = 25.22$, v= 2.00, $R_l = 68.04$, $\pi = 6.39$; Model-dependent parameters: $\phi = 41.48$, $\beta = 11.70$

Chile

	$\theta = 0.5$ ($\rho = 2.25$)				$\theta = 1.0$ ($\rho = 1.30$)				$\theta = 2.5$ ($\rho = -1.56$)			
τ_b	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*
Pro	8.57	20.13	1.90	–	8.57	20.13	1.90	–	8.57	20.13	1.90	–
100	8.57	20.39	2.29	0.39	8.57	20.39	2.10	0.19	8.57	20.39	1.98	0.08
75	7.73	20.80	2.92	1.02	8.13	20.82	2.43	0.52	8.39	20.84	2.12	0.21
50	7.04	21.14	3.43	1.53	7.73	21.21	2.72	0.82	8.22	21.27	2.25	0.34
25	6.46	21.42	3.87	1.96	7.37	21.57	2.99	1.09	8.05	21.68	2.37	0.47
0	5.97	21.66	4.23	2.33	7.04	21.89	3.24	1.34	7.89	22.07	2.49	0.59

Fixed parameters: $\tau_d = 6.00$ under prohibition, $\tau_d = 4.8$ otherwise, $\tau_i = 24.19$, v= 1.06, $R_l = 27.05$, $\pi = 12.06$; Model-dependent parameters: $\phi = 5.64$, $\beta = 17.88$

Table 1. Growth rate simulations (continued)

Indonesia

	$\theta = 0.5$ ($\rho = 1.88$)				$\theta = 1.0$ ($\rho = -0.18$)				$\theta = 2.5$ ($\rho = -6.37$)			
τ_b	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*
Pro	12.33	17.65	4.13	–	12.33	17.65	4.13	–	12.33	17.65	4.13	–
100	12.33	17.84	4.43	0.30	12.33	17.84	4.28	0.15	12.33	17.84	4.19	0.06
75	8.34	18.22	5.06	0.94	9.95	18.30	4.66	0.53	11.25	18.36	4.36	0.23
50	6.30	18.42	5.39	1.26	8.34	18.61	4.91	0.79	10.35	18.80	4.50	0.38
25	5.07	18.54	5.59	1.46	7.18	18.84	5.10	0.97	9.58	19.17	4.62	0.50
0	4.24	18.62	5.72	1.59	6.30	19.01	5.24	1.11	8.92	19.49	4.73	0.60

Fixed parameters: $\tau_d = 5.00$ under prohibition, $\tau_d = 3.0$ otherwise, $\tau_i = 18.21$, v= 2.00, $R_l = 21.18$, $\pi = 10.49$; Model-dependent parameters: $\phi = 2.60$, $\beta = 48.86$

Mexico

	$\theta = 0.5$ ($\rho = 3.15$)				$\theta = 1.0$ ($\rho = 3.02$)				$\theta = 2.5$ ($\rho = 2.61$)			
τ_b	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*
Pro	12.72	30.66	0.27	–	12.72	30.66	0.27	–	12.72	30.66	0.27	–
100	12.72	31.34	1.43	1.16	12.72	31.34	0.85	0.58	12.72	31.34	0.50	0.23
75	10.45	32.23	2.95	2.68	11.48	32.32	1.68	1.41	12.19	32.38	0.86	0.59
50	8.87	32.85	4.00	3.73	10.45	33.12	2.37	2.10	11.71	33.33	1.18	0.91
25	7.70	33.31	4.78	4.51	9.60	33.79	2.94	2.67	11.26	34.22	1.48	1.21
0	6.81	33.66	5.38	5.11	8.87	34.36	3.42	3.15	10.84	35.03	1.76	1.49

Fixed parameters: $\tau_d = 10.00$ under prohibition, $\tau_d = 8.00$ otherwise, $\tau_i = 14.83$, v= 2.47, $R_l = 34.46$, $\pi = 22.82$; Model-dependent parameters: $\phi = 0.39$, $\beta = 30.28$

Table 1. Growth rate simulations (continued)

The Philippines

	$\theta = 0.5$ ($\rho = 0.87$)				$\theta = 1.0$ ($\rho = 1.32$)				$\theta = 2.5$ ($\rho = 2.65$)			
τ_b	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*
Pro	15.35	11.47	-0.89	–	15.35	11.47	-0.89	–	15.35	11.47	-0.89	–
100	15.35	11.70	-0.50	0.38	15.35	11.70	-0.70	0.19	15.35	11.70	-0.81	0.08
75	12.46	12.09	0.16	1.05	13.75	12.13	-0.33	0.56	14.67	12.16	-0.65	0.23
50	10.48	12.36	0.61	1.50	12.46	12.48	-0.03	0.86	14.04	12.58	-0.51	0.38
25	9.05	12.55	0.94	1.83	11.39	12.77	0.21	1.10	13.47	12.97	-0.38	0.51
0	7.96	12.70	1.19	2.08	10.48	13.02	0.42	1.31	12.95	13.33	-0.26	0.63

Fixed parameters: $\tau_d = 9.00$ under prohibition, $\tau_d = 7.20$ otherwise, $\tau_i = 15.37$, v= 0.69, $R_l = 16.25$, $\pi = 9.28$; Model-dependent parameters: $\phi = 3.65$, $\beta = 31.69$

South Africa

	$\theta = 0.5$ ($\rho = 0.08$)				$\theta = 1.0$ ($\rho = 0.63$)				$\theta = 2.5$ ($\rho = 2.26$)			
τ_b	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*	κ	R_d	γ	*gain*
Pro	5.28	12.71	-1.09	–	5.28	12.71	-1.09	–	5.28	12.71	-1.09	–
100	5.28	12.85	-0.88	0.21	5.28	12.85	-0.99	0.10	5.28	12.85	-1.05	0.04
75	4.72	13.01	-0.64	0.45	4.98	13.02	-0.86	0.23	5.16	13.02	-0.99	0.09
50	4.27	13.13	-0.44	0.65	4.72	13.16	-0.74	0.35	5.04	13.19	-0.94	0.14
25	3.90	13.24	-0.28	0.81	4.48	13.30	-0.64	0.45	4.93	13.34	-0.89	0.19
0	3.59	13.33	-0.14	0.94	4.27	13.42	-0.55	0.54	4.82	13.49	-0.85	0.24

Fixed parameters: $\tau_d = 5.00$ under prohibition, $\tau_d = 4.0$ otherwise, $\tau_i = 23.09$, v= 1.92, $R_l = 16.99$, $\pi = 10.24$; Model-dependent parameters: $\phi = 3.61$, $\beta = 19.07$