FINANCIAL DEEPENING

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Abstract
We develop a model of financial deepening, based on the distinction between limited bilateral commitment and limited multilateral commitment. We explore the effects of secular changes in financial depth on investment and output; on intermediation and interest rates; on the long-run velocities of circulation of different monetary instruments, and the use of outside money; on the patterns of saving and trade in paper. Three stages of financial development are identified. (JEL: E41, E43, E44, E51, O16, O42)

1. Introduction

Economists have long held the view that the development of the financial system (financial deepening) and economic development are closely intertwined.[1] The literature, however, contains relatively few formal models[2]—presumably because it has proved hard to integrate money and financial intermediation into a standard dynamic general equilibrium framework of macroeconomics and growth.

Here, we want to borrow from the model of money and liquidity that we developed in Kiyotaki and Moore (2004) to explore the impact of financial deepening. In that paper we drew a distinction between two aspects of financial contracting: bilateral commitment versus multilateral commitment. On the one hand, there may be a limit on how much a private agent can credibly promise to repay someone who provides finance: that is, the degree of bilateral commitment a borrower can make to an initial lender when selling a paper claim. On the other hand, there may be a limit on the extent to which the initial lender can resell the paper to someone else in a secondary market: in effect, the degree of multilateral commitment

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1. Goldsmith (1969), McKinnon (1973), and Shaw (1973) are among the earlier contributions, although the ideas date back to Adam Smith and Knut Wicksell. For more recent contributions, see, e.g., Bordo and Jonung (2003), and Demirguc-Kunt and Levine (2001).

2. Townsend (1983) is an early notable contribution.

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the borrower can make to repay any bearer of the claim.[3] Multilateral commitment to repay any bearer is generally more demanding than bilateral commitment to repay the initial lender because, as an insider, the initial lender may become better informed about (or develop greater leverage over) the borrower than an outsider. In broad terms, the degree of bilateral commitment in an economy places a bound on the entire stock of private paper, whereas the degree of multilateral commitment determines how much of this paper can circulate.

To be slightly more specific, we first assume that an agent can credibly commit to repay at most a fraction θ of his or her future output. The parameter θ in part reflects the legal structure and contractual redress available to a creditor in the event of default. In this sense, θ provides one simple measure of financial depth, capturing the degree of "trust" in the economy. We will be investigating the effects of an exogenous improvement in θ.

Second, we adopt the position that, unless steps are taken by the borrower at the time of issue, private paper cannot freely circulate later on, i.e., cannot easily be passed on at full value by the initial lender, an insider, to some new outsider. That is, ex ante, the borrower must expend resources in order that, ex post, outsiders are on an equal footing with the insider and paper is liquid. Without such expenditure, paper becomes illiquid after being initially sold: it cannot be subsequently resold in a secondary market. We interpret the conversion of illiquid paper into liquid paper as a rudimentary model of securitization, or financial intermediation—albeit that the borrower acts as his own intermediary at the time of issue. The costs of conversion are indexed by a parameter ϕ, which, like θ, is taken to lie between 0 and 1.[4] The higher is ϕ, the less costly is conversion. Taking ϕ to be another index of financial depth, we will be investigating the effects of an exogenous rise in ϕ.

We find that this "θ-ϕ model" predicts three stages of financial deepening, corresponding to three different regions of the θ-ϕ parameter space. In Region 1, where θ is low and there is little trust between agents, the economy is cash-based. Most saving is undertaken by holding cash, outside money that bears no interest (or, equivalently, by storing goods). That is, cash is used for both short-term and long-term saving. As there is a severe shortage of any form of commitment, there is very little private paper. All such paper is illiquid, and merely serves as a substitute for cash as a means of long-term saving. There is no financial intermediation because no one is willing to incur the conversion costs of issuing liquid paper if it commands no premium over illiquid paper. Since illiquid saving (holding illiquid private paper) earns no more than liquid saving (holding cash), agents are

3. These two aspects are spelt out further in Kiyotaki and Moore (2002).

4. The parameters θ and ϕ are akin to the parameters θ_1 and θ_2 we introduced in our earlier article Kiyotaki and Moore (2002)—except that θ_2 was simply the (exogenous) ratio of liquid to total paper, whereas in the present model this fraction is chosen by the suppliers of paper in response to equilibrium interest rates.

never "liquidity constrained": they are never constrained by their inability to resell private paper. However, agents with investment projects are "credit constrained": they would like to borrow more at the prevailing interest rate (zero), but are constrained by the upper limit θ. Without adequate means of transferring resources from savers to investors, the economy has too little investment. A rise in θ—financial deepening—would boost investment and output. As an example of an economy in Region 1, consider Europe in the early Middle Ages prior to the development of banking or negotiable financial instruments; or medieval India and China, sometimes described as graveyards of gold and silver.

In Region 2, where θ is higher and there is more trust, the economy enjoys specialized financial markets, in the sense that liquid paper is used exclusively for short-term saving, whereas illiquid paper is used for specific "point-to-point" long-term saving. Given its versatility, liquid paper sells at a premium over illiquid paper—there is an interest rate differential—and hence financial intermediation takes place: borrowers have an incentive to incur the costs of converting some of their illiquid paper into liquid paper at the time of issue. In saying that an economy has specialized financial markets, we mean the level of financial intermediation is such that, in relative terms, the supplies of liquid and illiquid paper balance the demands. The modern-day U.S. economy appears to be like this. However, the economy is not necessarily operating at first–best levels. The imperfections in financial contracting—in particular, the fact that θ is still appreciably below unity—imply that agents with investment projects are still credit constrained. Moreover, these agents are also liquidity constrained, insofar as they are constrained by their inability to resell their holdings of illiquid private paper. Given that too few resources are transferred from savers to investors, further financial deepening, through a rise in θ or ϕ, would boost investment and output in Region 2.

In an economy with a relatively high level of trust (θ high), if the costs of converting to liquid paper are high (ϕ low), there can be an imbalance between the supplies of liquid and illiquid paper. The markets are no longer specialized, in that savers resort to using cumbersome long-term savings portfolios, holding different vintages of illiquid paper as a surrogate for liquid saving. This is what distinguishes Region 3 from Region 2: without adequate financial intermediation, agents hold gross financial positions, with illiquid paper assets on both sides of their balance sheets. Arguably, the Japanese economy is currently in Region 3, with large cross-holdings of trade credit (and equity), and too little netting out. In financial terms, the economy is clogged up. However, this is not say that, in real terms, such an economy is necessarily operating less efficiently than an economy in Region 2. For a given level of ϕ, output is greater the higher is θ.

Indeed, with enough trust (θ close to 1, the upper part of Region 3), the economy can achieve first-best, despite the inconvenience of illiquid paper. Here agents neither are credit constrained (interest rates match the return on investment projects, and so the limit on borrowing, θ, is not binding), nor are liquidity constrained (there is no liquidity premium, no interest rate differential). In the limit, think of an Arrow–Debreu economy where θ equals 1, paper does not need to circulate (markets need not reopen), there is no financial intermediation and the value of ϕ is immaterial.

Section 2 presents the model. The three regimes are described in Section 3. Finally, Section 4 discusses what the model predicts about the long-run behaviour of the velocities of circulation of different monetary instruments. These predictions appear to square with the evidence given in, for example, Bordo and Jonung (2003).

2. A Model of Financial Deepening

The model from Kiyotaki and Moore (2004) is of a deterministic, discrete-time production economy with a single homogeneous good, corn, which can be stored one-for-one. Agents live for ever, and at the start of day t the utility of an agent is $\log(c_t) + \beta \log(c_{t+1}) + \beta^2 \log(c_{t+2}) + \cdots$, where c_{t+s} denotes his or her corn consumption in period $t+s$, and the discount factor β lies strictly between 0 and 1. To kick-start the economy, we assume that everyone is endowed with some corn, but only at the initial day $t = 1$.

Each agent undertakes a sequence of projects. Every three days, he starts a project that completes two days later. Given an even distribution of start-times, there are in effect three equal populations, indexed by whether an agent starts a project on days 1, 4, 7, ..., or days 2, 5, 8, ..., or days 3, 6, 9, ... The total population has measure 3.

Consider an agent starting a project on day t. To produce y corn on day $t + 2$, he must invest $G(y)$ corn. He is fully occupied throughout production: investing on day t, growing on day $t + 1$, harvesting on day $t + 2$. So he cannot operate overlapping projects. And since his human capital is a fixed factor, the cost function $G(\cdot)$ is strictly convex; specifically, $G(y)$ is proportional to $y^{1/(1-\lambda)}$, where λ lies strictly between 0 and 1.[5]

To raise funds for his project, the agent can issue claims against output. That is, on day t, he can issue "long-term" paper that matures on day $t + 2$. However, he has to contend with two imperfections in the funds market. First, because he can at any time threaten to withdraw his human capital from this new project, he cannot credibly pledge more than a fraction θ of the output (and he cannot raise anything against his future projects starting on days $t + 3, t + 6, \ldots$). θ is a key

5. We assume that an agent must invest every three days, without taking a break between projects, in order to keep his human capital intact. Alternatively, we might assume that λ is not too close to zero, so that the profit from a project is high enough to ensure that postponement isn't an attractive option (see Kiyotaki and Moore 2004).

parameter of the model. It measures the effective degree of commitment, or trust, in the economy. In our view, one important facet of financial development is the improvement in contractual arrangements and legal structures that shift bargaining power from debtors to creditors in the event of default and renegotiation; i.e., that raise θ. Thus, a prime focus of this article is on the long-run effects of an exogenous increase in θ.

Second, there is adverse selection in the day $t+1$ secondary market for his paper. We have in mind that a project comprises a large number of parts, some of which will eventually fail, although no one knows which when the project starts on day t. Overnight, the investing agent and any creditor who bought his paper on day t—who, as insiders, have access to the project—learn which parts will fail. In light of this, no outsider is willing to buy second-hand paper on day $t+1$, for fear of being sold "lemons". That is, although, ex ante, on the day paper is issued (day t) it can be freely sold to anyone, by the next day (day $t+1$) it becomes effectively illiquid: an initial creditor has to hold it until it matures (day $t+2$). For ease of reference, let's refer to this illiquid paper as blue paper.

There is an ex ante remedy to the problem of adverse selection. When starting the project on day t, the investing agent can bundle the parts together in such a way that they cannot later be unbundled. Paper secured against bundled parts is liquid on day $t+1$: it can be resold because outside buyers are confident of getting a fair mix, not just lemons. Call this red paper: like blood, it circulates. Thanks to its negotiability, red paper serves as inside money: people accept newly issued red paper for its exchange value rather than its maturity value. It provides liquidity, the means of short-term (overnight) saving.

Bundling is costly. To bundle a portion z $(\leq y)$ of the day $t+2$ output costs the investing agent an additional $[(1-\phi)/\phi]G(z)$ units of corn on day t, where ϕ lies strictly between 0 and 1. ϕ is the other key parameter of the model. The lower is ϕ, the higher are these additional costs. Note that because bundling yields no extra output, the costs are essentially deadweight. The only social purpose is to allow middle-aged paper to change hands.

We see bundling as a rudimentary form of banking: the conversion of illiquid into liquid paper. In this model, entrepreneurs (investing agents) are their own bankers; there are no financial intermediaries. We think another important facet of financial development is the reduction in the costs of financial intermediation, and the emergence of negotiability and securitization. Our second main focus, therefore, is on the long-run effects of an exogenous increase in ϕ.[6]

6. Financial deepening is also linked to better communication among lenders to keep track of individual borrowers. A borrower then has an incentive to build and maintain a reputation, not only to honour a bilateral commitment to the creditor who initially buys his paper, but also to honour a multilateral commitment to any subsequent bearer of the paper. Although this kind of reputational mechanism is not part of our formal analysis, we conjecture that it would serve to reinforce the effects of secular increases in θ and ϕ.

To be more specific, we want to investigate the impact of financial deepening—as captured by upward shifts in θ and ϕ—on output, on the patterns of trade in paper, red and blue, and on their respective prices, returns and interest rates. We restrict ourselves to a comparison of symmetric, steady-state equilibria—by which we mean aggregate quantities and prices are constant, and individual agents' activities follow identical three-period cycles (investing/growing/harvesting). We will identify three stages of financial development that are suggested by the model. There is space here to describe only briefly the three regimes; full details can be found in Kiyotaki and Moore (2004).

It should help to bear in mind the following points about any equilibrium. Because of an agent's logarithmic preferences (implying unbounded marginal utility at zero), he will consume corn every day, including on investing and growing days, albeit that he is rich in corn only on harvesting days. Hence on each harvesting day he will save for both of the following two days. On the one hand, red paper is suitable for saving overnight, from harvesting day to the next day, an investing day. In the absence of shocks, he is indifferent between holding newly issued or second-hand red paper, so the (gross) return on either must be equalized—say to $1/p$. That is, the price, in terms of current consumption, of a liquid claim to one unit of corn in two days' time is p^2, the price of a unit of newly issued red paper; and the price of second-hand red paper is p. On the other hand, newly issued blue paper is ideal for his saving over two nights, from harvesting day to the next growing day (point-to-point long-term saving). Let the price of a claim to one unit of corn in two days' time, that cannot be resold in the meantime, be q, the price of a unit of newly issued blue paper. Blue paper never yields less than red paper, otherwise it would be strictly dominated (it would be less resaleable and have a lower return), so $q \leq p^2$. Any difference, $p^2 - q$, is a liquidity premium that newly issued red paper commands over blue, and, we shall see, arises endogenously depending on the stage of financial development. The difference in overnight returns, $(1/\sqrt{q}) - (1/p)$, corresponds to the "interest rate" that appears in Keynesian models of liquidity preference: the difference in return that bonds enjoy over money, where here we take "bonds" to mean the illiquid blue paper.

Since agents always have the option of storing corn one-for-one, the net return on red paper cannot be negative, i.e., $p \leq 1$. At an advanced stage of financial development, when the supply of liquidity is high enough, this inequality may be strict. Otherwise, agents are indifferent between holding red paper and storage. Socially, it is inefficient to tie up corn in storage. As Samuelson (1958) pointed out, everyone would be better off if, instead of storing, they saved using some intrinsically useless object—green paper, say—which can be construed as outside money. In such an equilibrium, outside money plays an essential role, even though its steady-state net return is zero (assume a constant supply of outside money, so there is no inflation). From now on we suppose that green paper is used in lieu of storage. Remember that green paper can only have value if $p = 1$. So, when the economy uses outside money, the Keynesian interest rate is simply $(1/\sqrt{q}) - 1$, the overnight interest rate on bonds.

After we have described the three stages of financial deepening suggested by the model, we will return in Section 4 to the question of whether outside money circulates alongside inside money.

3. Three Stages of Financial Deepening

The continuous lines in Figure 1 divide the θ-ϕ parameter space into three regions (for the moment, ignore the dashed line), with different patterns of trade in red and blue paper. We should warn that although we label these regions 1, 2, and 3, they need not correspond to chronological stages of financial development. In particular, the southwest parts of Region 3 are less developed than the northeast parts of Region 2.[7]

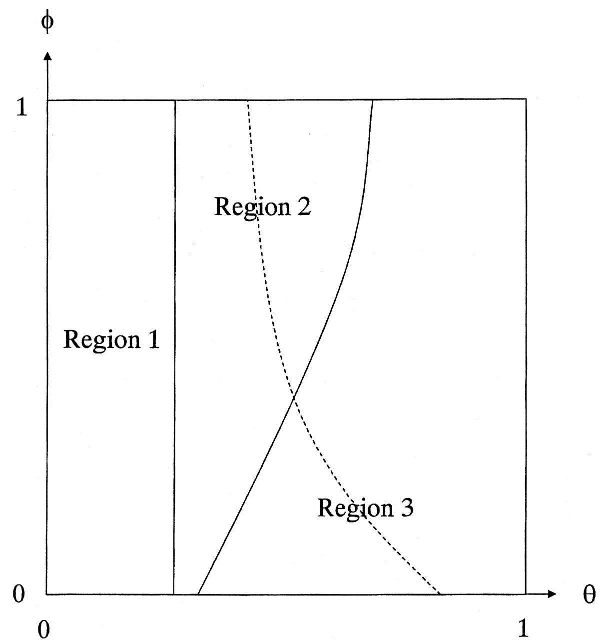

FIGURE 1. Three regions of financial deepening.

7. Although globally the boundary between Regions 2 and 3 slopes upwards, there may be local non monotonicities.

3.1. Region 1 (A Cash-Based Economy)

In financially undeveloped economies where there is little trust, θ is low and the supply of private paper is small. Agents' savings demand can be satisfied only through the use of outside money, green paper, which has zero net return. Each day, the supply of blue paper by investing agents is not even sufficient to meet the demand for illiquid paper by harvesting agents who are saving for consumption in two days' time (their next growing day). That is, blue paper competes directly against green paper held twice, and so must also have zero net return: $q = 1$.

Were red paper to be issued, it too would have zero net return, i.e., p would also equal 1. But then there would be no liquidity premium, and no return to bundling. Hence no investing agent chooses to incur the costs of bundling and issue red paper. Blue and green paper are the only savings instruments available. Green paper provides the exclusive means of saving overnight between harvesting and investing days. Consumption on growing days is financed by a mix of blue paper held over two nights (from the previous harvesting day) and green paper held overnight (from the previous investing day, which was in turn held over from the previous harvesting day): see panel 1 in Figure 2. Since neither savings' avenue earns any interest, agents are indifferent between them. On investing days, agents are not "liquidity constrained", inasmuch as they are not constrained by their inability to resell blue paper. However, they are "credit constrained", because they would like to borrow more at the prevailing interest rate (zero) but are constrained by the upper bound θ.

This kind of equilibrium corresponds to a cash-based economy in which, although there is an element of private debt, there is no banking (bundling), and no inside money. Investment and output are too low, relative to first-best: the absence of properly functioning paper markets means that too little corn is passed from savers to investors. Note that, within Region 1, an increase in ϕ would have no effect on the equilibrium since investing agents are not bundling; whereas an increase in θ would allow investing agents to borrow more, which would boost output without raising interest rates above zero.

3.2. Region 2 (An Economy with Specialized Financial Markets)

In more financially developed economies, with higher θ and a greater degree of trust, there is a liquidity premium and investing agents supply inside money, red paper, by bundling part of the output from their projects. Savers use specialized instruments, in the following sense. Each harvesting agent saves short-term (overnight for the next day's investment and consumption) by holding money: red paper, or perhaps green. And he saves long-term (over two nights for consumption on the next growing day) by holding bonds: blue paper. See panel 2 in

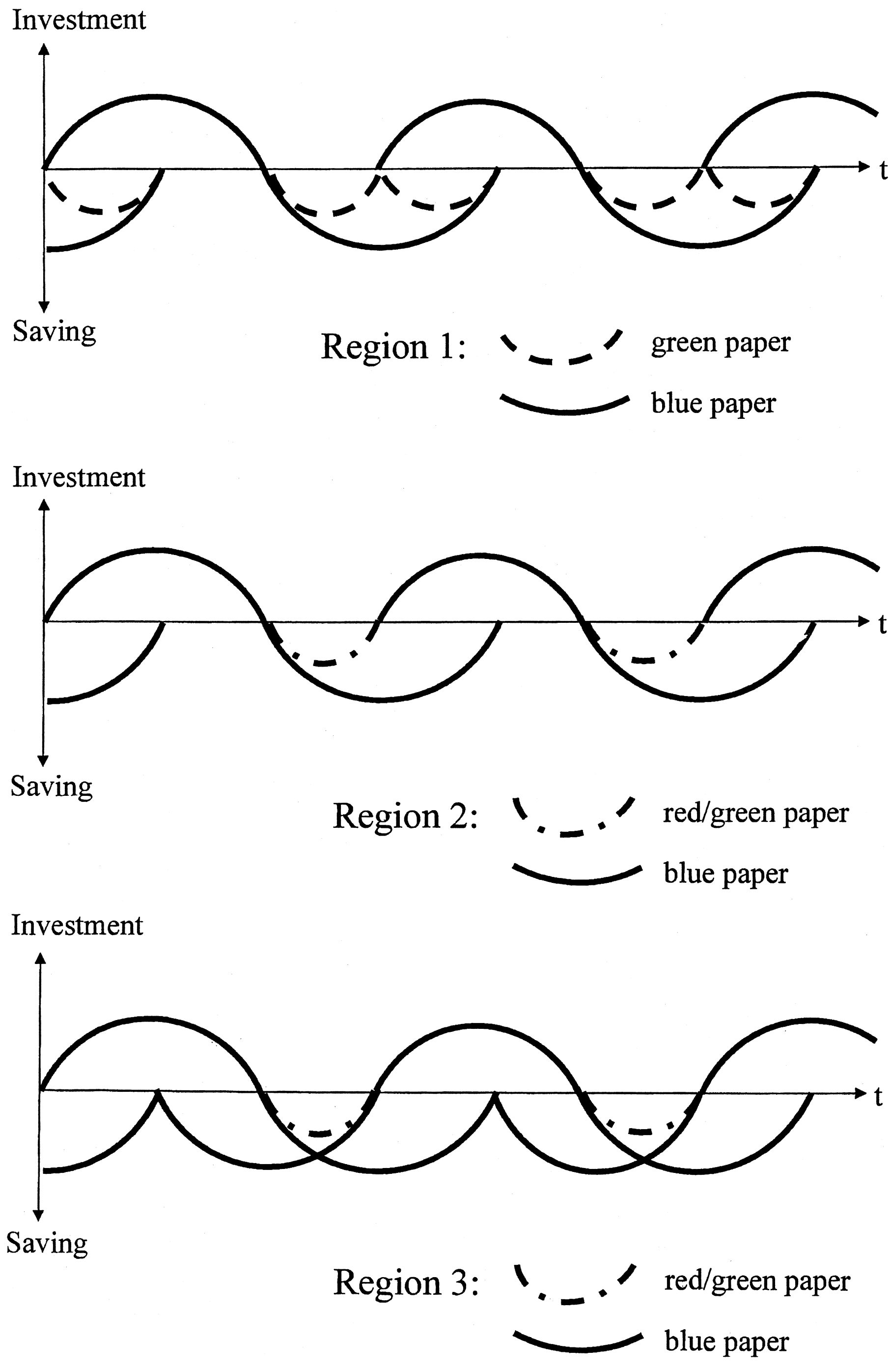

FIGURE 2. Patterns of trade in paper.

Figure 2. Roughly speaking, there in complete specialization between the liquid and illiquid paper markets.

Given such specialization, the economy appears to make best use of the different forms of commitment power: bilateral commitment (blue paper) for specific, point-to-point, long-term saving versus multilateral commitment (red paper) for short-term saving. But this is not to say that first-best is achieved. The shortage of paper keeps prices too high: In a first-best equilibrium p would equal β and q would equal β^2, whereas here $p > \beta$ and $q > \beta^2$.[8] Investing agents are still credit constrained, but now they are liquidity constrained too, because they are constrained by their inability to resell blue paper. Investment and output are still too low, relative to first-best. Within Region 2, further financial deepening, through an increase in θ (resp. ϕ), would directly lead to greater supply of paper (resp. liquidity), which would in turn facilitate the transfer of more resources (corn) from harvesting agents to investing agents, thereby boosting investment and output.

3.3. Region 3 (An Economy with Gross Financial Positions)

With a reasonably abundant supply of bonds (θ high), if bundling is too costly (ϕ low) there is an imbalance, with too little money relative to bonds. In response to the liquidity shortage, the economy makes a remarkable response. Each agent holds an elaborate overlapping savings portfolio as a means of getting round the inconvenience of having to keep the illiquid bonds over two nights until they mature. See panel 3 of Figure 2.

At the time of harvest, an agent adopts a mix of a "fast" savings strategy and a "slow" strategy. The fast strategy is to hold money (red paper, or perhaps green) overnight for the next day's investment and consumption. The drawback to this is that the return on money is low. The slow strategy entails buying illiquid bonds (blue paper) twice in succession, over four nights, until the following investing day. The drawback to this is that, at the margin, a profitable investment opportunity is put on hold for three days. To compensate, bonds earn a higher return than money. For an agent to be indifferent between these two strategies, the overnight return on red paper must equal the four-night return on holding blue paper twice, discounted by the three-night subjective factor β^3; i.e., $(1/p)$ must equal $\beta^3(1/q)^2$.[9]

Observe that, at the time of investment an agent simultaneously holds paper on both sides of his balance sheet. As in Region 2, he is liquidity constrained as well as credit constrained. But, unlike in Region 2, on the asset side, he holds

8. In fact, $q > (\beta^3 p)^{1/2}$. As we shall see, in Region 3 this becomes an equality.

9. The agent's discount factor equals β^3 given that his consumption pattern follows a three-period cycle.

middle-aged blue paper that he purchased the previous day (when harvesting), which more than pays for this consumption the following day (when growing). Of course he would like to divest himself of this surplus paper in order to raise more investment funds, but unfortunately he can't resell it.

This pattern of trade places a great weight on the paper markets. On any day, only the investing agents are issuing paper, whereas both the harvesting agents and the growing agents are buying it. The overlapping savings portfolios depicted in panel 3 generate a large demand for paper.

It should be noted that in the upper part of Region 3, where θ is very high (but still below 1)—i.e., where there is a great deal of trust—the economy performs well. The first-best is attained without the need for any circulation of paper: q equals β^2, there is no liquidity premium, and no need for any money, inside or outside. For these very high values of θ, then, the value of ϕ is immaterial. We see this as a nice example of the power of Adam Smith's "invisible hand", to create double-coincidences-of-wants in dated goods, wriggling round the inflexibility of illiquid paper. Think of the Arrow-Debreu economy as the extreme case of perfect bilateral commitment, where resaleability is not an issue because markets need not reopen.

However, when there is less trust, for lower values of θ in Region 3, the shortage of liquidity puts strain on the economy. Output and investment are below first-best. Greater financial deepening through a reduction in the costs of bundling (an increase in ϕ) would serve to increase the supply of inside money, boost output, and push the economy towards Region 2—witness the upward-sloping boundary between Regions 2 and 3. That is, multilateral commitment can substitute for bilateral commitment. Red paper works harder than blue.

In the equilibrium of Region 3, then, unless θ is very high, banking and financial intermediation are not developed enough relative to the scale of economic activity. The costs of bundling are too high: ϕ is too low, which leads to a liquidity shortage. Loosely put, there are too many bilateral contracts clogging the financial system; there is too little securitization. Agents hold gross financial positions that, ideally, should be netted out.

4. Long-Run Velocities

The international evidence provided by Bordo and Jonung (2003) and others suggests that over the long-run, presumably as a result of financial development: (i) the value of money divided by output—the money/output ratio (the inverse velocity)—is hill-shaped; and (ii) the broader is the monetary instrument, the later the peak of the hill arrives. With θ and ϕ taken as indices of financial development, our model makes the same predictions. We concentrate here on the effects of increasing θ (the conclusions for ϕ are similar).

First, take the narrowest form of instrument: outside money, green paper. For low values of θ, in region 1, the zero return on green paper dictates equilibrium prices: its only competitor is blue paper, whose interest rate also has to equal zero. Within region 1, a higher θ raises the nominal value of output, which lowers the green paper/output ratio. In Regions 2 and 3, however, green paper circulates alongside red paper—and then only if $p = 1$. Eventually, as θ rises and we move east in Figure 1, we reach the boundary where green paper ceases to have value: see the dashed line. The green paper/output ratio drops monotonically to zero. That is, in graphing the outside money/output ratio against θ, we trace the right-hand, downward-sloping half of a hill. The peak is at zero.

Incidentally, note that the point where green paper ceases to circulate may be in Region 2 or 3, depending on the value of ϕ. The higher is the value of ϕ, the less is the cost of bundling, the greater is the supply of red paper, and the sooner green paper disappears.

Turn now to a broader instrument: inside money, red paper. In Region 1 there is no red paper, so the red paper/output ratio equals zero. As θ increases in Figure 1 and we move east into Region 2, then into Region 3, red paper is used increasingly then decreasingly. Ultimately, we reach a point in Region 3 where, for very high levels of θ, the first-best can be attained: no deadweight costs of bundling are incurred and no red paper is supplied to the economy. One can show that the inside money/output ratio is indeed hill-shaped (see Kiyotaki and Moore 2004). And, clearly, the peak occurs at a higher value of θ than for outside money. Similar conclusions hold for the shape of the total money/output ratio, where total money is red plus green paper. All this appears to square with the evidence.

Intuitively, in a primitive economy without much trust between insiders (low θ), the only paper to circulate is outside money (green paper).[10] Newly issued illiquid private paper (blue paper) is too scarce to be bought at a discount. Greater trust (bigger θ) leads to a greater stock of private paper; its price falls, which creates a liquidity premium, and as a result there is financial intermediation: the economy is supplied with inside money (red paper). With yet more trust (high θ), the price of inside money falls too; it earns positive interest and drives away outside money. Ultimately (for very high θ), however, the supply of illiquid private paper is so great that the economy can manage without any money, inside or outside. Collecting these observations together to trace the path of financial development, we see that, initially, outside money is used; then inside money emerges and starts to dominate; but finally it too drops out of circulation.

Two final caveats are in order. First, in our analysis we have taken the three-period pattern of production as fixed. Suppose, concurrent with financial development, the pattern of production became more complicated—e.g., suppose projects took four days rather than three, or the timing of projects were stochastic. Then the

10. If outside money is not trusted either, only storage is used for short-term saving.

demand for intertemporal exchange would grow. The increase in demand could outstrip any increase in the supply of paper and liquidity, in which case money would not disappear.

Second, in very primitive—village—economies, where people know each other well and travel little, there is scope for more sophisticated intertemporal trading and mutual insurance arrangements sustained by individuals' reputations. In a sense, these economies enjoy a lot of trust, and are akin to our model with a very high θ, where money is not used.

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