The Empirics of International Currencies: Evidence from the 19th Century

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ABSTRACT

The Empirics of International Currencies: Historical Evidence*

Using a new database for the late 19th century, when the pound sterling circulated all over the world, this paper provides the first review of critical empirical issues in the economics of international currencies. First, we report evidence in favor of the search-theoretic approach to international currencies. Second, we give empirical support to strategic externalities. Third, we provide strong confirmation of the existence of persistence. Finally, we reject the view that the international monetary system is subject to pure path dependency in that it cannot remain locked into some past equilibrium. Our conclusion is that, for the late 19th century at least, money and trade were complements.

JEL Classification: F31 and N32
Keywords: dollar, international currencies, persistence, search theoretic approach to money, sterling and strategic externalities

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"For better or worse – and opinions differ on this –
the choice of which language and which currency
is made not on merit, or moral worth, but on size."
(Kindleberger 1967, p. 11)

One century ago, the United States set up a special expert body, known as the National Monetary Commission, to discuss ways and means to provide for a better management of the U.S. dollar and in particular to promote its role as an international currency. The U.S. National Monetary Commission led to creation of the Federal Reserve System and establishment of a large market of dollar "acceptances" that facilitated foreign holdings of the U.S. currency (Meltzer 2003). In the following decades, the dollar began an unchallenged ascent that transformed it into the world currency we know today.

Recently, however, the advent of a single European currency, mounting U.S. external indebtedness, and the rise of China have fueled considerable interest in determining whether this leadership is here to stay. Discussion of whether the dollar is at risk of losing its international currency role has become widespread in policy circles.

It is generally agreed that monetary leadership confers substantial benefits. One such benefit is easier management of external imbalances, because the market for assets denominated in a leading currency is liquid: think of the United States today. Estimates put the annual benefits to the United States of the dollar's key currency role at 2 percent of U.S. gross domestic product (Gourinchas and Rey 2005). In contrast, countries with exotic currencies are led to denominate their debts in foreign currency. They become vulnerable to crises: think of Indonesia in 1997. Research has set the cost for emerging countries of not being able to denominate their debts in domestic currency at U.S. $107 billion annually (Eichengreen 2004).

But applied research sheds little light on the sources of monetary leadership. In particular, the existing empirical literature does not take advantage of modern theory's critical advances. This paper brings new data and methods to bear on this topic. We focus on the late 19th century, when the pound sterling was the ruling currency. Because of free capital mobility and lack of

exchange controls, this period provides a unique natural experiment to study the forces through which international currencies emerge.

In this paper, we exploit insights from a new dataset constructed and described in previous joint research (Flandreau and Jobst 2005). This database records information on the currencies that were actually traded in every foreign exchange market circa 1900, and thus captures neatly the intriguing phenomenon of foreign circulation. We study it by using insights from modern theories of international money. These theories have three distinct features: they suggest that the emergence of international currencies is predicated on the existence of transaction costs; they emphasize the role of strategic externalities; and they predict various degrees of persistence in monetary leadership. Although these insights have so far remained fairly abstract and detached from empirical concerns, this paper reports strong supportive evidence.

The remainder of the paper is organized as follows. Section I provides an overview of the main intuitions in existing theories of monetary leadership. Section II studies the determinants of foreign circulation, and Section III reports evidence of strategic externalities. Section IV addresses the issue of persistence of international currency status. We end with general conclusions and speculations for the future.

I. The International Monetary System: Theory

The central motivation of the theory of international currencies is to explain this remarkable phenomenon: In general, a few currencies dominate the international scene, and one member of the group secures preeminence (Matsuyama et al. 1993). This role was played by the Dutch guilder in the 17th and 18th century, by the pound sterling in the 19th and early 20th century, and by the U.S. dollar since the mid-20th century.

Following Menger (1892, p. 254), theoretical approaches to this phenomenon have emphasized the role of transaction costs in coordinating agents on a single currency. Agents

select as money the assets that entail the smallest difference between the price at which they can be acquired and the price at which they are resold (a difference also known as the bid-ask spread). In other words, "liquidity" is a primary determinant of the emergence of a given currency.

From this common thread, the literature has provided two alternative emphases. One, pioneered by Hayek's work on currency competition, relates "liquidity" to underlying policies (Hayek 1976). For instance, monetary instability increases the transaction costs associated with using a given currency. This is because the resulting uncertainty makes agents less willing to accept that currency unless they are provided with a greater margin to cover them against future losses. Currencies whose value is beyond suspicion do not suffer from this flaw and so tend to displace the former ones (Calvo and Vegh 1992). Yet the resulting currency substitution does not imply that a single currency will dominate; rather, it implies that the number of currencies used internationally may be smaller than the number of existing currencies.

Note also that currency substitution should have disciplinary effects on monetary authorities because it entails costs in the form of forgone seigniorage. This game-theoretic implication was anticipated by Hayek (1976, Chap. VIII, p. 48) and is also a central aspect of modern theories of credibility (Kydland and Prescott 1977; Barro and Gordon 1983). Li and Matsui (2005) have provided the first explicit application of this insight to the theory of international currency in the framework of the search-theoretic approach to money. Using a two-country, two-currency framework, they discuss the strategic interactions between governments that compete for seigniorage and face the possibility of currency substitution.

The alternative view – pioneered by Kindleberger (1967) – is that transaction costs are determined by market size. Currencies with a large area of circulation are easily resold, for one can conveniently meet someone else who is willing to purchase them. One implication is that

international currencies are valuable because many other parties are using them,[1] generating strategic externalities. This issue is discussed in a first family of models with cash-in-advance constraints (Krugman 1980; Rey 2001).[2] Strategic externalities are captured by positing a unit cost function that is decreasing with the volume of transactions using a given vehicle currency: as more agents adopt the currency, the cost of using it also decreases. This creates persistence. Rising trade powers have difficulties pushing their currency to the top, since the established currencies tend to capture the market for new transactions. Therefore "history" determines current outcomes.[3]

Matsuyama and colleagues (1993) and Kiyotaki and Wright (1993) provided rigorous search-theoretic foundations for these insights. Their models focus on the transaction services that currencies provide in an uncertain matching environment. When an opportunity to trade occurs, agents holding the "wrong" currency suffer a utility loss compared to when holding the "right" one. Agents consistently try to adjust ex ante their holdings and so achieve optimality. Here again, strategic externalities emerge naturally because equilibrium outcomes are influenced by other agents' choices. Depending on the model's parameters, various degrees of persistence are also observed.

Before we conclude this section, two remarks are in order. First, we emphasize that the approaches just identified are not mutually exclusive. As Ravikumar and Wallace (2001) remarked, the formalism introduced by Matsuyama et al. (1993) is well suited to the study of currency substitution. As a result, an expanding theoretical literature has combined the insights

[1] . "World efficiency is achieved when all countries learn the same second language" (Kindleberger 1967, p. 9).

[2] . Note that Kindleberger himself backed away from this conclusion. However, some statements suggest that he briefly toyed with the idea. For instance, he argues that the selection of the dollar was "the work of circumstances" (1967, p. 10), which may be seen as a recognition of the possibility of multiple equilibria.

[3] . Krugman (1980, p. 523) argues that "*it seems clear that history will matter*. Once an exchange structure is established, it will persist… Suppose, for instance, that the currency of an economically dominant country becomes established as vehicle. This role will be self-reinforcing, swelling transactions in the currency. Even if the country's predominant position vanishes, its currency's special role may then persist. [This explains] the persistence of sterling's role as a vehicle, long after British commercial preeminence had passed" (our italics). Krugman concludes that modern models "look as if they have something to do with the actual experience of international monetary history."

from models of currency substitution with the rigorous foundations that can be gleaned from search-theoretic approaches to money (Craig and Waller 1999; Engineer 2000; Head and Shi 2003; Peterson 2004).

Second, the theoretical literature on international currencies has progressed with very limited support from actual data. Yet a simple look at the historical evidence reveals an empirical puzzle: If history is as important as modern models suggest, then how does one explain that today the U.S. dollar, not the pound sterling, is the world's leading currency? This paper provides answers.

II. The International Monetary System: Evidence

A. Exchange Matrices: Theory and Data

A theory of international circulation is one that explains why certain currencies circulate abroad while others don't. To show how such theories should be tested, we build on Krugman's concept of the "exchange structure" (Krugman 1980). Consider a world where there are n countries, each with one currency and one foreign exchange market. Let's call a_{ijkt} the amount of currency i that has been sold against currency j on market k during period t. Recording a_{ijkt} for all i, j and k produces a three-dimensional matrix of dimension nxnxn. Krugman's study considered a restriction of this general framework to a three-country world with consolidated clearing according to currency pairs, so that there were three potential foreign exchange markets and the exchange structure was the 3x3 symetrical matrix.[4]

$$\Xi = \begin{pmatrix} \otimes & a_{21} & a_{31} \\ a_{21} & \otimes & a_{23} \\ a_{31} & a_{32} & \otimes \end{pmatrix}. \qquad (1)$$

[4] . In a given market, exchanging currency i against currency j is the same as exchanging currency j against currency i, so symmetry obtains ($a_{ijk} = a_{jik}$). In general, one would want to determine why bilateral exchange takes place in certain countries but not in others. For the sake of simplicity, this paper abstracts from this issue while recognizing its importance.

In this framework, a theory of international currencies is a set of arguments explaining why, in equilibrium, a minority of foreign exchange markets and currencies are used ($a_{ijkt} > 0$) while the majority is neglected ($a_{ijkt} = 0$). However, existing databases are inadequate to address this central question, owing to the very way information is collected. For example, the latest version of the Bank of International Settlements' *Triennial Survey* (BIS 2005), the most comprehensive reference source for bilateral foreign exchange activity, documents 41 independent currencies. If all transactions were consolidated according to currency pairs then there would be 820 possible cells.[5] But the *Survey* actually reports aggregate bilateral turnover for nine currency pairs only. As evidence from the financial press suggests and interviews with BIS statisticians confirm, this is only a fraction of all the relevant trades, and the complete list of existing routes is not known.[6] The use of such databases to test alternative assumptions on currency circulation is obviously inadequate as a result of the inherent selection bias.

This selection bias is central to all empirical studies of which we are aware. For instance, Krugman (1984) and Rey (2001) provided casual discussions of the historical relation between trade and currency status, but their evidence is limited to fragmentary elements on two international currencies (the U.S. dollar and the pound sterling). Other works build on research on foreign exchange (FX) market microstructure: Frankel et al. (1996) and Hartmann (1998) sought to analyze the determinants of pair wise liquidity in FX markets. These studies have concentrated on explaining the time-series pattern of bid-ask spreads for some leading bilateral foreign exchange markets, yet they have consistently ignored the reasons why a majority of currencies are never used.[7]

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[5] . nx(n-1)/2=820 when n=41.

[6] . Currency pairs not documented include "Nokkie-Stokkie" (Norwegian krone vs. Swedish krona), "Huf-Puf" (Hungarian forint vs. Polish zloty), "Kiwie-Aussie" (pretty obvious), and others: See Jennifer Hughes, "Non-dollar exchange traders hunting value cannot ignore US currency," *Financial Times* (November 17, 2005).

[7] . An extension of this literature is Lyons and Moore (2005), who derive conditions under which information asymmetries cause transactions to be concentrated in a handful of currencies.

Another set of empirical studies has analyzed the determinants of the currency composition of international reserves. Researchers have studied the effects of factors such as the size of the issuing country and its record of price-level and exchange-rate stability (Dooley et al. 1977; Eichengreen and Frankel 1996; Eichengreen 1999; Eichengreen and Mathieson 2001; Chinn and Frankel 2005; Eichengreen 2005). Others have looked at the currency of denomination of international bond issues. Eichengreen and colleagues (2005) show that country size is the most important determinant of the currency denomination of international bond issues. Cohen (2005) finds that exchange-rate movements, interest differentials, and the installed base (the amount of home-country issuance) have the greatest influence on the currency shares of international bond issues. But here again, since there is only data for those few currencies that are used as reserves or for debt denomination, these studies tell us nothing about why those particular currencies are selected in the first place.

Finally, there are a few studies focusing on the currency denomination of trade. One recent contribution is Goldberg and Tille (2005); using data on the choice of invoicing currency for 24 countries, they find that this choice depends on the amount of trade conducted with the issuing country and on business cycle considerations. Thus, available studies have in common a focus on the factors determining the relative importance of a small number of international currencies within foreign currency "portfolios". But the research does not really address the reasons why international currencies exist.

B. Monetary Status: A Limited-Dependent Analysis

What is needed, therefore, is a database that distinguishes currencies with an international circulation from currencies without. In Flandreau and Jobst (2005) we collected precisely this kind of data for the late 19th century. That period was the heyday of a system that had developed in the late Middle Ages. Every national financial center featured a foreign exchange market where bankers bought and sold foreign currency "bills of exchange" or "foreign

exchange", foreign currency time deposits) against domestic currency. These foreign exchange bills served to finance both commercial and capital transactions. In each center, local bulletins reported the fixing prices for foreign currencies that were actually traded. These publications can thus be viewed as spy ware devices that inform us whether or not a given foreign exchange route was used, recording "x_{ij}=0" if a_{ijk}=0 or "x_{ij}=1" if a_{ijk}>0. One can then use these x_{ij} to construct an *exchange matrix* Ω, which is a dichotomous mapping of the exchange structure:[8]

$$\Omega = \begin{pmatrix} * & x_{12} & x_{13} & \dots & x_{1n} \\ x_{21} & * & \dots & \dots & \dots \\ x_{31} & \dots & * & \dots & \dots \\ \dots & \dots & \dots & * & x_{n-1n} \\ x_{n1} & \dots & \dots & \dots & * \end{pmatrix}. \qquad (2)$$

The x_{ij} terms in the exchange matrix can be used to explain why certain currencies circulate abroad.

The information in the exchange matrix for 1900 is summarized in Figure 1, which aggregates the x_{ij} for all i's, $\forall j$. This gives an indication of the international "popularity" of alternative currencies, since it shows the number of foreign markets where a given currency is traded. Unsurprisingly, the pound sterling is ranked first.

Our strategy for explaining why the international monetary system looked the way it did in 1900 is to analyze the availability of currency j in market i as reflecting rational decision making. If agents in market i find it valuable to trade currency j, then a foreign exchange quote will be posted in the local bulletin. Calling u_{ij} the value of using currency j in market i, we can write the model as

$$x_{ij} = \begin{cases} 1 \text{ if } u_{ij} > 0, \\ 0 \text{ if } u_{ij} \le 0. \end{cases} \qquad (3)$$

[8] . Technically, the exchange matrix thus considers only trades against domestic currency, so that there are only two possible markets where trade in a given currency pair can take place. See note 6.

Here u_{ij} may depend on any variable we wish. Calling y_{ij} the vector of variables influencing u_{ij} and assuming that it is a linear function of its arguments (β is a vector of parameters, η_{ij} a random shock, F the cumulative distribution of ηij), we write

$$\Pr(x_{ij} = 1) = \Pr(y_{ij} \cdot \beta + \eta_{ij} \geq 0) = 1 - F(y_{ij} \cdot \beta). \quad (4)$$

To specify the arguments in the value function, we translate theoretical insights into the actual institutional setup of the time. As we shall see, this is a natural way to proceed, because it provides a historical motivation that is largely consistent with the insights from modern theories.

Consider market *i*. There, any banker can in principle draw a draft denominated in any foreign currency, as this merely implies making international arrangements with correspondents. Resulting costs could then be passed on to customers, so the question then becomes whether these costs would generate enough value for customers to pay for it. If not, there would be no local demand and the market for such bills would dry up. Thus, in the end, one expects to observe a market only in those currencies in which it is advantageous to transact.

We consider two families of explanatory factors. On the one hand, the currency substitution approach suggests that currencies with a higher risk of losing their value are penalized (Li and Matsui 2005). This may be the case if the country has a high inflation rate or displays exchange-rate volatility. It may also be the case if the country has a high debt burden, a poor reputation, or a bad economic record, since these factors are commonly believed to be good predictors of currency depreciation. In the absence of reliable price data for a number of countries in the sample, we capture monetary stability by using a gold-standard dummy variable (Bordo and Rockoff 1996; Flandreau and Zumer 2004). This takes care not only of foreign exchange stability but also of price stability, since inflation is endogenous in a fixed-exchange-rate system. Consistent with our previous remarks, these variables are supplemented with fiscal and

reputation indicators.[9] We measure the debt burden using the debt/GDP ratio (Flandreau et al. 1998). We capture reputation using the yield on gold bonds issued in international markets. Finally, we measure economic performance using GDP per capita (Bordo and Rockoff 1996). We call this first group of variables *good housekeeping* factors.[10]

The second group of variables is referred to as *matching* factors, which are inspired by a search-theoretic approach that emphasize searching costs. One important ingredient is inventory costs. For instance, Kiyotaki and Wright (1989, 1993) allow for heterogeneous costs of holding different currencies. Another important element is the probability of "meeting one's match". This probability may be reduced when agents are somehow "distant" from one another (see Matsuyama et al. (1993) and Kiyotaki and Moore (2003); see also Trejos and Wright (1996) and Ravikumar and Wallace (2001) for alternative interpretations). But, the probability of a meeting increases with the size of the trading partners (see e.g. Zhou 1997), a feature that is also emphasized in other approaches such as Rey (2001).

Historical evidence provides a natural way to translate these theoretical insights into measurable factors. First, relevance of inventory costs is ascertained in historians' discussions of bankers' drawing techniques, whose logic really dated back to the latte Middle Ages. Because international exchange instruments ("bills") were really international credit, bankers had to take into account interest rates, which reflected inventory costs. In his classic study of Renaissance finance, de Roover finds abundant anecdotal evidence of warnings against drawing bills on centers where interest rates are permanently or even temporarily high. For instance, one banker indicated that when interest rates were high in Barcelona, bankers in Florence and elsewhere refrained from drawing on that center: "*laudiamo la rimessa ma non la tratta*" (de Roover 1968, pp. 48-9). Flandreau and Gallice (2005) find similar evidence for the late 19th century. This

[9] . Hayek (1976, Chap. VIII, p. 48) was the first to emphasize the limits of "gold discipline". See also Flood and Garber (1984).

[10] . This was suggested to us by Mike Bordo.

suggests that bankers provided bills on centers where real interest rates were, on average, cheaper.

The second factor we consider is frictions. Because foreign exchange bills were private promises to pay certain sums in certain places, issuing them involved an element of uncertainty in that foreign market's conditions cannot be known as well as domestic ones. In addition, this greater uncertainty created more scope for moral hazard (on this issue in history, see e.g. Chapman 1984). Therefore, frictions were presumably greater for more distant centers than for closer ones. This can be viewed as an equivalent to the bilateral "distance" discussed in matching models.

Finally, historians usually associate the development of drawing facilities with the existence of substantial trade. The study by King and colleagues (1988) of the Hong Kong and Shanghai Banking Corporation (HSBC) in the second half of 19th century provides many examples. For instance, the authors explain that one reason why HSBC opened a branch in France (specifically, in the silk processing city of Lyons) was because of the bank's leading role in providing finance to the global silk trade and France's substantial business as both an importer and producer of silk. From an economic point of view, the logic is that money follows trade. When bilateral trade with a given country is important, drawing a bill payable in its currency is attractive because it finds ready domestic purchasers who need them to settle international transactions. Therefore, bilateral trade with country j as a share of the total trade of country i should increase the probability of finding the currency of country j in market i. Again, this intuition has a natural counterpart in the search-theoretic approach to money.

We assess the contribution of each group of factors by estimating equation (4) using both a logit and probit specification. We abstract at this stage from simultaneity issues, which will be

dealt with in detail in the remainder of the paper. Table 1 reports results. Given the similarity between logit and profit output, we limit ourselves to discussing the first part of the table. [11]

Column I reports parameter estimates for the general model. Two features stand out. First, the model's fit is satisfactory in terms of both the pseudo-R^2 and the percentage of currencies whose quotation is correctly predicted. Second, we notice a different performance between the two groups of controls identified before. On the one hand, matching variables perform very well. We observe that low short-term interest rates in the issuing country significantly increase the probability of its currency being traded abroad, that agents appear more willing, other things being equal, to trade currencies issued by geographically close countries, and that a greater bilateral trade with a given country is associated with a greater probability of using its currency. On the other hand, parameters for good housekeeping variables are much less satisfactory. Except for the debt burden, all are insignificant and some have the wrong sign.

The alternative sets of explanatory factors are then tried independently. We first experiment with matching factors alone. They perform essentially as well as the general model. In contrast, when the good housekeeping factors are considered independently, the quality of the fit deteriorates markedly. Pseudo-R^2 values are almost three times smaller than in the general model and some bizarre results emerge: for example, a significant large but negative contribution of the gold standard, exactly the opposite of what one would expect.[12] Finally, as shown in the bottom part of the table, this specification does a poor job of predicting when currencies are quoted.

[11] . Controls common to all regressions included a constant and a "coverage" factor, which was introduced to correct biases resulting from the heterogeneity of national statistical sources. (Parameter estimates without the coverage factor are identical, but coverage improves fit.) The extensiveness of the coverage of the foreign exchange market varied marginally from one national source to the other. We could not relate these differences to any meaningful economic variable and so concluded they were simply an artefact of the random characteristics of the source we used. Coverage is measured by the so-called expansiveness factor recommended in network econometrics (Wasserman and Faust 1994).

[12] . The distinction between colums IIIa and IIIb is motivated by the need to deal with possible multicolinearity between debt burdens and reputation, as suggested in Flandreau and Zumer (2004).

Two further exercises suggested by earlier readers are also provided. Column IV adds to the general model a colony dummy (=1 when a colony considers quoting its metropolis) in order to assess the potential effect of imperial links. The hypothesis we test is that the existence of an empire favors currency internationalization (see De Cecco 1974 for an early exposition). This variable turns out to have zero contribution, and other parameter estimates are unaffected. Finally, Column V controls for the possibility that trade is endogenous to quotation; to do so, we substitute for trade the standard variables of the gravity equation. Again, estimates of other variables remain stable.

The results of this exercise suggest that matching factors are very important. They also rule out one possible explanation for the poor performance of good housekeeping variables: that causality works through its influence on matching variables. This is demonstrated by the poor performance of good housekeeping when considered alone and by the correlation matrix of explanatory variables reported in Table 2, which indicates that multi-colinearity is not an issue.

We suggest the following interpretation of our results. Good housekeeping variables relate the value of trading currency *j* in market *i* to country *j*'s characteristics, whereas matching factors are interactive terms that relate foreign circulation to bilateral characteristics such as distance or trade. Results show that bilateral characteristics are far more important. This evidence supports the "matching" dimension of the modern search-theoretic approaches money.

III. Strategic Externalities: Empirical Evidence

A. The Complete Model

Yet if matching is important then there should also exist feedback between individual choices, because whether to use currency *j* in country *i* is decided *given others' decisions* (Wright 1995, 1999). Consider again the model in equation (4). Let's call x_{ij}^{c} the exchange matrix that is equal to Ω *except* for term x_{ij}, which has been coded as missing; hence x_{ij}^{c} represents other agents' decisions. We can therefore rewrite (4) as

$$\Pr(x_{ij}=1)=\Pr(y_{ij}\cdot\beta+\eta_{ij}\geq 0\,|\,x_{ij}^{c})=\Phi(y_{ij}\cdot\beta+\eta_{ij},x_{ij}^{c}). \qquad (5)$$

In the language of game theory, function Φ is the individual response function corresponding to a Nash strategy. Individual choices influence the response function of others, and equilibrium requires that ex post individual strategies be consistent with ex ante ones. Individual quoting decisions are jointly determined. This is the essence of strategic externalities – that x_{ij}^{c} does influence x_{ij}.

In this paper we explore one channel through which strategic externalities may operate. Specifically, we look at the effect that a large number of foreign quotations for a given country (i.e., "international currency status") has on the liquidity of that country's money market. In a nutshell, the argument we are about to test is whether the interest rates of leading currencies were lower because lots of agents were using them, so that (in turn) their currencies were more likely to be quoted abroad.

This approach, obviously motivated by earlier theoretical consideration, is again guided by historical insights. On the one hand, narrative evidence that liquid financial centers tended to attract foreign exchange business is provided by Nishimura (1971). He shows that, in the late 19th century, the share of bills drawn on London from outside the United Kingdom vastly surpassed the share drawn from within. In the words of another scholar, Lombard Street, where London's money market was located, "belonged to all nations" (King 1936, p. 282).

On the other hand, evidence that larger markets enjoyed lower interest rates is provided in contemporary discussions such as expert reports for the U.S. National Monetary Commission, whose concern was (among other things) to promote the international role of the U.S. dollar. One expert for the commission argued that, barring exchange risk, money interest rates should equalize consistently with the interest parity condition – but only up to a liquidity premium. This premium would always be positive for narrower markets, because moving from a less liquid to a more liquid currency entails greater costs than moving the opposite direction.

Intuitively, assets that could be bought and sold on broader markets would trade at a higher price (i.e., a lower interest rate). In the words of one expert:

> Thus it is that funds freely move to and fro between London, Paris, Berlin, and Amsterdam, *an exact equality in [interest] rates being prevented by the fact that the discount markets in these cities differ in size*… For instance, the Paris discount market is broader than that of Amsterdam, and there is consequently less risk in forwarding funds to Paris for investment than to Amsterdam. That the Paris discount rate should rule somewhat lower than that of Amsterdam is accordingly natural.[13]

In effect, Jacobs reasoned here in terms of strategic externalities. Attractive interest rates in London, he acknowledged, led U.S. bankers to hold London balances even though this would "add to the importance of London and militate against the development of New York as a financial center."[14]

Empirical evidence of the relation suggested by Jacobs is provided in Figure 2. The figure shows that, the larger the number of foreign quotations a currency received, the lower was its interest rate. Of course Figure 2 is consistent with causality running either way or both, so it provides no decisive evidence on that score.

To examine this matter rigorously, we formalize the argument in a simple framework. Let r_{jt} be the interest rate in center j at a date t. This interest rate can be written in terms of an imaginary, perfectly liquid, short-term financial instrument whose interest rate is a_t. The spread between r_{jt} and a_t is by definition equal to the sum of a liquidity premium and the expected rate of exchange-rate change with respect to the imaginary currency (used as numéraire). The liquidity premium is assumed to depend on two terms, the demand for currency i in the global foreign exchange market (ω_i) and a set of variables that represents local money market

[13] . Jacobs (1910), pp. 7-8; our italics.
[14] . Ibid., p. 13.

development (Y_{1t}). Denoting the liquidity premium by $\pi(\omega_{it}, Y_{1it})$ and the expected depreciation by $E(\Delta e_{it+1} / e_{it})$, we have

$$r_{it} - a_t = \pi(\omega_{it}, Y_{1it}) + E(\Delta e_{it+1} / e_{it}) . \quad (5)$$

As already stated, many countries were on fixed exchange rates (gold standard), and those that floated did not exhibit systematic trends. Therefore, expected depreciation can safely be ignored. (Regressions limited to countries on a gold standard were also performed and did not change the results.) The demand for currency *i* in the global foreign exchange market is the sum of individual demands in local markets weighted by the relative share θ_k of each country. Country *k*'s demand for currency *i* is a function of its (unobservable) utility u_{ki}. Finally, interest rates in market *i* are determined by international demand and domestic factors:

$$r_{it} = \gamma_1 \sum_{k \neq i} \theta_k \cdot u_{kit} + Y_{1i} \cdot \beta_1 + \varepsilon_{it} . \quad (6)$$

This formula can be combined with the "matching" equation estimated in Section II where the value of holding currency *j* in market *i* is a function of the interest rate in market *j*, the share of bilateral trade with *j* in *i*'s total trade, and bilateral distance. Denoting these latter two exogenous variables by Y_{2ij}, we can write

$$u_{ijt} = \gamma_2 \cdot r_{jt} + Y_{2ijt} \cdot \beta_2 + \eta_{ijt} . \quad (7)$$

Since r_i is an nx1 vector (there are n countries) and since u_{ij} is a vector of dimension $n(n-1)$x1 (there are $n(n-1)$ bilateral exchange markets), we use the transformation matrices W and M to write the complete model in structural form as follows (we drop the indices for simplicity):[15]

$$\begin{aligned} r &= \gamma_1 \cdot W \cdot u + Y_1 \cdot \beta_1 + \varepsilon \\ u &= \gamma_2 \cdot M \cdot r + Y_2 \cdot \beta_2 + \eta. \end{aligned} \quad (8)$$

As can be seen, interest rates in a given market depend on the value that foreigners find in using that currency (first equation). Conversely, the value of holding a given foreign currency

[15] . Here W is weighting matrix, and M simply assures that all markets for currency *j* depend on the same interest r_j.

depends on the corresponding interest rate (second equation). The result is a two-way influence between interest rates and utilities. To summarize, equation (8) describes the international monetary system that results from a Nash equilibrium as described by a system of simultaneous equations.

Figure 3 illustrates the two-way feedback for a given country. The first equation in system (8) is the *liquidity* schedule; it describes the incidence of greater value of the domestic currency for foreigners on domestic interest rates. The second equation is the *popularity* schedule, which describes the incidence of lower domestic rates on the value of holding that currency for foreigners. Equilibrium is defined by point *E*.

B. Estimation

Because of simultaneity, it will not be enough to estimate the second equation using a standard probit method and then estimate the first equation using the predicted utility variable obtained from the first regression. One way of adressing this issue is to think of (8) as a sequential system. At date *t*–1, agents make decisions regarding currency holdings based on the signals they receive (second equation). This determines the demand for each currency in each market and sets period–*t* interest differentials (first equation). Rewriting (8) with time indices yields

$$\begin{aligned} r_t &= \gamma_1 \cdot W \cdot u_t + Y_{1t} \cdot \beta_1 + \varepsilon_t \\ u_t &= \gamma_2 \cdot M \cdot r_{t-1} + Y_{2t} \cdot \beta_2 + \eta_t . \end{aligned} \tag{10}$$

Given that ε_t and η_t are well-behaved Gaussian residuals, a straight estimation is possible: first derive a probit estimate of the second equation; then replace u_t in the first equation by its fitted value and use standard OLS techniques to estimate the equation

$$r_t = \gamma_1 \cdot W \cdot \hat{u}_t + Y_{1t} \cdot \beta_1 + \varepsilon_t . \tag{11}$$

However, superior approach is to recognize that *r* and *u* are simultaneously determined. For this it we must first rewrite the system in reduced form (time indices dropped for simplicity):

$$r = \left(I_n - \gamma_1 \cdot \gamma_2 \cdot W \cdot M\right)^{-1} \cdot \left(Y_1 \cdot \beta_1 + \gamma_2 \cdot W \cdot Y_2 \cdot \beta_2\right) + \left(I_n - \gamma_1 \cdot \gamma_2 \cdot W \cdot M\right)^{-1} \left(\varepsilon_t + \gamma_2 \cdot W \cdot \eta\right)$$
$$u = \left(I_{n(n-1)} - \gamma_2 \cdot \gamma_1 \cdot M \cdot W\right)^{-1} \cdot \left(\gamma_1 \cdot M \cdot Y_1 \cdot \beta_1 + Y_2 \cdot \beta_2\right) + \left(I_{n(n-1)} - \gamma_2 \cdot \gamma_1 \cdot M \cdot W\right)^{-1} \cdot \left(\gamma_1 \cdot M \cdot \varepsilon + \eta\right). \quad (12)$$

Because ε and η are i.i.d., an unbiased estimation of the reduced-form system is feasible using maximum likelihood techniques. This provides fitted values of $\hat{r}$ and $\hat{u}$ that are orthogonal to residuals; then $\hat{r}$ and $\hat{u}$ can be plugged back into the structural system (8). The second step in this approach involves OLS estimation of the first equation and probit estimation of the second equation. This estimation strategy, known as two-stage probit least squares (or 2SPLS), produces robust estimates (see Maddala 1984).[16]

Results are reported in Table 3. For domestic variables (Y_1) we used GDP per capita (a measure of domestic development) and a democracy index. Neo institutional perspectives have emphasized the role of democratic institutions, parliamentary control of the executive, and the rule of law in financial development (North and Weingast 1989; Bordo and Rousseau 2005). Democracy is therefore a natural proxy for these factors.

Table 3 presents estimates for (I) the "naïve" model that ignores that *r* and *u* are jointly determined, (II) the sequential model that assumes agents decide on foreign currency trading for 1900 based on signals received in 1890 (thus setting 1900 interest rates), and (III) the more sophisticated 2SPLS model. There is little difference between the output of the naïve and sequential models. However, compared to columns I and II, 2SPLS estimation gives an enhanced effect of interest rate on the utility of holding the corresponding currency (γ_2=–0.52 instead of –0.31 and –0.36). The effect of the popularity of a given currency on interest rates, by contrast, is similar across equations (γ_1=–0.89, –0.91 and –1.12).

The important conclusion to draw from these exercises is that we find evidence of the two-way causality (from transaction costs to holding behavior and from holding behavior to transaction costs) that is a central feature of modern models of international currencies. There

[16] . Note, however, that the standard errors are not consistent owing to spatial correlation.

are strategic externalities, and they matter. The next section discusses the extent of their importance.

IV. Persistence

A. Testing for Path Dependency

The most important effect suggested by the theory of strategic externalities is persistence. To see this, consider the following thought experiment. Suppose that, starting from a situation of equilibrium at *E*, the economy under consideration experiences an increase of its total exports. The result is that the value of holding its currency abroad is enhanced. This boosts international demand for its money, causing further declines of its interest rate. Interest-rate declines provide a further boost, and so forth. The long-run effect depends critically on the product of parameters γ_1 and γ_2. Assuming for simplicity that $\gamma_1\gamma_2>0$ (as we have found is the case), two main regimes are to be distinguished.[17]

First, if $0<\gamma_1\gamma_2<1$ then there will be persistence but no path dependence, since the economy will be converging toward a new equilibrium. However while the process losts, the country has higher interest rates and lower popularity *than is warranted by the long-run equilibrium*. Formerly minor trading powers, for instance, drag the anchor of their previous insignificance and experience a delayed rise to monetary leadership (Figure 4a).

Second, if $\gamma_1\gamma_2>1$ then the dynamics are explosive. Interest-rate declines fuel an expansion of foreign holdings, which encourages reduction in liquidity premiums until they become zero and the greatest possible number of foreigners hold the currency. Moreover, there are no compensating forces and so important currencies become increasingly important while unimportant ones go the other way. This situation is that of a lock-in effect (a specific instance of path dependency). Escape from such an equilibrium is both delayed and brutal. Intuitively, it

[17] . We neglect here the degenerate regime where $\gamma_1\gamma_2=1$, since it is statistically unimportant.

arises when the liquidity popularity feedback is "big enough" (formally, when their product is greater than 1:Figure 4b).[18] Table 3, column III, implies that $\gamma_1\gamma_2$=0.463, which is smaller than 1. The data thus suggests that there is persistence but no lock-in effects.

B. A Counter Factual Assessment

Having found evidence of historical persistence, it is interesting to delve further into the matter and provide an estimation of the actual contribution of "history" to 1900 international monetary architecture. One way to do this involves recognizing that, in our approach, the vehicles of persistence are interest rates and the value of holding given currencies. It is therefore possible to define two vectors that register the effect of past "events" as the difference between the actual values and long-run equilibrium values. As indicated, a country whose formerly small trading power has increased encounters higher interest rates and lower value for its currency than it "ought to". We define these vectors as ε_{Ht} and η_{Ht}, respectively. Formally:

$$\begin{aligned} \varepsilon_H &= r - r_E \\ \eta_H &= u - u_E . \end{aligned} \tag{13}$$

where r_E and u_E are defined as solutions to (hats denote estimated parameters from Table 3).

$$\begin{aligned} r_E &= \hat{\gamma}_1 \cdot W \cdot u_E + Y_1 \cdot \hat{\beta}_1 \\ u_E &= \hat{\gamma}_2 \cdot M \cdot r_E + Y_2 \cdot \hat{\beta}_2 . \end{aligned} \tag{14}$$

Because persistence acts in a symmetrical fashion for interest rates and the value of holding a given currency (as seen in Figure 4a), one need only examine persistence in a single dimension. We thus consider the matter by performing the intuitively appealing comparison between the actual popularity of currencies in 1900 (measured by the number of quotes each received in foreign markets) and equilibrium popularity (measured by computing the counterfactual, "history free" numbers for quotes each currency ought to have received as a solution to (14)).

Figure 5 displays the results. It can be seen that the United States received substantially fewer quotes than if history had not taken place. The United States, a rising trade power, was

[18] . For convenience, Figures 2.a and 2.b illustrate what happens when γ_1=1 so that $\gamma_1\gamma_2$> 1 boils down to γ_2>γ_1.

penalized during its ascendancy. On the other hand, several European countries were actually much more popular than in the history-free scenario. The most striking example is France, which received about 25 percent more quotes than it would have *sans* history. France, a former world trade leader, enjoyed an substantial advantage from persistence. These are illustrations that history mattered substantially.

C. Extensions

We can think of several extensions: empirical, analytical, and normative. The empirical extension would be to extend our framework to consider additional data and periods. One would want to document such phenomena as the rise of the pound sterling in the late 18th century, and its decline in the 20th century, in order to gain a clearer understanding of the mechanics of persistence and dynamics of decline. For instance, if distance induces smaller frictions then the scope for strategic externalities might be increased as a result of technological progress. That is, there is no reason why persistence could not be historically dependent.

An interesting analytical extension would be to adapt the framework under study to take into account other forms of path dependency; for example, in David (1985) the declining average costs are supplemented with switching costs, unlike what happens in the models of international money on which we have relied here. Suppose then that establishing a new local market for a given currency involves paying a set-up cost. By assumption, the set-up cost is paid once and for all – that is, the first time the market is created. In the cross-section that we have considered, it is obvious that such a dynamic feature cannot be handled. But it could very well be dealt with provided that more data are gathered and more periods considered.

Finally, it would be interesting to go from the positive description offered here to more normative assessments. Persistence may induce the world economy to deviate from its "optimal" trajectory (see David (1985) and Leibowitz and Margolis (1990) for controversial discussions of this point in a different context). The evidence we reported of a long-run

association between international currencies and trade shares suggests that the resulting diseconomy might not be so large, at least in the year 1900. Looking at things this way could also help to explain why certain countries (but not others) sought institutional solutions to boost the use of their currency on international markets during the period under study. That we find U.S. leaders setting up the National Monetary Commission for experts to discuss ways and means to promote the international role of the dollar may be indicative that those countries for which the imbalance between potential and actual status was greatest (see Figure 5) find it in their own interest to subsidize the promotion of their currency, thus limiting the global diseconomy. Further analysis of these matters should be very fruitful.

Conclusions

This paper has provided the first empirical study of the determinants of international currency status. We did this in the context of the late 19th-century international monetary system. In line with the prediction of Charles Kindlberger, we did not find much evidence that currencies become international as a result of the issuing country's moral worth. In contrast, we found evidence of the importance of size, distance, and inventory costs, evidence that is consistent with the prediction of search-theoretic models of international currencies. Moreover, we reported strong evidence of strategic externalities: currencies become international on account of their low liquidity premia and (conversely) had low liquidity premia on account of their international circulation. Such feedback, we explained, has the potential for creating persistence.

We then estimated the size of this feedback and found it too small to generate strict path dependency. Nonetheless, persistence was found to be sizeable. Concrete evidence was provided by comparing observed monetary status in the late 19th century with its history-free, counterfactual equilibrium. We found that, in the late 19th century, history benefited mostly

European countries and disadvantaged the United States. Our model suggests imputing this to Europe's earlier lead in international trade.

The evidence in this article thus leads to conclusions related to Kindleberger's insight that size is everything. Our findings strongly support his notion that, over the very long run, trade share is a powerful driver of international monetary leadership. This simple insight, for which we reported abundant evidence, should go a long way toward explaining why it is the U.S. dollar, not the pound sterling, that is the main international currency today. The implication must be that money and trade are complements. With respect to modern debates on the prospects of the international monetary system in the 21st century, this means that the most likely development should be the (delayed) emergence on the international scene of the currencies of new trading powers. China's yuan is the currency that comes immediately to mind. Determining how long it will take for this to happen requires further work.

References

Barro, R. J. and D. B. Gordon, 1983, "Rules, Discretion and Reputation in a Model of Monetary Policy", *Journal of Monetary Economics*, Vol. 12, No. 1, pp. 101-21.

[Bank of International Settlements] BIS, 2005, *Triennial Central Bank Survey*, Basel: BIS.

Bordo, M. and H. Rockoff, 1996, "The Gold Standard as a Good Housekeeping Seal of Approval", *Journal of Economic History*, Vol. 56, No. 2, pp. 389-428.

Bordo, M. and P. Rousseau, 2005, "The Finance-Growth Link: History and the Role of Political Environments", mimeo.

Calvo, G. A. and C. Vegh, 1992, "Currency Substitution in Developing Countries: An Introduction", IMF, Working Paper 92/40.

Chapman, S., 1984, *The Rise of Merchant Banking*, London: Unwin Hyman.

Chinn, M. and J. Frankel, 2005, "Will the Euro Eventually Surpass the Dollar as Leading International Reserve Currency?", unpublished manuscript, Wisconsin and Harvard.

Cohen, B., 2005, "Currency Choice in International Bond Issuance", *BIS Quarterly Review*, June.

Craig, B. and C. J. Waller, 1999, "Currency Portfolios and Nominal Exchange Rates in a Dual Currency Search Economy", Federal Reserve Bank of Cleveland, Working Paper 9916.

David, P. A., 1985, "Clio and the Economics of QWERTY", *American Economic Review*, Vol. 75, No. 2, pp. 332-37.

De Cecco, M., 1974, *Money and Empire. The International Gold Standard, 1890-1914*, Oxford: Blackwell.

de Roover, R. A., 1968, *The Bruges Money Market around 1400*, Brussel: Paleis der Academiën.

Dooley, M, P. Lizondo, and D. Mathieson, 1977, "The Currency Composition of Foreign Exchange Reserves", *IMF Staff Papers*, 36, pp. 385-434.

Eichengreen, B., 1999, "The Euro as an International Currency", *Journal of the Japanese and International Economies*, Vol. 12, No. 4, pp. 483-506.

Eichengreen, B., 2004, "Financial Instability", prepared for the "Copenhagen Consensus" (May 2004) and forthcoming after revision in Bjorn Lomborg (ed.), *Global Crises, Global Solutions*, Cambridge University Press.

Eichengreen, B., 2005, "Sterling's Past, Dollar's Future: Historical Perspectives on Reserve Currency Status", NBER Working Paper, No. 11336.

Eichengreen, B. and J. Frankel, 1996, "The SDR, Reserve Currencies, and the Future of the International Monetary System", in M. Mussa, J. Boughton, and P. Isard (eds), *The Future of the SDR in Light of Changes in the Internatioal Financial System,* Washington, DC: IMF, pp. 337-77.

Eichengreen, B., R. Hausmann, and U. Panizza, 2005, "The Mystery of Original Sin", in B. Eichengreen and R. Hausmann (eds), *Other People's Money: Debt Denomination and Financial Instability in Emerging Market Economies,* University of Chicago Press.

Eichengreen B. and D. Mathieson, 2001, "The Currency Composition of International Reserves: Retrospect and Prospect", in Charles Wyplosz (ed.), *The Impact of EMU on Europe and the Developing Countries,* Oxford University Press.

Eichengreen, B., R. Hausmann, and U. Panizza, 2005, "The Mystery of Original Sin", in B. Eichengreen and R. Hausmann (eds), *Other People's Money: Debt Denomination and Financial Instability in Emerging Market Economies,* Chicago: University of Chicago Press.

Engineer, M., 2000, "Currency Transaction Costs and Competing Currencies", *Journal of International Economics*, Vol. 52, No. 1, pp. 113-36.

Flandreau, M. and F. Gallice, 2005, "Paris, London and the International Money Market: Lessons from Paribas 1885-1913", forthcoming in Y. Cassis and E. Bussière, *London and Paris as International Financial Centres in the Twentieth Century*, Oxford University Press, 2006, pp. 78-106.

Flandreau, M. and C. Jobst, 2005, "The Ties That Divide: A Network Analysis of the International Monetary System 1890-1910", , Vol. 65, No. 4, pp. 977-1007.

Flandreau, M., J. Le Cacheux, and F. Zumer, 1998, "Stability without a Pact? Lessons from the European Gold Standard 1880-1913", in Begg, D., et al. (eds), *EMU: Prospects and Challenges for the Euro,* special issue of *Economic Policy*, No. 26, pp. 117-62.

Flandreau, M. and F. Zumer, 2004, *The Making of Global Finance 1880-1914* (OECD Development Center monograph), Paris: OECD.

Flood, R. and P. Garber, 1984, "Gold Monetization and Gold Discipline", *Journal of Political Economy*, Vol. 92, No. 1, pp. 90-107.

Frankel, J., G. Galli, and A. Giovannini, 1996, *The Microstructure of Foreign Exchange Markets*, The University of Chicago Press.

Goldberg, L. and C. Tille, 2005, "Vehicle Currency Use in International Trade", Federal Reserve Bank of New York, January 2005.

Gourinchas, P. and H. Rey, 2005, "From World Banker to World Venture Capitalist: U.S. External Adjustment and the Exorbitant Privilege", unpublished manuscript, UC Berkeley and Princeton University.

Hartmann, P., 1998, *Currency Competition and Foreign Exchange Markets : the Dollar, the Yen and the Euro*, Cambridge University Press.

Hayek, F. A. von, 1976, *Denationalization of Money, The Argument Refined*, 2nd ed., London: Institute of Economic Affairs, 1990.

Head, A. and S. Shi, 2003, "A Fundamental Theory of Exchange Rates and Direct Currency Trades", *Journal of Monetary Economics,* Vol. 50, No. 7, pp. 1555-91.

Jacobs, L., 1910, *Bank Acceptances*, Publications of the National Monetary Commission, Vol. XX, No. 3, [U.S.] 61st Cong., 2d Sess. Senate Doc. 569, Washington, DC: Government Printing Office.

Kindleberger, C., 1967, *The Politics of International Money and World Language* (Essays in International Finance, No. 61), Princeton University Press.

King, F. H., C. E. King, and D. J. King,, 1988, *The Hongkong Bank in Late Imperial China, 1864-1902: On an Even Keel,* New York: Cambridge University Press.

King, W. T. C., 1936, *History of the London Discount Market*, London: Routledge.

Kiyotaki, N. and R. Wright, 1993, "A Search-Theoretic Approach to Monetary Economics", *American Economic Review*, Vol. 83, No. 1, pp. 63-77.

Kiyotaki, N. and J. Moore, 2003, "A Cost of Unified currency", in P. Mizen (ed.), *Central Banks, Monetary Theory and Policy: Essays in Honour of Charles Goodhart*, Vol. 1, Cheltenham: Edward Elgar.

Kiyotaki, N. and R. Wright, 1989, "On Money as a Medium of Exchange", *Journal of Political Economy*, Vol. 97, pp. 927-954.

Krugman, P. R., 1980, "Vehicle Currencies and the Structure of International Exchange", *Journal of Money, Credit and Banking*, Vol. 12, No. 3, pp. 513-26.

Krugman, P. R., 1984, "The International Role of the Dollar: Theory and Prospect", in J. F. O. Bilson and R. C. Marston (eds.), *Exchange Rate Theory and Practice*, University of Chicago Press.

Kydland, F. E. and E. C. Prescott, 1977, "Rules Rather than Discretion: The Inconsistency of Optimal Plans", *Journal of Political Economy*, Vol. 85, No. 3, pp. 473-91.

Leibowitz, S. J. and S. E. Margolis, 1990, "The Fable of the Keys", *Journal of Law & Economics*, Vol. 33, No. 1, pp. 1-25.

Li, Y. and A. Matsui, 2005, "A Theory of International Currency and Seigniorage Competition", mimeo.

Lyons, R., and J. Moore, 2005, "An Information Approach to International Currencies", NBER Working Paper, No. 11220.

Maddala, G. S., 1984, *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge University Press.

Matsuyama K., N. Kiyotaki, and A. Matsui, 1993, "Toward a Theory of International Currency", *Review of Economic Studies*, Vol. 60, No. 2, pp. 283-307.

Meltzer, A. H., 2003, *A History of the Federal Reserve*, vol 1: *1913-1951*, Chicago University Press.

Menger, K., 1892, "On the Origins of Money", *Economic Journal*, Vol. 2, pp. 239-55.

Nishimura, S., 1971, *The Decline of Inland Bills of Exchange in the London Money Market, 1855-1913*, Cambridge University Press.

North, D. C. and B. Weingast, 1989, "Constitutions and Commitment: The Evolution of Institutions Governing Public Choice in Seventeenth-Century England", *Journal of Economic History*, Vol. 49, pp. 803-32.

Peterson, B., 2004, "The Effects of Trade Linkages on Dollarization", mimeo.

Ravikumar, B. and N. Wallace, 2001, "A Benefit of Uniform Currency?", Pennsylvania State University, manuscript.

Rey, H., 2001, "International Trade and Currency Exchange", *Review of Economic Studies*, Vol. 68, No. 2, pp. 443-6.

Trejos, A. and R. Wright, 1996, "Search-Theoretic Models of International Currency", *Proceedings*, Federal Reserve Bank of St. Louis, May, pp. 117-132.

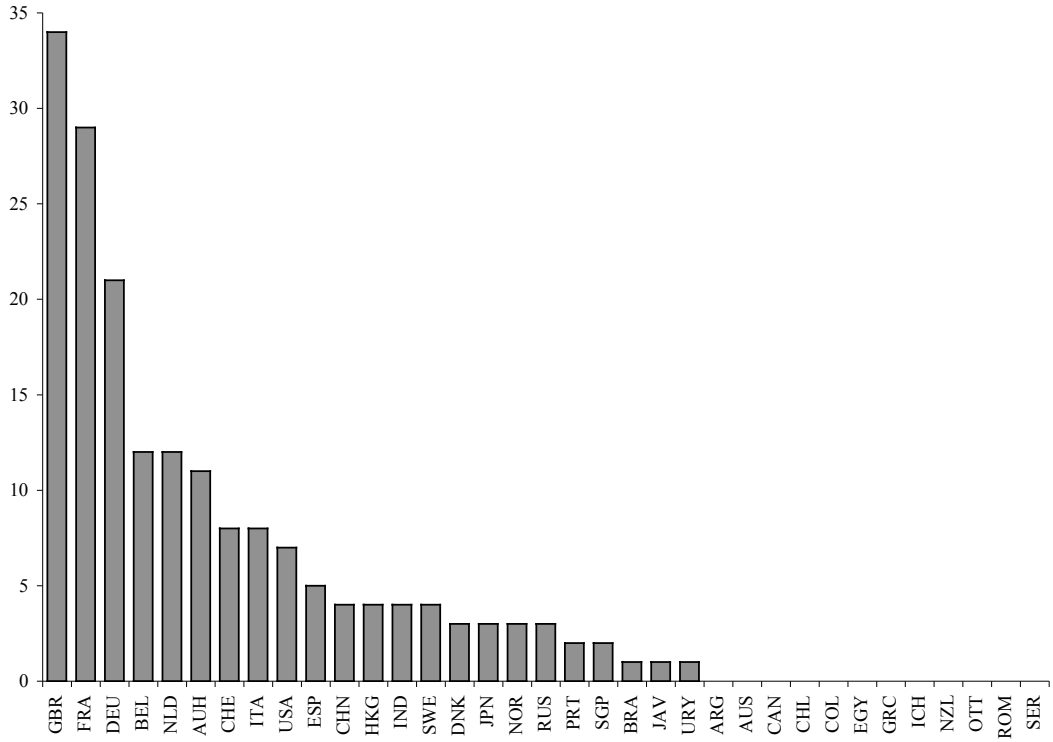
Wasserman, S. and K. Faust, 1994, *Social Network Analysis. Methods and applications*. Cambridge: Cambridge University Press.

Wright, R., 1995, "Search, Evolution and Money", *Journal of Economic Dynamics and Control*, Vol. 19, No. 1-2, pp. 181-206.

Wright, R., 1999, "A Note on Asymmetric and Mixed Strategy Equilibria in the Search-Theoretic Model of Fiat Money", *Economic Theory*, Vol. 14, No. 2, pp. 463-71.

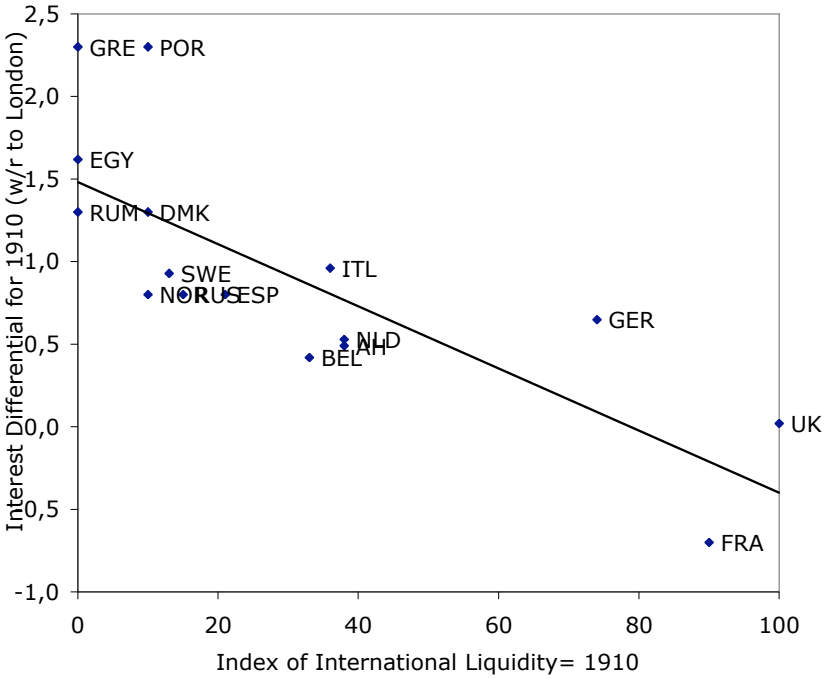
Zhou, R., 1997, "Currency Exchange in a Random Search Model", *Review of Economic Studies*, Vol. 64, pp. 289-310.

Figure 1: Foreign Circulation of Individual Currencies in 1900:
Number of Markets Where Given Countries' Currencies are Traded



Source: Flandreau and Jobst 2005. To facilitate comparison with Figure 5 below and relation with econometric work in Section IV we have restricted the ranking to countries usable in Section IV. This makes 35 currencies/countries. This is more limited than the sample used in regression analysis in section II.

Figure 2 : Short Term Interest Rate Differentials Vs. London and International Liquidity



Source: Authors' database.

Figure 3. Equilibrium Foreign Circulation and Liquidity Premium for Country *i*'s Currency

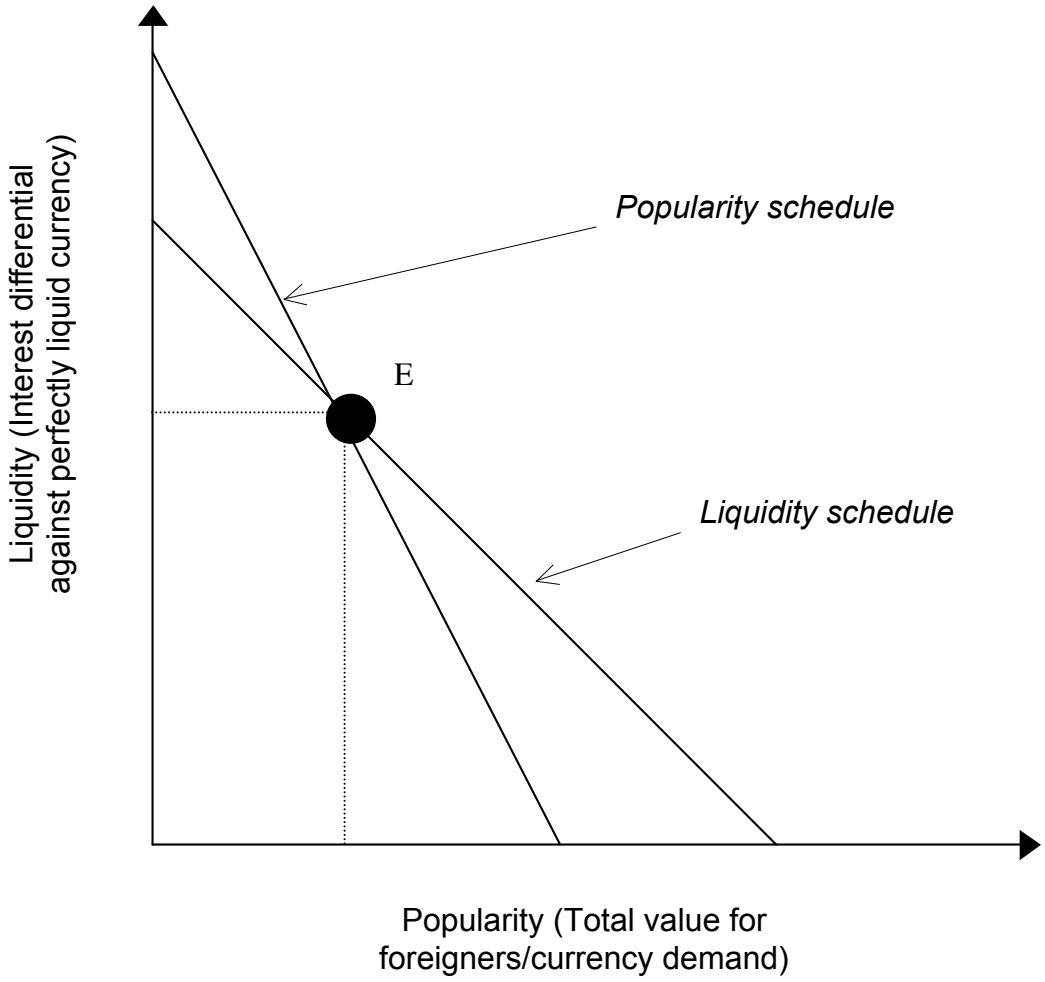


Figure 4a. Currency Status and Persistence: Stable Dynamics $0<\gamma_1\gamma_2<1$)

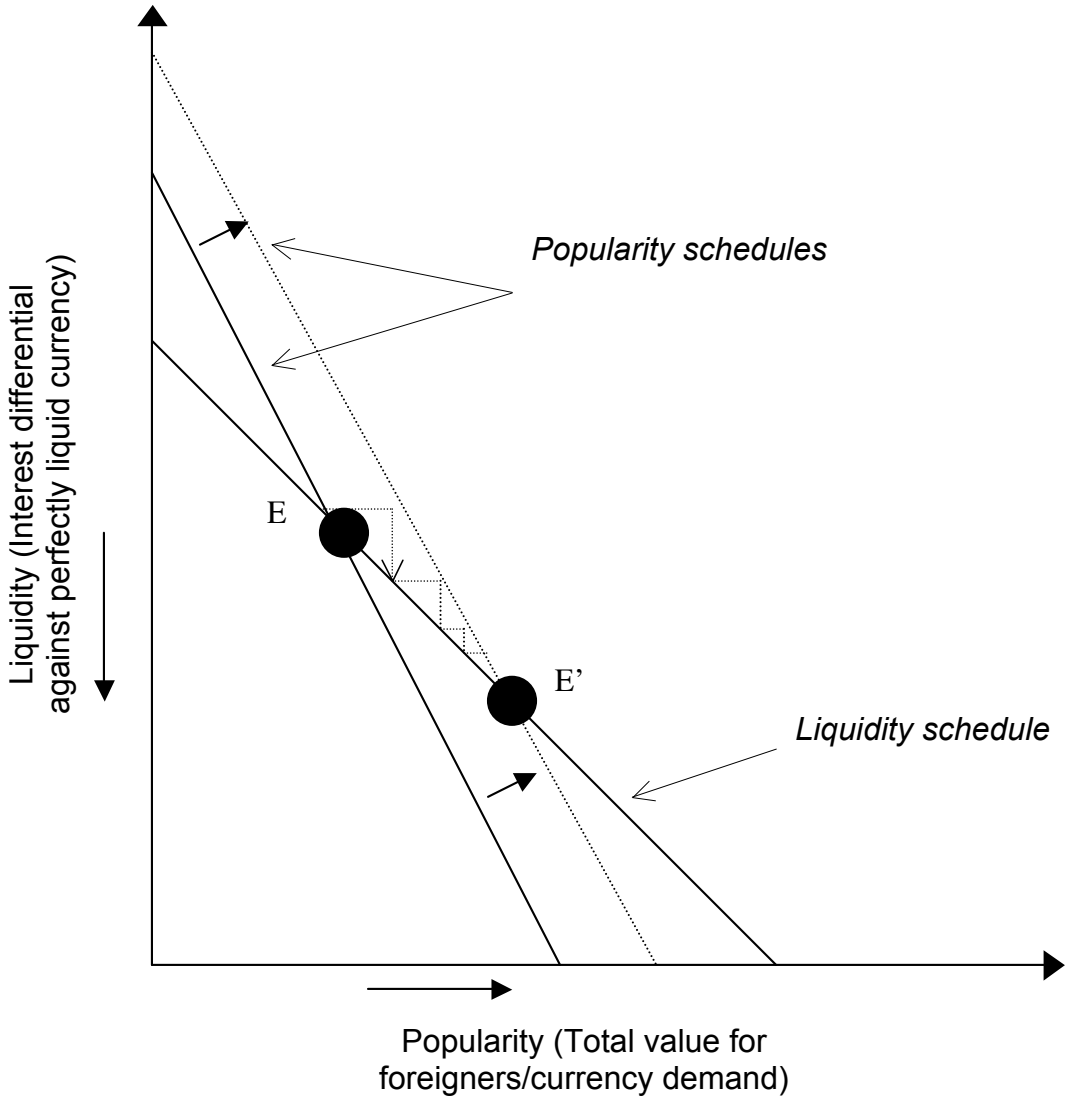


Figure 4.b. Currency Status and Lock-in: Unstable Dynamics ($1<\gamma_1\gamma_2$)

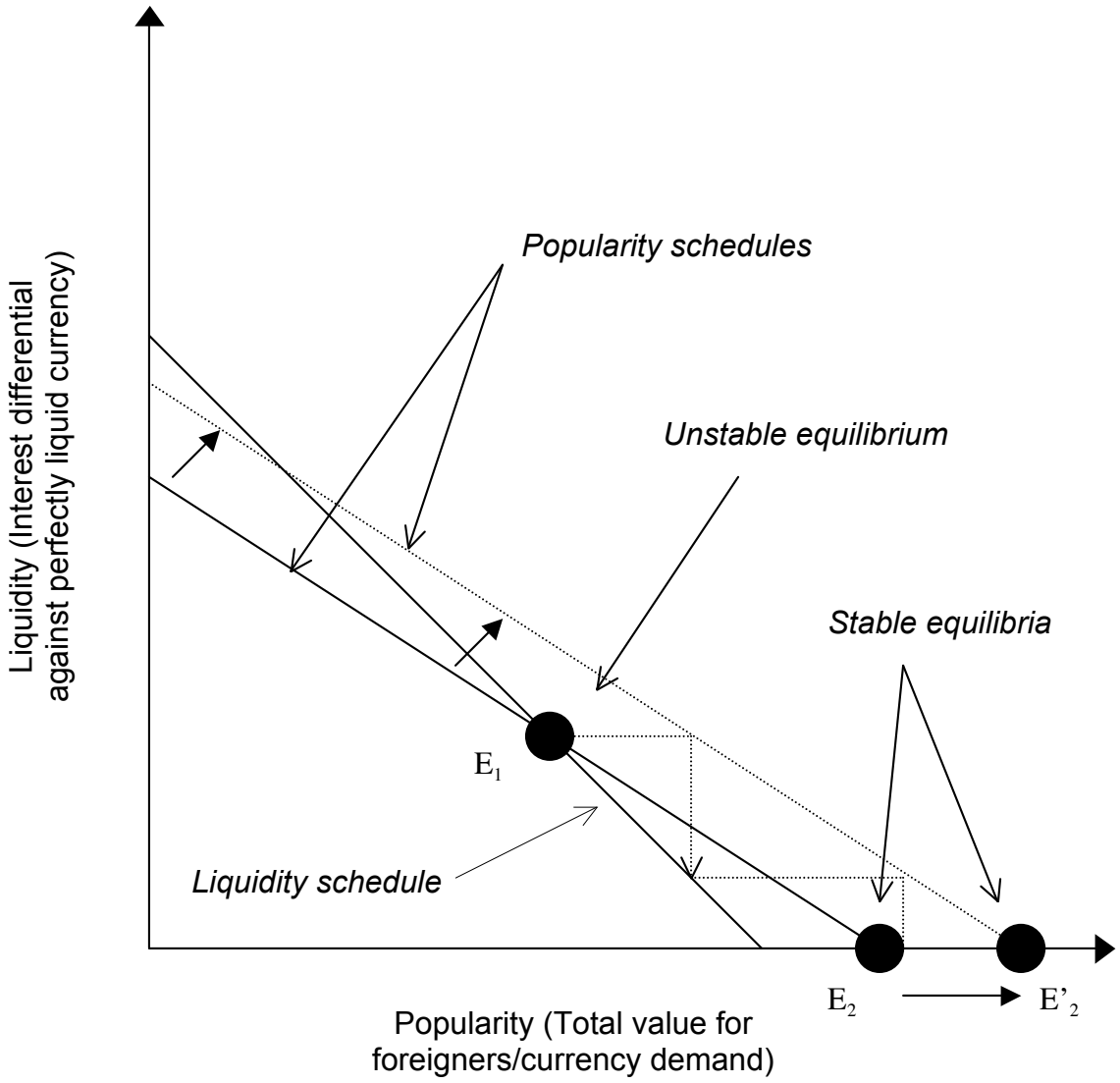
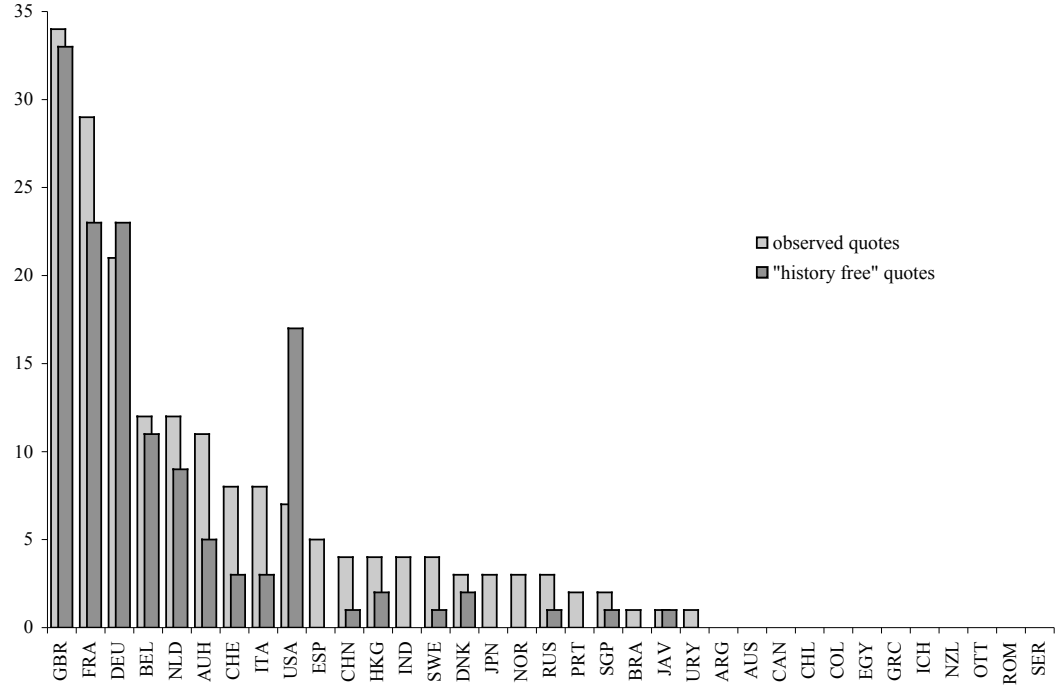


Figure 5 : History Measured: Actual Versus Counterfactual Number of Foreign Markets Where Currencies Circulated in 1900



Sources: see text. Counterfactual is obtained by computing the long run "history free" equilibrium.

Table 1: Explaining Foreign Circulation

	LOGIT						PROBIT					
	GENERAL	MATCHING	GOOD HOUSEKEEPING		COLONIES	INSTRUMENT. TRADE	GENERAL	MATCHING	GOOD HOUSEKEEPING		COLONIES	INSTRUMENT. TRADE
VARIABLES	(I)	(II)	(IIIa)	(IIIb)	(IV)	(III)	(I)	(Ia)	(Ib)	(IV)	(V)	(V)
"Good housekeeping"												
on gold	-0.33		-0.64 *	-0.00	-0.33	-0.17	-0.17		-0.30 *	0.00	-0.17	
	(-0.89)		(-2.32)	(-0.01)	(-0.89)	(-0.88)	(-0.88)		(-2.21)	(0.02)	(-0.89)	
debt burden	-0.14 *		-0.00	-0.05 *	-0.14 *	-0.06 **	-0.06 **		-0.00	-0.03 *	-0.06 **	
	(-2.42)		(-0.03)	(-1.95)	(-2.42)	(-2.39)	(-2.39)		(-0.02)	(-2.18)	(-2.39)	
Bond yields	0.07		-0.72 **		0.07	0.03	0.03		-0.29 **		0.03	
	(0.60)		(-6.13)		(0.60)	(0.55)	(0.55)		(-6.51)		(0.55)	
GDP per capita	-0.15		0.87 **	1.51 **	-0.15	0.19	0.19		0.50 **	0.78 **	0.19	
	(-0.59)		(4.79)	(8.04)	(-0.59)	(1.48)	(1.48)		(5.27)	(8.32)	(1.46)	
"Matching"												
interest rate	-0.99 **	-0.82 **			-0.99 **	-0.42 **	-0.42 **	-0.38 **			-0.42 **	-0.35 **
	(-5.65)	(-7.29)			(-5.65)	(-5.96)	(-5.96)	(-7.97)			(-5.96)	(-7.54)
distance	-0.76 **	-0.76 **			-0.76 **	-0.41 **	-0.41 **	-0.41 **			-0.42 **	-0.58 **
	(-6.52)	(-6.59)			(-6.49)	(-6.86)	(-6.86)	(-6.83)			(-6.87)	(-10.51)
share in bilateral trade	0.25 **	0.27 **			0.25 **	0.11 **	0.11 **	0.12 **			0.11 **	
	(9.54)	(10.33)			(9.45)	(11.85)	(11.85)	(12.80)			(11.70)	
colony					-0.02						0.31	
					(-0.02)						(0.39)	
"Others"												
foreign GDP												0.37 **
												(9.41)
constant	4.74	4.30 **	-7.20 **	-15.09 **	4.74	1.32	1.32	2.13 **	-4.62 **	-7.91 **	1.36	-1.70
	(1.75)	(3.48)	(-4.50)	(-10.59)	(1.74)	(1.06)	(1.06)	(3.43)	(-5.78)	(-11.29)	(1.09)	(-2.02)
coverage	2.05 **	2.01 **	1.41 **	1.34 **	2.05 **	1.06 **	1.06 **	1.04 **	0.78 **	0.72 **	1.06 **	0.58 **
	(7.27)	(7.25)	(8.27)	(8.12)	(7.26)	(7.47)	(7.47)	(7.43)	(8.54)	(8.25)	(7.45)	(5..5)
number of obs.	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408	1408
Pseudo R2	0.59	0.58	0.21	0.16	0.59	0.57	0.57	0.56	0.20	0.15	0.57	0.42
log likelihood	-247.23	-251.57	-470.21	-503.07	-247.23	-257.23	-257.23	-262.51	-476.08	-505.19	-257.16	-344.03
predicted vs. observed												
0 when truly 0	83.66	83.59	83.66	84.16	83.66	83.81	83.81	83.81	83.88	84.52	83.81	82.74
1 when truly 1	10.80	10.87	2.56	1.28	10.80	10.09	10.09	9.94	1.78	0.99	10.09	7.88
1 when truly 0	1.28	1.35	1.28	0.78	1.28	1.14	1.14	1.14	1.07	0.43	1.14	2.20
0 when truly 1	4.26	4.19	12.50	13.78	4.26	4.97	4.97	5.11	13.28	14.06	4.97	7.17

Results refer to logit and probit estimates, *z*-statistics in parentheses.

Table 2: Matrix of Correlations between Explanatory Variables

	on gold	debt burden	long term interest rate	GDP per capita	short term interest rate	distance	trade share
on gold	1						
debt burden	-0.21	1					
long term interest rate	-0.52	0.27	1				
GDP per capita	0.45	-0.00	-0.43	1			
short term interest rate	-0.17	-0.27	0.54	-0.39	1		
distance	-0.09	-0.02	0.12	-0.05	0.23	1	
trade share	0.14	-0.10	-0.24	0.26	-0.27	-0.26	1

Source: Authors' database.

Table 3: Estimating Strategic Externalities

Equation		(I) "NAIVE" PROBIT - OLS	(II) SEQUENTIAL MODEL	(III) TWO STAGE PROBIT
r	*u*	-1.09	-0.87	-0.91
		(-7.10)	(-4.72)	(-2.83)
	GDP per	0.27	0.19	0.15
	capita	(0.68)	(0.38)	(0.25)
	democracy	-0.10	-0.13	-0.09
	index	(-1.39)	(-1.46)	(-0.82)
	constant	2.27	3.36	3.59
		(0.77)	(0.91)	(0.78)
	observations	35	35	35
	adjusted R^2	0.68	0.51	0.33
u	*r*	-0.36	-0.31	-0.52
		(-7.06)	(-6.78)	(-8.12)
	distance	-0.46	-0.38	-0.44
		(-6.91)	(-5.64	(-6.28)
	share	0.15	0.16	0.15
		(11.54)	(12.36)	(10.94)
	coverage	1.13	1.17	1.24
		(6.92)	(7.04)	(7.09)
	constant	2.09	1.03	2.70
		(3.12)	(1.61)	(3.73)
	observations	1190	1190	1190
	log likelihood	-205.2	-207.0	-195.0

Source: See text. *t*- and *z*-statistics in parentheses.