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# THE EFFECT OF MULTILATERAL TRADE CLEARINGHOUSES ON THE DEMAND FOR INTERNATIONAL RESERVES

by

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## Abstract

This paper attempts to capture the portfolio incentives for central bank participation in a multilateral trade clearinghouse and to discuss the relation of those incentives to the volume of trade. Clearinghouses for the netting of multilateral intra-regional trade have existed since the 1950s, but no work to date has attempted to explore the incentive effects of such arrangements. Instead previous work, primarily empirical, has focused on the tendency of preferential arrangements (clearing as well as favorable protectionist policies) between nations to encourage trade flows between them. This paper advances the notion that the effects of clearing arrangements must be modelled as a portfolio choice problem, in order to ascertain the precise influence of clearing alone.

The model developed here describes the choice of the central bank between holding reserve balances and investing in productive assets. For a given distribution of net export receipts and a given cash management policy of the central bank, expected daily demand for international reserves is derived. This demand is re-derived to illustrate the effects of a clearinghouse; in addition, reserve demand is augmented to account for debt payments to external creditors.

Regardless of whether the central bank makes external debt payments, the clearing arrangement reduces the demand for reserves to finance trade. It is possible, were the "freed" reserves invested in development of the export industry, that the clearing arrangement could translate into an increased volume of trade. If the country is burdened with external debt payments however, it is possible that the "freed" reserves would simply be used to increase payments to external creditors.

# The Effect of Multilateral Trade Clearinghouses On the Demand for International Reserves

by

Ellen E. Meade*

## 1. Introduction

Since the 1930s, bilateral and multilateral payments arrangements have existed to facilitate trade and economize on the transfer of foreign exchange. The European Payments Union of the 1950s was the first multilateral payments arrangement. Beginning in the early 1960s, the countries of Latin America, Central America, and the Caribbean organized payments facilities. The payments union for the Latin American nations -- ALADI -- functioned efficiently until the early 1980s, when high debt payments to external creditors caused ALADI debtors to become delinquent on debts to the facility.

The exact benefits of a multilateral payments arrangement have never been fully explored. Previous research has focused on the effects of regional economic integration, where integration may include regional trade and tariff agreements, exchange controls, and other arrangements in addition to multilateral trade clearing. Thus the independent effects of a multilateral payments clearinghouse for trade are not known.

This paper attempts to isolate and model the effects of a multilateral clearing arrangement, and then to draw conclusions about the effects of such an arrangement in the presence of sizable debt to external creditors. The model attempts to capture the "pure clearing" effects of a trade facility

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*The author is a staff economist in the International Finance Division. This paper represents the views of the author and should not be interpreted as reflecting those of the Board of Governors of the Federal Reserve System or other members of its staff. I have benefited from fruitful discussions and comments from Catherine Mann, Ed Green, David Howard, Robert Kahn and Peter Kenen.

— that is, the benefits of the multilateral netting of accounts with end-of-period settlement. The approach used follows the transactions demand for money and the precautionary demand for international reserves literature, where the central bank has a demand for dollar reserves in order to make payments for imports.

In the first section of the model, I derive the expected daily demand for dollar reserves for a central bank when no clearing arrangement exists and there is no external debt. Then the effects of a multilateral clearing arrangement are investigated; it is shown that expected reserve holdings decrease under a clearing arrangement. Next, reserve demand is derived for a country with no clearing arrangement, but with debt service payments. The effect of a clearing facility is then explored, assuming that the debt service payments constitute a priority claim on the reserves of the central bank. The focus of the model is on the potential for clearing arrangements to free reserves for alternative uses.

The paper proceeds as follows: section 2 details the institutional arrangements of the historical payments agreements and the present-day Latin American clearing facility. A discussion of the price approach (the "trade" approach) vs. the non-price approach (the "portfolio" approach) to the modelling of a trade clearinghouse follows in the next section. This section is important because it explains why it is necessary to model the effects of a clearinghouse on the individual central bank, rather than on the economy as a whole. The fourth section discusses the transactions demand for money and the precautionary demand for international reserves literature, specifies a model for the demand for dollar reserves of a central bank, and investigates the effect of a clearinghouse on this demand for reserves. In section 5, the reserve demand is

re-derived assuming that the foreign central bank has a priority debt to external creditors. A discussion of the possible impact of changes in the demand for dollar reserves on intra-regional trade is contained in section 6. Section 7 concludes the paper.

## 2. Institutional Background

### Historical Clearing Arrangements

An institution for the clearing of intra-regional trade was not an idea original to Latin American governments. Bilateral payments agreements were first developed in the 1930s in order to enable countries to conserve on free foreign exchange and to establish provisions for trade between countries with exchange controls. "The essential element in these arrangements was the control over the use of national currency balances in the hands of non-residents."[1] During this period, the agreements were used to facilitate trade between free-exchange countries and the exchange-control countries of Eastern Europe.

In the mid-1940s, countries in Western Europe began to formulate bilateral arrangements in order to conserve free foreign exchange reserves. While it is difficult to generalize the characteristics of those postwar bilateral agreements, it appears that the currencies of the two trading partners were acceptable as means of payment and that reserve or "hard" currencies (i.e., dollars, sterling or gold) were only necessary to settle net balances in excess of some negotiated credit limit.[2]

The first multilateral trade clearinghouse -- the European Payments Union -- was formed in 1950, replacing these post-World War II bilateral payments arrangements. The European Payments Union (EPU) was expected to

increase the volume of intra-regional trade directly by lessening the liquidity constraint facing member governments, and indirectly by discouraging trade restrictions and discrimination among members.

Liquidity of the member governments was increased as a result of two provisions in the EPU arrangements.[3] First, the union provided for the multilateral clearing of accounts. Each member was expected to settle its net balance with the union once per month in gold or dollars. This multilateralism further reduced the need for "hard" reserves relative to individual bilateral trading arrangements, and eliminated the problem of excess holdings of "soft" currencies associated with the bilateral payments agreements. The increase in liquidity was a result of the pure clearing function of the EPU ("pure clearing function" is the term that will be used henceforth to describe the multilateral clearing of accounts).

The second way in which the European Payments Union increased liquidity in the region was through the provision of partial credit at the time of settlement. A debtor could pay a portion of the net settlement balance in gold or dollars, and owe the remainder to the EPU.[4] In effect, this arrangement allowed for the extension of credit from the net creditors in the facility to the net debtors. The credit provisions temporarily transferred liquidity from creditors to debtors. This aspect of the trading arrangements will be referred to as the "credit function", i.e., increases in liquidity or trade volume which result from the extension of credit to union members across settlement periods (i.e., inter-period credit as opposed to the intra-period credit provided during a given settlement period).

In addition, the formation of the European Payments Union was accompanied by the commitment of member governments to the promotion of free

trade in the region, through the reduction of trade barriers and the elimination of discriminatory practices. Thus any increase in intra-regional trade after the formation of the European Payments Union was due to the simultaneous effects of a lessening of liquidity constraints and the reduction of barriers to trade.

Latin American Clearing Facilities

Multilateral clearing facilities exist for all three of the regional common market areas in Latin America. The trade clearinghouses for both the Latin American Integration Association and the Central American Common Market were established shortly after the common markets were formed in the early 1960s.[5] The common market and trade clearinghouse for the Caribbean countries were not organized until the early 1970s.[6]

The three multilateral clearing facilities share similar institutional characteristics and, for that reason, it is not necessary to describe each individual clearing arrangement. The ALADI clearinghouse will be the focus of this paper; the institutional arrangements for the ALADI facility will be reviewed, as well as the evolution of the trading behavior of each member government. The reason for choosing ALADI as the representative trading arrangement is that the member countries are the largest of the Latin American nations and that information about the operation of the ALADI facility is somewhat more easily obtained.

The ALADI trade clearing facility was formed in 1965 by an agreement among member central banks, with the central bank of Peru appointed to record all transactions. The specifics of the trading arrangements are outlined in bilateral agreements, so that certain details of the clearinghouse (bilateral credit limits, for instance) are unique to each pair of countries

involved. Other regulations apply to all member countries. Bilateral credit limits constrain the dollar value of trade which can take place between two countries in any settlement interval. Every four months, accounts are tabulated multilaterally and net settlement is made in dollars (the actual debiting and crediting of accounts takes place at the Federal Reserve Bank of New York which acts as agent for the central bank of Peru). Should a country not be able to meet settlement, there are provisions for the extension of short term credit from the facility. Interest is assessed on short term credit; the interest rate charged is 90 percent of the prime rate at New York commercial banks.

It is useful at this point to describe the actual mechanics of trade with and without a clearing arrangement. It is assumed that a simple export of goods from, for example, Argentina to Venezuela involves six actors: the Argentine exporter, the exporter's local commercial bank, the central bank of Argentina, the Venezuelan importer, the importer's local commercial bank, and the central bank of Venezuela. As is the case in many Latin American countries, and as will be presumed here, dollars are held only by the central banks and all trade is denominated in dollars; furthermore, exchange controls demand that dollar export revenues be exchanged for local currency. Thus, the importer must use his commercial bank as an intermediary in order to obtain dollars for bolivars, and the exporter must exchange dollars for australs through his commercial bank.

In the absence of a clearing arrangement, trade between the two Latin American nations would necessitate the following: the Venezuelan importer would arrange for his local commercial bank to make payment to the Argentine exporter.[7] The Venezuelan commercial bank would exchange bolivars for dollars

at its central bank, and would transfer the dollars to the Argentine exporter, who would exchange the dollars at his commercial bank for australs. That commercial bank would pass on the dollars to the Argentine central bank. Dollars would flow out of Venezuela and into Argentina at the time of the transaction.

When a clearing arrangement is in existence, the Venezuelan importer will still arrange for the local commercial bank to conduct the transaction. The commercial bank will approach the central bank, which will supply the requisite papers to authorize the transaction and the exchange of dollars. These papers will be passed along from the Venezuelan importer to the Argentine exporter, who will pass them on through the Argentine commercial bank to the Argentine central bank. Once the transaction is fully authorized, the papers are sent to the central bank of Peru so that the transaction can be recorded through the clearing facility. The central bank of Argentina will make payment to the Argentine commercial bank in australs; the exporter's account will be credited for the amount of the transaction. At this point, the central bank of Argentina will have a dollar claim on the central bank of Venezuela. These claims accumulate until the time of settlement when the Peruvian officials multilaterally net out all recorded transactions, and authorize dollar transfers between member accounts. Unlike the transaction without a clearing arrangement, no dollar reserves flow out of Venezuela and into Argentina until the date of settlement.

From the inception of the ALADI clearinghouse in 1965 until the early 1980s, the facility functioned effectively and processed an increasing proportion of intra-regional trade.[8] In the early 1980s however, the clearing-house ceased to function smoothly, as debtor balances accumulated and remained

unsettled. This inability to meet settlement appears to have been related to the high level of external debt payments owed to commercial banks and official institutions outside the region. Debtor countries regarded their external debt payments as higher priority claims than debts to the ALADI clearinghouse.[9] The clearinghouse was forced to suspend operations temporarily, until the pressures of external debt payments could be attenuated (through the negotiation of debt rescheduling agreements which reduced debt service payments and/or through the negotiation of new loan agreements which increased reserves in the debtor nations).

Operating in conjunction with the clearinghouse are trade agreements formulated by the Latin American Integration Association which regulate tariffs and other trade barriers between members of the union. Thus regional trade in Latin America is facilitated by the clearinghouse which increases liquidity (through both pure clearing and credit provisions), and the common market which reduces (or eliminates) internal tariffs and integrates trade policy in the region.

### 3. Price vs. Non-Price Incentives

There are two possible approaches to the analysis of the effects of a trade clearinghouse on regional welfare. The first approach involves the examination of trade patterns and volumes before and after the introduction of a facility for intra-regional trade. The second approach emphasizes portfolio considerations in that it analyzes the central bank demand for reserves before and after the trade clearinghouse. Both approaches will be discussed in turn below; for reasons to be outlined, the portfolio approach better captures the role of a trade financing facility and is modelled in this paper.

Trade Approach

The first approach to the clearinghouse issue examines the changes in welfare of the region (or member country) after the creation of the trade facility. This approach follows the customs union literature in emphasizing the potential for a clearinghouse to create/divert trade as a result of changing relative prices within the region.[10] If welfare is defined in terms of intra-regional trade volume, then a clearinghouse facility which increases intra-regional trade flows increases welfare. In addition to the change in regional trade volume, a trade financing facility may have some effect on trade flows between members of a facility and countries outside the region. Thus if the creation of a clearinghouse causes trade to be diverted away from extra-regional trading partners, then the welfare gains may not be clear-cut; any increase in intra-regional welfare due to the creation of trade (after a clearing facility is established) must be weighed against the welfare loss outside the region due to trade diversion. Clearly, this approach to the clearinghouse question emphasizes the trade-off between intra-regional and extra-regional welfare.

Unfortunately the investigation of the trade creation/diversion effects of a trade clearinghouse is not straight forward. First, if intra-regional trade volumes increase or extra-regional flows are diverted at the aggregate level, it is because some underlying incentives have changed which have increased (decreased) the desirability of intra(extra)-regional trade. This reasoning suggests that a more appropriate model of a clearinghouse would try to capture the change in incentives for the participating country.

Furthermore, examination of time series data on trade patterns may lead to spurious conclusions about the impact of a trade facility. Between

1966 and 1979, intra-regional exports as a percentage of total exports rose from 13 percent to 17 percent. If the rise in intra-regional exports as a proportion of total exports were to be attributed to the existence of a clearing facility for trade alone, clearly some facts would be ignored. For example, the rise in the fraction of intra-regional exports could well be due to the relaxation of trade barriers which accompanied the formation of the clearing facility. Alternatively, shifts in growth and demand within the ALADI region could have produced the increase in the fraction of intra-regional exports. Whether the increase in regional trade volume was due to the formation of a clearinghouse per se, or to reductions in trade and tariff barriers, or to trend growth and demand shifts, is unclear. Thus, it appears that any examination of time series data on intra-regional and intra-clearinghouse trade volumes must be done cautiously.[11]

Portfolio Approach

The portfolio approach to a trade clearinghouse looks at the alteration of non-price incentives and how this change in incentives could influence the reserve-holding behavior of the central bank. In the absence of a clearinghouse, each trade transaction involves the exchange of dollars such as that described above in the hypothetical trade between Argentina and Venezuela. Thus, the central bank must keep dollar reserve balances available to satisfy the demands of importers. With a clearinghouse however, only the net settlement is paid in dollars since offsetting transactions cancel out. In addition, it will be the case that a clearinghouse lengthens the holding period for dollars; that is, in the no-clearinghouse case, not only are all transactions settled in dollars, but they are settled in dollars immediately. With a clearinghouse, there will be some intra-period credit extended until the appointed time for

multilateral reconciliation of balances. To sum up, the "pure clearing" function ascribed to the clearinghouse could affect reserve-holding behavior in two ways: through reducing the dollar reserves held for transactions purposes (because of the multilateral netting of accounts) and through changing the time when dollar reserves need to be paid (because of the lengthening of the settlement period).

Empirical evidence lends support to the hypothesis that the existence of a clearinghouse reduced the need for hard currency reserves in order to conduct trade. From the ALADI facility's first full year of operation in 1966, and continuing until 1980, transactions registered through the clearinghouse were an increasing proportion of intra-regional exports (see Table 1).

Table 1
(millions of dollars)

| | (1) Transactions Registered through ALADI | (2) Intra-regional Exports | Percentage (1)/(2) |
|---|---|---|---|
| 1966 | 106 | 676 | 15 |
| 1970 | 560 | 1278 | 43 |
| 1974 | 2396 | 4026 | 59 |
| 1979 | 6420 | 8759 | 73 |
| 1980 | 8663 | 10927 | 79 |

Source: Inter-American Development Bank, Economic and Social Progress in Latin America: Economic Integration, 1984.

Seventy to 75 percent of the clearinghouse transactions were multilaterally netted out at settlement; only 25 to 30 percent of the clearinghouse transactions required an exchange of reserves. As the proportion of intra-regional trade processed through the ALADI facility increased, so did the potential for member central banks to reduce reserve holdings. As the demand for reserves was reduced, dollars were freed for alternative uses.

## 4. The Model

The model formulated in this paper is based in part on the transactions demand for money literature and in part on the precautionary demand for international reserves literature which followed later. The inventory approach to the transactions demand for money is originally associated with the work of Baumol and Tobin. In the Baumol model (1952), the consumer must make an allocation decision between investing in an asset yielding return r and holding transactions balances (which earn no interest). Funds cannot be shifted costlessly between the asset and cash; each investment or liquidation costs $\delta$ per transaction (the fee is fixed). Baumol derives the demand for transactions balances for a situation where income is received periodically but expenditures are incurred at a constant rate each day, and the consumer minimizes costs (that is, the opportunity cost of holding cash and the fixed transactions fee).

In the Baumol model, cash holdings follow the familiar "saw-tooth" form, where assets are augmented periodically but cash balances are steadily drawn down. Miller and Orr (1966) suggested that this pattern of cash holding better describes the consumer than the firm, as a firm has more erratic behavior arising from the unpredictability of both income inflows and expenditure outflows. They adopt the basic Baumol framework, but assume that net cash flow follows a stationary random walk. Furthermore, they assume that cash holding can be described by an (S,s) inventory model where transactions balances fluctuate within a band but when one of the boundaries of the band is reached, then assets are liquidated or invested until cash holding is returned to a desired level x. Given this framework and the firm's objective

of cost minimization, Miller and Orr derive the firm's transactions demand for money.

The literature on the demand for international reserves has emphasized that this demand is precautionary in nature, rather than a transactions demand, but arises from the transactions demand of commercial banks. Debate has focused on the appropriate definition of reserve assets, what constitutes reserve adequacy, and whether reserve adequacy is identical to reserve demand. Kenen and Yudin (1965) were the first to point out the importance of measuring reserve adequacy against the variability of payments rather than the level of imports. In general, the models of central bank reserve demand are based on the trade off between holding additional reserves (where the opportunity cost is forgone investment) and imposing expenditure-changing or expenditure-switching adjustment should reserves be inadequate. In Clark (1970) and Kelly (1970), all policy adjustment takes place through expenditure-changing, as the government is assumed to have perfect control over national income. A high level of reserves entails a lower level of income, but reduces the probability that policy adjustment will be necessary. On the other hand, lower reserve levels raise income, but simultaneously increase the probability of adjustment and thus the variability of income. The central bank must trade off level and variability of income in formulating its demand for reserves.

The approach of Heller (1966) is somewhat similar to the model used in this paper. Reserves are presumed to follow a stationary random walk with constant, symmetrical step size. For a constant opportunity cost of holding reserves in liquid form, and a constant adjustment cost should policy action be required, Heller derives an explicit formula for reserve demand

by equating the marginal cost of reserve holding with the marginal cost of adjustment.

There are two problems with Heller's analysis. First, Heller derives reserve demand for a string of negative realizations of the random variable; that is, from a given initial reserve level, he derives the probability of reserves falling to zero if a deficit occurs each period. He does not consider different combinations of deficits and surpluses, or different paths of the random variable, which could also result in draining reserves to zero. Second, Heller does not discuss what happens after the zero reserve level is reached. The necessary policy adjustment and the subsequent effect on reserve levels is not addressed. Hamada and Ueda (1977) have attempted to resolve these issues by considering possibilities other than a straight run of deficits and by defining the path for reserves after the initial level of reserves is exhausted.[12]

The model formulated here relies on the work by Miller/Orr and Hamada/Ueda, with presumed stochastic trade balance and central bank management having an (S,s) inventory approach to reserve holding. First the demand for international reserves is derived for the situation of no clearing arrangement. Then the clearing arrangement is introduced and the reserve demand is re-derived. Before concluding the section, I will discuss the validity of the necessary restrictive assumptions.

4.A. No Clearinghouse Case

The government must make an allocation decision: dollars can be held as reserve assets by the central bank (earning short-term interest rate $r_S$ per day), or invested in productive assets (earning long-term interest rate $r_L$, where $r_L > r_S$).[13] If dollars are held as reserves, the forgone interest

or opportunity cost r is equivalent to the difference between $r_L$ and $r_S$.

Dollars can be transferred from liquid assets (reserves) to illiquid assets (investment) at the cost of $\omega$ per transfer. This transfer cost is independent of the size or direction of the transfer and of the time since the last transfer; $\omega$ simply represents some lumpy cost of undertaking an investment project. Conversion of illiquid assets to liquid form is impossible however, as investment projects are fixed once they are undertaken.

If central bank reserves are deemed insufficient, the government must take some policy action to restore liquid balances. Following the international reserves literature, it is assumed that the government has perfect control over national income, and that it uses expenditure-reducing policies to achieve a desired trade balance when reserves are insufficient (given a fixed marginal propensity to import, m). Thus if reserve balances are too low to support trade, income is reduced enough to produce a surplus which will restore reserves to desired levels. The cost of this policy adjustment is (1/m) units of income per unit increase in reserves.

Reserve balances are required to finance trade and all trade is is conducted in dollars.[14,15] It is assumed that assets are sufficient to pay for all trade transactions (there is no insolvency problem). The issue is the allocation of funds between reserves and investment opportunities, and thus this framework ignores two crucial allocation decisions: the allocation of reserves across a portfolio of interest-bearing assets, and the currency composition of reserves.

The net trade flow per day is assumed to follow a sequence of independent Bernoulli trials, where the trade balance is in surplus by d dollars with probability p and in deficit by d dollars with probability q. Thus

over any n day interval, the mean trade balance would equal $\mu = nd(p-q)$, and the variance $\sigma^2 = 4npqd^2$. For the case considered here, it will be assumed that the probability of surplus is equal to the probability of deficit or $p = q = 1/2$. The assumption of symmetric probabilities is made in order to ensure that the expected value of the trade balance is zero.[16]

The central bank is assumed to follow an (S,s) process of reserve management, which means that reserve balances are permitted to fluctuate within a narrow band until one of the boundaries of the band is reached, at which point balances are returned to some desired level, either by expenditure-reducing policies which restore reserve assets, or by investment which reduces reserve assets. In this model, reserve balances may fluctuate between zero and y, but are returned to x when a boundary is hit.[17] In order to simplify the analysis, it is assumed that the cost of converting (y-x) dollars of reserves into investment projects when reserves hit the upper boundary is equal to the cost of restoring x dollars of reserves through expenditure-reducing policies when the lower boundary is reached. This cost of transfer is represented by $\delta$, where $\delta = \omega = x/m$ (recall that 1/m is the income cost for each unit of reserve increase).

Given the assumed process for net reserve flow and the cash management strategy of the central bank, it only remains necessary to describe the central bank objective function. The central bank seeks to minimize the expected cost per day, that is

$$(1) \qquad \min_{x,y} \quad E(c) = \delta(E(T)/n) + rE(M)$$

where $E(c)$ = expected cost per day
$\delta$ = cost of liquid to illiquid asset conversion or income reduction
$E(T)$ = expected number of conversions/reductions over an n day interval
$n$ = number of days in the interval
$r$ = opportunity cost of holding reserves
$E(M)$ = expected reserve balance per day

The first term in (1) represents the cost of converting reserves into investment or enacting expenditure-reducing policy, while the second term is the opportunity cost of holding reserve balances.

In order to minimize the central bank's cost function with respect to x and y, it is first necessary to derive the cost function in terms of those control variables. It is shown in the appendix that the objective function can be stated as:

$$(2) \qquad \min_{\text{wrt } x,X} \; E(c) = \frac{\delta d^2}{xX} + \frac{r(X + 2x)}{3}$$

where $X = (y - x)$.

The first order conditions for a minimum are:

$$\frac{dE(c)}{dx} = -\frac{\delta d^2}{x\,X} + \frac{2r}{3} = 0$$

$$\frac{dE(c)}{dX} = -\frac{\delta d^2}{xX} + \frac{r}{3} = 0$$

which yield the following optimal values for x and y:

$$(3) \qquad x = \left(\frac{3\delta d^2}{4r}\right)^{1/3}$$

$$(4) \qquad y = 3x \quad .$$

Note that the level to which reserve balances are returned when a boundary is reached (x) is not the mid-point of the boundary interval. The return point (x) is closer to the bottom boundary of the range (0) and implies that the

purchase of investment assets will occur in larger quantities and thus less frequently than expenditure-reducing policy measures.

Of most interest is the solution for E(M), the expected daily reserve balance (i.e., the demand for dollar reserves). In the appendix it is shown that,

$$(5) \qquad E(M) = (X + 2x)/3 = (y + x)/3$$

Substitution of (3) and (4) into (5) yields a solution for transactions reserve holdings in terms of $\delta$, d, and r:

$$(6) \qquad E(M) = \frac{4}{3}\left(\frac{3\delta d^2}{4r}\right)^{1/3}$$

Noting that the variance of net reserve flow $\sigma^2$ divided by the number of days in the interval (n) is equal to the square of the realization ($d^2$), expected daily reserve holdings can be re-written as:

$$(7) \qquad E(M) = \frac{4}{3}\left(\frac{3\delta\,\sigma^2}{4rn}\right)^{1/3}$$

Expected daily reserve holdings rise with the cost of transfer and with the variance of the net flow (over the time period), but they are inversely related to the opportunity cost of reserves and the number of days in the time interval.

4.B. Clearinghouse Case

The formation of a clearinghouse for intra-regional trade alters the above model in two fundamental respects: the realization of the stochastic variable changes for days between settlement dates, and a certain net intra-regional balance is owed on settlement day. For exports processed through

the clearinghouse, income is not received until the end of the settlement period; for imports, payment is not made until the end of the settlement period. If it is assumed that some proportion $\alpha$ (where $\alpha < 1$) of any given realization of reserve flow is processed through the facility, then net positive realizations (+d) will be reduced by ($d\alpha$), and net negative realizations (-d) will be increased by ($d\alpha$). Thus in any given day between settlement dates, net cash flow is a sequence of independent Bernoulli trials where the net flow equals ($d(1-\alpha)$) with probability p and $-(d(1-\alpha))$ with probability q.[18] To ensure expected trade balance equilibrium, it is still assumed that $p = q = 1/2$.

As previously stated, a clearinghouse arrangement postpones net payment for intra-regional exports and imports until the date of settlement. This can be modelled here by assuming that the time interval for each trading period is n days long, with settlement for intra-regional trade occurring on the last (nth) day. On day n, intra-clearinghouse exports and imports are multilaterally netted out, and the balance is settled in dollars.[19] The expected daily reserve demand is thus dependent on the particular day of the settlement period. For days 1 to (n-1), reserve demand can be written as:

$$(8) \qquad E(M)_c = \frac{4}{3}\left(\frac{3\delta(d(1-\alpha))^2}{4r}\right)^{1/3}$$

From (8), it is obvious that daily reserve holdings have decreased under a clearing arrangement. In fact, the derivative of expected balances with respect to $\alpha$ is negative, implying that increases in the proportion of trade processed through the facility reduce reserve demand, thus freeing funds for alternative uses:

$$\frac{dE(M)_c}{d\alpha} = \frac{4[(-3d\delta(1-\alpha))/2r]}{9[(3\delta(d(1-\alpha))^2/4r]^{2/3}} < 0$$

The reduction in the realization of the net trade balance between day 1 and (n-1) is equivalent to reducing the variance of the trade flow.[20]

On day n, net settlement must be made for intra-clearinghouse trade. Assume for simplicity that no trade is conducted on day n, and therefore reserve demand is entirely related to net settlement of the clearinghouse. Reserve demand is known with certainty for day n, and is equal to the number of positive realizations of $d\alpha$ between days 1 and (n-1), less the number of negative realizations. That is, if the (n-1) day trading interval can be divided into $n_1$ days of net exports ($+d\alpha$) through the clearinghouse and $n_2$ days of net imports ($-d\alpha$), then the central bank owes the facility $(n_2 - n_1)d\alpha$ in dollars on day n (by definition, $n_1 + n_2 = n-1$). Obviously, if $n_1 = n-1$, then the central bank receives $(n-1)d\alpha$, and if $n_2 = n-1$, the central bank owes $(n-1)d\alpha$ in reserves. Any other outcome between $-(n-1)d\alpha$ and $+(n-1)d\alpha$ is equally likely however. Thus reserve demand on day n is known with certainty and is equal to,

$$(9) \qquad E(M)_{cn} = (n_2 - n_1)d\alpha \quad .$$

## 4.C. Review of Assumptions

A discussion of the assumptions of the above model requires an examination of two issues: first, the representation of the transfer cost $\delta$ incurred in both the conversion of reserves to productive assets and the enactment of expenditure-reducing policy measures; second, the requirements implicit in representing the net trade balance by independent Bernoulli trials.

Addressing the first point, $\omega$ and $(1/m)$ may not be realistic cost measures. Furthermore, it may be entirely inappropriate to equate these different costs. It does seem reasonable to assume that there are costs associated with initiating investment projects. Whether those costs are invariant to the size of the project, and independent of time or project is open to question. Similarly, there are costs associated with expenditure-reducing policy measures. It is simplistic to think that the government has perfect control over expenditure, that the marginal propensity to import is constant, and that expenditure-reduction is the only policy tool available. These simplifications are minor and arguably necessary for the model; the second assumption, that the two costs are equal, is made purely to simplify the analysis.

The representation of the net trade balance by a sequence of independent Bernoulli trials requires that trade flows be independent of previous flows and that there be no seasonal swings in trade patterns. It is unlikely that intra-regional trade in Latin America has satisfied this restriction. Not only should trade between partners be correlated over time, but seasonal commodities (such as agricultural products) should result in tremendous swings in trade over the annual cycle. The examination of serially correlated trade would substantially complicate the analysis however and for that reason, the Bernoulli distribution is chosen.

## 5. The Model with External Debt

In the event that the government has contracted public external debt owed to foreign commercial banks, then the central bank has a demand for reserves in order to make debt payments over and above the reserve demand

arising from trade payments. In this section, I assume the government has borrowed D dollars from external commercial banks, which it must repay at interest rate $r_D$ over time t. It is further assumed that full repayment of the external debt is not possible, and that the central bank pays only a fraction $\beta$ (where $\beta < 1$) of its principal payments. The exogenous, predetermined debt service payment to foreign commercial banks augments the central bank's objective function linearly, raising the daily expected cost, but leaving unchanged the optimal x and y parameters. (This is because the payments on external debt are not dependent on x and y.) As in the previous section, the focus of the analysis is on the expected demand for reserves. No longer are reserves demanded simply to finance trade, but are necessary to make external debt payments as well. Expected reserves are higher with external debt, but once again the introduction of a clearing mechanism reduces reserve demand.

The particular approach to modelling external debt chosen here ignores many crucial issues. First, the debt level is exogenously given as is the reason for the contraction of that debt. A more realistic approach would have imbalances in trade leading to the accumulation of external debt. As the presumption in this model is that exports and imports are on average equal (because the net trade realizations are symmetric and the probabilities of those realizations are equal), the model is not equipped to handle imbalances in trade. Thus external debt is exogenous and not motivated within the framework of the model.

Furthermore, partial repayment of the principal is presumed to be exogenous to the model. Issues of reputation and repudiation are ignored here; it is assumed that the government is not in default and that partial repayment

is consistent with future borrowing.[21] The determination of the fraction $\beta$ of principal to be repaid is also ignored. While much of the literature on external debt in developing countries is concerned with issues of reputation and repudiation, this paper concerns itself with issues of reserve demand, and the alteration of that demand in the presence of external debt. In reality, most Latin American governments make only partial payments on external debt but are not declared in default nor are they denied access to additional credit.

The country has contracted a debt level D to be repaid over period t at interest rate $r_D$. For simplicity, it is assumed that the per day payment owed is (D/t) of principal and ($Dr_D/t$) in interest.[22] As stated above, the country chooses to repay a fraction $\beta$ of the principal due. The foregone interest on this fixed debt payment augments the central bank's cost function:

$$(1') \qquad \min_{x,y} \; E(c)_D = \delta(E(T)/n) + r[E(M) + (D(\beta + r_D)/t)]$$

The daily expected demand for reserves now contains two terms: the original demand which depends on the realization of net trade, and the predetermined debt service payment.

$$(6') \qquad E(M)_D = \frac{4}{3}\left(\frac{3\delta d^2}{4r}\right)^{1/3} + \frac{D(\beta + r_D)}{t}$$

Obviously expected demand is higher when the central bank holds reserves in order to make trade and external debt payments, than in the case with no external debt.

The organization of a trade clearing facility would reduce reserve holdings by changing the realization of the random variable (from plus or minus d dollars per day to plus or minus $d(1 - \alpha)$) between days 1 and (n-1).

Analogous to the discussion contained in the previous section, expected daily reserve demand for days 1 to (n-1) becomes:

$$(8') \qquad E(M)_{cD} = \frac{4}{3}\left(\frac{3\delta(d(1-\alpha))^2}{4r}\right)^{1/3} + \frac{D(\beta+r)}{t}$$

On settlement day n, reserve demand is the sum of the clearinghouse payment the debt service payment,

$$(9') \qquad E(M)_{nD} = (n_2 - n_1)d\alpha + (D(\beta+r_D))/t \quad .$$

Generally speaking, external debt payments increase and clearing arrangements reduce the daily demand for reserves.[23]

6. Effects on Trade

Whether the reduction in reserve demand associated with the introduction of clearing arrangements results in an increased volume of trade is unclear. With the advent of trade clearing facilities in the 1950s, the claim was made that intra-regional clearing arrangements would increase intra-regional trade. While it appears possible that a clearing facility could raise the level of intra-regional trade, it is not a guaranteed outcome.

In section 4, it was demonstrated that clearing arrangements for a country with no external debt payments would reduce reserve demand. In the context of the model used here, the reduction in reserve demand would translate directly into an increase in investment, as the clearing mechanism frees reserves for alternative uses. Presumably, an increase in certain types of investment projects could eventually lead to an increased volume of trade (both intra- and extra- region). However, this increased trade could result only if investment were made in the appropriate export industries and would not

be realized immediately, but would require some time lag. Thus, clearing arrangements have the potential to increase intra-regional trade, but do not guarantee such an outcome.

With the introduction of external debt burdens, it becomes possible that a reduction in reserves for financing trade could simply serve to make additional debt service payments. If external debt constitutes a priority claim on the dollar reserves of the central bank,[24] and debt is not fully serviced (i.e., $\beta < 1$), then additional dollar reserves could be used to fund debt service (the country might choose to raise $\beta$ rather than to increase investment).

The policy implications of this are striking. Additional funding to clearing facilities such as ALADI could be used to increase the reserves of member central banks (bilateral credit limits could be augmented because the funds would be available to finance facility credit if a country was unable to pay its net balance on settlement date), perhaps allowing them to enlarge debt service payments.

## 7. Conclusions

This paper has attempted to capture the portfolio incentives for central bank participation in a multilateral trade clearinghouse and to discuss the relation of those incentives to the volume of trade. Clearinghouses for the netting of multilateral intra-regional trade have existed since the 1950s, but no work to date has attempted to explore the incentive effects of such arrangements. Instead previous work, primarily empirical, has focused on the tendency of preferential arrangements (clearing as well as favorable protectionist policies) between nations to encourage trade flows between

them. This paper advanced the notion that the effects of clearing arrangements must be modelled as a portfolio choice problem, in order to ascertain the precise influence of clearing alone.

The model developed here describes the choice of the central bank between holding reserve balances and investing in productive assets. For a given distribution of net export receipts and a given cash management policy of the central bank, expected daily demand for international reserves was derived. This demand was re-derived to illustrate the effects of a clearing-house; in addition, reserve demand was augmented to account for debt payments to external creditors.

Regardless of whether the central bank makes external debt payments, the clearing arrangement reduces the demand for reserves to finance trade. It is possible, were the "freed" reserves invested in development of the export industry, that the clearing arrangement could translate into an increased volume of trade. If the country is burdened with external debt payments however, it is possible that the "freed" reserves would simply be used to increase payments to external creditors.

Footnotes

1. Trued and Mikesell (1955), p. 1.

2. "Hard" currencies refers to the reserve currencies, while "soft" currencies denotes the currencies of the two partners in a bilateral trading arrangement.

3. The discussion here presumes that a decrease in the demand for reserves constitutes an increase in liquidity because reserves are freed for alternative uses.

4. Under the initial arrangements of the EPU, the amount of credit provided to any member was based on a quota system. Each member of the EPU had a quota equal to fifteen percent of total trade with other EPU members in 1949. The amount of credit available to any member depended on the relationship between the total debt of that country and its quota. For low ratios of debt to quota, full credit was available; as the ratio increased, an increasing proportion of debt had to be paid in gold or dollars. The settlement process was similar for creditors to the EPU: for low ratios of credit to quota, all the credit was extended to the union; as the ratio increased, the creditors received an increasing fraction of credit in hard currencies. Thus the amount of debt or credit was a sliding scale of quota. These arrangements were eventually altered; for details, see Triffin, Europe and the Money Muddle.

5. The Latin American Free Trade Association was created in 1960 and was replaced in 1980 by the Latin American Integration Association (ALADI). At present, ALADI members include Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay, and Venezuela. A trade clearinghouse was organized for ALADI members in 1966.

The Central American Common Market was established in 1962; Costa Rica El Salvador, Guatemala, and Nicaragua are members. A facility for intraregional trade was organized in 1961.

6. Members of the Caribbean Common Market, organized in 1973, include: Antigua, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, Montserrat, St. Kitts-Nevis-Anguilla, St. Lucia, St. Vincent, and Trinidad and Tobago. A trade clearing facility was founded in 1977.

7. Whether the importer obtains trade credit from the commercial bank (or some other source) or has the funds available to finance the transaction is not addressed here. Although trade credit is a very likely source of import finance and somewhat changes the details outlined, it is irrelevant to the basic explanation of the transaction.

8. Details are given in Table 1 below.

9. The reason for this will not be investigated here, but may be due to the fact that the maintenance of a reputation is more valuable outside the region than within, since Latin American nations are dependent on extraregional commercial banks and official institutions as primary sources of credit.

10. For a review of the customs union literature and a discussion of the potential consumption effects (which are ignored in the above description), see Lipsey (1981).

11. Empirical studies which examine the extent of regional economic integration are plentiful, but there are no studies on the impact of clearinghouse formation on trade. The existing studies estimate gravity equations — the value of exports from country i to country j is regressed on a constant, income in the two countries, population in i and j, distance between the countries, and a dummy variable indicating whether or not the countries have a preferential trading arrangement. The significant coefficients on the dummy variables support the hypothesis that increases in regional integration lead to increases in intra-regional trade. Increased regional integration may be due to the existence of a clearing facility, preferential trade and tariff arrangements, and/or shifts in demand.

12. Although similar in the spirit of analysis to Miller and Orr, Hamada and Ueda do not describe reserve management with an (S,s) policy. Instead they use a random walk with reflecting barriers (for a description see Hamada and Ueda, pp. 726-728 or Feller, p. 311). Reserve demand is described by a square root formula rather than the cube root formula of Miller and Orr.

13. There is no distinction here between the government and the central bank.

14. In addition it is assumed that reserves are used only to finance trade, so that the entire reserve balance is dependent upon expected trade flows.

15. The difference between transactions and precautionary money holdings is irrelevant here. The central bank has a precautionary demand for reserves which varies one-for-one with the transactions demand of the commercial bank.

16. If trade is balanced initially, then it is expected that trade will be balanced after n days if the probabilities are symmetric. Were p and q unequal, the country would be a net exporter or net importer. The accumulation or decumulation of reserves which would result from asymmetric probabilities would necessitate other adjustments (such as exchange rate changes or offsetting capital flows) which are not incorporated in the model.

17. The zero lower bound of the range is not critical for the results, but zero simplifies the analysis somewhat. It is probable that central banks would not allow reserves to fall to zero before augmenting the stock.

18. Admittedly it is a bit artificial to assume that the same dollar amount of trade is processed through a clearinghouse for import and exports. This assumption is made in order to simplify the analysis and does not imply that the net actual intra-regional trade balance is zero.

19. It is assumed that the amount of import credit drawn over the settlement period, $dn\alpha$, is less than or equal to the amount of import credit available. Similarly, the central bank has extended an export credit line of at least $dn\alpha$ to foreign country governments. This does not imply that intra-regional trade volume is limited to $dn\alpha$ over the period. Any trade in excess of the bilateral credit limits is simply not processed through the clearing facility.

20. Recall from equation (7) that the daily variance ($\sigma^2/n$) equals $d^2$ in the absence of a clearing facility. Daily variance (days 1 to n-1) is reduced by $(1-\alpha)$ with the clearing arrangement.

21. While the early literature on LDC debt associated partial repayment with default, some of the more recent literature has concentrated on situations where partial repayment may be perfectly consistent with preservation of a reputation and lead, not to default, but to opportunities for further borrowing. See Grossman and Van Huyck.

22. The length of the loan (t) is in days so as to preserve consistency with the time interval n. This is a simple interest loan and ignores compounding. The total amount to be repaid is $D(1 + r_D)$, of which a fraction is owed each day.

23. Of the four cases derived here, it is clear that the lowest reserve demand results under a clearing arrangement when no external debt is owed. The highest demand results with no clearinghouse but with external debt payments. Whether reserve demand under clearing and debt is less than demand with no clearing and no debt depends on whether the reduction in balances due to clearing more than offsets the fixed debt service payment.

24. If external debt constitutes a priority claim on central bank resources, it might legitimately be asked why any dollar reserve assets are held at all when they could be used to make debt payments. Empirical observation suggests that reserve assets are held despite external debt burdens, and the extent to which the two are traded off is unclear. The term "priority claim" is used here to mean that debt servicing is more important to the government than payments for imports. Thus increases in liquidity might be used to service debt.

Appendix

This appendix outlines the derivation of the central bank cost function in terms of the control parameters x and y. The original cost function is given as:

$$\text{(A-1)} \qquad \min_{x,y} \quad E(c) = \delta(E(T)/n) + rE(M)$$

The first term in (A-1) represents the expected cost of augmenting or reducing reserves, and the second term represents the opportunity cost of holding reserve balances. The derivation of (A-1) in terms of x and y follows Miller and Orr, and fundamentally relies on the analysis of the gambler's ruin problem outlined in Feller.

A. Expected Cost of Transfer, $\delta E(T)/n$

If T is the total number of transfers between into and out of reserve assets over an n day interval, and $\gamma$ represents the time between transfers ($\gamma$ is an independent random variable with mean G), then

$$\gamma_1 + \gamma_2 + \ldots + \gamma_T \leq n < \gamma_1 + \gamma_2 + \ldots + \gamma_T + \gamma_{T+1}$$

Summing and taking expectations:

$$E\left(\sum_{i=1}^{T} \gamma_i\right) \leq n < E\left(\sum_{i=1}^{T+1} \gamma_i\right)$$

From Wald (p.53), the independence of $\gamma_i$ with respect to n implies that:

$$E\left(\sum_{i=1}^{T} \gamma_i\right) = E(\gamma)E(T) = G \cdot E(T)$$

Thus,

$$G \cdot E(T) \leq n < G(E(T) + 1)$$

After some algebraic manipulation this becomes:

$$(1/G - 1/n) < E(T)/n \leq 1/G$$

As the number of days in the time interval becomes larger, $E(T)/n$ approaches the limit of $1/G$. The next problem is to find an expression for G in terms of x and y. This is equivalent to solving for the expected duration of the game in the gambler's ruin problem, as outlined in Feller (p.286). For the symmetric probability case ($p = q = 1/2$), the mean time between transfers in dollar terms is shown to be:

$$G = x(y-x)/d^2$$

Finally, the first term in equation (A-1) can be represented as:

$$\delta E(T)/n = \delta d^2/(x(y-x)) \qquad \text{(A-2)}$$

B. Expected Opportunity Cost per day, rE(M)

In order to derive the expected opportunity cost in terms of x and y, it is necessary to have an expression for mean reserve holdings. The probability of holding z units at any time is described by the following difference equation:

$$f(z) = pf(z-1) + qf(z+1) \qquad z \neq x$$

With boundary conditions:

$$f(x) = p(f(x-1) + f(y-1)) + q(f(x+1) + f(1))$$

$$f(0) = 0, \text{ and } f(y) = 0.$$

The probability density satisfies

$$\sum_{z=0}^{\infty} f(z) = 1.$$

For the symmetric probability case, the solution of the difference equation yields steady state reserve holdings as a triangular distribution with mean $(x + y)/3$. Thus the expected opportunity cost per day is,

$$rE(M) = r(x + y)/3 \qquad \text{(A-3)}$$

Combining (A-2) and (A-3) gives the expression for the central bank objective

function in terms of x and y:

$$E(c) = \delta d^2/(x(y-x)) + r(x+y)/3 \quad .$$

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