PRINCETON STUDIES IN INTERNATIONAL FINANCE NO. 28

International Adjustment, Open Economies, and the Quantity Theory of Money

Arnold Collery

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
PRINCETON UNIVERSITY · 1971

PRINCETON STUDIES
IN INTERNATIONAL FINANCE

This is the twenty-eighth number in the series PRINCETON STUDIES IN INTERNATIONAL FINANCE, published from time to time by the International Finance Section of the Department of Economics at Princeton University.

Arnold Collery is Professor of Economics at Amherst College. He is the author of *National Income and Employment* (2nd edition, 1970) and a number of journal articles.

This series is intended to be restricted to meritorious research studies in the general field of international financial problems, which are too technical, too specialized, or too long to qualify as ESSAYS. The Section welcomes the submission of manuscripts for this series.

While the Section sponsors the studies, the writers are free to develop their topics as they will. Their ideas and treatment may or may not be shared by the editorial committee of the Section or the members of the Department.

FRITZ MACHLUP
Director

Princeton University

PRINCETON STUDIES IN INTERNATIONAL FINANCE NO. 28

International Adjustment, Open Economies, and the Quantity Theory of Money

Arnold Collery

INTERNATIONAL FINANCE SECTION
DEPARTMENT OF ECONOMICS
PRINCETON UNIVERSITY
PRINCETON, NEW JERSEY
JUNE 1971

L.C. Card No. 78-163866

Printed in the United States of America by Princeton University Press
at Princeton, New Jersey

CONTENTS

TABLE OF CHARTS

INTERNATIONAL ADJUSTMENT, OPEN ECONOMIES, AND THE QUANTITY THEORY OF MONEY

1. INTRODUCTION

The adjustment mechanism in international trade has been a subject of controversy since Hume first suggested its existence. Agreement on certain basic premises, such as the quantity theory of money, has not prevented combatants from disagreement over events likely to cause balance-of-payments deficits or on the mechanism by which they might be eliminated. The controversy carries over into the analysis of exchange depreciation, the battle between absorption and elasticity approaches being the most recent manifestation.

Fundamentals are often neglected, because everyone is sure they are understood. Yet the confusion is so great that balance-of-payments adjustment and exchange-rate variations are even analyzed in models without money. Since the foreign-exchange rate is the price of one money in terms of another, how can anything be said about the behavior of such a price in a world without money? In a world of barter, what possible meaning can be given to a balance-of-payments deficit?

In this paper there is an attempt to return to fundamentals. To do so, we shall first present a quantity-theory model of a closed economy and then extend it to an open economy. The comparative-static, equilibrium propositions implicit in the analysis shall be deduced and consideration given to the conditions necessary for stability. In the end we shall maintain that there are three different approaches that can be and have been taken to explain the stability of the equilibrium distribution of gold, and we shall insist that only one of them is good theory. We shall also show that, under the quantity theory, propositions about the distribution of gold can be easily turned into propositions about the exchange rate when money stocks are inconvertible.

So much has been written on the subject in the last two hundred years that it would be surprising if we had many entirely new propositions to present here. The few propositions that I feel are novel may, as so often is the case, be rediscoveries, as the absorption approach is a rediscovery of Ricardo and his doctrine that gold flows out only when

"money is redundant." If this paper makes a contribution to trade theory it will be because it presents a terse, but fairly complete, statement of what the quantity theory implies in an open economy and because it points to one of the main sources of controversy.

2. THE QUANTITY THEORY IN A CLOSED ECONOMY

Assume that output in a closed economy consists of two goods, A and B. Let Q_A and Q_B represent the quantities of these goods produced and P_A and P_B their prices. Money output and income would then equal P_AQ_A plus P_BQ_B.

The amount of money that people wish to hold, L, is some fraction, K, of output. If we let p represent P_B / P_A, we have

(1) $L = K P_A (Q_A + p Q_B)$,

where Q_A plus $p Q_B$ is real output measured in terms of good A.

In a state of equilibrium desired money balances, L, must equal the stock in existence, M. Therefore, we also have

(2) $L = M$.

The basis of the monetary system is some commodity money; we shall assume gold. The money stock is a multiple, g, of the money gold stock, P_GG, where P_G is the price of gold and G is the physical quantity of it. The gold-stock multiplier, g, is equal to or greater than one. Thus,

(3) $M = g P_G G$.

All or only part of P_GG may circulate as money; if some of it does not circulate, it serves as reserves.

If the three equations are solved simultaneously, eliminating L and M, the following equation is obtained:

(4) $P_A K(Q_A + p Q_B) = g P_G G$.

The gold stock, G, is assumed to be independent of its value; a higher value does not increase its production and a lower value does not increase its consumption.[1] Treat K, g, and P_G also as parameters.

[1] If gold were in current production, then either A or B would have to be gold. If we assumed that the A-good was gold, then P_A would equal P_G, and equation (4) would become $K (Q_A + p Q_B)$ equals $g G$. Given K, g, and real output, the equation would determine G. An increase in the demand for money, an increase in K, would have no effect on prices, if relative prices were fixed by constant costs of production. The increased demand for money would simply lead to an expansion of the supply, since G would increase. Changes in the gold-stock multiplier would also leave the price level unchanged, since any change in g would be thwarted by an inversely proportional change in G. There is a necessary qualification, however, to this last proposition. In the long run, G might again rise somewhat because the substitution of cheap money, paper or deposits, for dear money, gold, would free resources, making real output greater than it

Finally, assume that Q_A plus $p\ Q_B$, real output measured in terms of A-good, is constant in equilibrium, given tastes, supplies of the productive factors, and the production functions; Q_A, Q_B, and p are determined by production conditions and consumer preferences and are constant in equilibrium unless the conditions or preferences change. Equation (4) then contains only one endogenous variable, P_A, which is an index of all prices other than of gold. Its equilibrium value is known once g, P_G, G, K, and real output are known.

Any change in the term on the right side of equation (4), given K and real output, would lead to a proportional change in P_A in equilibrium. Since the right side is the supply of money, the price of A-good is proportional to the money supply. And, since we are assuming that relative prices are constant in equilibrium, all prices, other than the price of gold, are proportional to the money stock.

There are three ways the money supply could be increased: by an increase in the gold-stock multiplier, g; by an increase in the price of gold, P_G; or by an increase in the physical stock of monetary gold, G. Thus, a doubling of the gold-stock multiplier, the price of gold, or the physical gold stock would double the price level. A doubling of the price of gold would have no effect, however, on the price level if the gold-stock multiplier were cut in half; the increase in P_G would be offset by a decrease in g, leaving the money stock unchanged.

Any increase in a term on the left side of equation (4), other than P_A itself, would lead to a proportional decrease in P_A. The equilibrium price level is, therefore, inversely proportional to K, the fraction of output the public wishes to hold in the form of money, and real output.

Changes in the equilibrium price level are to be explained by temporary divergences between the demand and supply of money. If g, P_G, or G were to increase or if K or real output were to decrease, there would be an excess supply of money temporarily. The excess supply of money would imply an excess demand for goods. Prices would rise, increasing the demand for money until it again equalled the supply.[2]

---

would have been. Finally an increase in the price of gold would raise all prices in proportion, no matter what happened to the gold-stock multiplier, since with constant costs, relative prices would be unchanged. We shall not pursue this analysis further here.

[2] This comparative, static, equilibrium analysis depends on an assumption of stable markets. When an initial equilibrium is disturbed, relative prices could vary during the process of adjustment. If a disturbance of an equilibrium could cause p to rise or fall erratically, the analysis would be of little interest. For

3. THE QUANTITY-THEORY MODEL EXTENDED TO AN OPEN ECONOMY

To convert this model of a closed economy into one for an open economy, assume that there are two countries, A and B, in which equations (1), (2), and (3) must hold. Country A exports A-good and Country B exports B-good. Using superscripts to indicate the country, we have

$$(4a) \quad P_A^A K^A (Q_A^A + p^A Q_B^A) = g^A P_G^A G^A \text{ and}$$

$$(4b) \quad P_A^B K^B (Q_A^B + p^B Q_B^B) = g^B P_G^B G^B.$$

The price of foreign exchange in Country A, the price of B's money in terms of A's, equals P_G^A / P_G^B. Ignoring all impediments to trade, the price of any good in Country A must equal the price of that good in Country B multiplied by the price of foreign exchange in A. Therefore,

$$(5) \quad P_A^A = (P_G^A / P_G^B) P_A^B \text{ and}$$

$$(6) \quad P_B^A = (P_G^A / P_G^B) P_B^B .$$

Equations (5) and (6) are equivalent to saying that a unit of gold must be capable of exchanging for the same quantity of either good in either country; gold has the same purchasing power everywhere.

From equations (5) and (6) we learn that P_B^A / P_A^A equals P_B^B / P_A^B, so

$$(7) \quad p^A = p^B = p,$$

where p is the relative price of the B-good in either country.

Let us consider first the case of a "small" country, one that can have no significant effect on prices in international markets. Assume that Country A is such a small country and that prices in the rest of the world are unaffected by its behavior.

If equations (5) and (7) are substituted into (4a), we find that

$$(8) \quad G^A = \frac{K^A (Q_A^A + p\, Q_B^A)}{g^A} \frac{P_A^B}{P_G^B},$$

where P_A^B, P_G^B, and p are determined outside of Country A. Gold reserves in Country A are then dependent on A's desired ratio of money to income, K^A, its gold-stock multiplier, g^a, its real output, Q_A^A plus $p\, Q_B^A$, and the purchasing power of gold in the rest of the world, P_A^B / P_G^B. If the demand for money increased in Country A, K^A would

---

stability of relative price, an increase in p must lead to an excess supply of B-good and an excess demand for A-good.

be greater and the gold stock would increase in equilibrium. If its real income increased, this would also raise its equilibrium gold stock. An increase in the gold-stock multiplier, through say an open-market purchase by the monetary authorities, would reduce its gold holdings. And any increase in prices in the rest of the world relative to the price of gold in A would increase A's equilibrium gold stock.

The adjustment from one equilibrium to another can be explained in the following manner. If the desired ratio of money to income increased in A, if real income increased in A, if its gold-stock multiplier decreased, or if prices increased in the rest of the world relative to the price of gold, the demand for money would temporarily exceed the supply in Country A. The excess demand for money would lead to a reduction in expenditures, creating an excess supply of commodities. The goods that could not be sold domestically at unchanged prices would be sold abroad, where the demand for them is virtually infinitely elastic. In exchange for the goods, gold would be received, raising the stock of money until it was again equal to the demand. With prices determined in world markets independently of supply and demand conditions in Country A, changes in prices would play no significant role in the adjustment to disequilibrium; a country would gain gold whenever its demand for money exceeded the supply. It would make no sense to ask what mechanism such a gold flow would trigger to prevent the flow from continuing indefinitely, for the movement of gold into the country would be an adjustment mechanism itself. The flow of gold eliminates the cause of it, which was an excess demand for money.

Let us now turn to an alternative analysis, one which is based on the assumption of two interdependent countries, neither of which dominates the other. This is the case that has received most attention in the literature.

Equations (4a), (4b), (5), (6), and (7) can be solved simultaneously to yield the following equation in which the relative price of B-good is the only price that appears.

$$(9)\quad \frac{G^A}{G^B} = \frac{g^B K^A (Q_A^A + p\, Q_B^A)}{g^A K^B (Q_A^B + p\, Q_B^B)}.$$

If the total amount of monetary gold held by the two countries is constant—G^A plus G^B is constant—an increase in G^A / G^B implies an increase in G^A and a decrease in G^B. When G^A / G^B has increased,

Country A has experienced a balance-of-payments surplus and Country B a deficit.

Country B's terms of trade is p; its reciprocal is A's terms of trade. Assuming for the present that the terms of trade and real output in both countries are constant, several *ceteris paribus* propositions are implicit in equation (9).

First, an increase in the gold-stock multiplier in any country would cause that country to lose gold. If g^a rose, G^A / G^B would fall; Country A would have a temporary balance-of-payments deficit, Country B a surplus. If g^B rose, G^A / G^B would rise; A would have the surplus and B the deficit. An increase in the gold-stock multiplier in any country would also lead to world inflation. Since an increase in g^A implies an increase in G^B, given g^B, P^B_G, K^B, and real output in B unchanged, equation (4b) implies that P^B_A would be higher. If P^B_A rises, P^A_A rises proportionally—equation (5). A country's ability to raise the world price level would be limited by its gold stock. A continual increase in the gold-stock multiplier would eventually lead to a loss of all monetary gold. And one country's ability to alter the world price level depends on the acquiescence of the other. If Country A raised g^A, tending to inflate, Country B could simultaneously lower g^B, to prevent inflation. Country B would then gain gold from Country A. In a war of this sort, the country attempting to inflate must eventually lose—it must stop its action, alter its price of gold, or abandon the gold standard, if the rest of the world persists in its anti-inflationary policies.

A second proposition implicit in equation (9) concerns real output. An increase in output in any country would cause that country to gain gold. If $(Q^A_A + p\,Q^A_B)$ rose, G^A / G^B would rise, and if $(Q^B_A + p\,Q^B_B)$ rose, G^A / G^B would fall. An expansion of output in any country would, therefore, generate a balance-of-payments surplus for it. In addition, growing real output in any country would cause prices to fall everywhere. Since the country whose output has not increased would lose gold, its price level would be lower in equilibrium. But if its equilibrium price level were lower so would be that of the other country, if the prices of gold are unchanged. Both these implications of growth depend on an implicit assumption about monetary policy; the gold-stock multipliers are constant. If a growing country raised g in proportion to the growth, the equilibrium distribution of gold would be unchanged and prices would remain the same in both countries. For if g^A

is increased in proportion to an increase in $(Q_A^A + p\ Q_B^A)$, the equilibrium value of G^A / G^B would remain the same.

A third proposition implicit in equation (9) concerns the price of gold. An increase in the price of gold in one of the countries, devaluation, without a change in the gold-stock multiplier would have no effect on gold holdings; devaluation under these circumstances would not produce a balance-of-payments surplus. Since the equilibrium distribution of gold is determined by equation (9) and since P_G^A and P_G^B do not appear in that equation, changes in gold prices could have no effect on gold distribution. An increase in the price of gold in one country with its gold-stock multiplier unchanged would increase its money stock and prices in proportion and leave unchanged the money stock and prices in the other country. It must be carefully noted, however, that this conclusion also depends on other factors remaining unchanged. If the devaluing country reduced its gold-stock multiplier in proportion to the increase in the price of gold, initially keeping its money stock constant, it would gain gold and in the new equilibrium it would have higher prices. The other country would lose gold and have lower prices. That Country B would lose gold if Country A reduced g^A is clear from equation (9), as we have shown above. If G^B falls, so does P_A^B, given B's parameters unchanged.

If the devaluing country took even stronger anti-inflationary action, letting g fall enough to stabilize prices, then with the price of gold unchanged in the other country, prices would fall in the nondevaluing country in proportion to the devaluation and it would lose even more gold. According to equation (5), if P_G^A is higher and P_G^B and P_A^A unchanged, P_A^B will be proportionally lower.

A final proposition implicit in equation (9) concerns the demand for money. An increase in the amount of money that people wish to hold in any country relative to output would increase that country's equilibrium stock of gold. If K^A increased, G^A / G^B would increase; Country A would have a temporary balance-of-payments surplus; Country B a deficit. If K^B increased, G^A / G^B would decrease; Country B would have the surplus and A the deficit. In addition, it is clear that an increase in K in either country would lead to world deflation. Since an increase in K^A reduces G^B, then, according to equation (4b), P_A^B would fall. But if P_A^B falls, P_A^A falls proportionally—equation (5).

If a country was thought likely to raise the price of gold, the de-

mand for money in that country would fall and the demand for money in the other country rise, as speculators got rid of one money to obtain the other. If P_G^A were expected to rise, K^A would fall and K^B would rise; according to equation (9) both changes would redistribute gold toward Country B. Country A would experience a serious drain on its gold stock. If Country B reduced g^B to prevent an expansion of its money stock, the net effect would be a contraction of the world's money supply and world deflation. Assuming Country B wished to remain on the gold standard, it might be forced to do what was expected.

4. STABILITY OF THE DISTRIBUTION OF GOLD

The propositions of comparative, static equilibrium considered in the previous section would be of no interest if the equilibrium distribution of gold given by equation (6) were unstable. Which leads us to ask whether G^A / G^B would fall if it were above its equilibrium value, as given by equation (9), and if so, why?

Since we are assuming no impediments to trade, equations (5) and (6) cannot be violated; goods must sell for the same price everywhere when expressed in the same currency. If, therefore, equation (9) does not hold, it must be because equations (4*a*) and (4*b*) are violated. Disequilibrium exists when the demand and supply of money are not equal in both countries.

Imagine that an initial equilibrium is disturbed by some magical redistribution of gold between the two countries; Country A gains gold and B loses it. With no change in any parameter in equation (9), G^A / G^B would exceed its equilibrium value. What would then happen? It is clearly impermissible to say that the excess supply of money in Country A would raise A's prices and the excess demand for money in B would lower B's prices, for that would imply that gold could have different values in different countries when there are no impediments to trade. What we can say is that the excess supply of money in Country A would lead to an increased demand for goods; the excess demand for money in B would lead to a reduced demand for goods. Country A would spend its excess money holdings at the same time that Country B reduced demand to reestablish its desired money holdings. The excess supply of commodities created by Country B would match the excess demand for commodities created by Country A. Country A would buy the commodities not bought by B, and Country B would get back its gold. Thus, the equilibrium distribution of gold

determined by equation (9) would be stable in the sense that, if a country had more than its equilibrium holdings, its holdings would fall; if it had less, it would rise.[3]

Consider now a less artificial disturbance to equilibrium. We showed in the previous section that an increase in the gold multiplier in any country would reduce its equilibrium gold holdings. If, therefore, g^A increased, in equilibrium G^A would be less and G^B greater. Temporarily, until the adjustment occurred, G^A / G^B would be above its new equilibrium value. How should we explain the decline in G^A / G^B to its new equilibrium value?

The increase in the money supply in Country A brought about by the increase in the gold-stock multiplier would generate an excess demand for commodities. Prices would rise in Country A and would also rise in Country B, since the value of gold must be the same in both countries. The higher prices in Country B with no change in its money stock would lead to an excess demand for money; the demand for goods would fall in Country B. Some higher price level would exist at which the excess supply of goods in Country B, its excess demand for money, would equal the excess demand for goods in Country A, its excess supply of money. At that price level, Country A would import more than it exports, paying Country B for its excess of exports over imports with gold. G^A / G^B would fall.

It would be foolish to ask after the gold movement has occurred what the mechanism is that prevents its continuance. The movement of gold from A to B is itself an adjustment mechanism, for it comes about in response to an excess supply of money in one country and an excess demand in the other. The movement of gold eliminates both the excess supply and the excess demand. Unless the movement were insufficient or too great to restore equilibrium or unless some new disturbance to equilibrium were to occur, no further gold movement would take place. Insofar as prices are part of the mechanism, it is price movements that cause the gold movements, rather than gold

[3] If the gold-stock multipliers applied instantaneously in each country and were different, prices could initially rise or fall in the adjustment process, depending on whether g^A were greater or less than g^B. If g^A exceeded g^B, the excess demand for goods in A would be greater than the excess supply of goods in B. Furthermore if the multpliers applied instantaneously, then the initial adjustment could cause G^A / G^B to fall below its equilibrium value and then rise above it again. There could be perpetual oscillations around equilibrium, and it is even possible that the divergences from equilibrium could become greater and greater.

movements causing the prices to change. For it is higher prices that lead to the excess demand for money in Country *B*.

5. INTERNATIONAL TRANSFERS

Assume that Country *B* must make an annual transfer to Country *A*. There are two questions that we shall ask. First, would the transfer necessarily cause Country *B* to lose gold and require some adjustment mechanism to bring it back? Second, if the transfer were actually made in gold, would the gold return, and, if so, by what mechanism?

The equilibrium distribution of the monetary gold stock is given by equation (9). Assuming that an international transfer were made by *B* to *A* and that the assumption on which equation (9) was established were valid, the equilibrium distribution of gold would be unaffected. In the new equilibrium the receiving country would have no more nor less gold or money than it had originally, for nothing in equation (9) is changed. But one may ask if under these circumstances it would have more gold temporarily?

The answer is that it might not. The expected receipt of the transfer in Country *A* could lead to an increased demand for goods. Higher income is expected and none of it, according to equation (4*a*), will be added to money stocks; the demand for goods would, therefore, rise by the entire amount of the transfer. If it did not, money holdings would rise. The expected payment of the transfer could lead to a reduction in the demand for commodities in Country *B*, since lower income is expected and money balances are not to be reduced. Demand must fall by the exact amount of the transfer, or money balances would change. Therefore, Country *A* would demand the goods not bought by Country *B*. *A*'s imports would rise or its exports would fall. Country *A* would demand *B*'s currency to pay for its import surplus, while Country *B* would demand Country *A*'s currency to pay the transfer. Country *B*, the paying country, need never lose gold.

But it is legitimate to ask what would happen if the transfer were paid in gold and demands did not change until money stocks changed. Since we know from equation (9) that the equilibrium distribution of gold is unaltered, there must be some mechanism to return the gold to Country *B*. What is that mechanism? The gold flow would be reversed for the following reason. The gold movement alters the money stock in both countries. In *A*, the receiving country, there would be an excess supply of money. In *B*, the paying country, there would be an excess