COMMODITY PRICE SHOCKS AND INTERNATIONAL FINANCE

by

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Abstract

This thesis examines the relationship between commodity price shocks and international finance. As movements in world commodity prices can produce important financial consequences for a country, so can a country's financial position influence its participation in world commodity markets. For example, fluctuations in a commodity's price can clearly affect the wealth or indebtedness of a producer of that commodity. Somewhat less obviously, a country's financial position, such as its net indebtedness, or even its ability to incur indebtedness, may in turn affect its commodity production. This thesis addresses these issues in both theoretical and empirical terms.

When a commodity plays a prominent monetary role, as gold and silver often have, fluctuations in the price of that commodity can produce still greater effects, making a direct impact on a country's exchange rate and price level. This thesis examines such an historical occurrence: the case of China and silver in the early 1930's.

Chapter One uses a theoretical framework to investigate how international financial markets affect production and consumption decisions by a typical developing country, a small commodity-producing nation facing uncertain terms-of-trade. This investigation studies neither the extreme case of no financial markets nor the opposite extreme case of complete equity markets, but rather the more realistic intermediate case in which countries do not trade equities but can borrow and lend internationally. This possibility of intertemporal substitution results in greater specialization and higher welfare than in the case of no financial markets, but less specialization and lower welfare than the scenario in which risk is shared through international equity markets.

Chapter Two considers an important historical episode in which a commodity price shock severely disrupted a small country whose monetary system was based on that commodity. Prior to 1935, China maintained a silver standard: its currency floated in line with the world price of silver and was freely convertible into silver. When the world price of silver tripled from 1932 to 1935, China experienced a currency appreciation, price deflation, and a rapid outflow of silver. Earlier research has attributed the exodus of silver to a widening of China's trade deficit or to the fall in the Chinese price level. This study proposes, then offers evidence in support of, a new interpretation: that silver leaving China actually represented speculative capital flight motivated by the prospect of China's abandoning the silver standard.

Chapter Three tests empirically a hypothesis that circulated in the mid-1980's as a possible explanation of depressed commodity prices: that developing countries' debt-servicing difficulties had lead them to increase commodity production. Two versions of this proposition are tested using commodity price data from 1960 to 1986: first, that the supply curve shifted outward in response to developing countries' need to

generate increased foreign exchange; second, that because LDC's exported commodities in order to reach target foreign exchange revenue requirements, the "supply curve" for commodities in fact sloped downwards. To understand the effect of a specific policy indebted LDC's might have used to stimulate exports, the study also examines commodity-country pairs to determine whether real exchange rate devaluation had a discernible effect on supply. Empirical findings point overwhelmingly against the importance of supply-side effects in explaining the mid-1980's commodity price slump, suggesting that demand or inventory behavior may have been of greater significance.

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INTRODUCTION

INTRODUCTION

This thesis consists of three essays investigating the relationship between commodity price shocks and international financial markets. This relationship is examined theoretically in the first essay then empirically in the second and third essays. The first essay develops a model of a small country that produces commodities under uncertain terms-of-trade, borrowing if necessary to smooth consumption over time. The second essay focuses specifically on the effects on China of a sudden appreciation of silver in the early 1930's. The third essay considers the role played by external indebtedness of commodity-producing countries in the commodity price decline from 1980 to 1986.

An important focus of the thesis is the interaction between commodity price movements and international debt. The effects of commodity price shocks on international debt are by now evident, as recently demonstrated on a large scale by the rapid accumulation of developing country debt in the 1970's following the oil shock. How a country's indebtedness in turn affects its production of commodities and its response to actual and potential commodity price changes may be less well understood. Both questions remain of considerable importance today given the continued volatility in commodity markets and the large overhang of external debt in many commodity-producing nations.

In the framework of a simple theoretical model, the first essay studies simultaneously the effect of commodity price changes on debt and the effect of debt on commodity production. A risk-averse country maximizing the expected utility of its lifetime consumption must make production decisions under uncertain terms-of-trade. The country is

allowed to borrow and lend internationally, and period-by-period must determine both how much to borrow and how much to specialize in its risky comparative advantage good. Terms-of-trade realizations, by affecting income, have a direct impact on borrowing, which is by definition equal to consumption minus income. A country's net debt in turn influences its level of production specialization, as risk-aversion in general depends on wealth.

The primary distinction between this representation of international trade under uncertainty and earlier formulations lies in the depiction of capital markets available to the country. For example, Brainard and Cooper (1968) (as well as other papers published shortly thereafter) analyze the problem in the complete absence of financial markets. Terms-of-trade uncertainty therefore leads a risk-averse country to partial diversification rather than complete specialization according to comparative advantage. Helpman and Razin (1978) later demonstrate that when trade in both goods and real equities, i.e. proportional output shares, is permitted, production diversification becomes entirely unnecessary and total specialization occurs.

The present model, however, makes a more realistic assumption about international financial markets, allowing international trade in assets in the form of nominal debts or liabilities, but not in the form of state-contingent claims such as real equities. Lessard (1983) estimated that in 1981 over 80% of external financing to developing countries took the form of nominal debt rather than direct foreign investment or foreign equities. Although it is incorrect to ignore completely non-debt instruments used in international finance, it is clearly important to

emphasize debt over other forms of financing.

Solution of the problem, which requires certain technical simplifications for tractability, demonstrates that when only borrowing and lending are permitted, both specialization and expected utility are lower than under complete financial markets but higher than with no financial markets at all. The very ability to use borrow and lend, permitting consumption-smoothing in the face of volatile output, induces greater specialization in the risky comparative advantage good. Full specialization according to comparative advantage, however, does not occur because each country must still individually assume its entire terms-of-trade risk. This is a clear welfare loss resulting from incomplete markets for risk-sharing.

Borrowing limits, a concern of many developing country borrowers, are easily incorporated into the analysis and as expected, lower specialization and expected utility. Important extensions of this research would include endogenously determined borrowing limits and the possibility of default.

Throughout history, commodities have played a vital role in economies worldwide not only as traded goods but also as a form of money. Indeed, certain commodities, typically precious metals, have held far greater significance as a store of wealth, unit of accounting and a medium of exchange, both domestically and internationally, than as products with intrinsic consumption value. Unless <u>all</u> countries adhere to the same metal standard, the price of the metal in countries not using the metal standard may vary. These global fluctuations in the price of the metal, rather than causing a shift in production, are likely to have far-reaching

macroeconomic consequences, affecting prices, exchange rates, and possibly aggregate output in the countries maintaining the metal standard.

The second essay of this thesis examines the effect of a precipitous increase in the world price of silver on China in the early 1930's. At the time, China was the only country in the world adhering to a silver standard. The sudden rise in the price of silver, induced primarily by extraordinary purchases by the U.S. Treasury, caused an appreciation of the Chinese currency and widespread deflation throughout China. At the same time, record amounts of silver left China for sale overseas, causing China to abandon the silver standard within less than two years, in November 1935.

Until recently, the standard interpretation of China's departure from the silver standard was that of Friedman and Schwartz (1963). Their analysis focuses almost exclusively on the worsening of China's trade deficit, which they attribute to the real exchange rate appreciation. The outflow of silver from China, according to Friedman and Schwartz, was simply the capital account counterpart of the trade deficit, i.e. the funds that financed China's excess imports. Since silver constituted the basis of China's monetary system, the loss of silver reduced China's monetary base, thereby lowering Chinese output and prices.

Recent work by Brandt and Sargent (1988) challenges the traditional interpretation, arguing that the silver outflows from China represented China's expenditure of a windfall gain permitted by the real appreciation of silver. According to Brandt and Sargent, Chinese prices were effectively determined by international commodity arbitrage, implying that the appreciation of the Chinese currency was offset by a corresponding

decline in the Chinese price level. Therefore, while no real appreciation occurred, a smaller quantity of silver could support an unchanged level of real balances. With no contraction in the real money supply or output, China could thus export silver temporarily in exchange for additional resources to consume or invest.

This essay proposes a third interpretation of the drain of silver from China, explaining these flows as speculative capital flight in reaction to early warnings that the Chinese government might abandon the silver standard. The currency appreciation and price deflation caused by the rise in silver generated considerable alarm in China. The central government reacted first by pleading with the United States, then by imposing a series of increasingly strict capital controls that failed in practice but signaled to speculators that China might soon suspend convertibility of paper into silver or impose an embargo on silver.

Statistics on China's trade flows, balance-of-payments, and price movements indicate that by far the greatest outflow of silver occurred in 1934 and 1935, years in which the trade deficit had begun to narrow and the deflation had slowed considerably. In other words, the timing of China's silver exports is inconsistent with the explanation of either Friedman and Schwartz or Brandt and Sargent. The surge in silver exports began in early 1934, as the United States renewed its commitment to greater silver purchases and China reiterated its fears of an uncontrolled rise in silver. This suggests that the third interpretation better explains the facts than either of the previous two.

The essay first presents a historical overview of the facts surrounding China and the silver standard in the early 1930's, then

evaluates the three alternative interpretations of the silver outflow from China. Two appendices provide background information on the Chinese financial system and American silver policy.

While the second essay studies the effect of a commodity price shock on international capital flows, the third essay examines a phenomenon in which the direction of causality may be reversed. Specifically, the third essay investigates whether the debt-servicing difficulties of developing countries in the mid-1980's led them to increase production of commodities, thereby depressing world commodity prices.

The prolonged decline in dollar commodity prices from 1980 into late 1986, despite a recovery in world industrial production since 1984 and a decline in the dollar since 1985, had given rise to various explanations emphasizing the supply side. Some suggested that the supply curve had shifted outward as a result of developing countries' need to generate increased foreign exchange earnings. Others observed that even as commodity prices fell, indebted developing countries produced an unchanged or even greater quantity of commodities, implying that the "supply curve" might have become "downward-sloping" as debtors attempted to attain target levels of export earnings.

A World Bank study in which debt entered with a significantly negative coefficient in a commodity price determination equation provided some empirical support of these propositions. Furthermore, an unacceptably high empirical estimate of the elasticity of dollar commodity prices with respect to the real dollar exchange rate could be explained if it was found that the "supply curve" indeed exhibited a negative slope.

The two distinct hypotheses---that the supply curve had shifted

utward and that the "supply curve" sloped downward---were tested on commodity price data from 1960 to 1986. Price indices for non-oil commodities overall and the subgroups of food, beverages, agricultural raw materials, and metals were expressed as a function of a time trend, industrial production in the industrial countries, the real dollar exchange rate, and various specifications of developing countries' debt-service requirements. Consistent insignificance of coefficients on debt-service measures suggested the absence of any systematic outward shift in supply. A downward sloping "supply curve" would imply increased price sensitivity to demand shifts such as changes in world industrial production or the real dollar exchange rate. Chow tests comparing the 1960's and 1970's against the 1980's, however, indicated no significant increase in price sensitivity in the latter period, the years in which debt-servicing needs might indeed have induced a downward slope in "supply."

To determine whether exchange rate policies implemented by certain highly indebted developing countries did in fact elicit an increase in the export of commodities, this study also considered specific commodity-country pairs, such as Chile and copper. Instrumental variable regressions in which the supply of the commodity was expressed as a function of the real local currency price suggested that real devaluations in developing countries could not explain commodity supply behavior.

Although developing countries' indebtedness could in theory have lead them to increase their production of commodities, empirical evidence suggests that this did not in fact occur in the mid-1980's. The decline in commodity prices that could not be attributed to stagnation in

industrial production or the appreciation of the dollar may have been the result of microeconomic changes affecting demand or unusual inventory management. The recovery of commodity prices since 1986 despite the ongoing problems in developing country debt-servicing provides some confirming evidence that supply-side behavior by these countries was indeed of relatively low empirical importance in the mid-1980's.

Overall, these essays affirm the strong links between commodity price shocks and international financial markets. Theoretically, it was demonstrated that not only may commodity price movements affect international debt, but a country's indebtedness may influence its production of commodities, through wealth-induced changes in its aversion to terms-of-trade risk. Empirically, the important macroeconomic consequences resulting from a price shock to a commodity on which one's monetary system is based were examined in detail for China in the 1930's. Although the influence of international indebtedness on commodity price behavior was empirically not significant in the mid-1980's, concern for the potential feedback of a country's international financial position on its commodity production nonetheless acknowledges the important relationship between commodity price movements and international finance.

CHAPTER ONE

OPTIMAL PRODUCTION DIVERSIFICATION UNDER UNCERTAIN TERMS-OF-TRADE WITH INTERNATIONAL BORROWING AND LENDING

OPTIMAL PRODUCTION DIVERSIFICATION UNDER UNCERTAIN TERMS-OF-TRADE WITH INTERNATIONAL BORROWING AND LENDING

Despite the strong real-world connection between terms-of-trade shocks and developing country borrowing, there has been little theoretical work linking the two subjects. Production diversification, especially reduced specialization in a single export, is in some sense central to both issues. Diversification will reduce a country's vulnerability to terms-of-trade shocks and thus help it manage its debt more effectively, resulting in smaller fluctuations in consumption, or less frequent balance-of-payments crises. At the same time, the very ability to accumulate debt (or in favorable periods, assets) should enable a country to diversify less---to sacrifice less of its comparative advantage---since intertemporal reallocation can act to cushion terms-of-trade shocks. This paper attempts to bridge the theoretical gap between single-period models of production under uncertainty and intertemporal consumption-savings models, focusing on the role of production diversification and its relevance to both these areas.

Diversification can be defined as the reduction in the dependence on any single product, especially primary commodities, in a nation's total output. Early interest in the subject initially centered on the supposed "secular decline" of commodity prices relative to manufactures,[1] but theoretical work on trade under uncertainty

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[1] Arguments are found in the work of Prebisch (1950) and Singer (1950).

demonstrated that uncertainty alone could motivate diversification, independent of long-term trends. In one of the first papers on the subject, Brainard and Cooper (1968) proposed a portfolio approach to exports for a risk-averse country needing to make trade commitments before terms-of-trade are known. Subsequent work, generally in the framework of one-period production models,[2] also demonstrated that uncertainty in the terms-of-trade will induce a country to produce less of its normal export, more of its normal import, i.e. to sacrifice some of its comparative advantage in favor of direct production of its "consumption basket."

If trade in both goods and assets is allowed, however, optimal asset choice makes production diversification unnecessary, as shown in the work of Helpman and Razin (1978). In particular, if equity shares can be traded internationally, then countries simply maximize the stock market value of their equity shares, and hedge terms-of-trade uncertainty through diversification of their asset portfolio; diversification in production becomes unnecessary.

The experience of developing countries in the 1970's and 1980's, however, makes evident the need for a new approach to output diversification in which the primary asset traded internationally is not equity, but debt denominated in a non-commodity numeraire, typically dollars. Despite the decline in world interest rates since 1984, the debt-servicing problems of many developing countries continue, in many cases exacerbated by low and unpredictable commodity prices. Indeed,

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[2] See, for example, Ruffin (1974), Kemp and Liviatan (1973), Anderson and Riley (1976).

the economic declaration of the 1987 Summit Meeting in Venice stated: "We recognize the problems of developing countries whose economies are solely or predominantly dependent on exports of primary commodities, the prices of which are persistently depressed. ... Further diversification of these economies should be encouraged, with the help of the international financial institutions..."[3] The 1987 World Economic Outlook of the IMF asserts: "a leading policy issue for developing countries is their foreign trade strategy. The issue is of special importance for countries with unduly large external debts and heavy reliance on exports of primary products."

This paper extends the portfolio approach to diversification in production, first developed by Brainard and Cooper (1968), to an intertemporal context in which countries can borrow and lend over time. We know from standard gains-from-trade arguments that, provided that there are no feedback effects on commodity prices, opening trade in assets (in this case, bonds denominated in the consumption good) can only improve welfare, since the country is not forced to trade in these assets. Here, we construct the general diversification problem and proceed to solve explicitly a simple two-period example. We demonstrate precisely how the ability to borrow and lend unambiguously raises national welfare by allowing a country to take greater risks in production, i.e. to increase its specialization in commodities with higher expected return. An immediate policy implication is that decreased access to international credit markets may cause developing

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[3] New York Times, 11 June 1987, p. A16.

countries to reduce specialization and lower expected utility for all potential borrowers.

This paper is organized as follows: Section II introduces the model in terms of its key assumptions and mathematical representation. Section III solves a simple example of the model explicitly, and examines the effect of a borrowing limit.

II. The Model

A. Key Assumptions

We first present the model's key assumptions and their implications.

(1) Representative Agent. We model a developing country as a representative agent that maximizes the present discounted utility of its lifetime consumption. This is equivalent to assuming that the country is run by a central planner, that all agents in the country are identical, or that there is a complete domestic stock market.[4]

(2) Single Consumption Good. The assumption of a single consumption good is intended to reflect the fact that a country's consumption is typically much more varied than its production. We assume that the country consumes the same market basket over time, using

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[4] Note that the related issue of whether free trade is optimal is not directly addressed in this model, in which the country is depicted as a representative agent unable to influence world prices. Under the small country assumption, traditional optimal tariff arguments are clearly not applicable. Moreover, if the country can be represented as a single agent, there can obviously be no externalities domestically. This approach differs from that of Newbery and Stiglitz (1984) or Eaton and Grossman (1985) where incomplete markets for risk-sharing among differing domestic agents imply that free trade can be welfare-reducing or Pareto-inferior to protected trade

its various exports as a means of obtaining the dollars necessary to purchase that basket of goods. Since the price of the consumption good, as numeraire, is precisely one dollar, we can think of the country as directly "consuming" dollars. This simplification can be justified by the fact that in most developing countries, domestic consumption of the country's own major export commodities is a trivial fraction of total production. Thus, income effects of terms-of-trade shocks will normally overwhelm substitution effects. In this paper, we concentrate exclusively on the income effects.

(3) Ricardian Technologies. Production technologies in this economy are Ricardian, in line with the earlier models (e.g. Kemp and Liviatan (1973)), and exhibit constant returns to scale. The country is endowed in every period with a constant labor supply, normalized to one, which it allocates across different sectors. The country can produce the consumption good directly (the safe return) or produce a "cash crop," the entire output of which is exported in exchange for the consumption good. Each sector's output, expressed in terms of the consumption good, is stochastic. For a given country, comparative advantage in a particular sector is represented by a high expected payoff (again in terms of the consumption good) per unit labor relative to other sectors.[5] In a world of certainty, the country clearly should allocate all its labor to the sector with the highest return. We assume

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[5] In general equilibrium, "comparative advantage" would be measured relative to another country. We assume that such advantages are reflected in the mean "dollar" prices countries obtain in different export markets for a unit's labor. Again, dollars are used to buy a wide assortment of imports. Here, the country is concerned with how to obtain those dollars.

that each period, the country can re-allocate its labor freely.

(4) Incomplete Markets. We assume that the only asset traded internationally is a safe bond denominated in the consumption good, or borrowing and lending on fixed "dollar" terms. In particular, equity markets such as those described by Helpman and Razin (1978) are not available. Nor are commodity-linked bonds, futures, or option markets.

This assumption, albeit a simplification of reality, reflects the overall paucity of such risk-sharing markets relative to commercial bank debt or bonds denominated in money (the consumption good) terms. Developing countries themselves, for political reasons, often restrict foreign equity participation in their enterprises. Futures and options markets are extremely thin or non-existent for maturities beyond one year. Commodity-linked bonds, an excellent instrument for intertemporal substitution with no terms-of-trade risk, have apparently failed to gain widespread acceptance.[6]

B. Mathematical Representation

We model the country described above as one that consumes only one good, which is the numeraire, and maximizes the present value of its utility over time. Its utility function is additively separable in time and its constant discount factor is ß. We can write this as:

$$(1) \quad \underset{\alpha_{it},\, c_t}{\text{Max}} \quad \sum_{t=0}^{T} ß^t U(c_t).$$

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[6] See Lessard and Williamson (1985) pp. 86-87 for further discussion of commodity-linked bonds and the incompleteness of this market.

The country can borrow and lend freely in international capital markets at the constant riskless interest rate r. Thus, its net wealth at the beginning of period t, w_t, evolves as:

$$(2) \quad w_t = (y_{t-1} + w_{t-1} - c_{t-1})(1 + r) \quad \text{for} \quad t = 1 \text{ to } T.$$

No default on borrowing requires that

$$(2a) \quad c_T = y_T + w_T.$$

If we also impose an exogenous borrowing limit L, then we have the further restriction:

$$(2b) \quad w_t \leq -L \text{ for all } t.$$

The country is endowed in every period with one unit of labor, which it allocates across sectors to generate income. Labor income, y_t, in any period is:

$$(3) \quad y_t = \sum_{i=0}^{N} (\alpha_{it})(\tilde{z}_{it})$$

where the labor shares α_{it} satisfy $\sum_{i=1}^{N} \alpha_{it} = 1$ for all t, and

$$0 \leq \alpha_{it} \leq 1 \text{ for all i and all t.}$$

$\tilde{z}_{it}$ denotes the country-specific stochastic return on sector i in period t per unit labor input.

In any period, the labor shares (α_{it}'s) are chosen before the realizations of the returns ($\tilde{z}_{it}$'s) are known. Consumption (c_t), and therefore savings or borrowing, is chosen after the $\tilde{z}_{it}$'s are known. The country in effect makes a series of alternating decisions, allocating labor given existing net wealth, then choosing consumption based on inherited net wealth and this period's labor income. The labor allocation problem is exactly analogous to the standard portfolio

problem without short sales, since labor shares must be non-negative.[7] The objective function in any period, however, will vary---depending not only on the underlying utility function but also on current wealth, and the number of periods remaining. The consumption-savings choice also differs from the standard problem (as found in Samuelson (1969), for example): since labor (rather than wealth) is being allocated across alternative "investments," wealth obtained by foregoing present consumption is not itself allocated into those "investments," although holdings of wealth may affect labor allocation.

The first steps in the solution of the country's optimization problem for a general utility function and an arbitrary process for the random returns can be found in Appendix 1. In general, however, restrictions on the utility function and the stochastic processes will be needed to solve the model explicitly.

III. Example of Logarithmic Utility, Binary Outcome for Risky Good, Two Periods

A. Unrestricted Borrowing, Lending, and Factor Allocation

We now apply this approach to production diversification in a simple example that clearly illustrates the benefits of international borrowing and lending, and their effect on output decisions. In this optimizing framework combining comparative advantage, terms-of-trade risk, and access to international capital markets, we demonstrate how

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[7] See Markowitz (1959), pp. 170-185, for an explicit solution to this portfolio problem.

intertemporal substitution can take the place of production diversification. We also determine explicitly the effects of a borrowing limit on production and consumption decisions.

In this example, we consider a country with logarithmic (a special form of CRRA) utility allocating its labor between one safe and one risky good.[8] The country's lifetime will consist of only two periods, and the subjective discount rate and the world interest rate are assumed to be zero. There are exactly two states of nature: each period, the random return $\tilde{z}$ takes the value $z+\sigma$ with probability one half and the value $z-\sigma$ with probability one half. Shocks are serially independent. The safe return is defined as R. By assumption:

$$0 < z - \sigma < R < z < z + \sigma$$

The symbol d will be used to denote $z - R$; by the above assumption, $d < \sigma$.

In this two-period model, the country must make three consecutive choices: α_1, c_1, and α_2. (Consumption in the second period is not chosen but is determined by the intertemporal budget constraint: $c_2 = w_2 + y_2$. Thus, default never occurs.) We solve for the optimal choice of these three terms in reverse order, as in any dynamic programming problem.

(i) Solution of α_2^*. In the second period, the country allocates labor given w_2 to maximize $EU(c_2)$, or $EU[w_2 + \alpha_2(\tilde{z}_2 - R) + R]$.

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[8] Production of the safe good is analogous to complete diversification, i.e. direct production of the consumption basket. The only important feature lost in our assumption of a single risky product is the diversification opportunity made possible by the covariance of returns across risky projects. In the general, multi-commodity case, covariance enters critically in the solution.

Substituting $z+\sigma$ and $z-\sigma$ for $\tilde{z}$, we find the first-order condition with respect to α_2, yielding $\alpha_2^* = (R + w_2)(z - R)/[\sigma^2-(z-R)^2]$.

(ii) Solution of c_1^*. Next, we explicitly derive the value function $J_2(w_2)$, which denotes the expected utility of consumption when entering the second period with wealth w_2, assuming an optimal choice of α_2. Substituting the values of $\tilde{z}$, we obtain: $J_2(w_2) = 0.5 \log [w_2 + \alpha_2^*(z + \sigma - R) + R] + 0.5 \log [w_2 + \alpha_2^*(z - \sigma - R) + R]$. Note that the derivative of this expression with respect to w_2 is $1/(w_2 + R)$.

In the first period, after y_1 is known, the country must choose consumption c_1 to maximize its expected lifetime utility, namely $u(c_1) + J_2(w_1 + y_1 - c_1)$. Maximization with respect to c_1 produces $c_1^* = (w_1 + y_1 + R)/2$. Thus the country will enter the second period with wealth $w_2 = (w_1 + y_1 - R)/2$.

(iii) Solution of α_1^*. To find the optimal α_1, the country solves:

$$\underset{\alpha_1}{\text{Max}} \quad EU\{[0.5(w_1 + y_1 + R)]\} + EJ_2[\, 0.5(w_1 + y_1 - R)]$$

$$\text{where } y_1 = \alpha_1(\tilde{z}_1 - R) + R$$

For logarithmic utility, we obtain:

$$\alpha_1^* = [(2R + w_1)(z - R)]/[\sigma^2 - (z - R)^2]$$

Note that for a given w, $\alpha_1^*(w) > \alpha_2^*(w)$. A longer horizon enable a country to take greater risks.

We can now calculate explicitly the gain in expected utility resulting from the ability to borrow and lend. Beginning with zero wealth, i.e. $w_1 = 0$, the optimal program (α_1^*, c_1^*, and α_2^*) generates expected utility of: $2 \ln R + 3 \ln \sigma - (3/2) \ln (\sigma + d) - (3/2) \ln (\sigma - d)$. If the country were forced to balance its current account

period-by-period, each period it would allocate labor as α_2^* (with $w_2 = 0$) and have expected utility of: $2\,[\ln R + \ln \sigma - (1/2)\ln(\sigma - d) - (1/2)\ln(\sigma + d)]$. Thus, the expected utility gained from the ability to borrow and lend is: $\ln\,[\sigma / (\sigma 2 - d^2)^{0.5}]$, which will always be positive since the numerator of the argument is greater than the denominator. The stronger the comparative advantage and the riskier the export, the greater the gain in utility. Of course, utility would be still higher under complete markets, in which the country could receive with certainty the mean of its income (z), allowing complete specialization according to comparative advantage.

To summarize the conclusions of the logarithmic utility, binary outcome, two-period example:

(1) The ability to borrow and lend increases expected utility in two ways: by permitting intertemporal substitution given income, and by inducing greater specialization according to comparative advantage.

(2) In any period, the share of labor allocated to the risky project increases with wealth, decreases with the variance of the risky return, and increases with the differential between the mean of the risky return and the safe return.

(3) For given wealth, the share of labor allocated to the risky project increases with the number of periods remaining.[9]

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[9] A further extension backwards to period zero shows that at the end of the zeroth (third-to-last) period, when the country has inherited wealth w_0 and labor income y_0, the country's optimal consumption c_0^* is $(1/3)[2R + w_0 + y_0]$. At the beginning of period zero, when the country has inherited net wealth w_0 and must allocate labor, i.e. choose α_0, it will choose: $\alpha_0^* = [(3R + w_0)(z - R)]/[\sigma^2 - (z - \sigma)^2]$. In other words, for longer horizons, an increasing proportion of labor is dedicated to

(4) Consumption, given wealth, depends only on the safe return, not on the expectation or variance of the risky return. An increase in the variance of the risky return causes a re-allocation of labor away from the risky good that leaves constant the expected utility of consumption.[10]

Since it may be extremely costly to shift labor across production sectors, the identical problem with no re-allocation of labor is examined in Appendix 2. The technique used is the same, but we must add the constraint $\alpha_1 = \alpha_2$.

B. Borrowing Limits

Because a borrowing country may be unable or unwilling to repay loans greater than a certain sum, lenders often impose credit ceilings, beyond which a country is not permitted to borrow further.[11] Such borrowing limits, which we assume to be exogenous, are easily

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the risky project, subject to the constraint $0 \leq \alpha \leq 1$. For longer horizons, consumption appears to be approaching R, implying that present wealth matters less since it will be spread out over more periods.

[10] We can contrast this finding with the results of standard "income fluctuations" models such as Leland (1968), Sibley (1975), and Miller (1974). For isoelastic utility functions, they showed that savings rise and consumption declines when the variance of income rises. Of course, these models differ importantly from the export diversification example; in the former, the individual cannot substitute away from the risky cash flow.

[11] See Eaton and Gersowitz (1981) for the derivation of borrowing limits from the penalties lenders can impose on debtors who default.

incorporated into our two-period example.[12] It will be shown that a "potentially binding" borrowing limit will induce a country to specialize less.

A borrowing limit L will not be considered even "potentially binding" if the country's unconstrained production-consumption plan would never entail borrowing an amount greater than L. In our example, with $w_1 = 0$, the country if unconstrained will wish to borrow $(R-y_1)/2$ during the first period. Borrowing will be positive only if the risky sector receives a negative shock in the first period. Since we know that α_1^* (for $w_1=0$) will be $2Rd/(\sigma^2-d^2)$, borrowing when the first-period shock is negative must equal $\{R-[\alpha_1^*(d-\sigma)+R]\}/2 = Rd/(\sigma+d)$. Thus if $L > Rd/(\sigma+d)$, then the country can ignore the borrowing constraint since it will never be binding.

For any $L < Rd/(\sigma+d)$, however, the country will be liquidity constrained, i.e. unable to borrow all it would like, if it chooses α_1^* and a negative shock occurs in the first period. Of course, the country can avoid this risk altogether by selecting an α_1 sufficiently low that it will not be liquidity constrained when the first-period shock is negative.

As a function of L, this α_1 equals $2L/(\sigma-d)$, which we can denote α_1^{LC}, the choice of α_1 above which the country may be liquidity

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[12] We also calculate the effect of a borrowing limit expressed as a fixed fraction of first-period income, i.e. θy_1. This corresponds to a maximum ratio of debt payments to exports, or "debt-service ratio." For $\theta > d/(\sigma-d)$, the borrowing limit will never be binding. For lower θ, the limit will be important if α_1 is greater than $2\theta R/[(2\theta+1)(\sigma-d)]$. The explicit solution for $\alpha_1^*(\theta)$, is: $\{R[4\theta^2(d-3\sigma)^2+4\theta(d-3\sigma)(d+\sigma)+9(\sigma+d)^2]^{(1/2)} +2R\theta(\sigma+5d)-3R(\sigma+d)\}/[8\theta(\sigma^2-d^2)]$. At $\theta=0$, this expression reduces, using l'Hopital's rule, to $4Rd/3(\sigma^2-d^2)$, as expected.

constrained. Note that for $L < Rd/(\sigma+d)$, α_1^{LC} is strictly less than α_1^*.

If the country chooses α_1 such that $\alpha_1^{LC} < \alpha_1 < \alpha_1^*$, then its expected utility will be:

$$0.5\{\log[(R+\alpha_1(d+\sigma)+R)/2] + J_2[\alpha_1(d+\sigma)/2]\}$$

$$+ \quad 0.5\{\log[\alpha_1(d-\sigma)+R+L] + J_2(-L)\},$$

since if it is liquidity constrained, the country will always consume all available resources (y_1 plus L) in period one, then enter the second period with wealth -L.

Maximizing expected utility with respect to α_1, we obtain :

$$\alpha_1^{**} = [4Rd + 2L(\sigma+d)]/[3(\sigma^2 - d^2)].$$

We define α_1^{**} as the optimal choice of α_1 when the country faces the borrowing limit $L < Rd/(\sigma+d)$. It is easy to verify that when $L = Rd/(\sigma+d)$, then $\alpha_1^{LC} = \alpha_1^{**} = \alpha_1^*$. For lower values of L, however, we have the relation $\underline{\alpha_1^{LC} < \alpha_1^{**} < \alpha_1^*}$.

If $L < Rd/(\sigma+d)$, α_1^{**} is the optimal choice of α_1 in the range above α_1^{LC}. Since expected two-period utility is everywhere a continuous function of α_1 (in particular at α_1^{LC}) and $d^2EU/d\alpha_1^2$ is always negative in both the constrained and unconstrained regions, we can assert that $\underline{\alpha_1^{**} \text{ is the optimal choice of } \alpha_1}$ in the entire range of $0 \leq \alpha_1 \leq 1$, for any $L < Rd/(\sigma+d)$.

As we would expect, α_1^{**} is a decreasing function of L. A lower borrowing limit induces the country to specialize less, and lowers expected utility. Note that even if L=0, i.e. no borrowing at all is permitted, $\alpha_1^{**} = 4Rd/[3(\sigma^2-d^2)]$, which is higher than $Rd/(\sigma^2-d^2)$, the value of α chosen when neither borrowing nor lending is allowed and the country must balance its current account period by period.

APPENDIX 1: Country's Optimization Problem with General Utility Function and Arbitrary Stochastic Process

Like any dynamic programming problem, this problem is approached backwards, beginning with the last decision, the single labor-allocation decision facing a country entering its last period of consumption with wealth w_T. The country chooses α_T, its share of labor dedicated to the single risky activity, to maximize its expected utility. Or:

$$(i) \qquad \max_{\alpha_T} \; EU[w_T + \alpha_T\tilde{z}_T + (1 - \alpha_T)R] = EU[w_T + \alpha_T(\tilde{z}_T - R) + R]$$

The first-order condition for a maximum is simply:

$$(4) \qquad E[U'(w_T+\alpha_T(\tilde{z}_T-R)+R)(\tilde{z}_T-R)] = 0.$$

The sufficient condition for a maximum will hold almost surely provided that the utility function is concave, i.e. that $u'' < 0$.

We can now ask how the optimal choice of α_T, as determined in (4), is affected by the initial wealth w_T. The answer will obviously depend on the country's utility function, but it will be interesting to examine the effect for different functional forms of u. We perform this exercise in comparative statics by totally differentiating the first-order condition (4), obtaining:

$$E[u''(c_T)(\tilde{z}_T-R)^2]\, d\alpha_T + E[u''(c_T)(\tilde{z}_T-R)]\, dw_T = 0, \text{ or}$$

$$\frac{d\alpha_T}{dw_T} = \frac{-\,E[u''(c_T)(\tilde{z}_T-R)]}{E[u''(c_T)(\tilde{z}_T-R)^2]}$$

$$c_T = w_T + \alpha_T(\tilde{z}_T - R) + R$$

Considering specific utility functions, if u(c) is of constant absolute risk aversion (CARA), such as $u(c) = -e^{-\theta c}$, then $u'' = -\theta u'$, and $d\alpha_T/dw_T = 0$ by the first-order condition (4). If u(c) is of constant relative risk aversion (CRRA), such as $u(c) = c^r/r$, then $u''(c) = (r-1)c^{r-2}$, and without further restrictions on the stochastic structure of $\tilde{z}_T$, $d\alpha_T/dw_T$ is of ambiguous sign.

(ii) We now incorporate the consumption decision occurring in the next-to-last period. Suppose we define $J_t(w)$ as the expected utility of consumption in the remaining T-t+1 periods beginning in period t, which the country enters with wealth w_t. We assume optimal labor allocation (choice of α) in each of the T-t+1 periods, and optimal consumption in the T-t periods before the last. (In the Tth period, which is the last period, there is no choice in consumption: $c_T = w_T + y_T$.)

Using this definition of $J_t(w)$, we can express the consumption decision of a country inheriting net wealth w_{T-1} in the second-to-last period as:

$$(5) \quad \max_{c_{T-1}} \quad u(c_{T-1}) + \beta J_T[(w_{T-1} - c_{T-1})(1 + r)],$$

where c_{T-1} denotes consumption in the second-to-last period. Since we cannot express J in terms of a general functional form, we re-write (5) as:

$$\underset{c_{T-1},\ \alpha_T}{\text{Max}} \quad u(c_{T-1}) + \beta EU[(w_{T-1} - c_{T-1})(1 + r) + \alpha_T(\tilde{z}_T - R) + R]$$

First-order conditions are:

$$(6) \quad 0 = u'(c_{T-1}) - \beta(1+r)EU'[(w_{T-1} - c_{T-1})(1 + r) + \alpha_T(\tilde{z}_T - R) + R]$$

$$(7) \quad 0 = E\{u'[(w_{T-1} - c_{T-1})(1+r) + \alpha_T(\tilde{z}_T - R) + R] \cdot [\tilde{z}_T - R]\}$$

Since (7) uniquely defines α_T for a given c_{T-1}, this value of α_T can be substituted into (6) allowing an explicit solution for c_{T-1}.

Taking total differentials of (6) and (7) and eliminating $d\alpha_T/dw_{T-1}$ to solve for dc_{T-1}/dw_{T-1}, we obtain:

$$\frac{dc_{T-1}}{dw_{T-1}} = \frac{\{E[u''(c_T)(\tilde{z}_T - R)^2]Eu''(c_T) - E^2[u''(c_T)(\tilde{z}_T - R)]\} \cdot \beta(1+R)^2}{E[u''(c_T)(\tilde{z}_T - R)^2][u''(c_{T-1}) + \beta(1+r)^2 Eu''(c_T)] - \beta(1+r)^2 E^2[u''(c_T)(\tilde{z}_T - R)]}$$

c_T denotes consumption in the last period. The substitution used here was:

$$\frac{d\alpha_T}{dw_{T-1}} = \frac{dc_{T-1}}{dw_{T-1}} \cdot \frac{u''(c_{T-1}) + \beta(1+r)^2 Eu''(c_T)}{\beta(1+r)E[u''(c_T)(\tilde{z}_T - R)]} - \frac{(1+r)Eu''(c_T)}{E[u''(c_T)(\tilde{z}_T - R)]}$$

Examination of individual terms indicates that this expression will always be positive, but it cannot be reduced further for the general case. If u(c) is CARA, then $E[u''(c_T)(\tilde{z}_T - R)] = 0$, so

$$\frac{dc_{T-1}}{dw_{T-1}} = \frac{Eu''(c_T)\beta(1+r)^2}{}$$

$$\frac{dw_{T-1}}{} \qquad u''(c_{T-1}) + ß(1+r)^2Eu''(c_T)$$

By the first-order condition shown in (6),

$$u'(c_{T-1}) = ß(1+r)Eu'(c_T), \text{ so}$$

$$u''(c_{T-1}) = ß(1+r)Eu''(c_T),$$

since for CARA utility functions, $u''(c) = -\theta u'(c)$. Thus,

$$\frac{dc_{T-1}}{dw_{T-1}} = \frac{Eu''(c_T)\ ß\ (1+r)^2}{ß(1+r)Eu''(c_T)+ß(1+r)^2Eu''(c_T)} = \frac{1+r}{2+r}$$

but the precise amount (as opposed to the change in the amount) to be consumed in the second-to-last period, as a function of w_{T-1}, cannot be explicitly determined, and must be found through solving (6) and (7).

APPENDIX 2: No Re-allocation of Labor

If the factors of production are highly specialized, then it may be inappropriate to assume that a country can costlessly re-allocate factors across industries over time. In the two-period, two-industry, logarithmic example with two states of nature, we incorporate an extreme form of industry-specificity in labor: complete lack of substitutability, or infinite costs of re-allocating.

We solve the same problem subject to the constraint $\alpha_1 = \alpha_2$. The country makes two (rather than three) decisions: first, its permanent choice of α; second, its consumption c_1 given the first-period outcome and its committed α for the second period. We expect the inability to re-allocate labor in the second period to lead the country to pursue a less risky policy in the first period.

The maximization problem can be expressed as:

$$\underset{\alpha}{\text{Max}} \quad EU(c_1) + EU(c_2)$$

$$\text{where} \quad c_2 = \alpha(\tilde{z}_1 + \tilde{z}_2 - 2R) - c_1$$

The first-order condition is:

$$0 = E\{[u'(c_1)][dc_1/d\alpha]\} + E\{[u'(c_2)][\tilde{z}_1+\tilde{z}_2-2R-(dc_1/d\alpha)]\}$$

After the first period's uncertainty is resolved, we know that c_1 will be chosen such that: $u'(c_1) = E_1[u'(c_2)]$, where E_1 denotes the expected value at the end of period one. By the law of iterated expectations, we have: $E[u'(c_1)] = E[u'(c_2)]$, the absence of a subscript on the expectation operator denoting the expectation at the end of period zero. We can use this envelope condition on first-period consumption to eliminate the terms involving $dc_1/d\alpha$. Thus, the first-

order condition is simply:

$$0 = E([u'(c_2)][\tilde{z}_1+\tilde{z}_2-2R]).$$

We can calculate the value of $[u'(c_2)][\tilde{z}_1 + \tilde{z}_2 - 2R]$ for each of the four equally probable outcomes for the first and second period shocks: (+,+), (+,-), (-,+), and (-,-). The first-order condition is then:

$$0 = \frac{2d+2\sigma}{H+2\alpha d-c_1^+} + \frac{2d}{H-c_1^+} + \frac{2d}{H-c_1^-} + \frac{2d-2\sigma}{H-2\alpha\sigma-c_1^-}$$

where $H = 2\alpha d + 2R$

c_1^+ = first-period consumption after <u>positive</u> first-period shock

c_1^- = first-period consumption after <u>negative</u> first-period shock

We can solve explicitly for c_1^+ and c_1^-, given α, using the fact that marginal utility of period-one consumption must equal <u>expected</u> marginal utility of period-two consumption. So,

$$\frac{1}{c_1} = \frac{1}{2}\left[\frac{1}{y_1+\alpha(d+\sigma)+R-c_1} + \frac{1}{y_1+\alpha(d-\sigma)+R-c_1}\right]$$

Defining $b = y_1 + R + \alpha d$, we use the quadratic formula to obtain:

$$c_1 = \frac{3b - [b^2 + 8\alpha^2\sigma^2]^{0.5}}{4}$$

(We can reject the positive square root of the determinant by considering the limiting case of $\alpha = 0$, for which $c_1 = b/2$ clearly maximizes utility.)

Actual values of c_1^+ and c_1^- are easily obtained by substituting $y_1^+ = R + \alpha(d+\sigma)$ and $y_1^- = R + \alpha(d-\sigma)$ into the definition of b, then

expanding the expression for c_1. Substituting these values into the first-order condition (8) will produce an implicit solution for α. The explicit solution, calculated by computer, appears too complicated to yield new insights. Because of risk-aversion, we know that the α chosen in this example without re-allocation of labor will be lower than the corresponding α_1^* in which labor can be re-allocated.

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CHAPTER TWO

WHAT CAUSED CHINA TO LEAVE THE SILVER STANDARD?

WHAT CAUSED CHINA TO LEAVE THE SILVER STANDARD, 1934-1935?

I. Introduction

The experience of China in the early 1930's has been regarded by historians as a striking example of a small open economy devastated by a single external shock. The shock in this case consisted of a tripling of the real world price of silver from 1932 to 1935,[13] resulting primarily from silver purchases by the United States government of an unprecedented magnitude. Since China's monetary system at the time was based on silver, this remarkable increase in the price of silver caused a sharp appreciation of the Chinese currency as well as widespread deflation. Large exports of silver from China ensued---in two years, China's monetary silver fell by one-fourth[14]---and after several failed attempts to curb the silver outflow, China ultimately abandoned the silver standard in November 1935. Commenting on the U.S. silver policy, Friedman and Schwartz (1963) wrote: "The silver program is a dramatic illustration of how a course of action, undertaken by one country for domestic reasons and relatively unimportant to that country, can yet have far-reaching consequences for other countries if it affects a monetary medium of those countries. China was most affected."

The case of China also holds special interest because the Chinese

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[13] In the U.S., silver increased from 24.6 cents in December 1932 to 81 cents on 26 April 1935, a 229% increase. The corresponding increase in U.S. wholesale prices was 23%.

[14] China's monetary silver fell from C$ 2.275 billion at the end of 1933 to C$ 1.703 billion ounces at the end of 1935, according to the estimates of Rawski (1984).

silver standard represented an unusual hybrid of fixed and flexible exchange rates. In the early 1930's, China was the only major country adhering to a silver standard in a world predominantly tied to gold. Although Chinese currency floated against other currencies in line with the world price of silver, the Chinese dollar was inextricably linked to silver. The large circulation of silver coins made it impossible to revalue or devalue in terms of silver. Furthermore, as in all metal-backed regimes, China's money supply depended on its stock of monetary silver, which in turn varied with its balance-of-payments, as well as speculative trade in silver.

According to Friedman and Schwartz[15], an exogenous rise in the world price of silver led to a real appreciation, a fall in net exports, and thus a balance-of-payments deficit, necessitating an outflow of silver. The silver outflow in turn implied a monetary contraction, which resulted in deflation and, given some rigidities in prices, a sharp fall in output. China's ultimate departure from silver is thus attributed to exogenous forces, primarily the U.S. silver purchases, that compelled China to abandon the silver standard in November 1935 when the depression became too severe.

Recent research on prewar China, however, has demonstrated that this line of reasoning may be inconsistent with some of the facts. Rawski (1984), for example, points out that although silver did flow out of China in 1934 and 1935, increased circulation of bank notes redeemable for

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[15] This interpretation is shared by many other, including official Chinese reports during the crisis. For other similar accounts, see: Paris (1938), Westerfield (1936), Lin (1936).

silver more than outweighed the loss of silver, implying that the money supply did not truly contract. Brandt (1985) shows that many prices in China were not rigid but extremely flexible, and in fact were determined by international commodity arbitrage based on fluctuations in silver. This would imply that deflation resulted directly from a nominal appreciation, not via a monetary contraction. Myers (1986), Rawski (1988), and Brandt and Sargent (1988)---citing levels of capital investment, transportation data, and new sectoral estimates of GDP---assert that, contrary to many contemporary reports, there was in actuality little or no depression at all in China, that deflation had virtually no effect on output.

Brandt and Sargent (1988) offer an alternative interpretation of China's experience in the early 1930's that better incorporates these recent findings: they explain the rapid outflow of silver not as the inevitable consequence of a sudden worsening in the trade balance, but as the expenditure of a windfall gain due to silver's real appreciation. Higher real silver prices permitted a lower stock of silver to support an unchanged level of real balances. Therefore, China could export silver, enjoying a one-time gain in consumption, but leaving the real economy otherwise unchanged. While the Chinese dollar did appreciate against other currencies and Chinese prices did fall, there was no real appreciation, no real output contraction, in fact, no economic crisis at all. The government's decision in November 1935 to nationalize silver and replace China's silver-backed currency with fiat money is viewed simply as a deliberate attempt by the Chinese government to increase its share of the capital gain resulting from silver's appreciation.

This paper proposes a third interpretation of China's last few years on the silver standard: that the large silver outflows from China arose from neither a growing trade deficit nor a windfall gain but rather from speculative sales of silver---and this caused the Chinese silver standard to collapse. Silver exports from China were far greater, in fact more than twenty times greater, in 1934 and 1935 than in 1932 and 1933. Yet, in 1934 and 1935, China's trade deficit was narrowing and the decline in the Chinese price level was decelerating. Neither Friedman and Schwartz's nor Brandt and Sargent's explanation of why silver left China is consistent with this phenomenal surge in silver exports in 1934 and 1935.

Although silver prices had been rising and the Chinese price level falling since 1931, it was in early 1934 that two conditions became strong enough to drive silver out of China in the form of speculative capital flight: (1) It had become clear that intervention in the silver market by the United States government was likely to drive world silver prices to new artificial highs; and (2) The Chinese government, threatened by the consequent currency appreciation and price deflation, declared that it would take drastic action if American purchases caused too great an increase in silver prices.

The American commitment to higher silver prices had been strengthening throughout 1933 as a succession of bills authorized the Treasury to pay considerably more than the market price in acquiring silver. By mid-1934, any remaining doubts were dispelled: under the Silver Purchase Act, the U.S. would most definitely purchase large amounts of silver over the next few years, and would be willing to pay more than double the going price.

The Chinese fear of an artificial rise in silver prices was perceptible as early as the beginning of 1933. Rumors of a silver embargo circulated, but no action was taken.[16] An academic study appeared in December 1933 indicating the harmful effects of higher silver prices.[17] In March 1934, in its ratification of the international silver agreement, the Chinese government warned that it would take "whatever action it may deem appropriate" to counteract the damage caused by rising silver prices.[18] Indeed, beginning September 1934, China took action in the form of capital controls that became increasingly stringent---to the point of a virtual embargo on silver in the spring of 1935, and the abandonment of the silver standard in November 1935.

These conditions, i.e. America's determination to support silver prices and China's strong aversion to deflation and silver export, clearly pointed to an eventual suspension of the silver standard. This combination of forces led those holding silver within China to seek to export it. Foreigners and Chinese alike sent large amounts of silver out of China, first legally then via smuggling, recognizing the probability of tighter controls later. As the price of silver rose further and the Chinese government protested more loudly, the silver standard's demise appeared imminent.

Although it appeared in mid-1934 that silver would rise further, speculators' incentives to redeem paper for silver then to ship this

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[16] Leavens, Silver Money, p. 221.

[17] Leavens, Silver Money, p. 223.

[18] Tang, China's New Currency System, p. 65.

silver out of China were independent of whether one expected the price of silver to rise further or to begin to fall. The sensible strategy for anyone holding paper or silver money in China was to convert the funds to foreign currency or to transfer them abroad. For example, holders of silver expecting silver to rise would want to move the silver abroad to avoid the potential export restrictions. Holders of silver expecting silver to fall would want to sell the silver for foreign currency, since the Chinese dollar would depreciate with a fall in silver. Holders of Chinese dollars expecting a rise in silver (and therefore either a suspension of convertibility from paper to silver, or a silver embargo) would want to convert their notes to coins and again ship the silver abroad. Holders of Chinese dollars expecting silver to fall should obtain foreign exchange; since exchange transactions were restricted, this necessitated an export of silver to purchase the foreign exchange.

Given the genuine threat of China's imposing tighter capital controls, it appears most reasonable to view China's silver exports as speculative "capital flight," rather than the financing of an appreciation-induced trade deficit or the balance-of-payments deficit permitted by a one-time windfall gain.

This paper will be organized as follows. Section II reviews the historical facts surrounding the silver episode in China in the early 1930's. Section III evaluates three alternative explanations of the events---Friedman and Schwartz's, Brandt and Sargent's, and this paper's. Section IV concludes.

II. HISTORICAL BACKGROUND: THE CHINESE SILVER STANDARD, 1932-1935[19]

1. Currency Appreciation and Price Deflation in China, 1932-1933

China's adherence to a silver standard benefited China at the outset of the Depression, as the world price of silver fell, the Chinese currency depreciated, and China's exports were stimulated in a period of depressed world trade. Commodity prices in terms of Chinese currency actually rose, permitting China to avoid the deflation afflicting many other countries at the time.

In 1932, these trends reversed themselves: China experienced an exchange rate appreciation, deflation in prices, and a severe decline in exports. The departure from the gold standard by Britain in September 1931, and by Japan in December 1931 led to a nominal appreciation of silver, and thus the Chinese currency. From 1931 to 1932, the Chinese dollar appreciated 23.7% against the pound and 70.1% against the yen, although the Chinese currency did depreciate by 2.9% against the U.S. dollar. Wholesale prices in China fell by 11% but since prices abroad were falling or nearly constant, the Chinese currency experienced a real appreciation.

Exports from China declined substantially, by about 45%, in 1932. This decline in exports resulted not only from the real appreciation of the Chinese dollar, but also the deepening of the Depression in the U.S. and elsewhere---world industrial production fell 17% in 1932, and the Japanese takeover of Manchuria, a region that had been generating about

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[19] An overview of China's macroeconomy and financial system is presented in Appendix A.

one-third of all Chinese exports.

Although imports also declined in 1932, exports fell by more, causing China's trade deficit to widen from C$ 816 million to C$ 867 million according to official records, from C$ 584 million to C$ 746 million in "corrected" reports. Invisibles registered a small improvement (the fall in the Chinese dollar value of foreign debt service more than offset the decline in overseas remittances), but the current account showed a worsening of about C$ 100 million. While capital items such as foreign investments and loans increased slightly, the Chinese balance-of-payments position showed a deficit of C$ 266 million, approximately C$ 100 million larger than in 1931. In 1932, China exported silver for the first time since 1917.

2. Flow of Silver from China, 1934

China's silver exports amounted to C$ 10 million in 1932, increased slightly to C$ 14 million in 1933, but as indicated in Table 10, did not truly gain momentum until mid-1934 as the U.S. began major purchases under the Silver Purchase Act.[20] Although official exports declined sharply as of mid-October 1934 in response to newly imposed capital controls, total silver exports for 1934 (not including smuggled exports) were C$ 256.7 million, about 20 times greater than in 1932 or 1933. Since a standard Chinese silver dollar was equivalent to 0.81666 ounces of silver, 1934 exports represented more than 10% of China's entire monetary stock of silver, which was estimated at 1700 million ounces in January 1933.[21]

Most of the export of silver in 1934 can be attributed to silver destocking by foreign banks. Considerable silver had accumulated in foreign banks from 1929 to 1932, when the low price on world markets discouraged the conversion of silver into foreign currency. Silver stocks in foreign banks fell from C$ 275.7 million at the end of 1933 to C$ 54.7 million at the end of 1934, a decline of C$ 221 million, or 85%! In terms of dollar amounts, this transfer of silver was concentrated in just a few major banks: Hongkong and Shanghai Banking Corporation (C$ 76.4 million), Chartered Bank (C$ 68.9 million), Banque de l'Indochine (C$ 16.9 million), Yokohama Specie Bank (C$ 15.7 million), and National City Bank of New York (C$ 10.8 million) were responsible for about 85% of foreign banks' silver

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[20] See Appendix B for background information on the U.S. Silver Policy.

[21] Leavens, Silver Money, p. 369.

destocking.[22]

During the same period, the four government banks, known as the "Central Banking Group," actually increased their stocks of silver by C$ 35.5 million, from C$ 192.2 million at the end of 1933 to C$ 227.7 million at the end of 1934. Changes in silver stocks were distributed as follows: Central Bank of China (+ C$ 29.0 million), Bank of China (- C$ 20.6 million), Bank of Communications (+ C$ 20.6 million), and Farmers Bank of China (+ C$ 3.6 million).[23]

Commenting on the sudden flow of silver from China, Leavens wrote: "In part these exports arose from the transfer of funds abroad by individuals and corporations who decided that it was well to take their profits without further delay. Many were influenced by rumors and expectations that, if the price of silver should rise considerably, China would be forced to place restrictions on the export of the white metal or to devalue the Chinese dollar....Although the Government from time to time issued denials of any such intentions, there was real justification for apprehension on this score....the same possibility of embargo or devaluation influenced banks and at least one large corporation to ship silver abroad for safekeeping....Thus, the urge to export silver before it was too late was increased, in a vicious circle."[24]

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[22] Tamagna, Banking and Finance in China, p. 104.

[23] Tamagna, Banking and Finance in China, p. 139.

[24] Leavens, "American Silver Policy and China," Harvard Business Review, Autumn 1935, vol. 14, no. 1, p. 52.

3. China's Reaction to the U.S. Silver Policy, 1934-35

Although American advocates of higher silver prices had claimed that an appreciation of silver would help China,[25] the Chinese government realized at a fairly early stage that a rapid increase in the price of silver could prove detrimental to the Chinese economy. Throughout 1933, the Chinese financial community had exhibited some apprehension towards higher silver prices. In signing the London Silver Agreement on 21 March 1934, China added the caveat that its government would "consider itself at liberty to take whatever action it may deem appropriate, if, in its opinion, changes in the relative values of gold and silver adversely affect the economic condition of the Chinese people."[26] On 23 September 1934, the Chinese government protested directly to the U.S. government, describing the harmful effects of the U.S. silver policy on China, and the likely consequences of a further rise in silver: "Since 1931, the rising value of silver in terms of foreign currencies has involved severe deflation and economic loss to China....A further material silver price increase would cause very serious injury to China, possibly severe panic..."[27]

China also requested that the U.S. refrain from additional open market purchases of silver, but did propose exchanging Chinese silver for

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[25] Excellent refutations of this illogical claim can be found in Frank D. Graham, "The Fall in the Value of Silver and its Consequences," Journal of Political Economy (1931), vol. 39. no. 4, pp. 425-470, and in T.J. Kreps, "The Price of Silver and Chinese Purchasing Power," Quarterly Journal of Economics (1934), vol. 48, pp. 245-287.

[26] Tang, China's New Currency System, p. 65.

[27] Ibid, p.66.

American gold, intimating that China was contemplating leaving silver in favor of a gold standard. The Chinese government wrote: "China should not alone maintain the silver standard, and is considering gradual introduction of a gold-basis currency which would necessitate acquiring gold."[28]

The U.S. politely responded on 12 October 1934 that it would "give the closest possible attention to the possibilities of so arranging the time, place, and quantity of its purchases" to minimize the adverse impact on China, but refused to relinquish the objective of the "enhancement and stabilization of the price of silver." The U.S. moreover showed no interest in a direct exchange of precious metals with China, pointing out the existence of free markets in both gold and silver.[29]

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[28] Ibid, pp. 66-67.

[29] Ibid, p. 67.

4. Export Restrictions on Silver, 1934-35

When it became clear to the Chinese that remonstrating with the United States would prove futile, the Chinese began to take measures to protect their rapidly dwindling silver supply. On 15 October 1934, the Chinese government raised the export duty on silver from 2.25% to 10% and imposed an adjustable "equalization charge" designed to annul any profits that might arise from unequal prices of silver in China and abroad. This measure aimed to achieve two purposes: to stem the increasing flow of silver from China, and to avoid further deflation by preventing the continued appreciation of the Chinese dollar. Of course, in imposing the equalization charge, China had effectively divorced herself from a true silver standard.

The equalization charge was constructed to equalize the "theoretical" exchange rate, or the value of the .866 ounces of standard silver contained in a Chinese dollar, and the market-determined exchange rate of the Chinese dollar on foreign currency exchanges. The difference between these two rates, expressed as a percentage of the market rate, minus the export tax of 10% for silver or 7.75% for standard silver dollars, determined the equalization charge. Any attempt to export silver would therefore imply zero profits from the silver resale and a loss of shipping, interest, and other costs.

Official silver exports from China decreased immediately in response to the equalization charge, as shown in Table 10. Official records show an even greater decline in 1935: China registered net imports of silver in every month but May from January through November 1935. By official count, the equalization charge proved a highly effective form of exchange

control.

On exchange markets, the immediate response to the imposition of the equalization charge was a fall in the value of the Chinese dollar, which declined more than 10% in the first few days the charge was in effect.[30] Although the equalization charge technically constituted a departure from a true silver standard, Chinese officials vigorously denied any rumors of a future devaluation or nationalization of silver.

The equalization charge was initially set at 8% on 16 October 1934, and was meant to be adjusted daily. In practice, the equalization charge was set slightly lower than the original formula dictated, but because of shipping costs, it would still have proved unprofitable to export silver, assuming payment of all taxes.[31] Of course, smuggling silver out of China without paying taxes remained economically attractive.

The instant depreciation of the Chinese dollar when the equalization charge was first imposed convinced policymakers that too high an equalization charge would depress the Chinese dollar and widen the "discrepancy" between the market exchange rate and the theoretical (i.e. based on silver) exchange rate. Too wide a gap, it was feared, would encourage smuggling. Therefore, on 1 April 1935, in what became known as the "gentleman's agreement," the Ministry of Finance requested that Chinese and foreign banks refrain from further export of silver. Since only banks were legally permitted to ship silver, this "gentleman's

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[30] Leavens, Silver Money, p. 301.

[31] A.B. Lewis and Lien Wang,"Changes in Currency and Prices in China," Economic Facts (1936), no.1, pp. 1-65, calculates on a daily basis the potential gain from silver export from August 1934 through May 1936.

agreement" constituted a virtual embargo on silver. Having secured the co-ooperation of the Shanghai banks, the Chinese government decided not to raise the equalization charge even as the "discrepancy" widened. Smuggling became still more profitable: from April through October 1935, the Chinese dollar in silver was typically worth about 25% more than its paper value.[32]

As the drain of China's silver, especially through smuggling, appeared increasingly serious, a growing number of national and regional regulations were imposed to conserve China's silver stocks while maintaining convertibility domestically. Since silver was smuggled out primarily through Hong Kong and Japan, many restrictions governing the internal transport of silver were imposed in the hope of preventing silver in other parts of China from reaching the borders. Dates and details of the important national and regional regulations pertaining to silver export or transport are presented in Tables 7 and 8.

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[32] See "Changes in Currency and Prices of China" for calculations.

5. Smuggling of Silver from China, 1934-1935

It is estimated that about C$ 200 million, or 150 million ounces of silver, was smuggled out of China in 1935, as well as about C$ 20 million in the last few months of 1934. Chinese silver was funneled through Hong Kong and Japan, wherefrom the metal ultimately found its way to London. British trade statistics indicate that in 1935 Britain imported 85.6 million ounces from Japan and 73 million ounces from Hong Kong.[33] In 1934, Japan had exported only 7 million ounces and Hong Kong a negligible quantity. In 1933, total monetary silver in Japan was 107 million ounces, but it is not this silver that left Japan in 1935, since at the prevailing exchange rates it would have been uneconomical to melt down Japanese coins.[34] The 1935 Review of London silver dealers Mocatta and Goldsmid noted that "While some 7 millions [of Japanese 1935 silver exports] may have come from Japanese mines, the bulk of it is silver smuggled out of China."[35] Hong Kong's monetary silver in 1933 was estimated at 162 million fine ounces, some in the form of coins in circulation.[36] Silver exported from Hong Kong most likely included some silver originally from Hong Kong and other silver that had been smuggled into Hong Kong from China.

Data on internal movements of silver within China confirm that silver followed a circuitous route within China either to the North then Japan, or to the South then Hong Kong. Statistics on internal flows in

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[33] Tang, China's New Currency System, p. 115.

[34] Leavens, "Silver Coins to the Melting Pot: The Known Supply Await Higher Prices," The Annalist, 5 July 1935, p. 3.

[35] Tang, China's New Currency System, p. 115.

[36] Leavens, Silver Money, p. 369.

1934 indicate that monthly net exports of silver from Shanghai to the interior (non-Shanghai) increased from C$ 0.7 million in September to C$ 9 million in October, C$ 43 million in November, and C$ 35 million in December.[37] The sudden increase in shipment from Shanghai to the interior in October and November suggests that silver originally destined for direct export from Shanghai was diverted to the interior, eventually to be exported, since the silver export controls of 15 October 1935 were most strictly enforced in Shanghai. Although China officially imported about C$ 7 million in silver from January through October 1935,[38] silver stocks in Shanghai banks declined by C$ 20 million from 31 December 1934 to 06 November 1935, when the monetary reform was imposed.[39] In other words, in 1935 Shanghai banks shipped at least C$ 27 million to banks in cities other than Shanghai where smuggling was easier. Of course, silver originally in circulation in Shanghai or elsewhere, or originally held in banks or hoards outside Shanghai also contributed significantly to the total quantity smuggled in 1935.

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[37] Tang, China's New Currency System, p. 71.

[38] Central Bank of China Bulletin (1936), p. 85.

[39] League of Nations, Commercial Banks (1935), p. 53 and Lin, The New Monetary System of China, p. 55.

Smuggling and the "Discrepancy"

Interregional patterns of exchange rates and prices reveal insights into the economics of smuggling and can begin to explain the puzzling "discrepancy" between actual and theoretical exchange rates of the Chinese dollar. In brief, silver increased in value near the borders of Japan and Hong Kong. While paper money remained convertible into silver at par in Shanghai, the ratio of silver's value to paper's value rose with increased proximity to the world market, reflecting the costs associated with illegal transport of silver within China.

An excellent example of this phenomenon could be found in Canton, the closest major Chinese city to Hong Kong, and thus a logical conduit for smuggled silver. Canton used its own silver-based currency, the Canton dollar, containing about 80% of the silver in the standard Chinese (Shanghai) dollar. Assuming complete convertibility in both cities and the absence of any restrictions on the movement of silver, a Shanghai dollar should have been worth about 1.25 Canton dollars, as indeed it was until about mid-October 1934, when the Canton (paper) dollar began to appreciate against the Shanghai (paper) dollar in Canton currency exchanges. By May 1935, the Canton (paper) dollar was worth more than the Shanghai (paper) dollar though the former was redeemable for less silver.

How can this be explained? The Canton paper dollar was convertible into silver in Canton, whereas the Shanghai currency was convertible into silver only in Shanghai, i.e. much farther from Hong Kong. Silver in Canton was evidently worth considerably more in Canton than Shanghai, reflecting the restrictions on shipping silver from Shanghai to Canton.

Note that in Canton, the exchange rate between the Shanghai silver dollar coin and the Canton dollar remained relatively constant, since once the silver Shanghai dollar physically arrived in Canton, its value had already increased.

Movements in price levels in different cities in China also reflected the geographical differences in the value of silver. A comparative study of prices notes that for the years 1932, 1933, and the first half of 1934, commodity prices in Hong Kong, Canton, and other cities in China moved approximately in unison.[40] In late 1934 and 1935, these price levels began to diverge as the value of silver varied according to location. As the world price of silver increased, price levels fell more in Canton than in Shanghai, more in Hong Kong than in Canton, implying that money (paper or silver) had become worth relatively less in Shanghai than Canton, less in Canton than Hong Kong.[41] In Hong Kong, where the full silver standard had been maintained with no restriction, prices declined by 17% from 1934 to 1935. In Canton, which enjoyed relatively good access to Hong Kong but was still part of China, prices in 1935 fell by 10%. Finally, in Shanghai, where the distance to the free market was considerably greater, commodity prices declined by less than 1%.[42] In sum, silver was more valuable in Hong Kong than Canton,

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[40] Because the basket of commodities used in the price index varied across cities, some minor deviations across cities can be attributed to relative price changes across commodities. Economic Facts, p. 98

[41] These price levels are denominated in local currency. No distinction is made between paper and silver money as local paper remained convertible at par into silver, i.e. a Canton paper dollar could be converted into silver in Canton.

[42] Economic Facts, p. 95.

more valuable in Canton than Shanghai.

In North China, where the standard Chinese dollar (rather than a separate currency) was used, anecdotal evidence suggests that silver was more valuable in cities near Japan, such as Tientsin, than in Shanghai. Although notes remained at all times redeemable for silver at par in Shanghai, observers noted: "After the first half of 1934, premiums for silver over banknotes began to appear, and from this time forward the relation between paper money and silver varied in different cities and at different times."[43] In April 1935, for example, a small premium for silver was reported in Tientsin, according to American sources.[44] Other specific observations are listed in Table 9.

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[43] Economic Facts, p. 99.

[44] U.S. Monthly Trade Report, May 1935.

6. The Departure from Silver, November 1935

Fears of devaluation mounted sharply beginning in mid-October 1935. From 14 October 1935 to 2 November 1935, the day before the currency reform was announced, the Chinese dollar depreciated by nearly 20% while the price of silver remained unchanged.[45] At the same time, there was a rush to exchange cash for real goods, causing domestic prices of commodities such as cotton, wheat, and bean oil to be bid upwards by about 15% in just over two weeks.[46] When the currency reform actually came, the Chinese dollar did not depreciate further, but was fixed in terms of U.S. dollars or sterling just below the market rates prevailing on 2 November 1935.

A large premium for cash over forward delivery of foreign exchange developed, implying extremely high interest rates in the Chinese dollar. In September 1935, for example, when the spot exchange rate of the Chinese dollar was 33.375 U.S. cents, it was observed that the value of the Chinese dollar in forward contracts was 33.25 U.S. cents for October, 32.25 U.S. cents for November.[47] The implicit differential between U.S. and Chinese interest rates would be [(33.25/32.25) - 1], or 3.1% per month. Those with access to foreign exchange markets could "buy [foreign exchange] for cash, sell [foreign exchange] for November delivery at rates which gave a return of approximately 35%."[48] According to one source,

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[45] Lin, The New Monetary System of China, pp. 76-77.

[46] Ibid, p. 77.

[47] Finance and Commerce, 30 October 1935, vol. 26, p. 464.

[48] Ibid

"Everyone was buying foreign exchange, few wanted to sell." [49]

The currency reform that many had begun to anticipate months earlier was finally enacted on 3 November 1935, with the following statement by Dr. H.H. K'ung, Minister of Finance:

> "...China's currency has become seriously overvalued. There has been severe internal deflation, with growing unemployment, widespread bankruptcies, flight of capital abroad, fall in government revenues and an adverse balance of payments. For the three and half months commencing July, 1934 exports of sivler amounted to more than 200 million dollars, and it was evident that unless immediate measures were taken, the country would be drained of its silver stock....In order to conserve the currency reserves of the country and to effect lasting measures of currency and banking reform, [silver will be nationalized and the silver standard abandoned.]"[50]

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[49] Leavens, Silver Money, p. 312.

[50] Finance and Commerce, 6 November 1935, vol. 26, p. 487.

7. Effects of Silver Outflow and Price Deflation, 1934-1935

According to contemporary Chinese reports, the combination of price deflation and monetary contraction created a severe economic crisis, with a shortage of capital, widespread bankruptcies, and an overall agricultural and industrial decline. In a speech on 10 October 1935, Finance Minister H.H. Kung stated that "an acute monetary situtation of near-panic proportions, throughout the country at large and Shanghai in particular, has arisen" and noted that "business failures and unemployment are widespread."[51]

Available aggregate estimates of China's GDP, while highly approximate, suggest that output contracted by about 9% in 1934, largely because of crop failure that caused a 12% decline in agriculture, but otherwise remained approximately constant in real terms from 1932 to 1935.[52]

Sectoral surveys of Chinese industry indicate a mixed performance in the years 1934 and 1935. Cotton-spinning, silk, matches, and cigarettes suffered a considerable decline in 1934, but flour, rubber goods, tea, coal, and cement performed favorably.[53] An monthly index of production in China based on the five industries subject to a consolidated tax (cigarettes, cotton yarn, flour, matches, and cement) shows steady

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[51] Tang, China's New Monetary System, p. 76.

[52] Brandt and Sargent, p. 31.

[53] "An Economic Survey of China for 1934" in the Central Bank of China Bulletin (1935). These statistics, however, are of questionable accuracy: for example, the cotton-spinning industry in 1934 "faced grave difficulties" according to one report, but grew 13.4% according to another!

improvement in the overall index each year from 1932 through early-1935, though production of cigarettes and matches falls.[54] Both industry and agriculture are reported to have improved considerably during the reflation that began in November 1935.

Can any decline in output be attributed to a monetary contraction associated with the outflow of silver? Since China's monetary base did not contract, but in fact expanded, contemporary reports linking the economic downturn to monetary stringency must be considered questionable. Although China's monetary silver declined sharply in 1934 and 1935, an increase in the circulation of banknotes more than compensated for the decline in silver, as shown in Table 11. Deposits too show no sign of decline. Although China's money supply did not shrink, deflation alone may have caused some economic contraction if the Chinese economy was characterized by some nominal rigidities.

Nominal Rigidities in Chinese Factor Prices

The presence of nominal rigidities would imply a contraction in output during a deflationary period. It is unclear to what extent Chinese markets exhibited such rigidities, and thus how plausible we must consider contemporary descriptions of depression. A 1938 study on the flexibility of prices in China found that although wholesale and retail prices tended to adjust with equal speed, there existed rigidities in factor prices---

[54] Central Bank of China Bulletin (1936), pp. 19-21.

debt payments, taxes, rents, and farm and industrial wages.[55] Despite a 20% fall in basic commodity prices, and a 15% fall in the cost of living, industrial wages in Shanghai declined by only 2% from 1931 to 1934.[56] That the market for labor did not function as an auction market with perfectly flexible wages is evident in the following passage from the Maritime Customs Decennial Report 1922-1931: "At the conclusion of the last decennial period there was little or no trades union activity in Shanghai. Today nearly every trade is organised, and the various unions boast a membership of approximately 200,000."[57] For the 1930-1933 period, sectoral indices show a large decline in the volume of business in many Shanghai industries.[58]

In the agricultural sector, although the relative prices of manufactures and commodities hardly changed, difficulties arose from the inflexibility of taxes, wages, rents, and interest payments. Owner farms represented slightly more than half of all Chinese farms, while tenants comprised 25%, part-owners 20%.[59] Expenses such as rent or family labor were generally paid in kind rather than on a fixed cash basis, though a 1934 survey found that about 20% (versus 5% in 1920-1925) of Chinese tenant farmers paid a fixed cash rent rather than an output-contingent

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[55] J.R. Raeburn and K.Hu, "The Flexibility of Prices in China," Economic Facts, no.9, April 1938, pp.395-405.

[56] Ibid, p. 402.

[57] Maritime Customs, Decennial Report 1922-1931, p. 21.

[58] Lin, The New Monetary System of China, p. 60.

[59] Buck, Chinese Farm Economy, p. 145.

rent.[60]. According to a 1920-1925 survey of 2866 farms, over half engaged some hired labor, which on average amounted to 36% of operating expenses excluding family labor.[61] In 1933, about 56% of Chinese farmers were in debt for cash, paying an average annual interest rate of 34%, according to a nationwide survey.[62] Studies also indicate that price paid by farmers were less flexible upward or downward than prices received by farmers.[63]

In sum, both the industrial and agricultural sectors were characterized by some rigidity in factor prices.

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[60] Feuerwerker, p. 36.

[61] Ibid, pp. 74, 77.

[62] Silver and Prices in China, pp. 95-96.

[63] Silver and Prices in China, pp. 50-51.

China's Reaction to Deflation

The economic hardships associated with China's deflation remain a subject of controversy. Both contemporary and historical accounts of the period report large reductions in output, widespread unemployment, and other symptoms of economic contraction. Recent research, however, suggests that the real costs of the deflation may have been exaggerated, as many indicators of aggregate activity show no slowdown at all. Theoretically, we know that some difficulties are likely to have arisen because of the sluggish adjustment of wages, rents, taxes, and debts but in actuality these difficulties may have been brief and confined to a few sectors. The rapid outflow of silver, which indeed reached spectacular proportions in 1934 and 1935, may have lead some observers to overstate the decline in economic activity.

What the Chinese government perceived as a widespread "crisis" in 1934 and 1935 in fact constituted transitory sectoral shocks and changes in relative prices, none of which can be directly linked to either the silver outflow or the price deflation. For example, a severe drought in central China in the summer of 1934 raised the price of rice relative to other crops.[64] Overall, agricultural output fell by about 12% in 1934, but returned to normal in 1935.[65] Reduced purchasing power in the drought-stricken regions lowered the domestic demand for manufactures.

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[64] John R. Raeburn and Hu Kwoh-Hwa, "The Values of Soybean Oil, Cotton Cloth, and Kerosene in Terms of Rice," Economic Facts, May 1937, no. 5, pp. 219-224.

[65] Myers, "The World Depression and the Chinese Economy, 1930-1936," p. 9.

In the manufacturing sector, certain key industries such as cotton spinning and silk reeling faced adverse price and demand shocks originating abroad. The Chinese cotton spinning industry in 1934 was hurt by rapid output growth by Japanese mills within China, which from 1933 to 1934 increased yarn production by 100% and cloth production by 44%.[66] A rise in material costs, which comprised 80% of total costs, resulted in some cotton spinning firms' producing at a loss.[67] Though the silk industry had been undergoing a long-term decline, foreign (primarily American and French) demand for Chinese silk fell especially sharply in 1934 as a result of Japanese competition and the continued development of rayon. A crisis caused by a transitory slump in silk prices in mid-1935 ---the price fell from C$ 500 in January to C$ 380 in June but recovered to C$ 800 in November[68]--- may have been wrongly attributed to the silver situation because of the coincidence in timing.

What is especially interesting about this episode is that China's reaction to the deflation may have caused greater damage to China's silver standard than the deflation itself. Since the government perceived deflation as extremely costly, we know that a further appreciation of the Chinese currency was likely to cause strong governmental reaction, including possible suspension of the silver standard, should silver's price rise sufficiently. Although the real effects of deflation were

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[66] Central Bank of China Bulletin (1935), p. 35.

[67] Ibid, p. 34.

[68] Central Bank of China Bulletin (1936), p. 25. Of course, the appreciation of the Chinese dollar in mid-1935 did aggravate the terms-of-trade shock. In U.S. dollars, the New York Exchange price recovered from $ 1.30 in May to $ 1.98 in November.

small, it was of paramount importance to the government to avoid or minimize these effects. They adopted a somewhat "alarmist" attitude, imposing increasingly stricter controls on silver transport in the hope of preventing too rapid an appreciation of the Chinese dollar. In the end, this merely fueled expectations that the government would eventually become desperate enough to sever all ties with silver, and thereby induced large silver exports. This outcome is especially ironic in that the real economic costs of deflation appear to have been minimal.

III. INTERPRETATION OF CHINA'S SILVER CRISIS, 1934-1935

A. Evaluation of Friedman and Schwartz's Interpretation

Friedman and Schwartz explain the outflow of silver from China as the capital account counterpart to an increase in China's trade deficit, which in turn they attribute to a real exchange rate appreciation. The adverse impact on China's trade balance is the focus of Friedman and Schwartz's discussion of the how the trebling of the price of silver affected China.[69] The silver exports necessary to finance the trade deficit would result in a monetary contraction, causing output and prices to decline. Friedman and Schwartz report that "students of the period are unanimous that the boon [due to a rise in silver] was more than offset by the economic effects of the drastic deflationary pressure imposed on China and the resulting economic disturbances."[70]

In brief, the line of causality in Friedman and Schwartz's argument can be stated as:

> (1) A rise in the world price of silver caused the Chinese currency to appreciate in real terms.
> (2) The real appreciation caused China's trade balance to worsen.

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[69] Friedman and Schwartz draw the following analogy: "... under the impact of the silver-purchase program, [silver's] initial price had nearly trebled. The effect on China's international trade position can perhaps be appreciated best by expressing these figures in terms more familiar to the reader. It was as if, when Britain and the United States were both on the gold standard in the 1920's, Britain had been confronted over the course of two years with a rise in the dollar price of the pound sterling from $ 4.86 to nearly $ 15.00, resulting from changes in the U.S. gold price, without any change in the pound price at which Britain was obligated to sell gold, and without any substantial change in external or internal circumstances affecting the supply of or demand for products it purchased or sold." (p. 490)

[70] Friedman and Schwartz, A Monetary History of the United States, p. 490.

(3) The deterioration of the trade balance caused China to export silver.

(4) The export of silver caused China's monetary base to contract.

(5) The monetary contraction caused a decline in Chinese output and prices.

Closer examination of actual data, however, reveals that only (1) is entirely true. Arguments (2) and (3) are partially true, but present an incomplete description of China's experience and furthermore overlook the true cause of the silver outflow from China. Recent empirical findings demonstrate that arguments (4) and (5) are incorrect.[71] Each link in Friedman and Schwartz's logic is evaluated below.

(1) The real appreciation of China's currency discussed in Part II, Section 1, indeed occurred, beginning in late 1931 and 1932.

(2) As the Chinese dollar appreciated in 1932, China's trade balance did in fact worsen, the deficit widening steadily from 1931 to 1933, as shown below.

YEAR	TRADE DEFICIT[72]	SILVER EXPORTS
1931	C$ 584 million	C$ -70 million
1932	C$ 746 million	C$ 10 million
1933	C$ 807 million	C$ 14 million
1934	C$ 569 million	C$ 280 million
1935	C$ 467 million	C$ 289 million

Some of China's trade deterioration in 1932, however, must be attributed to factors other than a real exchange rate appreciation, such as the Japanese occupation of Manchuria and the overall decline in world output. In July 1932, China lost Manchuria, a region that had generated

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[71] This point is shown by Brandt and Sargent (1987).

[72] "corrected" trade figures

a trade surplus of C$ 165 million in 1928, C$ 160 million in 1929, C$ 132 million in 1930, C$ 271 million in 1931, and C$ 88 million in the first 6 months of 1932.[73] An exogenous decline in world economic activity also contributed to a fall in China's exports in 1932: world industrial production fell by 15% in 1932, and did not recover to its 1931 level until 1934.[74] The Chinese dollar continued to appreciate through 1935, but the trade deficit narrowed beginning in 1934, partly as a result of recovery worldwide. While a worsening in the trade balance did occur, Friedman and Schwartz somewhat oversimplify its origin.

(3) Non-trade items on both the current account (such as emigrants' remittances) and the capital account (foreign investment or loans) also played a major role in determining China's balance-of-payments, and therefore exports of gold and silver. For example, emigrants' remittances declined by 9% in 1932, 9% in 1933, and 17% in 1934.[75] Flows of foreign investment in China had once dropped by 80% in one year, from C$ 202 million in 1930 to C$ 44 million in 1931, but in subsequent years overall changes in invisible items tended to offset each other. For example, both emigrants' remittances and the service of foreign loans fall in 1932, reflecting the appreciation of the Chinese dollar against other currencies.

The trade deficit, current account deficit, and the combined current and capital account deficit (exclusive of capital flight and shipment of

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[73] Bank of China statistics, derived from "China excluding Manchuria" figures.

[74] League of Nations, World Production and Prices.

[75] Lin, New Monetary System of China, p. 26.

gold and silver) all reach a low point in 1933, then begin to recover in the following year. In 1934, the trade deficit and the current account deficit, narrowed by one-third; the combined current and capital account deficit shrunk by about 50% in 1934, and an additional 50% in 1935.

Furthermore, in 1934 and 1935, the years in which by far the greatest amount of silver left China, the trade deficit had actually narrowed considerably. While China's trade statistics are not of high precision, by any measure ("corrected" trade data, official trade data, official trade data excluding Manchuria), China's trade deficit improved in both 1934 and 1935. Therefore, a deepening of the trade deficit cannot be the cause of the extraordinary increase in silver outflow in these two years.

(4) Since the increase in notes in circulation exceeded the decrease in monetary silver, it must be true that China's nominal money supply actually increased even as silver left China.[76] The fall in prices implied still greater growth of the real money supply.

(5) By international arbitrage, Chinese dollar prices of many commodities fell as a direct consequence of the appreciation of the Chinese currency,[77] independent of China's money supply. Output losses, as discussed in the last section of Part II, were probably of brief duration and limited to a few specific industries and regions.

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[76] For a thorough discussion of this phenomenon, consult Rawski (1984) or Brandt and Sargent (1987).

[77] Brandt (1985) documents the validity of the "law of one price" for many agricultural commodities.

B. Evaluation of Brandt & Sargent's Interpretation

Brandt and Sargent explain the outflow of silver from China as a windfall gain permitted by an increase in the world price of silver. Since China's price level obeyed the laws of international commodity arbitrage, a higher world price of silver simultaneously caused an appreciation of the Chinese currency and a fall in the Chinese price level. As prices fell, a lower silver stock could support an unchanged quantity of real "outside money," the reduction in silver stock constituting the one-time gain.[78] In the words of Brandt and Sargent:

> "The resulting temporary balance of payments deficit would be China's reward, a temporary dividend of additional resources either to consume or invest. [in footnote:] China's merchandise was in deficit every year after 1876. Prior to the 1930's, this deficit and treasury import were financed by overseas remittances and net foreign investment in China. Between 1933 and 1936 export of silver was the primary balancing item."

In brief, this silver export permitted a continued trade deficit despite a sharp fall in emigrants' remittances and foreign investment in China.

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[78] Myers ("The World Depression and the Chinese Economy, 1930-36," p. 28.) expresses this same idea, but with a slight technical error: "Because silver had appreciated, less silver could support the same volume of deposits and notes." This would not hold within China, where both assets (silver) and liabilities (deposits and notes) were denominated in the same numeraire, silver dollars. An appreciation of that numeraire relative to real goods and foreign currencies will <u>not</u> permit decreased assets to support the same liabilities.

The highlights of Brandt and Sargent's argument can be summarized as:

> (1) An exogenous rise in the world price of silver caused the Chinese price level to fall, as determined by international commodity arbitrage.
>
> (2) The fall in the Chinese price level resulted in a rise in the real value of "outside money" (or monetary silver), implying that China received a windfall gain. China could export silver (in exchange for goods) with no change in the real supply of outside money.
>
> (3) Silver export in fact replaced overseas remittances and foreign investment in financing China's ongoing trade deficit. The windfall gain, in other words, permitted China to maintain a trade deficit despite a decline in overseas remittances and foreign investment.
>
> (4) By international commodity arbitrage, there should have been no change in the Chinese real exchange rate; i.e. price movements should precisely have offset nominal exchange rate movements.
>
> (5) A vertical Phillips curve, resulting from complete flexibility of factor markets, ensured that China would suffer no output loss from the nominal deflation.

While this depiction does capture certain key features of China's balance-of-payments account, it fails to explain the sudden increase in silver exports occurring in 1934 and 1935. The features of Brandt and Sargent's position outlined above will be discussed below.

(1) The rapid fall in the Chinese prices for many internationally traded commodities confirms that, although trade represented only a small part of China's total economy, Chinese markets were well integrated into world markets.[79]

(2) According to the model of free banking under a commodity standard used by Brandt and Sargent to describe China's economy, a rise in the world price of silver should induce an export of silver that leaves unchanged the real stock of "outside money," or silver money. The fall

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[79] Again, Brandt (1985) successfully demonstrates this integration.

in China's price level should be automatically accompanied by a decrease in monetary silver. As the chart below indicates, the real supply of monetary silver did not remain constant, but grew in 1932 and 1933, then shrank in 1934 and 1935.

YEARS	CHANGE IN PRICE LEVEL[80]	CHANGE IN SILVER[81]
1931-32	-11.3 %	+ 1.0 %
1932-33	- 7.7 %	- 0.6 %
1933-34	- 6.5 %	- 12.3 %
1934-35	- 1.0 %	- 14.6 %

Most important, the timing of the Chinese deflation does not correspond to the pattern of Chinese silver exports. The outflow of silver from China increased by a factor of twenty in 1934 to about C$ 280 million, a level that was sustained in 1935 as well. Yet, Chinese deflation decelerated in 1934 and practically disappeared by 1935. In 1932 and 1933, when prices were declining (and thus the real value of silver rising) more rapidly, actual silver outflows were only C$ 10 million and C$ 14 million respectively.

(3) The table below indicates that emigrants' remittances and foreign investments both fell markedly in the early 1930's, but a few years before the rapid exodus of Chinese silver.

YEAR	OVERSEAS REMITTANCES	FOREIGN INVESTMENT	REMITTANCES & FOREIGN INV.	SILVER OUTFLOW
1930	316	202	518	-101
1931	360	44	404	-70
1932	327	60	387	10
1933	300	30	330	14

[80] Calculated from the National Tariff Commission's wholesale price index for Shanghai.

[81] Total monetary silver estimated by Rawski (1984).

1934	250	70	320	280
1935	260	0[82]	260	289

The sum of overseas remittances plus foreign investments and loans fell steadily from 1931 through 1935, the largest decline, amounting to C$ 115 million, occurring in 1931. In other years, the decrease in these inflows was much less dramatic: C$ 17 million 1931-1932, C$ 57 million 1932-1933, C$ 10 million 1933-1934, and C$ 60 million 1934-1935. Moreover, while overseas remittances and foreign investment did decline, less external financing was necessary in 1934 and 1935 as China's current account deficit narrowed. In fact, the current account deficit decreased by far more than did capital inflows (excluding sales of precious metals). Therefore, one should expect a decrease in China's exports of silver and gold, not the sharp increase that in fact occurred.

(4) The observed real appreciation, as discussed in Part II, Section 1, does not directly contradict Brandt and Sargent's claim, since wholesale price indices typically include some non-tradables, for which international commodity arbitrage would not hold. Although other factors also helped to determine the demand for China's exports, especially the level of world activity, to dismiss entirely the effect of exchange rate changes may be inappropriate.

(5) As discussed in Part II, the actual loss in output suffered by China was, contrary to most accounts of the period, brief and confined to specific sectors. Nonetheless, there exists sufficient evidence of

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[82] The zero foreign investment level reported for 1935 may simply reflect a lack of data. In any case, by far the largest decline in foreign investment occurred between 1930 and 1931.

nominal rigidities in debts, rents, taxes, and some wages that a truly vertical Phillips curve may be too strong an assertion.

C. A New Interpretation of China's Silver Outflows

Brandt and Sargent's interpretation successfully incorporates two new findings concerning China's silver episode: the rise in the total (inside plus outside) money supply, and the absence of a marked decline in output, both of which are inconsistent with Friedman and Schwartz's account. Neither of these explanations, however, convincingly explains the rapid outflow of silver from China taking place in 1934 and 1935. Friedman and Schwartz emphasize the trade deficit, which actually narrowed in these years. Brandt and Sargent focus on overall deflation, which again had considerably decelerated in 1934 and 1935.

An important entry in the balance-of-payments statistics entitled "Flight or Transfer of Capital," registers a sudden increase from a negligeable level through 1933 to C$ 200 million in 1934 and C$ 250 million in 1935. This entry alone can explain the dramatic increase in silver outflows, which showed no corresponding deficit in the current account. A widening trade deficit would have been consistent with either Friedman and Schwartz or Brandt and Sargent's interpretations. For Friedman and Schwartz, a larger trade gap would be the inevitable consequence of substitution effects associated with a real appreciation. For Brandt and Sargent, an increased trade deficit would represent the capital gain, or "China's reward, a temporary dividend of additional resources either to consume or invest."

In fact, China acquired not goods, but net claims abroad. Foreigners holding funds within China, primarily in foreign banks, transferred this capital overseas, presumably into foreign exchange. This transaction, which took place mainly before the imposition of capital

controls in October 1934, lowered foreign claims on China. Later, speculators smuggled silver abroad in exchange for foreign currency (or silver holdings outside China, for those anticipating a further increase in the world price of silver). If the purpose of silver export had been simply an increase in consumption, it would have been far more attractive to export gold, which was far less costly to smuggle per unit value, as the Chinese had done in years past. In brief, the purpose of silver export was to transfer capital outside of China before the currency, paper or silver, was further devalued via a suspension of convertibility or a total embargo on silver.

Factors other than the possibility of a departure from silver may also have contributed to the flight of capital in 1934 and 1935, but data suggest that these were not of great practical importance. In particular, after the Japanese had seized Manchuria, one of China's most productive regions, in early 1932, the threat of further aggression by Japan undoubtedly generated some political uncertainty in China. In fact, five years later, in the summer of 1937, Japan indeed attacked North China and Shanghai, marking the beginning of the Sino-Japanese War. The conflict with Japan in 1937 created sufficient financial instability that in August the Chinese government was forced to impose severe limits on cash withdrawals; remaining balances could be transferred between bank accounts but were not convertible to cash or foreign exchange.

Prior to 1937, however, little speculative activity can be attributed to the Japanese threat. The Japanese occupation of Manchuria had been completed by mid-1932, but only C$ 10 million in silver left China in 1932, followed by C$ 14 million in 1933. The true flight of

capital, in which hundreds of millions of Chinese dollars of silver left China, occurred in 1934 and 1935 as the world price of silver rose sharply and the Chinese government gradually dismantled the silver standard. After the currency reform of 3 November 1935, the worst had already happened and the smuggling of silver fell to a mere C$ 40 million in 1936.[83] Divorced from silver but freely convertible, the Chinese dollar maintained a stable exchange rate (against the U.S. dollar) throughout 1936 and most of 1937. Capital controls were not imposed until August 1937 and the Chinese dollar did not actually depreciate until 1938.

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[83] League of Nations, Balance-of-Payments Statistics, 1937.

IV. CONCLUSION

What lessons can be drawn from this analysis of China's departure from the silver standard? Clearly, the Chinese government faced an extremely difficult situation as the world price of silver began to increase at an unprecedented rate. The large circulation of silver coins made simple devaluation within a silver standard virtually impossible. Meanwhile, a complete separation from silver would have required abandoning a centuries-long tradition and the very basis of the Chinese monetary system.

Two historical comparisons suggest alternative solutions to China's gradual dissolution of the silver standard. At one extreme, China could have emulated Hong Kong, and simply have ignored the rapid increase in silver prices, the domestic deflation, and any outflow of silver, provided that banks maintained sufficient silver stocks to back note issues. Hong Kong maintained the silver standard without restriction through December 1935. As expected, the Hong Kong dollar appreciated in line with silver, prices fell sharply, and some silver left Hong Kong. Yet, a panicked redemption of notes for silver never occurred, presumably because it was clearly understood that Hong Kong was committed to the silver standard.

The case of Mexico represents the other extreme. Mexico maintained a fixed exchange rate with the U.S. dollar, but when the price of silver reached a sufficiently high level in April 1935, the silver in the peso coin, which circulated widely, became worth more than the currency itself. Mexico had two choices: allow the peso to appreciate or withdraw the silver peso coins entirely. Mexico chose the latter, and acted swiftly, declaring an emergency bank holiday then immediately nationalizing all

silver coins.

The Mexican experience received considerable attention in China. The Mexican reform was announced on 26 April 1935 and on 28 April 1935 (one day later, allowing for the time change), the headline of the North China Daily News, an English daily non-financial paper, read "Mexico Makes Sweeping Monetary Changes." Mexico's nationalization of silver coins is likely to have increased Chinese nervousness and induced greater smuggling.

Either of these alternatives would have been superior to the outcome that resulted from China's incremental departure from silver. Had the Chinese government realized that the true economic costs of the currency appreciation and price deflation were extremely low, simple adherence to the silver standard might have proved superior. It would at least have permitted the government to focus its attention on matters of greater real consequence. Had the government perceived a departure from the silver standard as imminent, or even probable, an abrupt transition would have enabled the government to take control of a greater quantity of silver, and would have prevented the dissipation of real resources expended in smuggling the silver abroad.

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Appendix A: The Chinese Economy and Financial System in the Interwar Period

The Chinese Macroeconomy

The Chinese economy in the late 1920's and early 1930's was primarily agricultural and relatively small on a global scale. Estimates for 1933 indicate that agriculture, consisting largely of food crops, represented about two-thirds of China's national income and about three-quarters of the employment of China's population of 500 million.[84] The non-agricultural sector was dominated by the handicraft industry, but also included some activity in trade and transportation. Exports, consisting mainly of raw silk, yellow beans, eggs and egg products, bean-cake, and other agricultural products were equal to about 2-4% of China's GDP.[85] Imports, composed primarily of cotton piece goods, raw cotton, rice, sugar, and metals, amounted to about 4-7% of China's GDP in the 1930-33 period.[86]

The Chinese Monetary System

China's monetary system in the late 1920's and early 1930's was extremely complex and decentralized. In various parts of the country there circulated silver coins, copper coins, and bank notes issued by "native" banks, government banks, or private commercial banks. Copper

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[84] Feuerwerker, The Chinese Economy, 1912-1949, p. 7, 9, 25.

[85] Bank of China, Statistics of China's Foreign Trade, 1930-1933, p. 24.

[86] Ibid, p. 25.

coins were used mainly in small personal transactions, whereas silver was the primary medium of exchange for larger commercial transactions. Usually, one type of currency could be used only within a given region though currencies of other regions were recognized. There flourished a multitude of money-changing houses whose exchange rates fluctuated frequently.[87]

Silver was the primary currency used in international transactions, China having first acquired large quantities of the metal in the early 18th century in exchange for silk and tea exports to the West. Over the years, silver grew in importance for domestic transactions as well, and by 1857, a national standard of silver currency, the Shanghai tael, was established. The tael was worth roughly one ounce of silver, but typically took the form of 50-tael "shoes" of silver weighing about four pounds and used in bank transactions. In 1933, the tael was abolished and replaced by the standard (Chinese) silver dollar, worth about 0.8166 ounces. Until 1933, the silver coins that circulated within China were primarily foreign coins or various provincial issues. The Shanghai mint, established in 1933, issued about C$ 133,000,000 in coins and bars from March 1933 through June 1935. Actual silver coinage in circulation was estimated to represent 68% of total currency in 1930 and 45% in 1935.[88]

Silver dollar bank notes in circulation were issued primarily by the Bank of China, the Bank of Communications, and the Central Bank of

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[87] For a detailed description, consult Tamagna, Banking and Finance in China, pp. 57-196.

[88] Young, China's Nation-Building Effort, p. 268.

China, but other Chinese and foreign banks issued some banknotes as well. Before 1931, no specific regulations governed the quantity of notes a bank could issue, but notes of the major Shanghai banks ordinarily traded at par. On 28 February 1931, a banking law was passed requiring note-issuing banks to hold reserves of 60% silver and 40% negotiable (usually government) bonds in against notes in circulation.

The Chinese Banking System

The Chinese banking system before the 1935 currency reform was comprised of three types of banks: "native" banks, foreign banks, and modern banks. Native banks were private, small, sometimes family-owned financial institutions that received deposits and granted loans to local residents, often based on personal acquaintance rather than on secured collateral.

Foreign banks operated primarily out of Shanghai and focused on the financing of international trade. They were especially active in foreign exchange transactions. Although foreign banks did issue some bank notes, much of the silver in foreign banks was held not to back issues of bank notes, but to ship abroad in exchange for foreign currency or China's imports.[89]

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[89] As Sir Arthur Salter observed: "Silver transferred to the foreign banks is immediately convertible into foreign exchange....silver transferred to the foreign banks [for payment for imports] foreshadows actual export overseas and is, in all its practical economic and financial effects, already an export." (China and Silver, 1934, pp.22-23)

Finally, the "modern" Chinese banks, most of which were based in Shanghai, provided financial services to Chinese industry. Included in this group were the government banks that issued most of the country's bank notes, and other non-government commercial banks. In the early 1930's, modern banks were growing in both number and capacity, as branches throughout the country opened up and both governments and other banks began to use the services of the modern banks rather than relying upon foreign banks.

In terms of relative importance in 1935, the main modern banks had total paid-up capital of about C$ 261 million, compared with about C$ 100 million for the nation's native banks. Of the foreign banks, only the Hongkong and Shanghai Banking Corporation conducted its primary business in China, but this bank alone had paid-up capital of some C$ 200 million. The other foreign banks performed only a small share of the business in China.[90]

Silver in China

China's silver stocks in 1933, before the massive outflow of 1934-1935, were estimated at 2.5 billion ounces, or 22% of the world's visible stock of 11.54 billion ounces.[91] About 1.7 billion ounces of

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[90] League of Nations, Commercial Banks, 1936.

[91] China's stock of silver increased sharply from 1918 through 1931, when China had a trade deficit but overall balance-of-payments surplus, largely because of remittances from Chinese overseas, foreign investment in China, and minor items such as foreign military and private expenditure in China. This balance-of-payments surplus accumulated in the form of imported silver. (Leavens, Silver Money, pp. 87-91)

China's silver took the form of monetary silver, representing about one-third the world's monetary silver. As shown below, China ranked second worldwide in terms of total silver holdings.[92]

Silver Stocks on January 1, 1933 (billions of ounces)

Rank/Country	Total Silver	Monetary	Nonmonetary
1. India	4.35	1.05	3.3
2. China	2.5	1.7	.8
3. USA	1.64	.64	1.0

On international markets, the exchange rate of the Shanghai tael, and later the Chinese dollar, moved in parallel with the price of silver, never varying by more than the costs of melting, shipping, and interest. Despite considerable fluctuations in the nominal price of silver---an increase of 32% in 1916 and a decrease of 40% in 1921---- deviations of the Chinese currency from parity stayed almost entirely within the bounds of silver's import and export points.[93]

As of 1930, when French Indo-China left the silver standard, China (including politically separate but economically dependent Hong Kong) was the only major country in the world on a true silver standard. Many American silver supporters claimed that India, Mexico, and a number of other Latin American countries followed a silver standard as well, but they failed to distinguish an abundance of silver coinage from an actual silver standard. Although a large fraction of India's currency

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[92] Leavens, "The Distribution of the World's Silver," Review of Economic Statistics, vol. 17, Nov.1935, pp.131-138.

[93] Dickson H. Leavens, "The Ratio Between the T.T. Rate and the Silver Price," 1928, studies this relationship on a monthly basis from 1909 to 1927. The fluctuations in the silver price are based on the average nominal price in sterling.

consisted of silver rupee coins, India was actually on the gold standard, the rupee's value tied directly to the British pound. Similarly, in Mexico, which had been on the gold standard since 1905, a large number of silver peso coins circulated, but the peso was linked not to silver but to the U.S. dollar at the rate of 3.60 pesos per dollar.

Since neither of these currencies followed a silver standard, a rise in silver would not automatically cause an appreciation of the Indian rupee or the Mexican peso. Nonetheless, if the dollar price of silver were to rise sufficiently and exchange rates remained unchanged, it is clear that at some point Mexican and Indian silver coins could become more valuable as silver than as currency. It would then become profitable to redeem notes for silver coins to melt down for their silver content. To prevent widespread melting of coins, the country would be forced to revalue its currency upward in terms of foreign currencies, to withdraw silver coins from circulation, or to prohibit the export of silver derived from coins.

Two historical episodes regarding silver coinage may be worth recounting for comparison with the Chinese experience in 1934 and 1935. When a rapid increase in silver prices threatened the rupee coin in 1917-1920, India decided to allow the rupee to appreciate against the pound. Since commodity prices overall were rising during this period, this appreciation did not generate a deflation. Later, as the price of silver and other commodities fell, the rupee depreciated accordingly. Mexico, on the other hand, immediately nationalized all silver coins and prohibited the export of silver coin in April 1935, as soon as the value

of the silver in the Mexican peso first exceeded its monetary value. Buoyed by the price of silver, the peso had just begun to appreciate from its stable rate of 3.60 to the dollar. The elimination of the silver coin permitted Mexico to maintain the exchange rate of 3.60 pesos per dollar, and avoid widespread deflation.

Silver Flows and China's Balance-of-Payments

Since 1876, China had consistently registered a trade deficit, which was partially offset by invisible items (such as remittances from overseas Chinese) on the current account and by foreign investment and loans on the capital account. In fact, from 1918 to 1931 China's combined current and capital account showed sufficient surplus to permit China to have annual net imports of precious metals. During this period, China every year recorded net imports of silver, accompanied by either an import of gold as well, or an export of gold of lesser value.[94]

When the balance-of-payments grew less favorable beginning in 1931,[95] China became a net exporter of precious metals, as shown in the chart below.[96]

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[94] Gold was regularly smuggled into China by returning emigrants, explaining the China's ability to export gold despite the much lower level of recorded imports. Although there was officially an embargo on gold as of 15 May 1930, the metal was routinely smuggled out, and after March 1931, the Central Bank could legally export gold with special permission.(Leavens, Silver Money, p 29)

[95] According to estimates in Lin, The New Monetary System of China, p. 26. Official records indicate a smaller increase in gold exports in 1931.

[96] These numbers are derived from Lin, The New Monetary System of China, p. 26.

YEAR	CURRENT+ CAPITAL ACCOUNT	GOLD EXPORT	SILVER EXPORT	TOTAL GOLD+ SILVER EXPORT
1930	-103	47	-101	-54
1931	-167	212	- 70	142
1932	-266	205	10	215
1933	-386	189	14	203
1934	-197	112	280	392
1935	-110	68	289	357

All numbers in millions of Chinese dollars.

In 1932 and 1933, China exported far more gold (in value) than silver. In 1934, China suddenly substituted silver exports for gold exports; gold exports dropped by 41% while silver exports increased by 1900%! It is striking that total exports of precious metals in 1934 nearly doubled even though the combined current and capital account deficit (excluding capital flight) shrunk by about one-half. These behavioral shifts suggest that, although silver movements depended on China's balance-of-payments, factors other than the balance-of-payments were the important determinants of China's silver flows in 1934 and 1935. A more detailed breakdown of China's balance-of-payments statistics from 1928

to 1935 are displayed in Table 6.[97].

China and the Depression, 1929-31

In the early years of the Depression, China was spared the severe declines in output and prices that were occurring in the United States and most European nations. Like other commodity prices, the price of silver in terms of dollars or sterling fell sharply beginning in 1929. With silver fell the exchange rate of the Chinese dollar. Most commodity prices in terms of Chinese currency rose between 1930 and 1931, with the result that China underwent a slight inflation rather than a major deflation. The fall in silver (and thus the Chinese dollar) was greater than the combined fall in foreign prices and rise in Chinese prices. Thus, China experienced a real depreciation, creating a stimulus to exports that partly offset the fall in activity in most of the countries to which China exported.

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[97] Official records of China's foreign trade fail to include smuggled imports and exports, and thus are generally recognized to understate the true extent of China's international commerce. "Corrected" estimates are available, but the method of correction, i.e. inflating recorded flows by a reasonable figure that changes year to year, seems highly subjective. Furthermore, many of the entries in the invisible account and capital account are only approximations rather than direct observations. Finally, the estimates used in this table and referred to later in this paper are, unfortunately, derived from four different sources, since no single source estimates the entire period. The official and "corrected" trade figures show the same general tendencies, the two sets of data differing only in degree. Despite their crudeness, these approximate figures justify a re-evaluation of the Friedman and Schwartz as well as the Brandt and Sargent explanations of China's silver crisis. Figures presented here were originally assembled in Lin, The New Monetary System of China, p. 26.

From 1929 to 1931, silver (and therefore the Chinese dollar) fell by 48% against the U.S. dollar, and 41% against the pound. During this period, American prices fell by 23%, British prices by 30%, implying that the real value of silver fell considerably in these countries. Nominal Chinese export prices increased just 2.2% during this period. This real depreciation resulted in increased competitiveness for Chinese exports. Chinese exports, measured in local currency, show very little decline in 1930 and 1931 despite the 25% fall in world industrial activity from 1929 to 1931. Perhaps more important, the overall Chinese price level rose, permitting China to avoid the real costs of deflation experienced elsewhere.

Appendix B: U.S. Silver Policy, 1933-35

Even before the U.S. Silver Purchase Act was passed on 19 June 1934, there existed considerable pressure in the U.S. to "do something for silver." The price of silver had fallen by nearly half in the first two years of the Depression, and silver producers, speculators, and politicians representing silver-producing areas such as Nevada and Utah urged for an increase in the price of silver as a means of expanding the U.S. monetary base and reflating the economy. It was further argued that raising the price of silver would increase the purchasing power of silver-holding nations such as China and India, thereby stimulating U.S. exports. In 1930, there was already talk of introducing a tariff on silver to check foreign supplies entering the United States, and in 1931, the U.S. Congress pointed out the need for an international conference on silver. In 1931 and 1932, there had been numerous failed bills in Congress calling for large Treasury purchases of silver.

In 1933, words began to materialize into action, and with each new victory for silver supporters, it became increasingly clear that the price of silver could soon reach new highs. The "Thomas Amendment" of 12 May 1933 permitted the President to fix the price ratio of gold to silver at any level, guaranteed that silver be considered as legal tender, and authorized the U.S. government to accept silver at fifty cents an ounce, about twice the existing price, as debt repayment from foreign governments. Only a few foreign nations actually made use of this proviso, making silver payments of about $11 million, far less than the $200 million the U.S. was authorized to accept. Following the World Monetary and Economic Conference in London in June-July 1933, large

silver holders (China, India, and Spain) and large silver producers (Australia, Canada, Mexico, Peru, and the United States) agreed not to depress the world silver market with excess supply.[98] On 21 December 1933, Roosevelt ordered the U.S. mint to pay half the monetary value of $ 1.29 per ounce, or 64 cents per ounce, for silver mined in the United States; the market price at the time was some forty cents per ounce.

In early 1934, there was considerable activity in both Congress and the Administration concerning silver. Some spoke of a bimetallic standard, others of increasing silver holdings. On 19 June 1934, silver supporters gained their greatest victory: the Silver Purchase Act. This act resolved that the U.S. Treasury should increase its silver holdings with the ultimate objective of raising the proportion of silver reserves to one quarter the combined value of its gold and silver reserves. At the time, silver constituted just over 10% of total silver and gold reserves. The Treasury was authorized to spend up to $1.29 per ounce, silver's monetary value, on international markets but no more than 50 cents per ounce domestically.

To prevent speculators from making windfall profits, the government imposed a 50% tax on profit derived from silver sales after 15 May 1934. As a further step, on 9 August 1934, the government "nationalized" silver, requiring that all silver already situated with the United States be delivered to the U.S. mint within ninety days, at a price of

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[98] Specifically, for the period 1934-37, India agreed not to sell more than 35 million ounces per year; China, none at all. The producing nations agreed to purchase or absorb in total at least 35 million ounces per year of domestically produced silver. Of this 35 million, the U.S. was responsible for acquiring 24 million, Mexico 7 million.

50.01 cents per ounce. Ironically, the speculators, among those who had pushed hardest for higher silver prices, were deprived of the benefits just as silver prices showed their greatest prospects of increasing.


NOMINAL PRICE OF SILVER IN USA, 1910–35
(1930=100)
NOMINAL PRICE OF SILVER, USA (CTS /OZ)
120
110
100
90
80
70
60
50
40
30
20
1910
1915
1920
1925
1930
1935

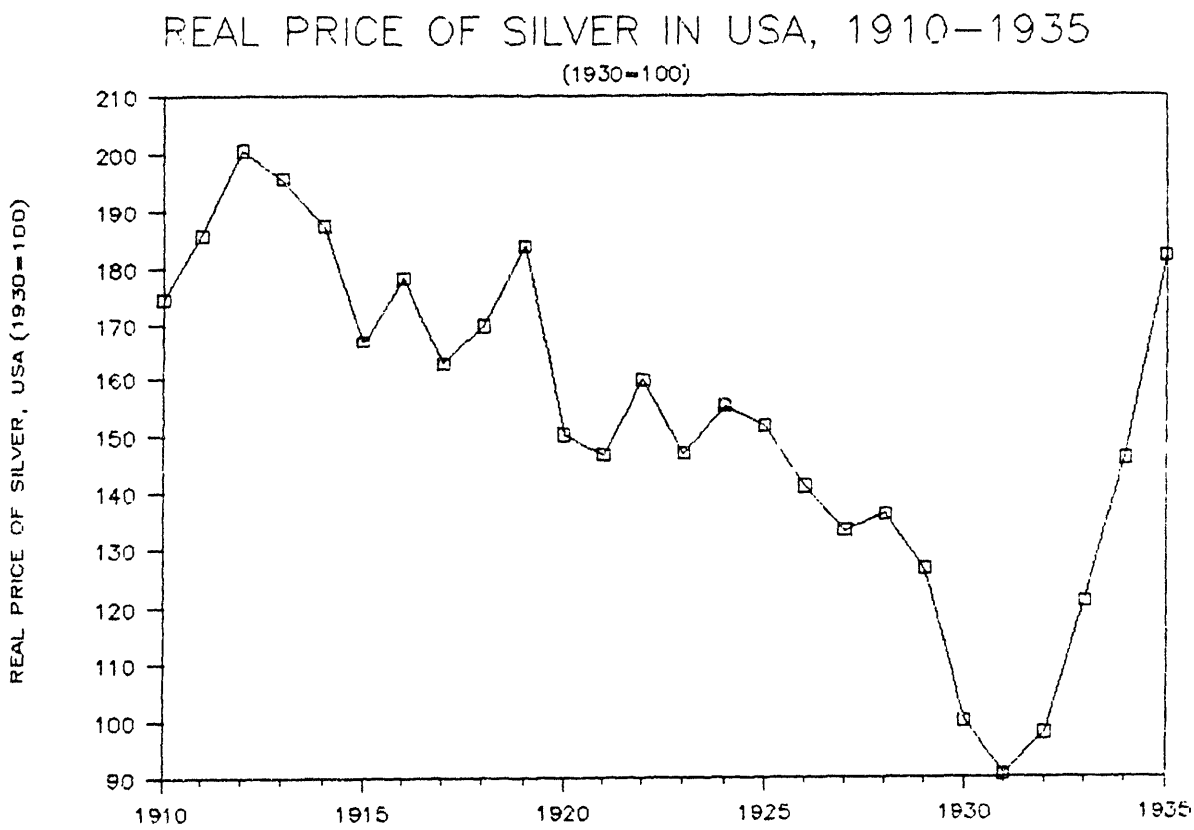
REAL PRICE OF SILVER IN USA, 1910–1935
(1930=100)
REAL PRICE OF SILVER, USA (1930=100)
210
200
190
180
170
160
150
140
130
120
110
100
90
1910
1915
1920
1925
1930
1935

Table 1
Nominal and Real Price of Silver (in US Dollars)
1910-1935

YEAR	PRICE LEVEL USA (1930=100) (A)	PRICE SILVER USA (cents/oz) (B)	REAL PRICE SILVER USA (1930=100) (B)/(A)
1910	81.4	54	174.6
1911	75.1	53	185.7
1912	80.0	61	200.7
1913	80.7	60	195.7
1914	78.7	56	187.3
1915	80.5	51	166.7
1916	98.9	67	178.3
1917	135.9	84	162.7
1918	152.0	98	169.7
1919	160.3	112	183.9
1920	178.7	102	150.2
1921	113.0	63	146.7
1922	111.9	68	159.9
1923	116.4	65	147.0
1924	113.5	67	155.3
1925	119.7	69	151.7
1926	115.7	62	141.0
1927	110.5	56	133.4
1928	112.1	58	136.2
1929	110.1	53	126.7
1930	100.0	38	100.0
1931	84.3	29	90.5
1932	75.3	28	97.9
1933	76.2	35	120.9
1934	86.5	48	146.0
1935	92.6	64	181.9

Sources: (A) Bratter, Silver Market Dictionary
(B) Silver and Prices in China

Table 2
Exchange Rate of Chinese Dollar, 1914-1935

YEAR	EXCHANGE RATE STERLING (pence per C$)	EXCHANGE RATE DOLLAR (cents per C$)
1914	21.3	44
1915	20.3	40
1916	24.9	51
1917	41.0	82
1918	41.0	67
1919	49.4	82
1920	53.0	90
1921	30.8	81
1922	29.3	49
1923	27.1	54
1924	28.6	52
1925	27.3	53
1926	25.6	55
1927	22.0	50
1928	22.7	45
1929	20.5	46
1930	14.8	42
1931	12.0	30
1932	14.8	22
1933	14.8	21
1934	16.1	26
1935	17.8	34

Sources: Silver and Prices in China, p. 7
and Shen, China's Currency Reform, p. 176.

Table 3
World Price Indices, 1927-1935

	CHINESE WHOLESALE PRICES (NatlTrfCom) (1929=100)	USA WHOLESALE PRICES (1929=100)	UK WHOLESALE PRICES (Economist) (1929=100)
1927	99.9	100.1	108.2
1928	97.3	101.5	106.2
1929	100.0	100.0	100.0
1930	109.9	90.7	84.0
1931	121.2	76.6	70.2
1932	107.6	68.0	67.7
1933	99.3	69.3	68.2
1934	92.9	78.7	71.0
1935	92.0	83.9	74.1

Source: League of Nations, World Production and Prices, various issues.

Table 4
CHINA'S FOREIGN TRADE (including Manchuria until 1932)
OFFICIAL FIGURES

YEAR	OFFICIAL EXPORTS (NOMINAL)	OFFICIAL IMPORTS (NOMINAL)	OFFICIAL TRADE BALANCE (NOMINAL)	WHOLESALE PRICE INDEX (1926=100)	OFFICIAL TRADE BALANCE (REAL)
1928	1545	1863	-318	101.7	-313
1929	1582	1972	-390	104.5	-373
1930	1394	2041	-647	114.8	-564
1931	1417	2233	-816	126.7	-644
1932	768	1635	-867	112.4	-771
1933	612	1346	-734	103.8	-707
1934	535	1030	-495	97.1	-510
1935	576	919	-343	96.1	357

CHINA'S FOREIGN TRADE (including Manchuria until 1932)
CORRECTED FIGURES

YEAR	CORRECTED EXPORTS (NOMINAL)	CORRECTED IMPORTS (NOMINAL)	CORRECTED TRADE BALANCE (NOMINAL)	WHOLESALE PRICE INDEX (1926=100)	CORRECTED TRADE BALANCE (REAL)
1928	1561	1794	-233	101.7	-229
1929	1648	1899	-251	104.5	-240
1930	1477	1965	-488	114.8	-425
1931	1687	2271	-584	126.7	-461
1932	922	1668	-746	112.4	-664
1933	673	1480	-807	103.8	-778
1934	616	1184	-569	97.1	-586
1935	662	1129	-467	96.1	-486

CHINA'S FOREIGN TRADE (excluding Manchuria)
OFFICIAL FIGURES

YEAR	EXPORTS (NOMINAL)	IMPORTS (NOMINAL)	TRADE BALANCE (NOMINAL)	TRADE BALANCE (REAL)
1928	1047	1530	-483	-475
1929	1070	1620	-550	-526
1930	944	1723	-779	-679
1931	915	2002	-1087	-858
1932	569	1524	-955	-850
1933	612	1345	-733	-706
1934	535	1030	-495	-510
1935	576	919	-343	-357

(All figures in millions of Chinese dollars)
Sources: Central Bank of China Bulletin (1936) (official figures).
Lin, The New Monetary System of China, p. 26 (corrected figures).

Table 5
ESTIMATES OF CHINA'S BALANCE-OF-PAYMENTS
(in millions of current Chinese dollars)

YEAR	CORRECTED TRADE BALANCE	ALL INVISIBLES	(of which) overseas remittances	CURRENT ACCOUNT	FOREIGN INVESTMENT+ LOANS	COMBINED CURRENT + CAPITAL	FLIGHT/ TRANSFER CAPITAL	GOLD EXPORT	SILVER EXPORT	ERRORS & OMISSIONS
1928	-233	207	251	-25	100	75	0	-9	-160	-94
1929	-261	193	281	-68	170	102	0	3	-159	-53
1930	-488	183	316	-305	202	-103	0	47	-101	-156
1931	-584	373	360	-210	44	-167	0	212	-70	-25
1932	-746	420	327	-326	60	-266	0	205	10	-51
1933	-807	391	300	-416	30	-386	0	189	14	-183
1934	-569	301	250	-267	70	-197	-200	112	280	-6
1935	-467	357	260	-110	0	-110	-250	68	289	-3

Source: Lin, The New Monetary System of China, p. 26.

Table 6
CHINA'S MONETARY SILVER STOCKS
(millions of Chinese dollars)

AT END OF	CHINESE BANKS Shanghai	FOREIGN BANKS Shanghai	ALL BANKS Shanghai	CHINESE BANKS Tientsin	FOREIGN BANKS Tientsin
DEC 31	179.3	86.9	266.2		
DEC 32	253.3	185.0	438.3		
DEC 33	271.8	275.7	547.5	54.3	51.0
JUL 34	330.6	232.2	562.8		
DEC 34	280.3	54.7	335.0	34.0	9.5
MAY 35	290.2	50.8	341.0		
SEP 35	293.4	42.7	336.1		
06 NOV 35	272.4	42.9	315.3	32.0	9.4

Sources: League of Nations, Commercial Banks (1935), p. 53.
Tamagna, Banking and Finance in China, p. 104.
Lin, New Monetary System of China, p. 55

Table 7
NATIONAL REGULATIONS

4/34	Coastwise shipment of silver in any form suitable for minting allowed only with permit issued by Ministry of Finance. (#1359)
9/8/34	Ministry of Finance limited foreign exchange transactions to legitimate business purposes.
10/15/34	Export tax on silver raised to 10% and variable equalization charge is imposed. (#1389)
10/31/34	Individuals travelling abroad may carry a maximum of C$ 50 in silver. (#1396)
11/21/34	License required for coastal shipments of silver. Only banks allowed to ship silver. (#1402)
11/27/34	Amount of silver individuals may carry to Manchuria limited to C$ 50. Shipment of silver to Manchuria by land or sea prohibited. (#1404)
12/4/34	Customs authorized to confiscate any silver shipped abroad or travelling within China without a necessary permit.
12/34	Ministry of Finance instructs Central Mint that regulations governing coinage of standard silver dollars must be strictly enforced. (If bar silver supplied by merchants is too impure, a 1.5% refining fee will be imposed.)
12/17/34	Maximum C$ 50 of silver may be transported from one treaty-port to another. Passengers travelling within China permitted to carry up to C$ 1000. (#1413)
1/14/35	Ban on silver transport either abroad or to regions where silver dollars were not in standard use. (#1422)
1/29/35	Substantial rewards offered for informants on smuggling (#1426).
3/27/35	Imported silver can be registered, then re-exported without charges. (#1440)
6/15/35	Hong Kong prohibited export of silver bars made in China.
6/17/35	Explicit permission required to carry silver within China. Violation will be interpreted as smuggling.
7/8/35	Fines for smuggling set at five times the value of silver smuggled. Smuggling of silver punishable by death. (#1454)
7/15/35	All sea-going junks restricted to maximum of C$ 100 per junk unless special permit is obtained. (#1455)

Source: China Monthly Trade Report, Shanghai, various issues. (Customs Notification numbers in parentheses.)

Table 8
REGIONAL REGULATIONS

10/1928	Peiping city government required special pass for export of silver greater than C$ 300.
4/26/33	Embargo on export of silver from Guangdong province: No one is allowed to take more than C$ 20 when leaving the province and export of bar silver is entirely prohibited. Smugglers detected lose all silver and are severely punished. Corruption of inspectors punishable by death. (Amendment 5/27/33: 80% of confiscated silver may be kept by inspectors.)
10/1933	Kansu provincial government prohibits export of silver.
12/4/33	Kwangsi provincial government limited individuals leaving province to C$ 20 in silver coins. Steamships limited to C$ 200 in silver, sailing vessels to C$ 100.
1934	Shensi government prohibited silver transport out of counties along provincial boundaries. Amount of silver carried can never exceed C$ 100. Fines for smuggling increase with quantity smuggled: 1-5% for C$ 100-10000, 5-10% for C$ 10000-30000, and 10% for over C$ 30000.
3/10/34	Hunan province requires permit for silver transfer out of province greater than C$ 500. Fine for smuggled silver set at 5%, of which 1% may be kept by inspectors as finders' reward.
11/14/34	Embargo from Guangdong province (capital Canton). Individuals may carry maximum of C$ 20 when leaving province. Export of bullion entirely prohibited.
12/1934	Hunan province reduces silver carrying allowance for any person leaving the province from C$ 500 to C$ 200. Shandong province forbids individuals to leave province with more than C$ 20 in silver. Banks wishing to ship silver out of province must obtain a special permit. Within province, transfers across districts limited to C$ 300.
1/16/35	Wuhu customs restrict silver export from Wuhu port to C$ 1000 per person.

Source: China Monthly Trade Report, Shanghai, various issues. Chinese Economic Journal, Shanghai, various issues.

Table 9
REGIONAL EFFECTS OF REGULATION

10/34	Tientsin: Runs on some of the larger banks met without difficulty.
	Tsingtao: Run on local branch of National Industrial Bank.
11/34	Peiping: Some banks not converting notes into silver.
	Canton: Silver being exported in small lots, though a seizure of C$ 100,000 and one of C$ 10,000 were made.
3/35	Shanghai: Coins circulated freely at par.
4/35	Shanghai: Coins continue to circulate freely.
	Tientsin: Small premium being paid for silver. Estimated smuggling in Northeast of C$ 20,000 to 30,00 per day. Local banks agreed not to export silver.
	Amoy: Silver at 20% premium over bank notes.
	Canton: 27% premium of silver dollars over notes.
	Silver shortages at Peiping, Amoy, Tientsin, Canton.
5/35	Tientsin: "Chinese government agents were stationed at local Chinese banks to question suspicious characters who wished to convert banknotes into silver, especially those who required amounts of more than C$ 100."
	Hopei: Provincial government limited amount of silver passengers could carry. Exchange shops paid a 3-4% premium for coins over notes.
early 6/35	Native banks limited withdrawals to C$ 500/account
	Redemption of notes suspended in North China.
	Tientsin: 200 Koreans were forced to exchange their silver for cash when suspected of smuggling.
6/35	Tientsin: silver can still be obtained on demand, but individuals must furnish adequate reason to the government before receiving coins.
7/35	Shanghai: banks refused to convert large amounts of notes.
	Silver at a premium over notes in the interior.
	Tientsin: One bank reported to redeem notes in Central Banknotes rather than silver in order to avert run.
7/24/35	Shanghai: Finance and Commerce article "Disparity in Price of Silver Between Different Cities in China" cites progressive increase in value of coins as they leave Shanghai. Shanghai to Hankow (+1%) to Hunan (+10%) to Guangdong (+20%) to abroad (+5%).
8/35	Tientsin: Exchange shops in Japanese concession paid a premium (8% in July, 10.5% in August, maximum in August 18%) for coins over notes.
	Tsingtao: Maximum redemption C$ 10 per person.
9/35	Tsingtao: Notes being taken to the interior to exchange for silver, even at a premium.
	Tientsin: Premium on silver dropped from 10% to 7.5%.

Source: China Monthly Trade Report, Shanghai, various issues.
Finance and Commerce, Shanghai, various issues.

Table 10
MONTHLY NET EXPORTS OF SILVER (in Chinese dollars)

1934	Jan	-1,783,036	
	Feb	1,566,950	
	Mar	-867,012	
	Apr	14,763,690	
	May	2,147,418	
	Jun	12,936,427	
	Jul	24,308,009	
	Aug	79,094,748	
	Sep	48,139,773	
	Oct	56,332,138	
	Nov	11,327,650	
	Dec	11,974,659	TOTAL 1934: 256,728,000
1935	Jan	-2,709,273	
	Feb	-550,034	
	Mar	-986,961	
	Apr	-2,429,919	
	May	1,043,022	
	Jun	-48,058	
	Jul	-98,506	
	Aug	-229,193	
	Sep	-736,761	
	Oct	-55,480	
	Nov	-110,816	TOTAL JAN-NOV 1935: -7,146,000
	Dec	66,542,608	

Source: Central Bank of China Bulletin, March 1936.

Table 11
Notes in Circulation

	Central Bank of China (A)	Bank of China (A)	Bank of Communic. (A)	Farmers Bank of China (A)	CENTRAL BANKING GROUP (A)	ALL MODERN BANKS (A)	FOREIGN BANKS (B)
END-1932	40.0	184.4	82.4	0	306.8	516.8	200.8
END-1933	71.1	183.7	83.1	2	339.9	613.9	192.9
END-1934	86.0	204.7	112.5	5.6	408.8	747.7	197.1
6 NOV 34	131.8	185.5	122.0	29.8	469.1		
END-1935	179.9	286.2	180.8	29.8	676.7	1032.9	225.7

Source: (A) Tamagna, Banking and Finance in China, p. 139, 185.
(B) Rawski, Estimates of China's Money Supply, p. 22

CHAPTER THREE

THE ROLE OF DEVELOPING COUNTRY DEBT AND CURRENCY DEVALUATION IN THE CURRENT COMMODITY SLUMP

I. INTRODUCTION*

Continued low commodity prices despite a recovery of global industrial activity in 1984 and the decline of the dollar since 1985 have begun to shift the focus of commodity price analysis from the demand side to the supply side. It has been suggested that indebted developing countries may be expanding exports in an attempt to obtain foreign exchange, thereby shifting the supply curve outwards. A related but distinct explanation asserts that debtor nations' foreign exchange requirements have caused the "supply" curve to slope downward: a fall in the price of a key export will, assuming the country's perceived elasticity of demand exceeds one, induce that country to sell more of that export in order to meet its debt repayment schedule. For stability, the supply curve must be steeper than the demand curve.

Recent econometric estimates have provided some empirical support for the importance of the supply-side. Gilbert (1986) reported that debt entered significantly into a commodity price determination equation: higher debt-servicing needs implied lower commodity prices, suggesting an outward shift of the supply curve. There is also empirical support of the hypothesis of a downward-sloping supply: the elasticity of dollar commodity prices with respect to the dollar exchange rate was found to be -1.6 (Dornbusch, 1985). In this model, where the world is divided into dollar and non-dollar regions, a vertical or upward-sloping supply curve would produce a coefficient between zero and minus one, depending on the market share and elasticities of dollar and non-dollar demand and supply. The excessive sensitivity implied by an

* My thanks to Sompheap Sem for research assistance and to Jean Kesser for typing services.

elasticity of -1.6 is theoretically tenable if the supply curve slopes downward.

This study distinguishes the various hypothesized relationships between developing country debt and primary commodity prices in terms of their implications for a change in the slope of the supply curve or a shift of the supply curve and sets up specific tests of these relationships. The study also examines the hypothesized relationships between real exchange rate changes in the developing countries and international commodity prices.

II. THE EFFECT OF DEVELOPING COUNTRY DEBT

Earlier Empirical Findings

A negative correlation between developing countries' debt-servicing levels and non-fuel primary commodity prices was established in an empirical paper by Gilbert (1986). In this analysis, nominal dollar commodity prices for all commodities, foods, agricultural non-foods, and for metals and minerals were expressed as a function of: their own lags, the dollar exchange rate, the nominal US interest rate, US wholesale prices, OECD industrial production, the price of oil, and the ratio of developing countries' total debt service to the commodity price index itself. Dividing debt-service requirements by the price of commodities generates a proxy for the volume of exports developing countries would need to sell to cover their debt payments.

Using a Sargan-Hendry general-to-simple methodology to refine the specification, Gilbert determined that total debt service divided by the commodity price, lagged four quarters, should enter as an explanatory variable for quarterly changes in the commodity price. In his final three-stage least-squares estimation, he found that debt service had a significant effect in reducing commodity prices.

A number of economic interpretations were proposed in light of this statistical finding. A "target revenue" explanation linked lower commodity prices to increased commodity exports; reasoning that debtors, needing to raise foreign exchange to make payments regardless of the terms-of-trade, would actually expand exports in the face of lower prices. A "wealth effect" theory emphasized that a fall in an export price would constitute a real decline in wealth to a nation with nominal dollar debt. This in turn would give rise to reduced consumption of goods as well as leisure, and again,

increased exports. Finally, a "real depreciation" hypothesis attributed an expansion of exports to a real depreciation or other policy reactions induced by debt-servicing difficulties.

Although Gilbert's work adds an important new dimension to the study of commodity prices, his analysis exhibits certain conceptual weaknesses. In terms of specification, it is clearly incorrect to express the change in commodity prices as a function of the level of debt-service divided by the commodity price. If debt-servicing needs force a country to expand its exports, a one-time fall in price corresponding to the one-time outward shift in supply would be expected. High debt-servicing should imply low, not falling commodity prices.

Furthermore, a satisfactory explanation is lacking for the four-quarter lag employed in Gilbert's estimation; it seems either too long or too short. A rise in debt-repayment needs may cause an immediate export response in the form of de-stocking, causing a simultaneous decline in the commodity price; in that case one would expect a zero or one-quarter lag. On the other hand, an export response requiring long-run capital investment in the form of mining plant or tree planting would imply possibly a lag of several years.

Outward Shift of Supply vs. Downward-Sloping Supply

The distinction between an outward shift of the supply curve and a change in the slope of the supply curve requires greater clarification. Under ordinary circumstances, debt-servicing obligations should not affect the supply of commodities; transitory shocks in revenue can be absorbed through short-term borrowing or lending. If, however, a country is incapable of further borrowing, then a shock to the debt repayment schedule, such as a rise in interest rates or a decline in lender confidence, may shift its export supply schedule outwards. At all prices, exports increase.

This outward shift may or may not be accompanied by a change in the slope of supply. If just a few commodities represent a very high share of a country's total exports, then a decline in price caused by a demand shock could lead to an increase in the quantity supplied, intensifying the price decline.

The economic importance of distinguishing the two supply effects is clear. If supply has shifted outward, then assuming no shift in demand the future course of prices will depend on the persistence of the supply shock. Conversely, if supply has changed slope, then today's low prices must be partly attributable to a demand shift. An analysis of price determinants should also focus on the demand-side. If the demand shock is transitory, prices should recover as soon as the shock disappears, and moreover, should rise equally dramatically in the case of a positive demand shock. Overall, a downward-sloping supply curve would imply greater price volatility for given supply and demand shocks. If it is expected that commodity prices will eventually be stimulated by an increase in demand, the slope of the supply curve will indicate how great a demand shift will be needed to generate a given price rise. A downward-sloping supply curve will clearly require less demand stimulus than an upward-sloping curve.

The "target revenue" theory of the debt-commodity price relation allows for both types of supply changes. An increase in the "target," i.e. higher debt-service, will shift supply outward. If the commodity in question is a primary means of attaining that "target," the supply curve may in addition slope downward. The "wealth effect" explanation, as it relates to changes in the commodity's price, emphasizes the downward slope in supply, although total debt outstanding rather than a given year's debt-servicing

should be the relevant variable. Of course, this explanation requires countries to believe that price declines are permanent. The "real depreciation" version of the debt-commodity price correlation is essentially a story of outward shifts in supply corresponding to each devaluation. If, however, real devaluations are directly responsive to the price of exports rather than to general debt problems, then the "real depreciation" hypothesis becomes a story of downward-sloping supply.

Evidence of an Outward Shift in Supply

The econometric specification of Gilbert (1986) is well-suited to capture shifts in the supply curve but not to detect the possibility of a downward-sloping supply. Any supply-induced intensification of a demand-based price decline will not be statistically evident or at least will be very difficult to detect in the presence of noise. 1/ Aside from the conceptual inconsistency discussed above, i.e. attributing a falling price to a high

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1/ Consider, for example, a constant profile of debt-service payments and a demand-induced fall in the commodity price. The debt-service variable enters on the right-hand side as the ratio of total debt-service to the nominal commodity price index, lagged four periods. The logarithm of the same commodity price index, in real terms, also enters with a four-period lag. For the debt-service variable to exhibit the expected negative coefficient, we would require: (1) that the level of commodity prices four periods ago be positively correlated with this period's change in price; (2) that the debt-service expression (with a constant numerator and the commodity price index in the denominator) be more closely correlated with this period's price change than the real commodity price expression. Thus, a supply side magnification of a demand side shock will be practically impossible to detect econometrically, though a fall in commodity prices caused by an increase in debt-service should be readily captured by this specification.

level of debt-service, Gilbert's results can be interpreted as evidence suggestive of an outward shift in supply.

Further investigation reveals, however, that the significance of debt-servicing in a commodity price determination equation is not at all robust. Alternative specifications were tested on both quarterly and annual data for the period 1961-1986, for the commodity price indices--all commodities, food, beverages, agricultural raw materials and metals--on a single-equation basis. These indices were deflated by US industrial goods prices. Real commodity prices were regressed on the level of industrial production in the industrial countries, the real dollar exchange rate (represented as relative US wholesale prices, relative to other industrial countries), developing country debt-servicing, a time trend and a constant. In the quarterly regressions, a four-quarter distributed lag was generally used on the right-hand side variables. Quarterly debt-servicing figures were constructed as moving averages based on annual data centered at mid-year. All regressions were performed in logs or first differences of logs, and were corrected for AR1 errors.

In a regression of the level of commodity prices, debt-servicing in the preceding four quarters did in many cases enter significantly but inevitably coefficients on the distributed lag contained both positive and negative terms. The sum of coefficients for the four quarters was approximately zero for each of the commodity groups tested. No significant long-run (i.e. over the first four-quarters) effect could be detected, although a different lag structure might yield more informative results. Regression results for commodities overall and for food, as a representative subgroup, are reproduced in Table 1.

Despite its logical shortcomings, an estimation similar to Gilbert's was also attempted, with all variables except debt-servicing entering as first differences of logs. Not a single coefficient on debt proved significant, and for each commodity subgroup, the sum of coefficients on the distributed lag equaled zero. The empirical results for "all commodities" and for food are shown in Table 2. The same regressions with a slightly different representation of debt, total debt-service divided by the commodity price index, yielded equally unfruitful results. Representative regressions for this specification are displayed in Table 3.

The consistent lack of significance corroborates Gilbert's own findings in his single-equation estimations. Only in his restricted three-stage least squares version is the importance of debt apparent. Considering both Gilbert's results and the results obtained here, the evidence of a debt effect on commodity prices must still be considered inconclusive for several reasons: (1) the apparently arbitrary result that debt is important only with a four-quarter lag; (3) the consistent lack of significance in any of the single-equation estimates; and (3) the zero long-term effect obtained by summing the coefficients of the distributed lag. Note that, in contrast, the effects of industrial production and the real dollar exchange rate were shown to be robust to these variations in equation specification. It must be concluded that empirical support of an outward shift in supply is extremely weak, if not non-existent.

The hypothesized economic relation between debt-servicing needs and commodity supply depends largely on developing countries' inability to borrow further in the face of debt-repayment shocks or export price shocks. It might consequently be expected that the influence of developing country debt will be

confined to the recent period of widespread liquidity constraints, tighter bank credit, and frequent rescheduling. Data from the 1970's, when debt and debt-service increased but LDC borrowers remained essentially solvent, could obscure effects associated with debt-servicing crisis in the 1980's.

A regression focusing solely on the 1980-1986 period, however, failed to produce compelling evidence of the relevance of debt. The regression in levels again produced significant debt coefficients of varying sign. While their sum was no longer uniformly zero in each equation, the mixed positive and negative coefficients, as well as an indication of high negative autocorrelation, do not constitute strong evidence of an outward shift in supply. The results for total commodities are presented in Table 4. With additional observations, and therefore more degrees of freedom, an annual specification might give more robust results. The effect of debt in regressions run in first differences for the 1980-86 period was again insignificant. Results are displayed in Table 5, where debt enters in levels, and in Table 6, where debt enters as the ratio of debt to commodity prices.

Evidence of a Downward-Sloping Supply Curve

The role debt may play in altering the slope of the supply curve should be observable empirically through the commodity price response to known supply and demand shocks. As mentioned earlier, for given quantity shocks to supply and demand, a downward-sloping supply curve will result in greater price volatility than would an upward-sloping or vertical supply curve. A price response exceeding 1% for a 1% change in the real exchange rate, for example, is highly suggestive of downward-sloping supply; it would be theoretically inconsistent with an upward-sloping or vertical supply curve.

Since a downward-sloping supply will result in greater price responsiveness than an upward-sloping curve, commodity price responses to

exchange rate and industrial production shocks during different time periods can be compared as a test of a change in the slope of the supply curve. Therefore, the sample was divided at 1980, assuming that liquidity constraints did not play a major role for most developing country exporters prior to this point.

Regressions on first differences of logs for the 1962-79 period and the 1980-86 period do not indicate that the slope of the supply curve has changed from positive in the 1960s and 1970s to negative in this decade. Comparing the sum of coefficients on four-quarter distributed lags of industrial production and the exchange rate, it is observed that for no commodity group index did both the industrial production and the exchange rate coefficients increase (in magnitude) in the 1980s. For total commodities, price responsiveness to the exchange rate increased from -0.7 to -1.2, but responsiveness to industrial production decreased from 2.3 to an implausible -0.5. For the commodity subgroups, the sum of coefficients either changed sign or declined (in magnitude) in the 1980s. Regressions over the 1962-79 period and the 1980-86 period are reproduced in Table 7 for total commodities and the four commodity subgroups.

It is also noteworthy that both metals and agricultural raw materials show elasticities of price with respect to the exchange rate that are greater than one in the 1960s and 1970s, but smaller than one in the 1980s. If anything, this would imply a downward-sloping supply pre-1980, an upward-sloping supply today. Although there are no obvious economic explanations for such supply behavior, there is no evidence here that debt has created a downward-sloping supply curve of non-fuel primary commodities in the 1980s.

In more restricted regressions measuring only contemporaneous commodity price responses to industrial production and exchange rate changes,

similar results held. The "all commodities" regression is shown in Table 8. Total commodity prices in the 1980s exhibited a stronger response to exchange rate changes but a lower response to industrial output fluctuations than in the preceding two decades. Again, no commodity group showed greater responsiveness to both demand variables in the 1980s than in the 1960s and 1970s. The elasticity of real metal prices to real exchange rate changes exceeded unity for the 1961-1979 period, again indicating the importance of factors other than debt.

In sum, the "target revenue" and "wealth effect" descriptions of debt's impact on commodity prices do not seem to be substantiated empirically. An outward shift in commodity supply, consistent with an exogenous increase in the "target revenue," was not detected statistically. A downward-sloping supply curve, a key implication of both the "target revenue" and "wealth effect" propositions, was not empirically evident either; if the supply curve has at any point been downward-sloping, it has not been as a result of increasing developing country debt.

III. THE EFFECT OF REAL DEPRECIATION IN DEVELOPING COUNTRIES

The Supply Response to a Real Depreciation

The role of real depreciations in increasing primary commodity supply in developing countries could be closely tied to that of debt. Indeed, if developing country monetary authorities devalue as a consequence of debt-servicing difficulties, commodity supply should shift outward as the "target revenue" hypothesis would predict. Similarly, if devaluation occurred in response to a fall in the price of the main export, there could be an increase in supply, making it look as though the supply curve was downward-sloping. Of course, real devaluations could take place for reasons unrelated to debt or export prices and these will have an impact on export supply.

The rationale for considering real depreciations as a determinant of commodity supply is clear: following a devaluation, a given (world) dollar price for a commodity translates into more (real) local currency units and thus should cause local producers and exporters to expand supply, assuming some of their costs are incurred in local currency.

This explanation does not require direct government involvement in the commodity supply process; the incentive extends to private as well as public enterprises. An internalization of the national welfare was implicit in previous scenarios where producers responded directly to national debt problems. This applies automatically to state-owned enterprises or to industries with close ties to government. For other businesses, supply may react to policy measures, such as export subsidies or tax incentives, designed to increase foreign exchange earnings. A real devaluation is an observable example of such a policy measure.

For any country-commodity pair, the commodity supply response to real depreciations can be ascertained by examining export volume as a function of the dollar commodity price and the real dollar exchange rate in terms of the local currency. For the moment, the causes of the depreciation--debt, a fall in export prices, a change in regime--need not be specified. Instead, the following questions are asked: For any country, does a real depreciation cause supply to increase? If so, have devaluations in developing countries depressed commodity prices?

Empirical Results: Metals

A logical point of departure for empirical testing is the metals subgroup. As non-agricultural commodities, metal supplies are not influenced by weather; thus, this source of disturbance can be ignored in modeling supply. Moreover, prices of metals have declined by more than any other commodity group--42% in real terms since 1980. Finally, many important metal producers are among the world's largest debtors, such as Chile, Peru, Bolivia and Brazil.

Econometric testing for the effect of real depreciations on commodity export supply was relatively straightforward. The first step was to identify country-commodity pairs, such as Chile and copper or Bolivia and tin, where the export is important to the country, or the country's market share in the commodity is high, or both.

In the Chile and copper example, it is expected that the volume of Chile's copper exports responds positively to both the dollar price of copper and the real Chilean peso value of the dollar. Two representations of supply were tested. In the first, Chile's copper exports were expressed as a function of a distributed lag of the real Chilean peso price of copper--i.e.,

the dollar price of copper multiplied by the nominal dollar exchange rate divided by the Chilean price index--and a time trend. In the second version, distributed lags of the dollar price of copper and the real Chilean exchange rate entered separately; if producers' costs are not entirely denominated in local currency terms, a 1% rise in the dollar price of copper and a 1% rise in the real value of the dollar might affect supply behavior differently.

Estimation required the use of instrumental variables, since Chile's copper exports in one period could affect both the copper price and Chile's real exchange rate in the same period. Current and lagged values of OECD industrial production served as instrumental variables in a two-stage least-squares regression. Industrial production should clearly be correlated with the price of copper, but is not influenced by the volume of Chile's copper exports. Results after the first estimation stage indicated that this instrumental variable representation of the real exchange rate was acceptable.

The export supply function was estimated for the following country-commodity pairs: Chile and copper, Zaire and copper, Zambia and copper, Peru and copper, Peru and lead, Bolivia and tin, Malaysia and tin, Thailand and tin, Bolivia and zinc, Peru and zinc, Brazil and iron ore, Chile and iron ore, Peru and iron ore, Liberia and iron ore. The period of estimation, which was performed on a quarterly basis, covered 1962-85, but was often considerably shorter because of data limitations.

Unfortunately, coefficients produced by these regressions gave no indication whatsoever as to how supply responds to price or real exchange rate changes. Representative regressions are reproduced in Table 9, where the dollar exchange rate and dollar commodity price enter separately, and in

Table 10, where the real local currency commodity price is the explanatory variable. A number of coefficients showed statistical significance, but again, coefficients on other lags tended to be of the opposite sign, resulting in no long-run effect. Although the sum of coefficients on the commodity price, the real exchange rate, or the local currency commodity price, was not uniformly near zero, there was no tendency for the implied effect on supply to be positive. Within the limitations of this specification, no supply response to real exchange rate depreciations can be discerned.

A Re-Examination of the Data

The inconclusive nature of the econometric testing suggests a re-examination of the data for a possible indication as to why no real exchange rate effect was detected or what alternative specification might prove more suitable. For the five metals (copper, lead, tin, zinc and iron) export volumes by major producers have been graphed on an annual basis and are reproduced in Figure 1. Graphs of these exporting countries' real exchange rates versus the US dollar can be found in the Figure 2.

Focusing on the most recent decline in commodity prices, it is immediately apparent from the graphs that although all the countries considered (except Bolivia) have experienced real depreciations since 1980, in only a few cases has export volume increased significantly since then: Chile and copper, Peru and lead, Peru and zinc, Brazil and iron. The timing of changes in Peru's lead exports, however, suggest that the real exchange rate had little effect: exports increased sharply in 1982 as Peru underwent a real appreciation, but decreased in 1984 and 1985 as the currency greatly depreciated. Chilean increases in copper exports and Brazilian increases in iron ore exports can be seen as the result of large-scale increases in

investments in the lowest-cost producers of these minerals. For all the other cases, excluding Bolivia, exports decreased or remained unchanged despite large currency depreciations. Even in the instances where the graphs indicated a correlation between real depreciation and export expansion, econometric estimations provide no support of the hypothesized exchange rate effect.

Similar consideration of two industrial country metal exporters, Australia and Canada, shows that the real exchange rate has not been the primary determinant of export volume. Excepting a few isolated years of slight appreciation, the Australian and Canadian currencies have depreciated consistently against the US dollar since the mid-1970s. In the same period, Australia's exports of copper and Canada's exports of zinc have steadily expanded. Australia's lead, zinc and iron exports and Canada's copper and lead exports, however, have essentially fluctuated around a constant volume with no apparent correlation to the real exchange rate.

In sum, then, we find no evidence, observational or econometric, of a systematic increase in supply caused by real depreciations in developing countries.

IV. OTHER EXPLANATIONS FOR DEPRESSED COMMODITY PRICES

Neither the debt nor real exchange rate theories of supply expansion appear to explain successfully the recent fall in commodity prices. Empirical testing provides no evidence of either an outward shift of the supply curve or a downward-sloping supply curve. Can supply behavior explain the price decline at all?

The volume of developing country exports of many commodities has decreased absolutely since 1980. Among the metals considered, tin, lead and iron ore exports decreased from 1980 to 1984, while copper exports increased but by much less than industrial production. Among the agricultural raw materials, rubber exports have increased about 10% since 1980, but timber exports have declined about 20% (however, log exports have been restricted by the major South-east Asian producers, who are encouraging domestic processing). Although the decline in the prices of foodstuffs and certain other agricultural raw materials such as cotton can be largely explained by the expansion of supply, it is not so obvious that the supply side has been an important factor in depressing metals and minerals prices. Production of metals and minerals largely reflects demand. Capacity, rather than production, is the important supply-side variable. It is not easy to estimate recent changes in capacity in these industries. Investments in mining and subsequent treatment facilities respond with a lag of several years to price changes. Therefore, a case can be made that prices today are being depressed by capacity coming on-stream in response to the increase in metals/minerals prices in the 1970s.

A decline in both price and quantity, as has been the case in the metals/minerals market in recent years, suggests an inward shift of demand.

While OECD industrial production has been stagnant since mid-1985, from the beginning of 1983 to mid-1985 it was at or above trend growth rates. In past studies, commodity prices were shown to be highly responsive to fluctuations in macroeconomic output. Is this historical relationship breaking down? Technical substitution resulting in more efficient use of raw materials may have reduced commodity demand despite a high level of industrial production. Another possibility is increased self-reliance in the industrial countries for their primary material needs; this would cause a decline in imports without decreasing total commodity consumption. A careful analysis of the demand-side could ascertain the relevance of these trends.

The behavior of inventories also merits further study. Historically, a high level of inventories, all else equal, will depress commodity prices. For some commodities today, however, inventory levels are extremely low. A one-time de-stocking by consumers would depress prices during the de-stocking but not appear in trade figures. In that case, prices after the de-stocking would rise in response to reduced inventory levels and trade flows would resume as before. Again, global consumption data should reveal to what degree the behavior of importing countries has affected price. These issues are being examined in ongoing studies.

The findings presented in this paper suggest that supply changes alone cannot be responsible for the current slump in non-food primary commodities. A leftward shift of a vertical demand curve accompanied by outward shifts in supply, for example, could explain both price and quantity movements. Some demand shift other than mere fluctuations in industrial output must be taking place, as the compelling export volume figures suggest. Whether, in addition, a supply effect has played a role will become more evident once more is understood about demand.

REFERENCES

Dornbusch, Rudiger (1985), "Policy and Performance Links between LDC Debtors and Industrial Nations," Brookings Papers on Economic Activity, 2, 303-368.

Gilbert, Christopher L. (1986), "The Impact of Exchange Rates and Developing Country Debt on Commodity Prices," World Bank Division Working Paper, 1986-4, March.

Table 1: COMMODITY PRICE DETERMINATION, 1961-1986 (LEVELS)

ESTIMATED EQUATION:

$$(\text{real commodity price})_t = C_o + \sum_{i=0}^{4} C_{1i}\,(\text{industrial production})_{t-1} + \sum_{i=0}^{4} C_{2i}\,(\text{real dollar exchange rate})_{t-i} + \sum_{i=1}^{4} C_{3i}\,(\text{LDC debt-servicing})_{t-i} + \varepsilon_t$$

All variables in logs.

RESULTS:

DEPENDENT VARIABLE 1 ALLCOM
FROM 1962: 2 UNTIL 1986: 1
OBSERVATIONS 96 DEGREES OF FREEDOM 81
R**2 .95931332 RBAR**2 .95228105
SSR .13184750 SEE .40345345E-01
DURBIN-WATSON 1.60757169
Q(27) = 46.0169 SIGNIFICANCE LEVEL .126697E-01

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-9.293379	11.31615	-.8212495
2	INDPRO	9	0	1.154284	.4125741	2.797763
3	INDPRO	9	1	.6431950	.4570354	1.407320
4	INDPRO	9	2	.2642714	.4644946	.5689440
5	INDPRO	9	3	.2154325	.4997093	.4311157
6	INDPRO	9	4	-.1040104	.4273728	-.2433717
7	RELWHPRI	7	0	-.3530552	.1702598	-2.073626
8	RELWHPRI	7	1	-.2300821	.1891359	-1.216491
9	RELWHPRI	7	2	-.5005748	.1881101	-2.661074
10	RELWHPRI	7	3	.1981074	.1959494	1.011013
11	RELWHPRI	7	4	.5099532E-01	.2075670	.2456812
12	LDCTDS	10	1	-.1757373	.5860063	-.2998898
13	LDCTDS	10	2	1.568106	1.103547	1.420969
14	LDCTDS	10	3	-2.814825	1.109647	-2.536686
15	LDCTDS	10	4	1.449209	.6168055	2.349539
16	RHO	1	0	.9928171	.1225396E-01	81.02010

DEPENDENT VARIABLE 2 FOOD
FROM 1962: 2 UNTIL 1986: 1
OBSERVATIONS 96 DEGREES OF FREEDOM 81
R**2 .94243354 RBAR**2 .93248378
SSR .28017317 SEE .58812651E-01
DURBIN-WATSON 1.85571731
Q(27) = 21.4219 SIGNIFICANCE LEVEL .766141

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
1	CONSTANT	0	0	4.188882	4.498874	.9310958
2	INDPRO	9	0	.7472711	.6063436	1.232422
3	INDPRO	9	1	.4445105	.6770116	.6565774
4	INDPRO	9	2	.6934935	.6876684	1.008471
5	INDPRO	9	3	-.3595467	.7398519	-.4859712
6	INDPRO	9	4	-.5220499E-01	.6398787	-.8158575E-01
7	RELWHPRI	7	0	-.1085660	.2481794	-.4374499
8	RELWHPRI	7	1	-.5546901	.2728706	-2.032795
9	RELWHPRI	7	2	-.9532209	.2695785	-3.535967
10	RELWHPRI	7	3	.4559173	.2797311	1.629841
11	RELWHPRI	7	4	-.3232297	.2701479	-1.196492
12	LDCTDS	10	1	.4198577	.8790213	.4776422
13	LDCTDS	10	2	1.283102	1.634282	.7851168
14	LDCTDS	10	3	-3.518994	1.641015	-2.144401
15	LDCTDS	10	4	1.565058	.8774926	1.783557
16	RHO	1	0	.9604809	.3290515E-01	29.18938

Table 2: COMMODITY PRICE DETERMINATION, 1961-1986 (FIRST DIFFERENCES)

ESTIMATED EQUATION:

$$\Delta(\text{real commodity price})_t = Co + \sum_{i=0}^{4} C_{1i}\,\Delta(\text{industrial production})_{t-i} + \sum_{i=0}^{4} C_{2i}\,\Delta(\text{real dollar exchange rate})_{t-1} + \sum_{i=1}^{4} C_{3i}\,(\text{LDC debt-servicing})_{t-i} + \varepsilon_t$$

All variables in logs.

RESULTS:

DEPENDENT VARIABLE 12 DALLCOM
FROM 1962: 3 UNTIL 1986: 1
OBSERVATIONS 95 DEGREES OF FREEDOM 80
R**2 .45119955 RBAR**2 .35515948
SSR .13291911 SEE .40761364E-01
DURBIN-WATSON 2.00699316
Q(27) = 37.6091 SIGNIFICANCE LEVEL .842484E-01

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.6275409E-01	.1152812	-.5443564
2	DINDPRO	18	0	.8785019	.4063814	2.161767
3	DINDPRO	18	1	.6953593	.4124330	1.685993
4	DINDPORO	18	2	.2868380	.4201404	.6827195
5	DINDPRO	18	3	.2831614E-01	.4438446	.6379742E-01
6	DINDPRO	18	4	-.9890509E-01	.4198097	-.2355950
7	DRELWHPR	17	0	-.2691803	.1723547	-1.561781
8	DRELWHPR	17	1	-.3176076	.1852606	-1.714383
9	DRELWHPR	17	2	-.5326685	.1918061	-2.777120
10	DRELWHPR	17	3	.2246847	.1953917	1.149920
11	DRELWHPR	17	4	.2108863E-01	.2023746	.1042059
12	LDCTDS	10	1	.6332328	.5853922	1.081724
13	LDCTDS	10	2	-.5050567	1.431084	-.3529190
14	LDCTDS	10	3	-.8723145	1.434968	-.6078982
15	LDCTDS	10	4	.7469169	.6110942	1.222261
16	RHO	1	0	.2825486	.1129603	2.501308

DEPENDENT VARIABLE 13 DFOOD
FROM 1962: 3 UNTIL 1986: 1
OBSERVATIONS 95 DEGREES OF FREEDOM 80
R**2 .34711027 RBAR**2 .23285457
SSR .29338602 SEE .60558444E-01
DURBIN-WATSON 2.01092482
Q(27) = 23.0966 SIGNIFICANCE LEVEL .679810

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.7427378E-01	.1477465	-.5027109
2	DINDPRO	18	0	.6826746	.6050211	1.128348
3	DINDPRO	18	1	.5072761	.6469756	.7840731
4	DINDPRO	18	2	.7338001	.6591303	1.113285
5	DINDPRO	18	3	-.5105018	.6974727	-.7319308
6	DINDPRO	18	4	-.3203938E-01	.6238273	-.5135938E-01
7	DRELWHPR	17	0	.1731943E-01	.2579573	.6714068E-01
8	DRELWHPR	17	1	-.6064393	.2793970	-2.170529
9	DRELWHPR	17	2	-.9309013	.2855174	-3.260401
10	DRELWHPR	17	3	.5106310	.2933275	1.740822
11	DRELWHPR	17	4	-.2980577	.3031253	-.9832824
12	LDCTDS	10	1	1.269754	.8428358	1.506526
13	LDCTDS	10	2	-1.592843	2.156416	-.7386526
14	LDCTDS	10	3	-.6632798	2.194060	-.3023070
15	LDCTDS	10	4	.9902117	.9045072	1.094753
16	RHO	1	0	.1252021	.1144768	1.093690

Table 3: COMMODITY PRICE DETERMINATION, 1961-1986 (FIRST DIFFERENCES)

ESTIMATED EQUATION:

$$\Delta \text{ (real commodity price)}_t = C_o + \sum_{i=0}^{4} C_{1i} \Delta \text{ (industrial production)}_{t-i} + \sum_{i=0}^{4} C_{2i} \Delta \text{ (real dollar exchange rate)}_{t-i} + \sum_{i=1}^{4} C_{3i} \text{ (LDC debt-servicing/real commodity price)}_{t-i} + \epsilon_t$$

All variables in logs.

RESULTS:

DEPENDENT VARIABLE 12 DALLCOM
FROM 1962: 3 UNTIL 1986: 1
OBSERVATIONS 95 DEGREES OF FREEDOM 80
R**2 .43941759 RBAR**2 .34131566
SSR .13577269 SEE .41196585E-01
DURBIN-WATSON 1.97438583
Q(27) = 31.6715 SIGNIFICANCE LEVEL .244467

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	.2561049E-01	.1137512	.2251447
2	DINDPRO	18	0	1.076154	.4154082	2.590595
3	DINDPRO	18	1	.7880824	.4155434	1.896510
4	DINDPRO	18	2	.3277227	.4111304	.7971260
5	DINDPRO	18	3	-.5086920E-01	.4320522	-.1177385
6	DINDPRO	18	4	-.5500125E-01	.4303122	-.1278171
7	DRELWHPR	17	0	-.2271584	.1715693	-1.324004
8	DRELWHPR	17	1	-.2543146	.1761239	-1.443953
9	DRELWHPR	17	2	-.3628154	.1756524	-2.065531
10	DRELWHPR	17	3	.3044028	.1798253	1.692770
11	DRELWHPR	17	4	.1107484	.2275743	.4866472
12	LDCTDS	10	1	.7826118E-01	.1021197	.7663674
13	LDCTDS	10	2	.7237430E-01	.9179958E-01	.7883946
14	LDCTDS	10	3	-.1215991	.9215201E-01	-1.319549
15	LDCTDS	10	4	-.3280591E-01	.8313073E-01	-.3946303
16	RHO	1	0	.3241147	.1308060	2.477828

DEPENDENT VARIABLE 13 DFOOD
FROM 1962: 3 UNTIL 1986: 1
OBSERVATIONS 95 DEGREES OF FREEDOM 80
R**2 .33089366 RBAR**2 .21380005
SSR .30067320 SEE .61305913E-01
DURBIN-WATSON 1.95747502
Q(27) = 23.1343 SIGNIFICANCE LEVEL .677777

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	.1001993	.1618845	.6189552
2	DINDPRO	18	0	1.220214	.6035268	2.021807
3	DINDPRO	18	1	.7687706	.6189306	1.242095
4	DINDPRO	18	2	.7993233	.6085187	1.313556
5	DINDPRO	18	3	-.4664752	.6337667	-.7360361
6	DINDPRO	18	4	-.3236738	.6485153	-.4990997
7	DRELWHPR	17	0	.4663141E-01	.2585423	.1803628
8	DRELWHPR	17	1	-.4659206	.2634143	-1.768775
9	DRELWHPR	17	2	-.6394327	.2619168	-2.4[illegible]1358
10	DRELWHPR	17	3	.6038866	.267019[illegible]	2.261586
11	DRELWHPR	17	4	.1145388	.3377918	.3390811
12	LDCTDS	10	1	.1297588	.7859548E-01	1.650970
13	LDCTDS	10	2	.5657782E-01	.5169720E-01	1.094408
14	LDCTDS	10	3	-.7907238E-01	.5488803E-01	-1.440613
15	LDCTDS	10	4	-.1163834	.6261116E-01	-1.858828
16	RHO	1	0	.3495992	.1398122	2.500491

Table 4: COMMODITY PRICE DETERMINATION, 1980-1986 (LEVELS)

ESTIMATED EQUATION:

$$(\text{real commodity price})_t = C_o + \sum_{i=0}^{4} C_{1i}\,(\text{industrial production})_{t-i} + \sum_{i=0}^{4} C_{2i}\,(\text{real dollar exchange rate})_{t-i} + \sum_{i=1}^{4} C_{3i}\,(\text{LDC debt-servicing})_{t-i} + \varepsilon_t$$

All variables in logs.

RESULTS:

DEPENDENT VARIABLE 1 ALLCOM
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 9
R**2 .98772180 RBAR**2 .96862239
SSR .50115135E-02 SEE .23597348E-01
DURBIN-WATSON 2.60388488
Q(12) = 26.7206 SIGNIFICANCE LEVEL .847507E-02

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	3.854150	1.897231	2.031461
2	INDPRO	9	0	3.267295	.4880019	6.695249
3	INDPRO	9	1	-2.391925	1.048822	-2.280582
4	INDPRO	9	2	1.867177	1.157208	1.613519
5	INDPRO	9	3	-1.195091	1.081859	-1.104665
6	INDPRO	9	4	2.113220	.7049501	2.997688
7	RELWHPRI	7	0	-.6569767	.1829424	-3.591166
8	RELWHPRI	7	1	.4972952	.4137690	1.201867
9	RELWHPRI	7	2	.9289634E-01	.4662657	.1992348
10	RELWHPRI	7	3	.3524988E-01	.4226004	.8341186E-01
11	RELWHPRI	7	4	.5708427	.1997258	2.858132
12	LDCTDS	10	1	-2.655128	.9751747	-2.722720
13	LDCTDS	10	2	3.580055	1.726840	2.073183
14	LDCTDS	10	3	-4.950950	1.621617	-3.053096
15	LDCTDS	10	4	2.614469	.7516245	3.478425
16	RHO	1	0	-.7845407	.2819872	-2.782186

Table 5: COMMODITY PRICE DETERMINATION, 1980-1986 (FIRST DIFFERENCES)

ESTIMATED EQUATION:

$$\Delta \text{ (real commodity price)}_t = C_o + \sum_{i=0}^{4} C_{1i} \Delta \text{ (industrial production)}_{t-1} + \sum_{i=0}^{4} C_{2i} \Delta \text{ (real dollar exchange rate)}_{t-i} + \sum_{i=1}^{4} C_{3i} \text{ (LDC debt servicing)}_{t-i} + \varepsilon_t$$

All variables in logs.

RESULTS:

DEPENDENT VARIABLE 12 DALLCOM
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 9
R**2 .83145255 RBAR**2 .56926762
SSR .71988479E-02 SEE .28282008E-01
DURBIN-WATSON 2.16946160
Q(12) = 10.4059 SIGNIFICANCE LEVEL .580396

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-1.465430	.7801017	-1.878512
2	DINDPRO	18	0	-.2967597	.7581996	-.3913609
3	DINDPRO	18	1	-.4856700	.7026720	-.6911759
4	DINDPRO	18	2	.1231908	.7228133	.1704324
5	DINDPRO	18	3	.2069536	.7237842	.2859327
6	DINDPRO	18	4	-.6651510	.7587601	-.8766289
7	DRELWHPR	17	0	-.3905635	.2204903	-1.771341
8	DRELWHPR	17	1	-.3434161	.2392397	-1.435448
9	DRELWHPR	17	2	-.1321617	.2154182	-.6135122
10	DRELWHPR	17	3	.2194131	.2260667	.9705678
11	DRELWHPR	17	4	-.3692215	.2614172	-1.412384
12	LDCTDS	10	1	.2107351	.9193036	.2292334
13	LDCTDS	10	2	-1.265760	2.124332	-.5958387
14	LDCTDS	10	3	.4628202	2.069319	.2236583
15	LDCTDS	10	4	.6833252	.8501860	.8037361
16	RHO	1	0	-.1733076	.3285007	-.525716

Table 6: COMMODITY PRICE DETERMINATION, 1980-86 (FIRST DIFFERENCES)

ESTIMATED EQUATION:

$$\Delta \text{ (real commodity price)}_t = Co + \sum_{i=0}^{4} C_{1i} \Delta \text{ (industrial production)}_{t-i} + \sum_{i=0}^{4} C_{2i} \Delta \text{ (real dollar exchange rate)}_{t-i} + \sum_{i=1}^{4} C_{3i} \text{ (LDC debt-servicing/real commodity price)}_{t-i} + E_t$$

All variables in logs.

RESULTS:

DEPENDENT VARIABLE 12 DALLCOM
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 9
R**2 .83223498 RBAR**2 .57126717
SSR .71654294E-02 SEE .28216286E-01
DURBIN-WATSON 2.00977762
Q(12) = 11.6298 SIGNIFICANCE LEVEL .475846

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.8196843	.7329794	-1.118291
2	DINDPRO	18	0	-.4430692	.7824914	-.5662288
3	DINDPRO	18	1	.9261485E-01	.7298450	.1268966
4	DINDPRO	18	2	.6991725	.8417937	.8305746
5	DINDPRO	18	3	-.6143730E-01	.9200311	-.6677742E-01
6	DINDPRO	18	4	.6346466	.7995285	.7937762
7	DRELWHPR	17	0	-.2878742	.2761710	-1.042377
8	DRELWHPR	17	1	-.2649292E-02	.3174618	-.8345231E-02
9	DRELWHPR	17	2	-.1858741	.2921486	-.6362313
10	DRELWHPR	17	3	.1948915	.2648321	.7359058
11	DRELWHPR	17	4	-.7443395	.3430225	-2.169944
12	LDCTDS	10	1	-.7839444	.1892672	-4.141998
13	LDCTDS	10	2	.6993982	.3175551	2.202447
14	LDCTDS	10	3	-.2864712	.3584665	-.7991575
15	LDCTDS	10	4	.4224543	.1813196	2.329888
16	RHO	1	0	-.6063838	.3519220	-1.723063

Table 7: TEST OF INCREASED PRICE SENSITIVITY 1962-79 VS. 1980-86

ESTIMATED EQUATION:

$$\Delta \text{ (real commodity price)}_t = C_o + \sum_{i=0}^{4} C_{1i} \Delta \text{ (industrial production)}_{t-1} + \sum_{i=0}^{4} C_{2i} \Delta \text{ (real dollar exchange rate)}_{t-1} + \varepsilon_t$$

All variables in logs.

RESULTS:

DEPENDENT VARIABLE 12 DALLCOM
FROM 1962: 3 UNTIL 1979: 4
OBSERVATIONS 70 DEGREES OF FREEDOM 59
R**2 .45587102 RBAR**2 .36364577
SSR .10326531 SEE .41836104E-01
DURBIN-WATSON 2.02778254
Q(24) = 26.2360 SIGNIFICANCE LEVEL .341302

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.3101250E-01	.9561789E-02	-3.243378
2	DINDPRO	18	0	1.123859	.4835625	2.324124
3	DINDPRO	18	1	1.100987	.5332210	2.064786
4	DINDPRO	18	2	.1051100	.5321646	.1975160
5	DINDPRO	18	3	-.4503316E-02	.5728182	-.7861685E-02
6	DINDPRO	18	4	.4299605	.5151164	.8346862
7	DRELWHPR	17	0	-.3406263	.2889649	-1.178781
8	DRELWHPR	17	1	-.2522172	.2868084	-.8793926
9	DRELWHPR	17	2	-.5893370	.2839860	-2.075233
10	DRELWHPR	17	3	.3586969	.2809951	1.276524
11	DRELWHPR	17	4	.1024357	.2830361	.3619176
12	RHO	1	0	.1894138	.1324036	1.430570

DEPENDENT VARIABLE 12 DALLCOM
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 13
R**2 .60942161 RBAR**2 .30897669
SSR .16682035E-01 SEE .35822248E-01
DURBIN-WATSON 1.83847514
Q(12) = 7.43353 SIGNIFICANCE LEVEL .827686

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.3426077E-02	.1573371E-01	-.2177539
2	DINDPRO	18	0	.2483674	.8350183	.2974395
3	DINDPRO	18	1	.3254538E-01	.7069625	.4603551E-01
4	DINDPRO	18	2	.3620647	.6714029	.5392659
5	DINDPRO	18	3	.1266255	.7168713	.1766362
6	DINDPRO	18	4	-1.271712	.7339673	-1.732655
7	DRELWHPR	17	0	-.3951537	.2152956	-1.835400
8	DRELWHPR	17	1	-.3547413	.2337927	-1.517333
9	DRELWHPR	17	2	-.2001167	.2109080	-.9488340
10	DRELWHPR	17	3	.1001896	.2271964	.4409824
11	DRELWHPR	17	4	-.2565133	.2797824	-.9168313
12	RHO	1	0	.3664260	.3137115	1.168035

DEPENDENT VARIABLE 13 DFOOD
FROM 1962: 2 UNTIL 1979: 4
OBSERVATIONS 70 DEGREES OF FREEDOM 59
R**2 .36620491 RBAR**2 .25878201
SSR .22830023 SEE .62205268E-01
DURBIN-WATSON 1.98652791
Q(24) = 14.1916 SIGNIFICANCE LEVEL .942205

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.3598761E-01	.1145166E-01	-3.142568
2	DINDPRO	18	0	.8155914	.7240183	1.126479
3	DINDPRO	18	1	1.262242	.8853573	1.425686
4	DINDPRO	18	2	.7043205	.8818169	.7987151
5	DINDPRO	18	3	-.9900458	.9326902	-1.061495
6	DINDPRO	18	4	.9469092	.7655534	1.236825
7	DRELWHPR	17	0	-.1947096	.4519457	-.4308251
8	DRELWHPR	17	1	-.4518670	.4320565	-1.045852
9	DRELWHPR	17	2	-1.126889	.4309982	-2.614602
10	DRELWHPR	17	3	.7632708	.4346250	1.756160
11	DRELWHPR	17	4	-.5771619	.4191549	-1.376966
12	RHO	1	0	-.4475087E-01	.1438252	-.3111476

DEPENDENT VARIABLE 13 DFOOD
FROM 1962: 3 UNTIL 1979: 4
OBSERVATIONS 70 DEGREES OF FREEDOM 59
R**2 .36620491 RBAR**2 .25878201
SSR .22830023 SEE .62205268E-01
DURBIN-WATSON 1.98652791
Q(24) = 14.1916 SIGNIFICANCE LEVEL .942205

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
1	CONSTANT	0	0	-.3598761E-01	.1145166E-01	-3.142568
2	DINDPRO	18	0	.0155914	.7240183	1.126479
3	DINDPRO	18	1	1.262242	.8853573	1.425686
4	DINDPRO	18	2	.7043205	.8818169	.7987151
5	DINDPRO	18	3	-.9900458	.9326902	-1.061495
6	DINDPRO	18	4	.9469092	.7655534	1.236895
7	DRELWHPR	17	0	-.1947096	.4519457	-.4308251
8	DRELWHPR	17	1	-.4518670	.4320565	-1.045852
9	DRELWHPR	17	2	-1.126889	.4309982	-2.614602
10	DRELWHPR	17	3	.7632708	.4346250	1.756160
11	DRELWHPR	17	4	-.5771619	.4191549	-1.376966
12	RHO	1	0	-.4475087E-01	.1438252	-.3111476

DEPENDENT VARIABLE 13 DFOOD
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 13
R**2 .47122442 RBAR**2 .06447398
SSR .41098932E-01 SEE .56226829E-01
DURBIN-WATSON 1.75180216
Q(12) = 10.0393 SIGNIFICANCE LEVEL .612513

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
1	CONSTANT	0	0	.9908408E-03	.2211476E-01	.4480450E-01
2	DINDPRO	18	0	.3729710	1.470488	.2536376
3	DINDPRO	18	1	-.9972799	1.145070	-.8709332
4	DINDPRO	18	2	.6432021	1.073120	.5993758
5	DINDPRO	18	3	-.3419191E-01	1.156284	-.2957052E-01
6	DINDPRO	18	4	-1.174655	1.178160	-.9970249
7	DRELWHPR	17	0	-.2223502	.3516611	-.6322854
8	DRELWHPR	17	1	-.4618817	.3695523	-1.249841
9	DRELWHPR	17	2	-.3828627	.3360021	-1.139465
10	DRELWHPR	17	3	.2606547	.3560188	.7321376
11	DRELWHPR	17	4	-.3673358	.4333583	-.8476491
12	RHO	1	0	.2780440	.3555300	.7820548

DEPENDENT VARIABLE 14 DBEV
FROM 1962: 3 UNTIL 1979: 4
OBSERVATIONS 70 DEGREES OF FREEDOM 59
R**2 .31291104 RBAR**2 .19645528
SSR .41533045 SEE .83901723E-01
DURBIN-WATSON 1.94394464
Q(24) = 15.3300 SIGNIFICANCE LEVEL .910730

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.2297853E-01	.2305752E-01	-.9965743
2	DINDPRO	18	0	1.856946	.9679082	1.918514
3	DINDPRO	18	1	1.729687	1.007720	1.716435
4	DINDPRO	18	2	-.8978575	1.007480	-.8911910
5	DINDPRO	18	3	-.3662724	1.088277	-.3365618
6	DINDPRO	18	4	1.423505	1.033690	1.377111
7	DRELWHPR	17	0	-.1811430	.5647688	-.3207384
8	DRELWHPR	17	1	.9421854	.5855718	1.609001
9	DRELWHPR	17	2	.4745760	.5830059	.8140157
10	DRELWHPR	17	3	.3053723	.5676482	.5379605
11	DRELWHPR	17	4	1.218536	.5708004	2.134785
12	RHO	1	0	.3501587	.1228109	2.851202

DEPENDENT VARIABLE 14 DBEV
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 13
R**2 .61859483 RBAR**2 .32520624
SSR .78789190E-01 SEE .77850542E-01
DURBIN-WATSON 1.91707471
Q(12) = 14.8011 SIGNIFICANCE LEVEL .252492

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	.4296077E-01	.4835425E-01	.8884590
2	DINDPRO	18	0	-.6312947	1.568351	-.4025214
3	DINDPRO	18	1	3.708291	1.479658	2.506182
4	DINDPRO	18	2	-.4231533	1.434077	-.2950701
5	DINDPRO	18	3	.3000533	1.491987	.2011098
6	DINDPRO	18	4	-.8600308	1.593471	-.5397216
7	DRELWHPR	17	0	-.6500567	.4616963	-1.407975
8	DRELWHPR	17	1	-.6968419	.4837173	-1.440597
9	DRELWHPR	17	2	-.3229019	.4425506	-.7296383
10	DRELWHPR	17	3	-.6525578	.4846034	-1.346581
11	DRELWHPR	17	4	-.9607469	.5764725	-1.666596
12	RHO	1	0	.6191590	.2103984	2.942794

DEPENDENT VARIABLE 15 DAGRAW
FROM 1962: 3 UNTIL 1979: 4
OBSERVATIONS 70 DEGREES OF FREEDOM 59
R**2 .42752305 RBAR**2 .33049306
SSR .14155143 SEE .48981392E-01
DURBIN-WATSON 1.85462478
Q(24) = 24.7616 SIGNIFICANCE LEVEL .418809

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.1719784E-01	.1366468E-01	-1.258562
2	DINDPRO	18	0	.8170342	.5919586	1.380222
3	DINDPRO	18	1	.9143522	.5872925	1.556894
4	DINDPRO	18	2	-.4218884	.5871976	-.7184778
5	DINDPRO	18	3	1.009891	.6345794	1.591433
6	DINDPRO	18	4	-.9712574	.6036251	-1.609041
7	DRELWHPR	17	0	-.4470408	.3329430	-1.342695
8	DRELWHPR	17	1	-.7628320	.3418753	-2.231317
9	DRELWHPR	17	2	-.1530044	.3408444	-.4488981
10	DRELWHPR	17	3	-.2818286	.3320382	-.8487835
11	DRELWHPR	17	4	.1861381	.3340846	.5571584
12	RHO	1	0	.3556280	.1294399	2.747438

DEPENDENT VARIABLE 15 DAGRAW
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 13
R**2 .80288158 RBAR**2 .65125203
SSR .74708542E-02 SEE .23972507E-01
DURBIN-WATSON 2.36924974
Q(12) = 11.2227 SIGNIFICANCE LEVEL .509932

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.1328903E-01	.1809043E-01	-.7345890
2	DINDPRO	18	0	-.8467793	.5437193	-1.557383
3	DINDPRO	18	1	.69949059	.4704923	1.486541
4	DINDPRO	18	2	.2393439	.4717281	.5073769
5	DINDPRO	18	3	.7869888	.4602804	1.709803
6	DINDPRO	18	4	-1.353815	.5050376	-2.680622
7	DRELWHPR	17	0	-.5604983	.1458401	-3.843238
8	DRELWHPR	17	1	-.7433704E-01	.1508145	-.4929037
9	DRELWHPR	17	2	-.2035281	.1352285	-1.505068
10	DRELWHPR	17	3	.2018885	.1479300	1.364757
11	DRELWHPR	17	4	.8605593E-01	.1706930	.5041563
12	RHO	1	0	.7104503	.2428170	2.925867

DEPENDENT VARIABLE 16 DMETALS
FROM 1962: 3 UNTIL 1979: 4
OBSERVATIONS 70 DEGREES OF FREEDOM 59
R**2 .34004444 RBAR**2 .22818756
SSR .21440719 SEE .60282835E-01
DURBIN-WATSON 1.94230359
Q(24) = 25.2294 SIGNIFICANCE LEVEL .393384

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.3160503E-01	.1387773E-01	-2.277392
2	DINDPRO	18	0	1.046336	.6958267	1.503731
3	DINDPRO	18	1	.4392807	.7651901	.5740805
4	DINDPRO	18	2	-.1494579	.7646960	-.1954474
5	DINDPRO	18	3	.4446174	.8201519	.5421159
6	DINDPRO	18	4	.5771435	.742624	.7774418
7	DRELWHPR	17	0	-1.412830	.4078898	-3.463755
8	DRELWHPR	17	1	-.2007391	.4124781	-.4866662
9	DRELWHPR	17	2	-.4609471	.4091905	-1.126485
10	DRELWHPR	17	3	-.2191120	.4048948	-.5411579
11	DRELWHPR	17	4	.3961927	.4072983	.9727335
12	RHO	1	0	.1952906	.1317764	1.481985

DEPENDENT VARIABLE 16 DMETALS
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 13
R**2 .45429365 RBAR**2 .03451953
SSR .29654587E-01 SEE .47761094E-01
DURBIN-WATSON 1.62145865
Q(12) = 6.14498 SIGNIFICANCE LEVEL .908598

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.3156336E-01	.1379204E-01	-2.288520
2	DINDPRO	18	0	1.905290	.9804813	1.943220
3	DINDPRO	18	1	-.8964305	1.130175	-.7931785
4	DINDPRO	18	2	.5061491	1.089867	.4644136
5	DINDPRO	18	3	-.5447492	1.136182	-.4794560
6	DINDPRO	18	4	-.5504823	.9660024	-.5698560
7	DRELWHPR	17	0	-.3486466	.2812669	-1.239558
8	DRELWHPR	17	1	-.8149019E-01	.3702615	-.2200882
9	DRELWHPR	17	2	.3795850	.3311930	1.146114
10	DRELWHPR	17	3	.4842153E-01	.3332857	.1452854
11	DRELWHPR	17	4	-.2415673E-01	.3909154	-.6179529E-01
12	RHO	1	0	-.1522549	.2674140	-.5693601

Table 8: TEST OF INCREASED PRICE SENSITIVITY, 1962-79 VS 1980-86

ESTIMATED EQUATION:

$\Delta(\text{real commodity price})_t = C_0 + C_1 \ \Delta(\text{industrial production})_t +$

$C_2 \ \Delta \ (\text{real dollar exchange rate})_t + \epsilon_t$

All variables in logs.

RESULTS:

DEPENDENT VARIABLE 12 DALLCOM
FROM 1962: 3 UNTIL 1979: 4
OBSERVATIONS 70 DEGREES OF FREEDOM 67
R**2 .28328685 RBAR**2 .26189243
SSR .13601850 SEE .45056930E-01
DURBIN-WATSON 1.99602256
Q(24) = 29.9752 SIGNIFICANCE LEVEL .185575

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.1592598E-01	.8736695E-02	-1.822884
2	DINDPRO	18	0	1.624368	.4420072	3.674980
3	DRELWHPR	17	0	-.9219415E-01	.2785534	-.3309748
4	RHO	1	0	.2380721	.1233102	1.930677

DEPENDENT VARIABLE 12 DALLCOM
FROM 1980: 2 UNTIL 1986: 1
OBSERVATIONS 24 DEGREES OF FREEDOM 21
R**2 .38181446 RBAR**2 .32293964
SSR .26403387E-01 SEE .35458485E-01
DURBIN-WATSON 1.81759245
Q(12) = 14.5633 SIGNIFICANCE LEVEL .266189

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	-.1741355E-01	.1098917E-01	-1.584610
2	DINDPRO	18	0	.7712587	.7162396	1.076817
3	DRELWHPR	17	0	-.4448739	.1881330	-2.364678
4	RHO	1	0	.3053370	.2563280	1.191196

Table 9: EXPORT SUPPLY DETERMINATION FOR METALS
[SUPPLY = F(DOLLAR COMMODITY PRICE, REAL DOLLAR EXCHANGE RATE)]

ESTIMATED EQUATION:

(volume of country X's export of commodity Y)$_t$ = C_0 + $\sum_{i=0}^{4} C_{1i}$ (dollar price of commodity Y)$_{t-i}$ + $\sum_{i=0}^{4} C_{2i}$ (real exchange rate of currency X)$_{t-i}$ + C_3 (time) + ϵ_t

Two-stage least-squares estimation used because of simultaneity of commodity price at t and real exchange rate at t. Instruments consisted of all other right-hand side variables as well as industrial production from t-3 to t, inclusive.

All variables in logs.

RESULTS (from second stage):

DEPENDENT VARIABLE 2 COPCHIL
FROM 1976: 4 UNTIL 1985: 4
OBSERVATIONS 37 DEGREES OF FREEDOM 27
R**2 .39634138 RBAR**2 -.86178851
SSR 8.9722172 SEE .57645845
DURBIN-WATSON 1.84245968
Q(18) = 19.9353 SIGNIFICANCE LEVEL .336472

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	24.38270	9.918116	2.458401
2	COPPER	31	0	-.6902514	2.980481	-.2315906
3	COPPER	31	1	-1.755693	2.602304	-.6746688
4	COPPER	31	2	2.929006	1.683682	1.739643
5	COPPER	31	3	-4.929020	1.860294	-2.649591
6	REACHIL	25	0	-10.60634	5.542709	-1.913567
7	REALCHIL	25	1	13.63252	6.726929	2.026559
8	REALCHIL	25	2	-6.564132	4.299423	-1.526747
9	REALCHIL	25	3	2.843653	3.292628	.8636423
10	TIME	40	0	-.4551187E-01	.2550348E-01	-1.784535

DEPENDENT VARIABLE 11 LEADPERU
FROM 1960: 2 UNTIL 1985: 4
OBSERVATIONS 101 DEGREES OF FREEDOM 91
R**2 .90198267 RBAR**2 -1.09009085
SSR 6.3113993 SEE .26335534
DURBIN-WATSON 2.10532559
Q(30) = 30.7146 SIGNIFICANCE LEVEL .429534

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	5.531975	2.037313	2.715329
2	LEAD	33	0	1.926787	1.405252	1.371133
3	LEAD	33	1	-2.439953	1.686389	-1.446850
4	LEAD	33	2	.7067839	.5730028	1.233474
5	LEAD	33	3	-.2607996	.2969827	-.8781643
6	REALPERU	26	0	-1.277748	2.523943	-.5062505
7	REALPERU	26	1	1.503582	2.765724	.5436486
8	REALPERU	26	2	-1.270390	1.379213	-.9210978
9	REALPERU	26	3	.8201315	.8276998	.9908563
10	TIME	40	0	.2033342E-02	.1284541E-02	1.582933

DEPENDENT VARIABLE 18 IRONBRAZ
FROM 1975: 4 UNTIL 1985: 4
OBSERVATIONS 41 DEGREES OF FREEDOM 31
R**2 .24887263 RBAR**2 .03080339
SSR 1.0101004 SEE .18051007
DURBIN-WATSON 1.64370282
Q(18) = 11.9222 SIGNIFICANCE LEVEL .851227

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	3.185461	1.363336	2.336519
2	IRON	32	0	-2.062088	2.209847	-.9331361
3	IRON	32	1	1.642821	1.397179	1.175813
4	IRON	32	2	.2094081	.8698490	.2407407
5	IRON	32	3	-.3899765	.7801880	-.4998495
6	REALBRAZ	24	0	.1338255	1.005479	.1330962
7	REALBRAZ	24	1	-1.035088	1.495013	-.6923600
8	REALBRAZ	24	2	1.257143	1.169102	1.075306
9	REALBRAZ	24	3	-.2741275	.6930964	-.3955113
10	TIME	40	0	.1919513E-02	.2044960E-01	.9386552E-01

Table 10: EXPORT SUPPLY DETERMINATION FOR METALS
[SUPPLY = F(LOCAL CURRENCY PRICE FOR COMMODITIES)]

ESTIMATED EQUATION:

(volume of country X's export of commodity Y)$_t$ = C_0 + $\sum_{i=0}^{4} C_{1i}$ (real price of commodity Y in terms of currency X)$_{t-i}$ + C_2 (time) + ε_t

Two-stage least-squares estimation used because of simultaneity of commodity price at t. Instruments consisted of all other right-hand side variables as well as industrial production from t-3 to t, inclusive.

All variables in logs.

RESULTS (from second stage):

DEPENDENT VARIABLE 2 COPCHIL
FROM 1976: 4 UNTIL 1985: 4
OBSERVATIONS 37 DEGREES OF FREEDOM 31
R**2 -.12105940 RBAR**2 -.30187543
SSR 7.2033878 SEE .48204496
DURBIN-WATSON 1.86612427
Q(18) = 13.5523 SIGNIFICANCE LEVEL .757778

NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	13.66624	5.491364	2.488679
2	PCOPCHIL	43	0	-2.583925	2.167292	-1.192237
3	PCOPCHIL	43	1	2.248946	2.357380	.9540022
4	PCOPCHIL	43	2	1.564389	1.078333	1.450747
5	PCOPCHIL	43	3	-2.472860	.8979449	-2.753911
6	TIME	42	0	.3626987E-02	.8336469E-02	.4350748

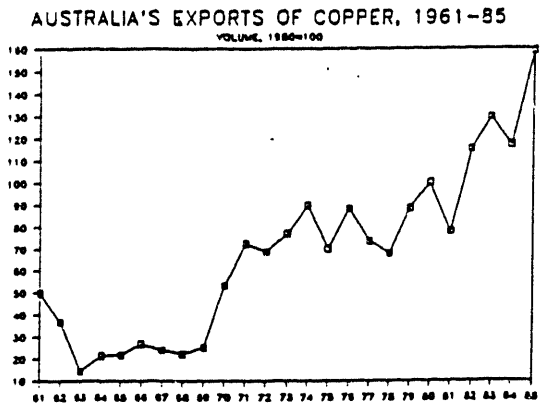
DEPENDENT VARIABLE 11 LEADPERU
FROM 1960: 4 UNTIL 1985: 4
OBSERVATIONS 101 DEGREES OF FREEDOM 95
R**2 -11900068 RBAR**2 -.17789545
SSR 3.7132095 SEE .19770285
DURBIN-WATSON 1.98898725
Q(30) = 24.8814 SIGNIFICANCE LEVEL .730776

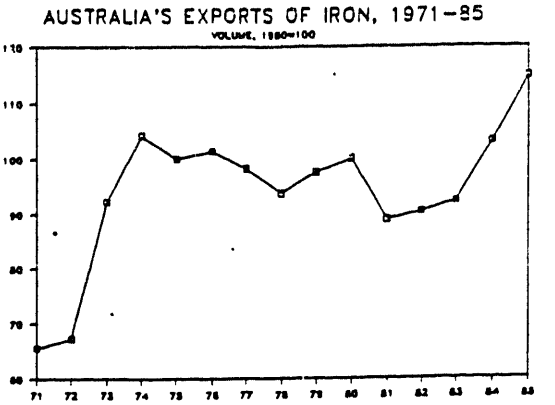
NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	4.653896	.3078893	15.11549
2	PLEDPERU	47	0	.9252640	.4524773	2.044885
3	PLEDPERU	47	1	-1.181971	.5764029	-2.050599
4	PLEDPERU	47	2	.3157920	.2979189	1.059993
5	PLEDPERU	47	3	-.9945766E-01	.1708482	-.5821406
6	TIME	42	0	.1999126E-02	.6822961E-03	2.929998

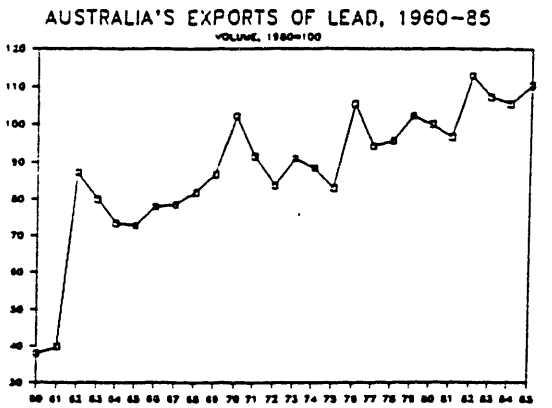
DEPENDENT VARIABLE 18 IRONBRAZ
FROM 1975: 4 UNTIL 1985: 4
OBSERVATIONS 41 DEGREES OF FREEDOM 35
R**2 .34072400 RBAR**2 .24654172
SSR .88658059 SEE .15915676
DURBIN-WATSON 1.65158462
Q(18) = 13.1739 SIGNIFICANCE LEVEL .781143

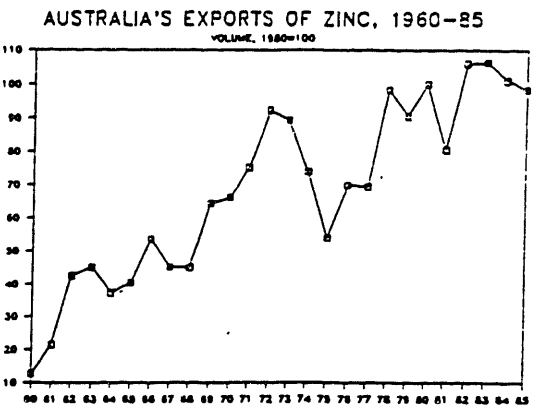
NO.	LABEL	VAR	LAG	COEFFICIENT	STAND. ERROR	T-STATISTIC
***	*****	***	***	**********	**********	**********
1	CONSTANT	0	0	4.015300	.8275370	4.852109
2	PIRNBRAZ	51	0	-1.036049	.7883604	-1.314170
3	PIRNBRAZ	51	1	.6901192	.7118354	.9694927
4	PIRNBRAZ	51	2	.6075094	.4312757	1.408633
5	PIRNBRAZ	51	3	-.3889755	.3590993	-1.083198
6	TIME	42	0	.1140765E-01	.2671024E-02	4.270889

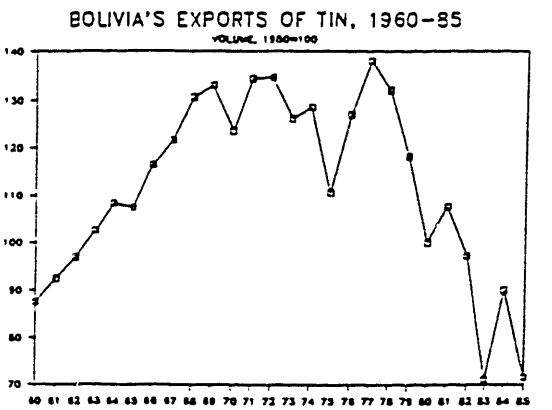
Figure 1: SELECTED COUNTRY EXPORT VOLUMES, 1960-85











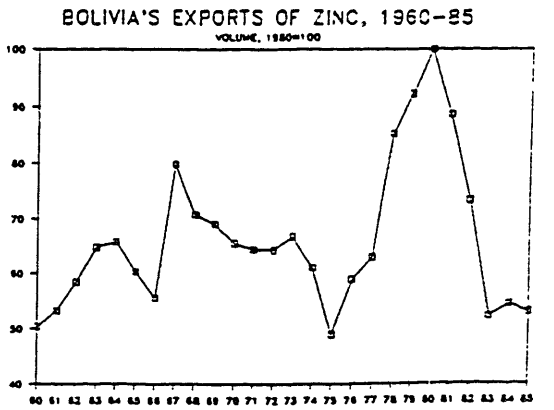
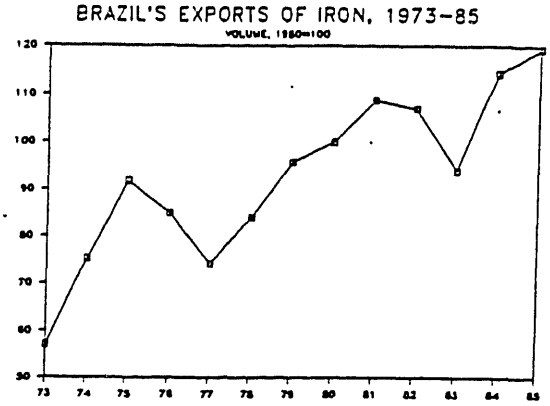
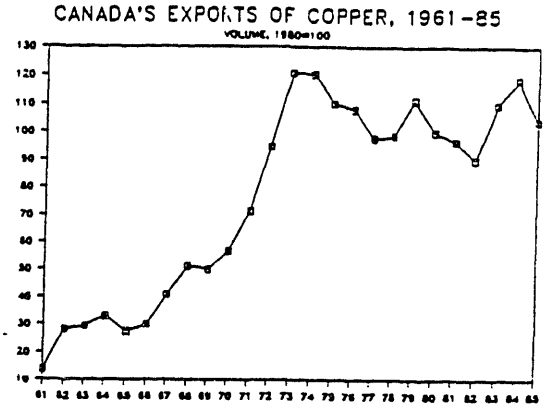
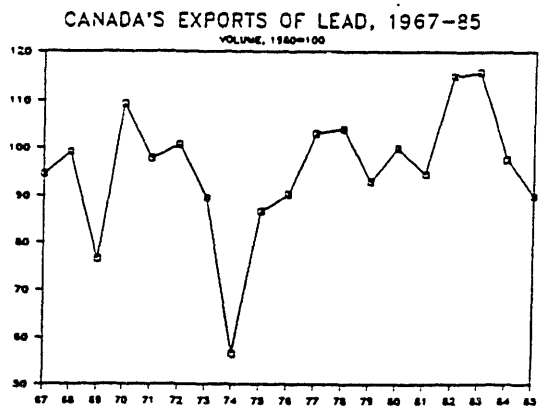
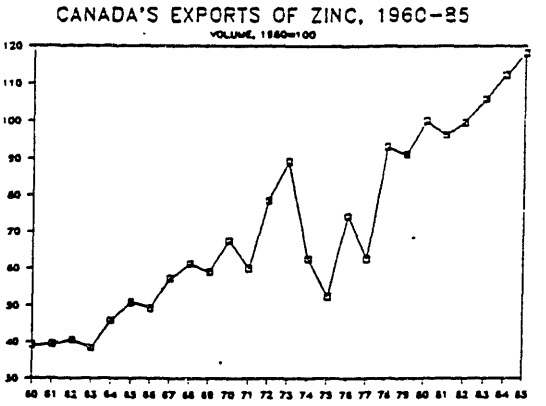


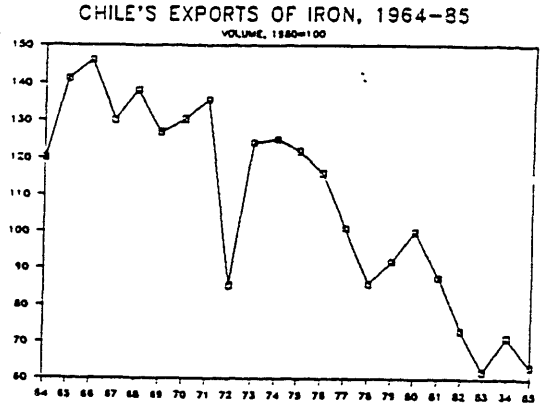
Figure 1: SELECTED COUNTRY EXPORT VOLUMES, 1960-85 (CONTD)











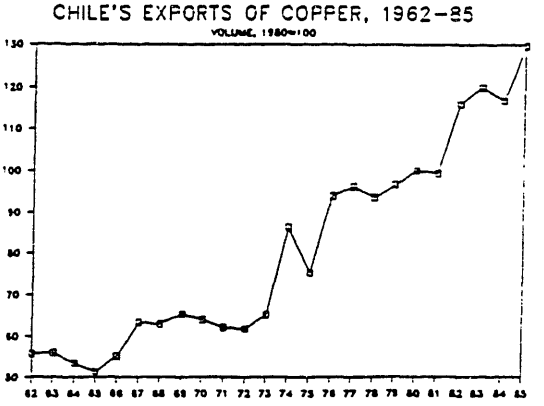
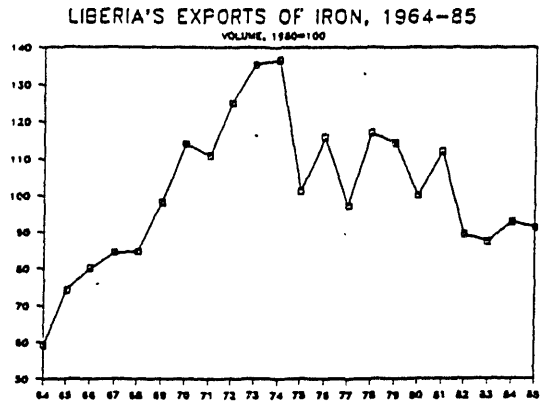
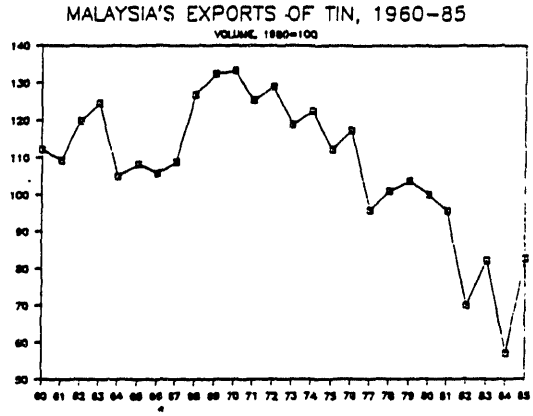
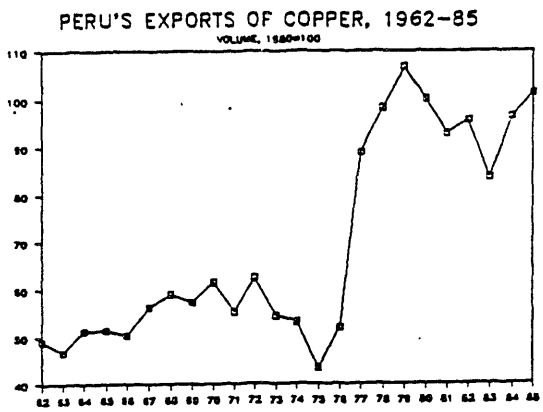
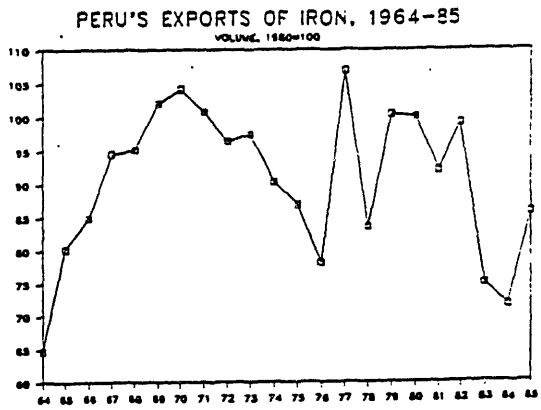


Figure 1: SELECTED COUNTRY EXPORT VOLUMES, 1960-85 (CONTD)









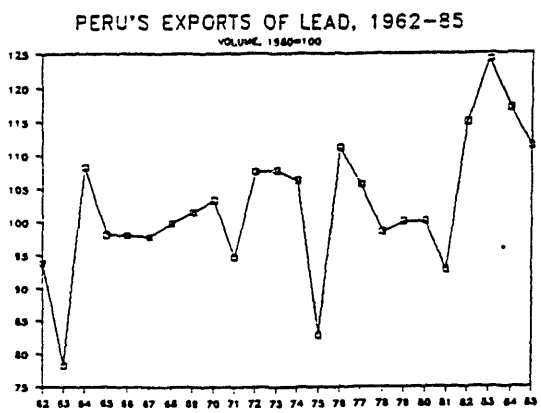
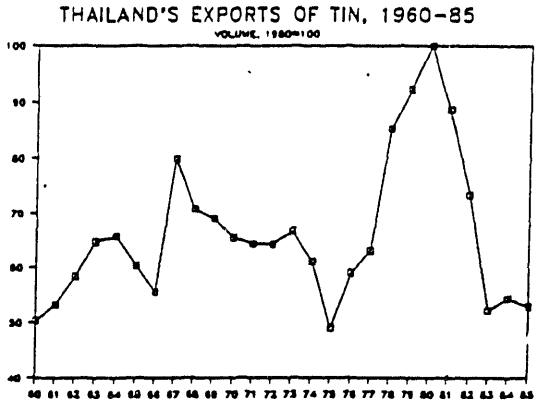
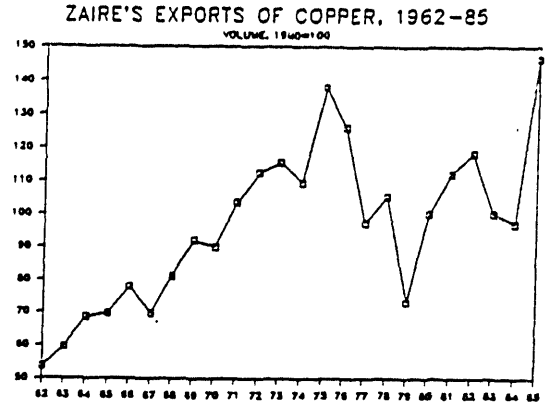


Figure 1: SELECTED COUNTRY EXPORT VOLUMES, 1960-85 (CONTD)





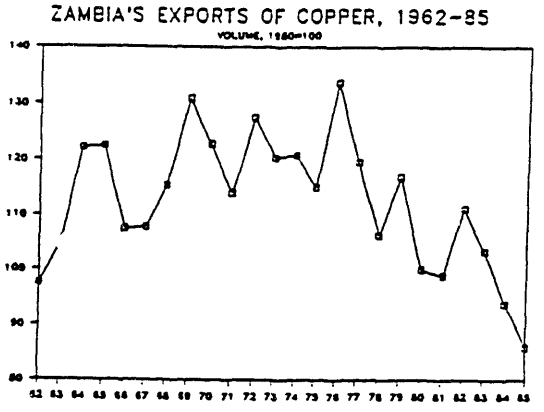
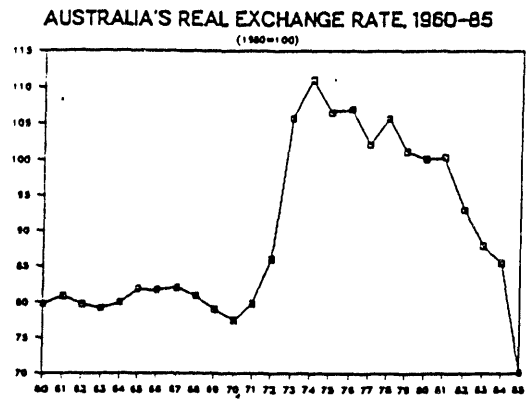
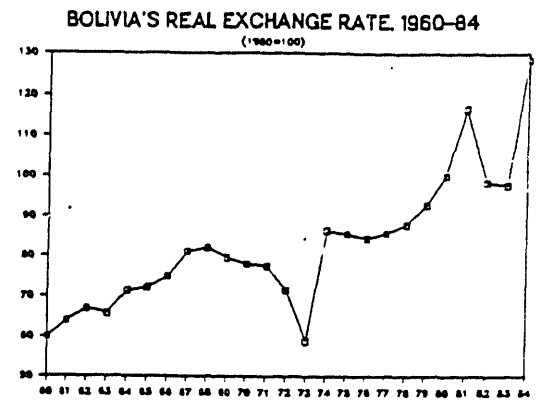
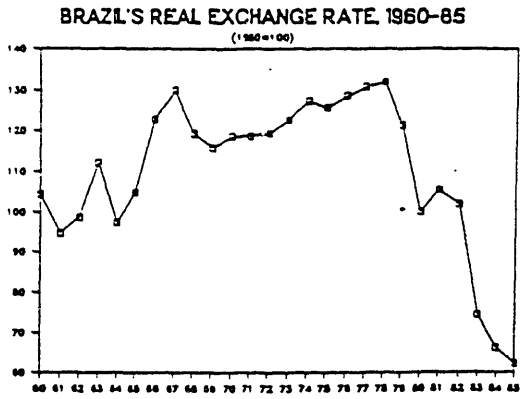
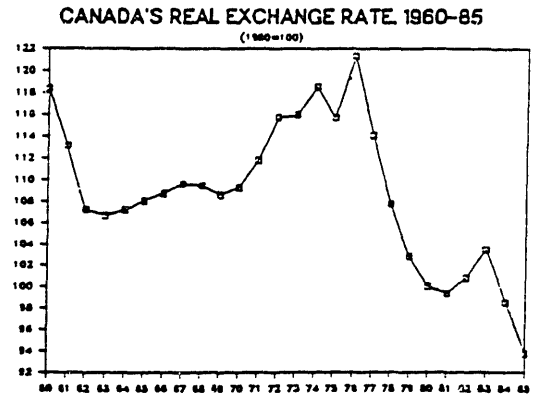


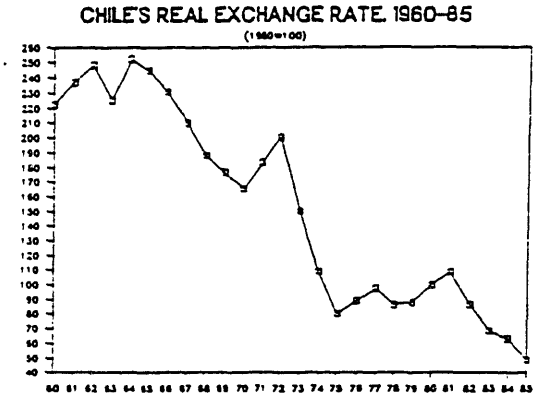
Figure 2: REAL EXCHANGE RATES FOR SELECTED COUNTRIES, 1960-85/A











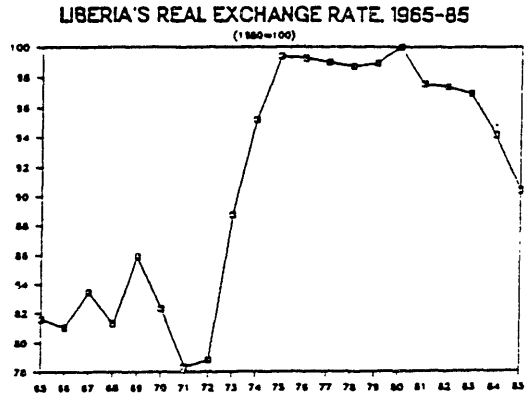
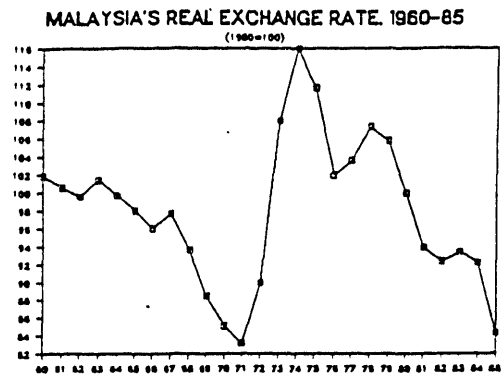
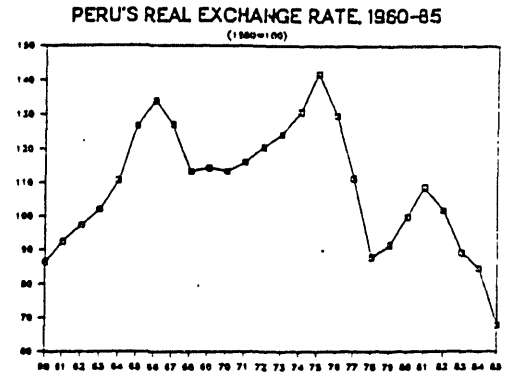
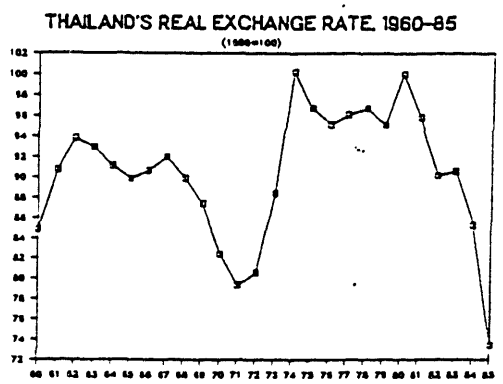
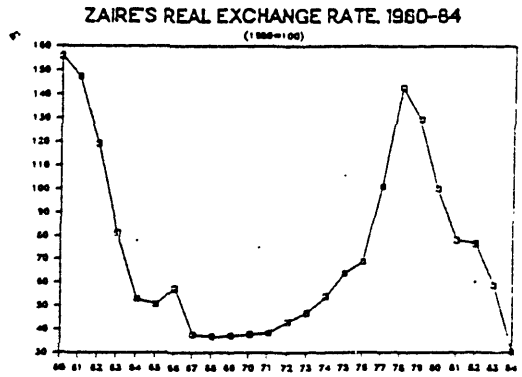


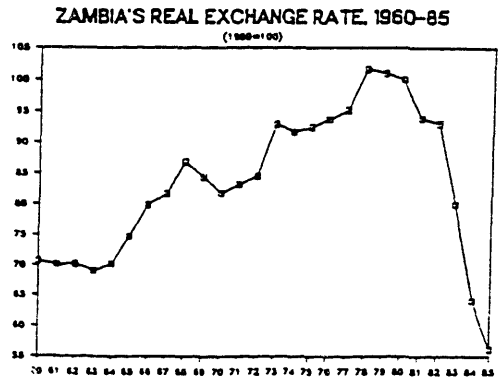
Figure 2: REAL EXCHANGE RATES FOR SELECTED COUNTRIES, 1960-85 (CONTD) /A











/A The real exchange rate denotes the currency's value in terms of US dollars, adjusted for inflation. Thus a rise in the exchange rate implies an appreciation against the dollar.

DATA SOURCES

International Monetary Fund, International Financial Statistics, various issues:

Commodity Export Volumes (lines 72c, 72g, 72q, 72t, 72v)

Commodity Price Indices (lines 76ax, 76ex, 76dw, 76bx, 76ay)

Industrial Good Prices (line 63a)

Industrial Production (line 66.b)

Real Dollar Exchange Rate (represented by US relative wholesale prices, line 63ey 110) (rise in exchange rate denotes dollar appreciation)

Real Exchange Rate of commodity exporters (represented by the nominal exchange rate in local currency units per US dollar, line rf, multiplied by US consumer prices, line 64, divided by local consumer prices, line 64) (rise in exchange rate denotes depreciation against dollar)

World Bank, EPDCS
Commodity Export Volume
Commodity Prices (individual commodities)

World Bank, EPDED
World Debt and Debt-Servicing