

# From closed to open door policy: An empirical study of China's international capital mobility, 1958-98

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## **Abstract**

This paper employs the intertemporal consumption smoothing approach to the current account to measure the effective degree of China's international capital mobility during the period 1958-98. In contrast to all previous known country studies using this framework, the hypothesis that capital has been at least mobile enough to allow for full consumption smoothing behavior is rejected. Also, although there is clear evidence of a drastic increase in mobility following the introduction of the open door policy in the late 1970s, the results indicate that there remain effective barriers to China's international capital movements.

**Keywords:** Capital mobility; China; Consumption smoothing; Current account

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## 1. Introduction

China's economic reforms and their implication for the country's growth have been remarkable. Since the introduction of the reforms in 1978, the country has grown at an annual average rate of over 9 percent, and real GNP per capita has almost quintupled. One of the reforms that has undoubtedly contributed significantly to the fast growth is the open door policy, initiated in 1979. In sharp contrast to the pre-reform policy aimed at self-sufficiency, the open door policy has led to increased international linkages in various forms. Key elements of the policy have included geographical targeting and decentralization of the management system; adoption of a system of import and export licensing and of tariffs and taxes; and liberalization of the exchange rate regime.<sup>1</sup> As a result, the country's foreign trade system has undergone a complete reorientation, transforming China into a country where foreign trade serves as the main engine of growth. At the end of 1996, China announced to the IMF that it met the requirements for current account convertibility. According to Chan et al. (1999), the process of marketization of China's foreign trade system was largely complete by 1997. In 1998 China's exports amounted to US\$184 billion, placing the country among the world's top ten exporters. Hence, from an insignificant pre-reform position, China is today one of the major international traders and also a significant participant in world capital markets.

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For details of the reform of the foreign trade system, see for instance Lardy (1990) and Chan et al. (1999).

This paper is concerned with measuring the effective degree of China's international capital mobility over the period 1958-98. How limited was the mobility of China's international capital before the inception of the open door policy in the late 1970s? More importantly, what were the implications of this policy liberalization on mobility? Has the country converged to a degree of international capital mobility that allows for optimal agent behavior? The questions are important because international capital mobility, by allowing for consumption smoothing and risk reduction, is crucial for global resource allocation.

To formally deal with these issues and test for the degree of capital mobility in an empirical model, the intertemporal consumption smoothing approach to the current account, or "consumption smoothing approach" for short, is used. The starting point, as advocated by Ghosh (1995) and Ghosh and Ostry (1995), is that the degree of capital mobility should preferably be regarded as a *relative* measure. That is, instead of investigating *absolute* measures of capital flows, or savings-investment correlations (as in Feldstein and Horioka, 1980), one should investigate actual capital mobility *relative* to what is optimal. The mobility measure is derived from the current account, which, from the balance of payments identity, is equal to capital flows including changes in reserves. By means of the consumption smoothing approach and the underlying assumption of the open economy permanent income hypothesis, one can construct a benchmark, or optimal, time series of the current account. Then capital mobility can be gauged by comparing the derived optimal

series with the actual series.

The optimal current account series is defined as the present discounted value of expected changes in *national cash flow*, where national cash flow is an income measure defined as output less government consumption less investment. When expectations about future national cash flow change, the optimal current account adjusts such that consumption is identical to the country's permanent national cash flow. This is referred to as full consumption smoothing behavior. Under the open economy permanent income hypothesis and the assumption of perfect capital mobility, the optimal and actual current account series should be identical.

If the variance or standard deviation of the actual current account is lower than the optimal, this indicates suboptimally low capital mobility, since agents have not been able to fully smooth their consumption. This suggests the presence of effective barriers to international capital movements. On the other hand, a higher standard deviation of the actual current account relative to the optimal current account indicates more mobility than is necessary for full consumption smoothing. Such outcome may suggest that speculation is the driving force behind capital flows (see Ghosh, 1995). Thus, seemingly small absolute capital flows are not necessarily an indication of too low mobility, nor seemingly large flows of too high mobility. The measure of mobility is obtained by comparing the actual flow with the hypothesized optimal flow. More formally, this is done by forming the variance or standard deviation ratio between the optimal and actual current account series, and then test whether it is

significantly different from unity.

The empirical approach, which involves vector autoregression and cointegration analysis, also follows mainly Ghosh (1995) and Ghosh and Ostry (1995).<sup>2</sup> However, in contrast to their studies as well as previous ones, the Johansen (1988) procedure is used when doing the cointegration analysis. This procedure allows for testing restrictions on the cointegrating space. Another refinement is the use of bootstrap simulations in making inference from the correlation and standard deviation ratio summary-statistics.<sup>3</sup> The bootstrap technique is applied, not to obtain standard errors as in Makrydakis (1999), but instead to construct confidence intervals.<sup>4</sup> Moreover, some important modifications of the standard bootstrap procedure, due to Kilian (1998), are made.

Previous studies using the consumption smoothing approach to test the degree of capital mobility have been done for countries with very different degrees of access to world capital markets. Ghosh (1995) concludes that for Japan, Germany, the United Kingdom, and Canada, capital mobility since World War II has been excessive, perhaps due to the presence of speculative forces.<sup>5</sup> Ghosh and Ostry (1995) find that

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<sup>2</sup> The empirical method is originally due to Campbell (1987) and Campbell and Shiller (1987).

<sup>3</sup> The suggestion to use Monte Carlo simulations in this framework is originally due to Hodrick (1992).

<sup>4</sup> Makrydakis' (1999) approach follows the guidelines of Hodrick (1992) and Hardouvelis (1994).

<sup>5</sup> The United States is the only country in Ghosh's study where the ratio of variances of the optimal and actual current account is not significantly different from unity.

for the majority of the 45 developing countries in their postwar sample, optimal and actual current account time series move closely together, suggesting that capital is mobile enough to allow for full consumption smoothing behavior, and that effective barriers to mobility are relatively low. Similar results for other countries are obtained by Makrydakis (1999) and Hussein and de Mello Jr. (1999). Otto (1992), Cashin and McDermott (1998), and Agénor et al. (1999) also compare variances but conduct no tests on them. Of the studies done so far, covering more than 50 countries, none has been able to reject the capital mobility null hypothesis of a variance (or standard deviation) ratio equal to unity, and conclude that mobility has been suboptimally low. For all countries, the results have indicated an optimal-actual ratio equal to or significantly smaller than unity, which in a consumption smoothing sense can be interpreted as enough or excessive mobility, respectively.<sup>6</sup>

In addition to the empirical evidence of excessive capital mobility, many countries have recently experienced severe financial crises that have been to some extent worsened by the resulting massive capital flows. Thus, considering both the results of previous empirical research and the recent financial crises, the question whether completely deregulated capital markets are optimal at all times is motivated. Of course, the intertemporal consumption smoothing approach is based on many simplifying assumptions, which may not be valid. Furthermore, older approaches, the

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In some countries under study, the ratio had an estimated value greater than unity. In those cases, however, the null hypothesis of a ratio equal to unity could not be rejected.

most famous being Feldstein and Horioka's (1980), suggest that international capital mobility amongst the major industrialized nations may be severely limited.<sup>7</sup> Also, if the consumption smoothing current account model is to produce satisfactory results, it should be able to predict suboptimally low capital mobility when the true mobility is low. Since the model has been applied to countries with very restricted markets, as well as to countries with a lower degree of regulation, but in general has indicated that capital has been at least mobile enough to allow for full consumption smoothing, it seems possible that the model systematically overstates the degree of mobility. From this perspective, it is especially interesting to apply the model to China, since the country was perhaps the most closed economy in the world during the first half of the sample period (1958-78), and was undergoing gradual liberalization in the second half (1979-98).

Besides the studies already mentioned, similar work has also been done by Shefrin and Woo (1990), although they did not specifically focus on the capital mobility issue. For a general survey of the theory and empirical results in this area, the reader should consult Obstfeld and Rogoff (1995, 1996). The rest of the paper is organized as follows. The next section outlines the theory for deriving and estimating the optimal current account. Section 3 reports the empirical estimation and results of tests of the model. Section 4 draws conclusions.

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For a discussion and criticism of the Feldstein-Horioka (1980) approach and other methods, see for instance Ghosh (1995) and Ghosh and Ostry (1995).

## 2. Theory

The current account is defined as the change in the country's net claims on the rest of the world, i.e., the change in its net foreign assets. In the balance of payments accounts, this is identically equal to capital flows including changes in reserves. Under the open economy permanent income hypothesis and the assumption of perfect capital mobility, the current account then serves as a buffer to smooth consumption in the face of expected shocks to national cash flow.

In deriving the benchmark series in line with these assumptions, the framework of Sachs (1982) is followed. Consider an open economy that produces a single tradable good. The economy is small in the sense that it faces a given real world interest rate. Normalizing population to 1, the single infinitely-lived consumer's preferences are given by

$$U_t = E_t \left\{ \sum_{s=t}^{\infty} \beta^{s-t} u(C_s) \right\} \quad 0 < \beta < 1 \quad (1)$$

where  $E_t$  is the conditional expectations operator;  $\beta$  is the subjective discount factor;  $u(\cdot)$  is the instantaneous utility function; and  $C_s$  denotes consumption of the single good. Assuming a constant real interest rate,  $r$ , the economy's budget constraint is given by

$$B_{t+1} = (1 + r)B_t + Q_t - C_t - G_t - I_t, \quad (2)$$



which, upon rearrangement, gives

$$CA_t = B_{t+1} - B_t = rB_t + Q_t - C_t - G_t - I_t, \quad (3)$$

where  $CA_t$  is the current account;  $B_{t+1}$  is the economy's net foreign assets at the end of period  $t$ ;  $rB_t$  is interest earned on previously acquired assets;  $Q_t$  is the level of output;  $G_t$  is the level of government consumption; and  $I_t$  is the level of investment.<sup>8</sup>

The problem, then, is to maximize (1) subject to (2), with a transversality condition imposed. To obtain a simple and empirically tractable closed form solution for consumption, a quadratic form for the utility function is posited, and it is assumed that  $\beta(1+r) = 1$ . The solution is

$$C_t = rB_t + \frac{r}{1+r} \left[ \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} E_t(Z_s) \right], \quad (4)$$

where

$$Z_s = Q_s - G_s - I_s. \quad (5)$$

Thus,  $Z_s$  is defined as national cash flow.

The small country assumption implies that output and investment may be treated as exogenous to the consumption decision. With a given interest rate, the country undertakes investment independently of domestic consumption-preferences up to the

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<sup>8</sup>

The model assumes that a riskless bond is the only internationally traded asset.

point where the marginal product of capital equals the world interest rate. Hence, investment and output are chosen independently of consumption. Government consumption is assumed to be exogenous as well.

Equation (4) is an open economy version of the permanent income hypothesis. It states that the country's consumption is equal to its permanent national cash flow, or annuity value of wealth, and as such it captures the notion of consumption smoothing. As Campbell (1987) points out, another way to see this is to express the hypothesis in terms of saving, here captured by the current account. Substitute (4) into (3) and rearrange the terms such that

$$CA_t = - \sum_{s=t+1}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} E_t \Delta Z_s, \quad (6)$$

where  $\Delta Z_s = Z_s - Z_{s-1}$ . Thus, according to the intertemporal consumption smoothing approach, the current account is equal to minus the expected present discounted value of all future changes in national cash flow. Obviously, the prospects of future positive changes in national cash flow imply that today's current account goes into deficit, since agents borrow in order to smooth consumption over time. Conversely, if agents expect future declines in national cash flow, the current account goes into surplus. This is also consumption smoothing behavior, or equivalently, as Campbell puts it, people save "for a rainy day".

Campbell (1987) and Campbell and Shiller (1987) develop an empirical method to estimate  $E_t \Delta Z_s$  and test the validity of (6), as follows. Note first that the current

account can be written as

$$CA_t = rB_t + Z_t - C_t = \begin{bmatrix} 1 & 1 & -1 \end{bmatrix} \begin{bmatrix} rB_t \\ Z_t \\ C_t \end{bmatrix} = \begin{bmatrix} \delta_1 & \delta_2 & \delta_3 \end{bmatrix} X_t = \delta' X_t. \quad (7)$$

Next, assume that  $Z_t$  is stationary in first differences. Then it follows from (6) that  $CA_t$  is stationary in levels, since it is a linear combination of expected changes in  $Z_t$ . According to (7), given that  $rB_t$  and  $C_t$  are stationary in first differences, the vector  $X_t$  must then be cointegrated, and  $\delta$  is the cointegrating vector. Since  $X_t$  is cointegrated, by the Granger representation theorem (see Engle and Granger, 1987), there exists an error correction representation

$$\Delta X_t = m + LB(L)\Delta X_t + \gamma\delta'X_{t-1} + \varepsilon_t, \quad (8)$$

where  $m$  is a  $3 \times 1$  vector of intercept terms;  $B(L)$  is a matrix polynomial in the lag operator;  $\gamma$  is a  $3 \times 1$  speed of adjustments vector and  $\varepsilon_t$  is a  $3 \times 1$  vector of white noise disturbances. Using (8) for forecasting purposes involves the cumbersome recursive updating of  $X_{t-1}$ . Fortunately, this problem can be circumvented by transforming (8) into the vector autoregression (VAR)

$$\begin{bmatrix} \Delta C_t \\ \Delta Z_t \\ CA_t \end{bmatrix} = c + LA(L) \begin{bmatrix} \Delta C_t \\ \Delta Z_t \\ CA_t \end{bmatrix} + G\varepsilon_t, \quad (9)$$

where

$$G = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ \delta_1 & \delta_2 & \delta_3 \end{bmatrix}, \quad (10)$$

and

$$c = Gm. \quad (11)$$

Ooms (1994) provides a proof of this transformation. Using Hall's (1978) well known result that consumption in this setting follows a martingale, it follows that the first equation in (9) is redundant. Thus, (9) reduces to a VAR in  $(\Delta Z_t, CA_t)$ . This is the empirical model from which the forecast of changes in national cash flow,  $E_t \Delta Z_s$ , is obtained. Given that the data is annual and that the sample is relatively small, this forecast is assumed to be based on the first-order VAR

$$\begin{bmatrix} \Delta Z_t \\ CA_t \end{bmatrix} = \begin{bmatrix} \Psi_{11} & \Psi_{12} \\ \Psi_{21} & \Psi_{22} \end{bmatrix} \begin{bmatrix} \Delta Z_{t-1} \\ CA_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}, \quad (12)$$

where the means of  $\Delta Z_t$  and  $CA_t$  have been removed. The main interest in (12) concerns the regression in which  $\Delta Z_t$  is the dependent variable. It is the present discounted value of all date  $t$  forecasts of this variable, conditional on the agent's full information set, that will determine the optimal date  $t$  current account. That is, according to (6), future expected changes in national cash flow are reflected in today's current account. Then, intuitively, not only will past values of  $\Delta Z_t$  be important in determining current changes in the variable, but also past values of  $CA_t$  should help to predict current changes in national cash flow, since it may contain additional information. Hence, an implication of the model is that the current account should Granger cause changes in national cash flow.

The date  $t$  forecast of a future one period change in national cash flow is then

$$E_t \Delta Z_s = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} \Psi_{11} & \Psi_{12} \\ \Psi_{21} & \Psi_{22} \end{bmatrix}^{s-t} \begin{bmatrix} \Delta Z_t \\ CA_t \end{bmatrix} = \begin{bmatrix} 1 & 0 \end{bmatrix} \Psi^{s-t} \begin{bmatrix} \Delta Z_t \\ CA_t \end{bmatrix}, \quad (13)$$

where  $\Psi$  is the  $2 \times 2$  matrix of coefficients,  $\Psi_{ij}$  ( $i, j = 1, 2$ ). Substituting this into (6), and simplifying, the result is

$$\widehat{CA}_t = - \begin{bmatrix} 1 & 0 \end{bmatrix} \left( \frac{1}{1+r} \Psi \right) \left( I - \frac{1}{1+r} \right) \Psi^{-1} \begin{bmatrix} \Delta Z_t \\ CA_t \end{bmatrix} =$$

$$\begin{bmatrix} \Phi_1 & \Phi_2 \end{bmatrix} \begin{bmatrix} \Delta Z_t \\ CA_t \end{bmatrix} = \Phi' \begin{bmatrix} \Delta Z_t \\ CA_t \end{bmatrix}, \quad (14)$$

where  $I$  is the  $2 \times 2$  identity matrix. Hence, each element in  $\Phi$  is a non-linear function of the underlying VAR parameters. Equation (14) defines the optimal current account series,  $\widehat{CA}_t$ , which can be compared to the actual series,  $CA_t$ . Under the open economy permanent income hypothesis and the assumption of perfect capital mobility, the two series should be identical. That is, if the model is true it follows that

$$\widehat{CA}_t = \begin{bmatrix} 0 & 1 \end{bmatrix} \begin{bmatrix} \Delta Z_t \\ CA_t \end{bmatrix} = CA_t. \quad (15)$$

Thus, the parameter restrictions can be written

$$\begin{bmatrix} 0 & 1 \end{bmatrix} = - \begin{bmatrix} 1 & 0 \end{bmatrix} \left( \frac{1}{1+r} \Psi \right) \left( I - \frac{1}{1+r} \Psi \right)^{-1}, \quad (16)$$

or, equivalently, by postmultiplying by  $(I - \frac{1}{1+r} \Psi)$ ,

$$\begin{aligned} \begin{bmatrix} 0 & 1 \end{bmatrix} \left( I - \frac{1}{1+r} \Psi \right) &= - \begin{bmatrix} 1 & 0 \end{bmatrix} \left( \frac{1}{1+r} \Psi \right) \\ &\iff \\ \begin{bmatrix} \Psi_{21} & (\Psi_{22} - (1+r)) \end{bmatrix} &= \begin{bmatrix} \Psi_{11} & \Psi_{12} \end{bmatrix}. \end{aligned} \quad (17)$$

In sum then, the model derived in this section sets the following agenda for the empirical estimation. First, to verify that national cash flow is stationary in first differences and that the current account time series is cointegrated, unit root and

cointegration analyses are performed. Next, the VAR is estimated, and Granger causality of the current account is tested for. By means of the estimated VAR parameters, the optimal current account series according to (14) is calculated, and then compared with the actual current account series. It follows that if capital is mobile enough to allow for full consumption smoothing behavior, the correlation between and standard deviation ratio of the optimal and actual current account series should both equal unity. This is tested for by means of bootstrapping. Finally, if the overall model is correct, it also follows that the linear restrictions in (17) must hold. This is tested for by means of a Wald test.

### **3. Empirical estimation and results**

Annual national account data from China's National Bureau of Statistics is used, and all variables are expressed in 1978 yuan per capita. Further details concerning the data are provided in the appendix. The full estimation period runs from 1958 to 1998. The period of liberalization (1979-98) is of course of special interest, and is therefore studied separately, but to be complete and to be able to compare results, the model is also estimated for the pre-reform period (1958-78).

The first step in the empirical analysis is to verify that all involved variables have the required order of integration. For practical implementation of the cointegration analysis, the approach is to rewrite the current account as

$$CA_t = V_t - C_t = \begin{bmatrix} 1 & -1 \end{bmatrix} \begin{bmatrix} V_t & C_t \end{bmatrix}', \quad (18)$$

where  $V_t$  is *total* national cash flow, defined as  $GNP_t - G_t - I_t$ .<sup>9</sup> Accordingly, it is necessary to verify that  $V_t$  and  $C_t$  are both individually I(1) and that the restricted cointegration vector in (18) holds such that  $CA_t$  is I(0). In addition, the model also assumes that  $Z_t$  is I(1). To verify the order of integration of the series  $V_t$ ,  $C_t$ , and  $Z_t$ , augmented Dickey-Fuller (ADF) tests are performed (for details, see Dickey and Fuller, 1981). First, models with 4 lags of the first difference of the dependent variable are estimated. Then, if possible, lags are reduced according to model reduction criteria, which are mainly F-tests for lag reduction and Lagrange Multiplier tests for residual autocorrelation. Table 1 displays the test results. For each variable, the null hypothesis of a unit root cannot be rejected. The ADF test for a unit root in the first difference of each variable is also performed. Now the null is rejected, except for  $\Delta Z_t$  in the period 1979-98. However, the null can safely be rejected at 10 percent, and given the short sample and that it is well-known that the power of the ADF test is low, it seems reasonable to assume that  $Z_t$  is I(1).

The next step is to test whether the restricted cointegrating vector  $(1, -1)$  in (18) holds such that  $CA_t$  is I(0). This analysis is conducted by means of the Johansen (1988) procedure; the results are provided in Table 2. The null hypothesis is that

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Differently put,  $V_t$  is equal to the sum of national cash flow,  $Z_t$ , and interest earned on previously acquired foreign assets,  $rB_t$ .



the specified vector  $(1, -1)$  forms a cointegrating relation, i.e., that the cointegrating rank equals one. As the table shows, it is not possible to reject the null in any of the time periods. In sum then, the results from the unit root and cointegration analyses indicate that  $C_t$ ,  $Z_t$ , and  $V_t$  are stationary in their first differences, while  $CA_t$  is stationary in levels.

Table 3 shows the main results of the VAR analysis. Note that the parameter estimates for the whole period and for the period 1979-98 are very similar. By contrast, the estimates for the period 1958-78 differ, especially for  $\Psi_{12}$ . The reason is that, although the current account moves and is different from zero in the pre-reform period, the magnitude of the movements in the liberalization period is much larger. The table also shows the results of the test that  $CA_{t-1}$  Granger-causes  $\Delta Z_t$ . For the full period and for the period 1979-98, it is possible to reject the null of non-Granger causality at the 7.8 percent level of significance. At first sight, the corresponding test for the period 1958-78 appears stronger, since it is possible to reject the null at 4.5 percent. However, this result is not in accordance with the model, since according to equation (6)  $CA_t$  predicts future *declines* in  $\Delta Z_t$ . The sign of  $\widehat{\Psi}_{12}$  for the period 1958-78 is positive, contradicting this prediction. By contrast, during the period 1979-98 the implication of the consumption smoothing model is satisfied, since  $CA_{t-1}$  negatively Granger-causes  $\Delta Z_t$ .

The VAR parameters are used to derive the optimal current account time series. Following Sheffrin and Woo (1990), results are presented for two different cases,

one based on an interest rate of 4 percent per year, and the other based on a rate of 14 percent.<sup>10</sup> By visually comparing the optimal and actual series, it is possible to assess the model's performance and the mobility of China's international capital. Figure 1 shows the actual and optimal series for each of the two subperiods. As expected, the model performs miserably during the period 1958-78, and the optimal current account differs substantially from the actual current account. But there is dramatic improvement following the liberalization in 1979. Since then, the optimal current account seems to have done a pretty good job in capturing the shifts of the actual series. Still though, both of the optimal series, especially the one based on the 4 percent interest rate, are more volatile compared to the actual current account. Thus, the visual evidence suggests that, although China has undergone much liberalization since 1979, there are still effective barriers to the country's international capital mobility.

The tests of the model confirm the visual analysis. Table 4 reports the estimated ratios of standard deviations of and correlations between the optimal and actual current account series. As Makrydakis (1999) points out, since the optimal current account is based on a forecast, there might be significant small sample bias inherent in statistics stemming from it. Therefore, to reduce the possibility of erroneous conclusions, bootstrapping is used in order to make inference about capital mobility

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<sup>10</sup>

Sheffrin and Woo's use of a 14 percent rate of interest stems from Bernanke's (1985) study of consumption-income relations.

from the estimated standard deviation ratios and correlation coefficients.

However, while Makrydakis (1999) use bootstrapping to obtain standard errors, the approach in this paper is different. As pointed out by Efron and Tibshirani (1993), using standard normal theory assumptions to make inference based on the bootstrap estimate of standard error may lead to erroneous conclusions, especially if the sample is small, so that the resulting bootstrap histogram is non-normal. In that case, it is better to use the percentiles of the bootstrap histogram to construct confidence limits. In a VAR framework, caution with respect to bias in the ordinary least-squares estimates has to be taken before calculating these percentiles, a point that is emphasized by Kilian (1998). To take this into account, he develops a bias correcting “bootstrap-after-bootstrap” method, which is made use of here. The method is basically divided into two parts. First, based on 1000 artificial series of  $\Delta Z_t$  and  $CA_t$ , 1000 bootstrap replications of each VAR parameter are obtained in order to estimate and correct for bias in each of the original parameters.<sup>11</sup> Then, by use of these bias corrected VAR estimates, another 2,000 artificial series of  $\Delta Z_t$  and  $CA_t$  are produced. For each series of  $\Delta Z_t$  and  $CA_t$ , the four VAR parameters are estimated and, again, bias corrected. Then, the ratio of standard deviations and correlation of the optimal and actual current account series are calculated. Repeating

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<sup>11</sup>

This is done by means of sampling with replacement from the original VAR residuals. To initialize the procedure, two initial observations are randomly selected using the block method of Stine (1987).

this procedure yields 2000 estimated standard deviation ratios and correlation coefficients. Finally, 95 percent confidence intervals are constructed from the percentile interval endpoints of the two resulting empirical distributions.<sup>12</sup> These endpoints are printed within brackets beneath the corresponding statistic in Table 4.

Under the null hypothesis of full consumption smoothing behavior the correlation and standard deviation ratio should both equal unity. From the table it is evident that, irrespective of which interest rate used, the null is not contained in the confidence interval for the standard deviation ratio, not even for the 1979-98 period. Since the calculated confidence intervals only contain ratios that are greater than unity, this suggests that capital mobility has been suboptimally low. The confidence intervals for the correlations also do not contain the null. Note that, for any given time period, the correlation coefficients and their corresponding confidence intervals are quite similar under both interest rates. By contrast, the precision with which the standard deviation ratios are estimated in the different periods greatly improves in the 14 percent interest rate case. In general, the model seems to work a little better with the higher interest rate.

Finally, Table 4 also reports the formal test of the whole model. If the con-

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Kilian (1998) applies the bootstrap-after-bootstrap algorithm to obtain confidence intervals for impulse response functions. Besides the brief description given here, the algorithm also involves a stationarity correction if the modulus of the largest root of the involved VAR companion matrices is greater than or equal to unity. For complete details of the bootstrap-after-bootstrap method and for proof of its asymptotic validity, see Kilian's paper.

sumption smoothing model is true, the restrictions in (17) hold, and it follows that  $\Phi' = (0, 1)$  such that the optimal current account is equal to the actual current account. The Wald test of these restrictions for each period and interest rate is presented in the bottom row of the table. It is evident that, regardless of which period and interest rate one chooses to look at, the restrictions implied by model are strongly rejected.

#### 4. Conclusions

The visual and statistical evidence presented in this paper indicate that the consumption smoothing model is rejected. Specifically, using interest rates of 4 and 14 percent, estimated standard deviation ratios of the optimal and actual current account series are significantly greater than unity, even during the period of liberalization (1979-98). Thus, the capital mobility hypothesis of a standard deviation ratio equal to unity is rejected, and the results suggest that there are still effective barriers to China's international capital movements. Among the approximately 50 countries studied so far by means of the intertemporal consumption smoothing approach to the current account, China stands out as the only country where such a result has been obtained. This may make sense, however, since the country was a more or less closed economy for the first half of the sample period, and was undergoing gradual liberalization in the second half.

Comparing the standard deviation ratios for the periods 1958-78 and 1979-98 in Table 4, it is obvious that they are considerably smaller in the latter period.

Also, from the optimal and actual current account series over the period 1979-98 displayed in Figure 1, it is visually evident that the optimal current account captures most shifts of the actual current account. A possible interpretation is hence that international capital mobility has indeed increased dramatically during the past two decades, but is still persistently suboptimal due to remaining effective barriers.

Although the model fails statistically, the results lend support to the intertemporal consumption smoothing approach in the sense that it is now evident that the model is capable of predicting in all directions, either indicating that capital mobility has been excessive, as in Ghosh (1995); or that it has been in line with full consumption smoothing, as for instance in Hussein and de Mello Jr. (1999); or that it has been suboptimally low, as in this paper. Given this model and its assumptions, the message then appears to be that, in order to experience suboptimally low capital mobility, one needs to have severe restrictions, such as currency inconvertibility under the capital account.<sup>13</sup> Partial controls do not necessarily imply restrictions to smooth consumption optimally. In fact, less restrictive controls may even lead to excessive capital flows.

However, it must be emphasized that there are many simplifying assumptions underlying this model, and hence several joint hypotheses that are subject to the

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<sup>13</sup>

In 1997, the Chinese government announced the goal of achieving capital account convertibility by the year 2000. Due to the Asian economic crisis, the timetable has changed, and the government now emphasizes a “gradual” liberalization (Groombridge, 2000).

tests, and model rejection can thus not be attributed to any single element. Remember that, besides perfect capital mobility and consumption smoothing behavior, assumptions include a single tradable good, a constant interest rate, quadratic utility, and exogenous government expenditure in a very simple setup. Deeper insights on capital mobility issues in this framework will require relaxation of these assumptions and further research.

## Appendix A: Data definitions

The annual data used in this paper is taken from *The Historical National Accounts of the People's Republic of China 1952-1995* and *China Statistical Yearbook 1999*. All data is expressed in 100 million yuan and converted into real terms per capita by dividing by the implicit GDP deflator (1978=100) and population. The usual definitions apply, with one small exception. In the data set, the following is an accounting identity:

$$GDP_t - D_t \equiv Q_t \equiv C_t + I_t + G_t + NX_t, \quad (\text{A.1})$$

where  $GDP_t$  is the gross domestic product,  $Q_t$  is the gross domestic expenditure (or, in China, GDP by expenditure approach),  $C_t$  is private consumption,  $I_t$  is of investment,  $G_t$  is government consumption, and  $NX_t$  is net exports of goods and services.  $D_t$  is a positive or negative discrepancy, defined as  $GDP_t - Q_t$ , resulting from the transformation of data in the Chinese Material Product System (MPS) into the System of National Accounts (SNA). In practice,  $D_t$  is small, in general below 3 percent of GDP, with an average of 0.13 percent of GDP. For complete details of the estimation, sources of the aggregates, and the transformation from MPS to SNA, the reader should consult the first of the publications mentioned above.

Besides the aggregates in (A.1), gross national product,  $GNP_t$ , is also given in the data set. The current account is then defined as in (18), i.e.,

$$CA_t = GNP_t - G_t - I_t - C_t. \quad (\text{A.2})$$



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Variable	1958-98		1958-78		1979-98	
	ADF	LM	ADF	LM	ADF	LM
$C_t$	3.94	1.04	-1.59	3.43	3.12	1.24
$Z_t$	7.67	0.60	-1.77	3.33	2.91	0.08
$V_t$	7.30	0.45	-1.77	3.33	9.01	0.08
$\Delta C_t$	-3.74*	0.27	-6.40**	2.26	-3.69*	0.88
$\Delta Z_t$	-3.79*	0.60	-6.38**	2.06	-3.33	0.34
$\Delta V_t$	-4.58**	2.05	-6.38**	2.06	-3.81*	0.22

Table 1: Augmented Dickey-Fuller (ADF) tests. Notes: LM is the Lagrange multiplier test for residual correlation from lags 1 to 2. \*\* indicates rejection at the 1 percent level of significance. \* indicates rejection at the 5 percent level of significance.

$\mathbf{H}_0: rank = 1$	1958-98	1958-78	1979-98
$\chi^2$	2.37	2.03	0.50
p-value	0.12	0.15	0.48

Table 2: Restricted cointegration tests.

	1958-98	1958-78	1979-1998
$\widehat{\Psi}_{11}$	0.935 (0.091)	0.576 (0.177)	0.927 (0.105)
$\widehat{\Psi}_{12}$	-0.825 (0.468)	3.721 (1.856)	-0.834 (0.473)
$\widehat{\Psi}_{13}$	0.117 (0.087)	0.053 (0.019)	0.132 (0.110)
$\widehat{\Psi}_{14}$	0.324 (0.228)	0.453 (0.128)	0.316 (0.227)
$\chi^2_{Granger}$	3.11	4.02	3.10
p-value	0.078	0.045	0.078

Table 3: Estimated VAR parameters. Notes: The standard errors (within parentheses) are White (1980) heteroscedastic consistent.  $\chi^2_{Granger}$  is the test statistic for the null hypothesis that  $CA_{t-1}$  non-Granger causes  $\Delta Z_t$ .



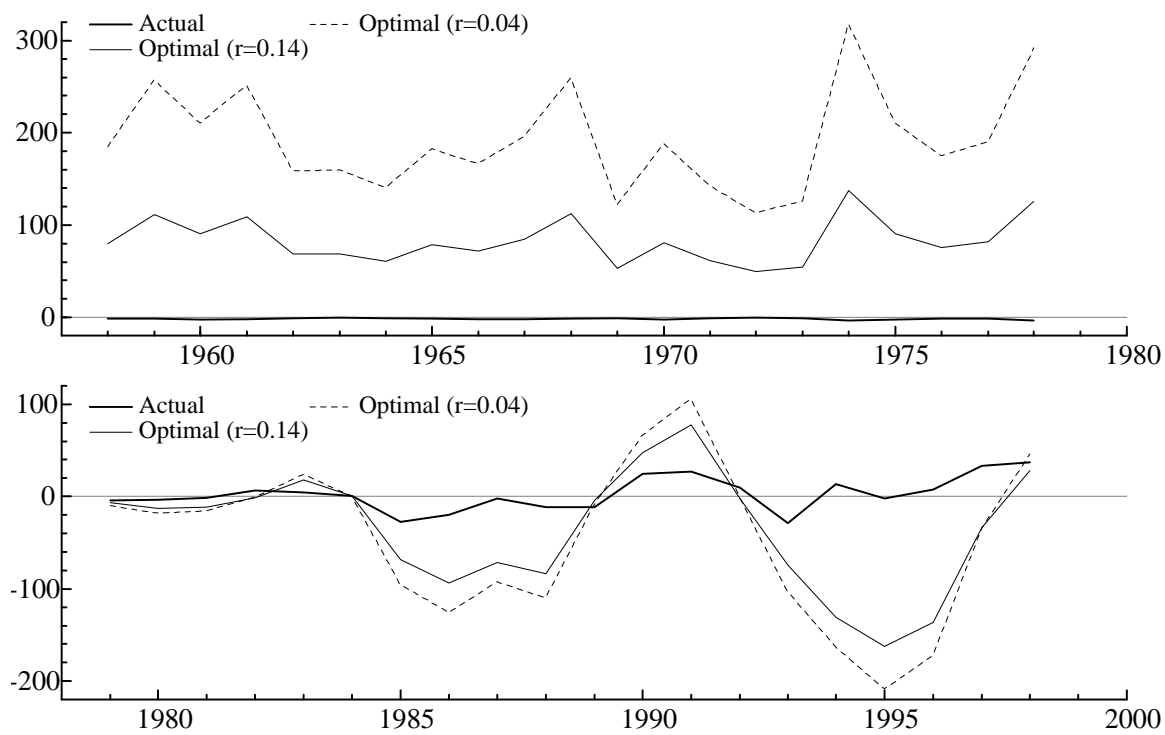


Figure 1: Optimal and actual current account series. Upper panel: 1958-78. Lower panel: 1979-98.

	1958-98		1958-78		1979-98	
	4%	14%	4%	14%	4%	14%
<i>Ratio</i>	6.45*	4.83*	64.35*	27.76*	4.62*	3.52*
	[2.34 26.37]	[1.89 13.40]	[7.32 180.33]	[11.10 63.18]	[1.48 36.0]	[1.28 14.42]
<i>Corr</i>	0.27*	0.23*	-0.80*	-0.79*	0.48*	0.44*
	[-0.36 0.73]	[-0.38 0.68]	[-0.99 -0.49]	[-0.99 -0.46]	[-0.53 0.89]	[-0.43 0.84]
$\chi_W^2$	75.2**	78.2**	88.5**	90.3**	46.0**	48.4**

Table 4: Tests of the model. Notes: *Ratio* is the estimated ratio of standard deviations of the optimal and actual current account series. *Corr* is the estimated correlation between the optimal and actual current account series.  $\chi_W^2$  is the Wald test statistic of the restrictions implied by the model. The numbers within brackets are the 95 percent confidence interval endpoints for each statistic, constructed from the bootstrap simulations. \*\* indicates rejection at the 1 percent level of significance. \* indicates rejection at the 5 percent level of significance.