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MTID Discussion Paper No. 81

Exchange Rate Misalignment and Its Effects on Agricultural Producer Support Estimate: Empirical Evidence from India and China

Fuzhi Cheng and David Orden

2033 K Street, NW, Washington, DC 20006-1002 USA • Tel.: +1-202-862-5600 • Fax: +1-202-467-4439 • ifpri@cgiar.org
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ABSTRACT

There have been different degrees of exchange rate disequilibrium in the developing countries during transition or reform periods since the mid 1980s. The level of the exchange rate and its misalignment can have significant impacts on agricultural policy measures such as Producer Support Estimates (PSEs). In the conventional PSE analysis, however, the actual (nominal) exchange rates are used. There is general agreement that the use of actual exchange rates may introduce a bias in the PSE calculations, and that this bias can be substantial in some cases. But there is less agreement on the most appropriate alternative.

In this study, we utilize various time series techniques to derive estimates of the equilibrium exchange rates in India and China from the 1970s to 2002 as determined by real economic fundamentals. The relevance and usefulness of the equilibrium exchange rates in the calculation of PSE for the two countries are then discussed. Drawing on the data sets and analyses developed earlier by Mullen, Orden and Gulati (2005) and Sun (2003), we find that agricultural support levels measured by the PSEs (from 1985-2002 for India and from 1995-2001 for China) are sensitive to alternative exchange rate assumptions. Specifically, exchange rate misalignments have either amplified or counteracted the direct effects from sectoral-specific policies. In India, such indirect effects are relatively small and mostly dominated by the direct effects. But in China, especially in recent years, the indirect effect from exchange rate misalignment (undervaluation) has been quite substantial.

Results from this study also show that the effect of the exchange rate depends on the relative importance of different PSE components. The increasing share of budgetary expenditures in India’s total agricultural support in recent years has resulted in more pronounced exchange rate effects measured by commodity-specific percentage “PSEs” that use the value of production at international prices as the denominator compared to those measured by commodity-specific percentage Market Price Support (MPS) with the

same denominator. For China, the exchange rate effects are more similar between the PSE and the MPS measures because budgetary expenditures have been relatively small.

The exchange rate effect when the PSE is “scaled up” from covered commodities to an estimate for the total agricultural sector is also demonstrated. Since the commodity coverage in both countries tends to be incomplete and the scaling-up procedure leads to a total MPS of greater magnitude, larger exchange rate effects are found in the scaled-up than the non-scaled-up version of total PSEs. The impact of scaling-up on the indirect effect is proportional to the share of covered commodities in the total value of agricultural production.

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ACRONYMS

API	Agricultural Policy Indicator
AD	Authorized Deal
BEER	Behavioral Equilibrium Exchange Rate
CPI	Consumer Price Index
FDI	Foreign Direct Investment
FEER	Fundamental Equilibrium Exchange Rate
GOI	Government of India
LERMS	Liberalized Exchange Rate Management System
LOOP	Law of One Price
MPS	Market Price Support
MMPO	Milk and Milk Products Order
MSP	Minimum Support Price
NATREX	Natural Real Exchange Rate
NRP	Nominal Rate of Protection
OECD	Organization for Economic Cooperation and Development
PPP	Purchasing Power Parity
PSE	Producer Support Estimate
QR	Quantitative Restriction
RBI	Reserve Bank of India
STE	State Trading Enterprise
TRQ	Tariff Rate Quota
UIP	Uncover Interest Parity
VEC	Vector Error Correction
WPI	Wholesale Price Index

EXCHANGE RATE MISALIGNMENT AND ITS EFFECTS ON AGRICULTURAL PRODUCER SUPPORT ESTIMATES: EMPIRICAL EVIDENCE FROM INDIA AND CHINA

Fuzhi Cheng and David Orden[1]

1. INTRODUCTION

Agricultural policies in the developing countries play a very important role in determining domestic commodity prices and the returns to agriculture. The nature and degree of the policy interventions differ across countries thereby producing different types of impact on producers and consumers. Various agricultural policy indicators (API) have been constructed to evaluate and monitor these policy changes (Josling and Valdes, 2004). A problem with conventional analyses based on the APIs, however, is that they usually have a sector-specific focus that can miss the important linkages between economy-wide policies and the agricultural sector. By changing the relative prices of importables, exportables, and home goods, some economy-wide policies, such as the exchange rate policies, can have impacts on agricultural incentives that might overwhelm those from sectoral policies. The different effects of sectoral and economy-wide policies on agriculture in the developing countries were documented in a classic series of studies by Krueger, Schiff and Valdes (1988 and 1991).

One feature of these early studies is that their analyses were based on the effect of exchange rates on agricultural price distortions, measured by the nominal rate of protection (NRP) or market price support (MPS). However, other types of incentives to agriculture exist such as the direct payments to farmers. For some countries, it has become evident that the analysis of agricultural support would be incomplete without consideration of the influence of government outlays on farmers' returns in the form of capital grants, input subsidies, and various other transfers involving government

[1] Consultant and Senior Research Fellow, respectively, Markets, Trade and Institutions Division, International Food Policy Research Institute, 2033 K Street NW Washington, D.C. 20006. E-mail: f.cheng@cgiar.org and d.orden@cgiar.org.

expenditure (Josling and Valdes, 2004). When both price and non-price incentives are included in more comprehensive APIs, such as the Producer Support Estimate (PSE), the measured effects of exchange rates on agriculture will be different, and can change as the shares of different components of the API change.

The relevance of exchange rates in PSE estimates has been pointed out by a number of authors including Harley (1996), Bojnec and Swinnen (1997), and Melyukhina (2002). This issue is particularly important for the developing countries since capital surges, macroeconomic instability and subsequent financial crisis in the last two decades, together with delayed or insufficient adjustments in the exchange rates, have generated substantial exchange rate misalignments in some of these countries. Pronounced misalignments in the exchange rate could potentially subsidize or tax the agricultural sector and lead to incorrect estimates of the level and sometimes the direction of agricultural support as measured by the MPS or PSE. In these cases, the effects of exchange rate misalignments have to be taken into account if meaningful calculations of the PSE are to be presented.

While there is general agreement that the use of misaligned exchange rates introduces a bias in the PSE calculations and that this bias can be substantial in some cases, there is much less agreement on the most appropriate alternative. The problem arises from the fact that it is fundamentally difficult to determine the equilibrium value of an exchange rate. A number of previous studies (e.g. Liefert, et al., 1996; Shick, 2002) have used effective exchange rates or purchasing power parity (PPP) exchange rates as the "equilibrium" exchange rates in their PSE calculations, and the findings from these studies generally indicate that alternative assumptions about exchange rates have significant impacts on the PSEs. Despite their plausible results, the calculations based on the PPP involve a high degree of discretion and the results are usually sensitive to the selection of a base year. Other models of equilibrium exchange rates are potentially preferred to the PPP approach in the PSE estimations (Harvey, 1996).

More recently, the single equation approach that relates the equilibrium exchange rate with economic fundamentals have gained prominence and been frequently used by both practitioners and policy makers to address issues of exchange rate misalignment and to test for over- or under-valued currencies. The current study, as part of a larger IFPRI project to compute PSEs for selected Asian developing countries, attempts to use the single equation approach of exchange rate determination and identify the relevance and usefulness of the equilibrium exchange rate in the PSE calculations.[2] We focus our analysis on two world's largest developing economies, India and China, where issues of exchange rate misalignment and the effects on the agricultural support have been important but nonetheless received little attention. This study is based on the agricultural support data sets and analyses developed earlier by Mullen, Orden and Gulati (2005) for India and Sun (2003) for China and draws on a common OECD PSE methodology with some modifications for use in a developing country context.

Using contemporary time series techniques including the unit root and Johansen cointegration procedures, long-run relationships are identified between the real exchange rate and the economic fundamentals in India and China for the period from the 1970s to 2002. The cointegration results are further used to generate measures of exchange rate equilibrium and misalignment for the two currencies. Our findings show that, due to poor external sector performance and depletion of foreign exchange reserves, the actual real exchange rate of the Indian rupee was overvalued in the years leading up to the financial crisis in 1991, but has since then move closer to the equilibrium. The Chinese yuan also experienced periods of misalignments which mostly consist of undervaluation. Rigid nominal exchange rates, low inflation rates, as well as strong economic fundamentals in recent years have driven up the gap between the actual and equilibrium value of Chinese currency, causing an undervaluation of about 20 percent.

The real equilibrium exchange rates in both countries are then converted to corresponding nominal rates and applied to the calculations of MPS and PSE in an effort to separate the effects of the economy-wide policies (exchange rate in this case) from agricultural policies. Our results show that the indirect effect of exchange rate

[2] Related papers are Mullen et al. (2004), Thomas and Orden (2004), Nguyen and Grote (2004), and Mullen, Orden and Gulati (2005).

misalignment measured by the commodity-specific MPS or PSE has either amplified or counteracted the direct effect to agriculture from sectoral-specific policies. In India, such indirect effects are relatively small and mostly dominated by the direct effects. But in China, especially in recent years, the indirect effect from exchange rate undervaluation has been quite substantial.

We also find that the indirect effects of exchange rate misalignment are affected by other PSE components such as the budgetary payments. The increasing importance of budgetary payments in India's agricultural support has resulted in more pronounced exchange rate effects measured by commodity-specific "%PSEs" compared to those measured by commodity-specific %MPS, when the denominator for each measure is the value of production at international prices. For China, the exchange rate effects are more similar between the PSE and the MPS measures because budgetary expenditures have been relatively small. The exchange rate effect when the PSE is "scaled up" from covered commodities to an estimate for the total agricultural sector is also demonstrated. Since the commodity coverage in both countries tends to be incomplete and the scaling-up procedure leads to a total MPS of greater magnitude, larger exchange rate effects are found in the scaled-up than the non-scaled-up version of total PSEs. The impact of scaling-up on the indirect effect is proportional to the share of covered commodities in the total value of agricultural production.

The paper is organized as follows. Section 2 provides some background information of India and China in terms of their macroeconomic environment and the agriculture sector. Section 3 reviews the existing literature on equilibrium exchange rate determination with emphasis on the single equation approach. Section 4 empirically estimates the equilibrium exchange rates of the two currencies. The equilibrium exchange rates are then applied to the MPS and PSE calculations in Section 5. Summary and conclusions are provided in Section 6.

2. ECONOMIC AND POLICY BACKGROUND

India and China are the world's two most populous countries, comprising about 40 percent of the world's total population and more than 20 percent of global agricultural GDP. The two countries started their economic reforms in the mid 1980s and the late 1970s, respectively. The primary goal of these two countries' economic reforms was to seek globalization of their relatively closed economies by opening up both trade and financial channels. Though some tentative steps toward liberalization were taken, changes in both channels were slow and uneven during the early stages of the reforms. Major progress took place in the 1990s and the last decade or so has witnessed a series of development in trade and financial sectors. Concurrent with these trends was the increased incidence of financial crises in other Asian countries, raising questions about the linkages between liberalization and economic instability. Notwithstanding the doubts, both countries continued the progress in dismantling trade restrictions and capital controls to further liberalize their economies, albeit more cautiously than in the pre-crisis period.

The liberalization has stimulated rapid economic growth in both countries but has also imposed structural adjustment pressures on the agricultural sectors. With further industrialization and urbanization, the governments of the two countries are facing the same important problem of how to assist their farmers relative to other producers. Fiscal limitations and commitments to the WTO are likely to constrain the governments from fully following the experiences of the developed countries in terms of agricultural support. Within each country, however, major reforms in sectoral and economy-wide policies have been implemented – in part to address the bias against agriculture.

2.1 OVERALL ECONOMY

Since its independence 50 years ago, India has followed a mixed economic system with a socialistic bent and extensive central planning (USDA, 2004). Basic economic activities are market driven, but dominated by the public sector and government controls. Historically, India's economy has been impaired by chronic large fiscal deficits, high inflation, and poor performance of the external sectors. India's GDP grew more strongly in the 1980s than during the 1970s following the initial reform efforts with growth rates higher in industry and service than in agriculture (Table 1). GDP has registered impressive economic growth in the 1990s after the financial crisis in 1991 and subsequent economic restructuring. In the period 1991-92 to 1996-97, GDP grew at a rate of 7.1 percent. During 1997-98 to 2003-04, GDP grew at 5.5 percent, a slight slowdown from the period immediately following new reforms brought on, among other factors, by a slowdown in public sector investments, falling world prices of most agricultural products, and the poor monsoon rains, especially in 2002-03 (Mullen, Orden and Gulati, 2005). Despite growth of the past two decades, however, India has lagged behind some of its neighbors in economic performance. India's per capita GDP was roughly equal to that of China in 1970 ($213 in real 1995 value). But by 2000, its per capita GDP ($477 real 1995 value) was only a little over half that achieved by China ($878) (Mullen, Orden and Gulati, 2005).

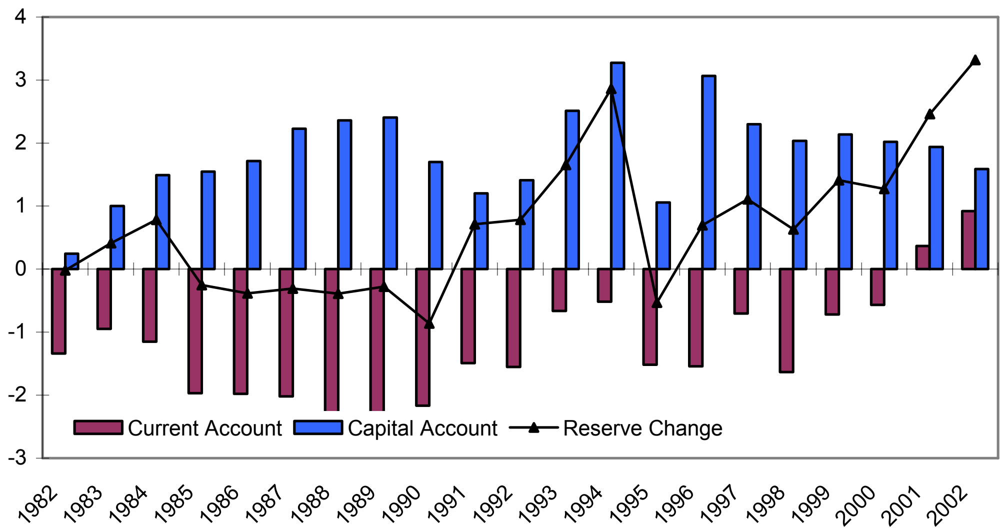
Table 1—GDP Growth Rates, India

Period	Total	Agriculture	Industry	Service
1970-71 to 1980-81	3.4	1.7	4.0	7.2
1981-82 to 1990-91	5.4	3.0	7.0	6.7
1991-92 to 1996-97	7.1	3.9	8.0	7.6
1997-98 to 2003-04	5.5	2.0	4.5	7.8

Source: Mullen, Orden and Gulati, (2005).

The slow process of trade and financial liberalization in the 1980s in India was characterized by deterioration of the current account and gradual losses of the reserves, which lasted from 1985 to 1989 and worsened in 1990 (Figure 1). Total exports of goods and services between 1985 and 1990 increased from $12.9 billion to $22.9 billion while total imports increased from $19.0 billion to $29.5 billion, leading to an average current account deficit of $5.8 billion per year. The current account deficit for India touched $7 billion (more than 2% of the GDP) in 1990. Two sources of external shocks contributed the most to India's continuous current account deficits before the crisis (Cerra and Saxena, 2002). One is the slow economic growth and weak export markets in a number of India's important trading partners especially the US, and the other is the military events in the Middle East in the late 1980s and early 1990s and the run-up in world oil prices.

Figure 1—Current, Capital Accounts and Reserve Changes: India (Percent GDP)



Source: IFS, IMF, various years and authors' calculation.

From the early 1980s up till 1990, India had no foreign direct investment (FDI) or portfolio investment and the capital account was dominated by the "net other investment" (Table 2). The net other investment was primarily debt-creating inflows consisting of external assistance, commercial borrowing and non-resident Indian deposits. The widening current account imbalances and reserve losses contributed to low investor confidence, which was further weakened by political instabilities within the country. Capital account suffered before the crisis when commercial bank financing became hard to obtain, and outflows began to take place on short-term external debts as creditors were reluctant to roll over maturing loans (Cerra and Saxena, 2002). Moreover, the previously strong inflows on non-resident Indian deposits sharply decreased and shifted to net outflows. Net capital inflows in 1991 dropped to $3.4 billion, less than half of the peak levels in the 1980s.

Table 2—Capital Inflows to India (Billion US$)

Year	Net Foreign Direct Investment	Net Portfolio Investment	Net Other Investment	Net Total Capital Inflows	% of GDP
1982	0	0	0.46	0.46	0.24
1983	0	0	2.05	2.05	1.00
1984	0	0	3.05	3.05	1.50
1985	0	0	3.28	3.28	1.55
1986	0	0	3.99	3.99	1.72
1987	0	0	5.73	5.73	2.23
1988	0	0	7.18	7.18	2.36
1989	0	0	7.21	7.21	2.41
1990	0	0	5.53	5.53	1.70
1991	0.07	0	3.37	3.44	1.20
1992	0.28	0.28	3.52	4.08	1.41
1993	0.55	1.37	5.15	7.07	2.51
1994	0.89	5.49	4.19	10.57	3.27
1995	2.02	1.59	0.24	3.85	1.05
1996	2.19	3.96	5.70	11.85	3.07
1997	3.47	2.56	3.62	9.65	2.30
1998	2.58	-0.60	6.60	8.58	2.03
1999	2.09	2.32	5.17	9.58	2.14
2000	1.98	1.62	6.01	9.61	2.07
2001	3.64	1.97	3.77	9.38	1.94
2002	2.58	0.93	4.56	8.07	1.59

Source: *International Financial Statistics*, IMF, various years.

The post-crisis adjustment program featured macroeconomic stabilization and structural reforms and the effects of these measures were evident on the external sector. Trade liberalization introduced drastic reduction in government interventions, trade restrictions, tariff rates, and public sector dominance. Total trade flows (imports and exports) increase from $50.1 billion in 1991 to $161.5 billion in 2002, and current account deficits averaged about $2.8 billion per year during this period. The current account turned into surpluses in the years 2001 and 2002 (Figure 1). Capital inflows also recovered during this period. The spurt of capital reached record high levels in 1994 and 1996 and the magnitudes were more than tripled compared with 1991 (Table 2). A significant drop of net capital inflows occurred in 1995, but from 1997, the net annual inflows have been relatively stable and stayed between $8 billion and $10 billion. The composition of the capital inflows has tilted toward more non-debt-creating foreign direct and portfolio investments, although their shares in total capital inflow remains lower than the net other investment. The reforms also brought confidence among international investors, including non-resident Indians (Cerra and Saxena, 2002). In general, during the post-crisis years, rising capital inflows and shrinking trade deficits have led to continued accumulation of foreign exchange reserves (Figure 1).

Compared to India, China has a larger economy, and its changes have been more drastic. China's economy has witnessed considerable achievements in the last two decades. From 1979 to 2000, the average annual growth rate of GDP was over 8 percent. The average GDP growth rate almost doubled in 1985-1995 compared to the pre-reform years (1970-1978). Even during the Asian financial crisis period, the average growth rate was still sustained at an average of 8.2 percent (Table 3). As in India, the industry and service sectors in China have grown faster than the agricultural sector during the last two decades. In 1996-2000, the growth rate of agriculture GDP was less than half that of industry and service.

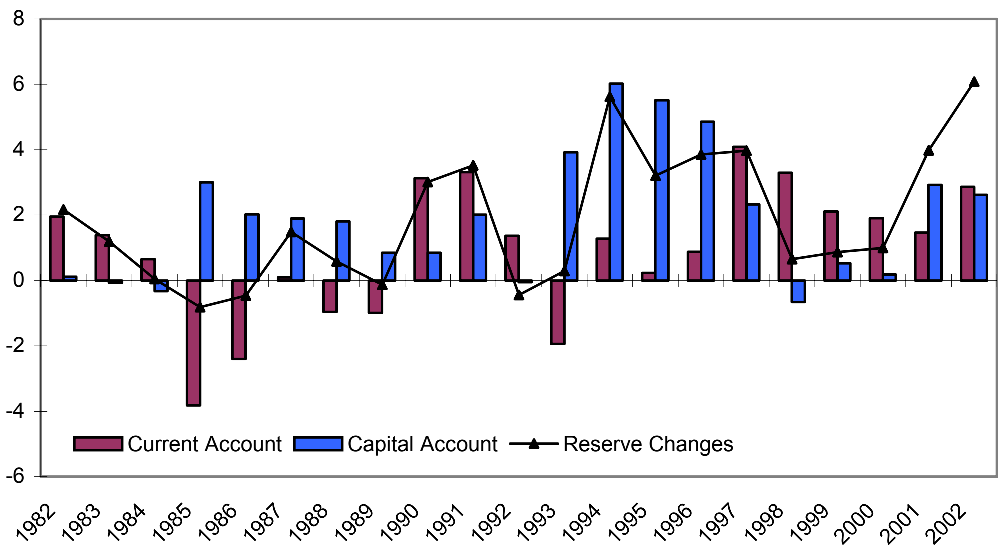
Table 3—GDP Growth Rates, China

Period	Total	Agriculture	Industry	Service
1970-1978	4.9	2.7	6.8	n.a.
1979-1984	8.5	7.1	8.2	11.6
1985-1995	9.7	4.0	12.8	9.7
1996-2000	8.2	3.4	9.6	8.2

Source: Sun, (2003).

Starting in 1978, the government of China had begun a process of gradual liberalization of trade, investment, and financial markets. Figure 2 shows the current account, capital account and the reserve changes for China during 1982-2002. Export growth was rapid due to measures of deregulation and improved competitiveness associated with low labor costs. Meantime, the value of imports increased but at a much slower rate. While occasional deficits did occur, the current account has been in surpluses for most of the 1980s and all of 1990s (except 1993). The annual current account surplus averaged about $15.3 billion during 1990-2002. Capital account during the same period had also experienced continuous surpluses following the inward capital surges. The surpluses peaked in the mid-1990s, but decreased sharply in the following years, largely due to Asian financial crisis and technology bubbles in the developed economies. The capital account surpluses resumed in the 2000s. Positive balance of payments along with fixed exchange rate are concurrent with proactive central bank interventions, which have resulted in substantial accumulation of foreign exchange reserves (Lin and Schramm, 2003).

Figure 2—Current, Capital Accounts and Reserve Changes: China (Percent GDP)



Source: IFS, IMF, various years and authors' calculation.

In contrast to the experience of India, the capital inflows to China has been uniformly dominated by FDI flows, while net portfolio and other investment have played an insignificant role, and in most years, been outflows (Table 4). China is the largest developing country host of FDI. In most recent years (2001 and 2002), although the total capital inflows to China were only about three times as large as those to India, FDI flows have been more than ten times larger. By the end of 2002, a year after joining the WTO, China overtook the US in FDI inflows, became the most attractive FDI destination in the world and received about $47 billion in FDI (net).

The FDI flows to China have been very stable for the period examined, even during times of Asian financial crisis. The reason is that FDI has very low sensitivity to international interest rates and is primarily driven by firms' consideration of long-term profitability. Other types of capital flows, including portfolio investments, are less costly to reverse and have been much more volatile through the years. Another reason for FDI to be a very desirable form of capital inflows to China is the belief that FDI brings along positive externalities, such as technology and management expertise (Huang, 2002).

Table 4—Capital Inflows to China (Billion US$)

Year	Net Foreign Direct Investment	Net Portfolio Investment	Net Other Investment	Net Capital Inflows	% of GDP
1982	0.39	0.02	-0.07	0.34	0.12
1983	0.54	-0.62	-0.15	-0.23	-0.07
1984	1.12	-1.64	-0.49	-1.00	-0.32
1985	1.03	3.03	4.91	8.97	3.00
1986	1.43	1.57	2.95	5.94	2.02
1987	1.67	1.05	3.28	6.00	1.89
1988	2.34	0.88	3.91	7.13	1.80
1989	2.61	-0.18	1.29	3.72	0.85
1990	2.66	-0.24	0.84	3.26	0.85
1991	3.45	0.24	4.34	8.03	2.01
1992	7.16	-0.06	-7.35	-0.25	-0.05
1993	23.12	3.05	-2.69	23.47	3.92
1994	31.79	3.54	-2.69	32.65	6.03
1995	33.85	0.79	4.04	38.67	5.52
1996	38.07	1.74	0.16	39.97	4.86
1997	41.67	6.94	-27.58	21.04	2.33
1998	41.12	-3.73	-43.66	-6.28	-0.66
1999	36.98	-11.23	-20.54	5.20	0.52
2000	37.48	-3.99	-31.54	1.96	0.18
2001	37.36	-19.41	16.88	34.83	2.92
2002	46.79	-10.34	-4.11	32.34	2.62

Source: *International Financial Statistics*, IMF, various years.

2.2 THE EXCHANGE RATES

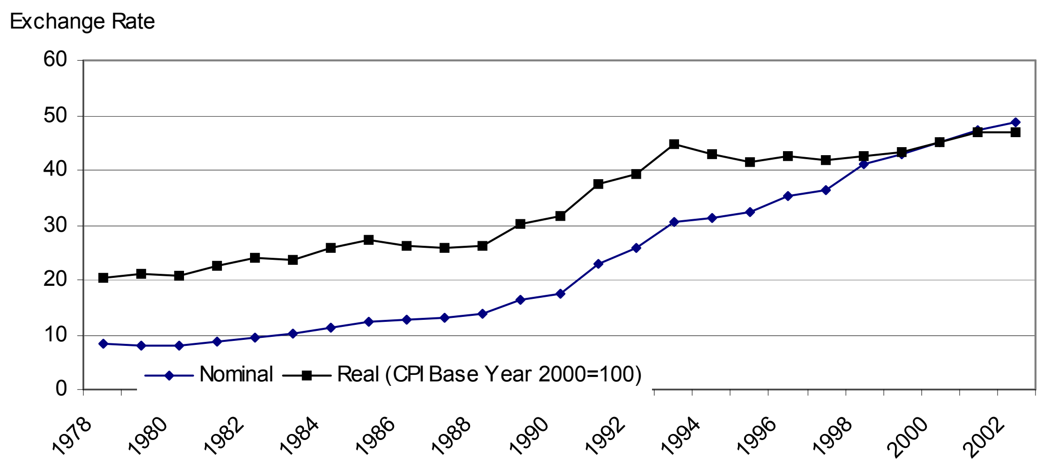
The fact that both countries have put special emphasis on boosting export-led growth by increasing their external competitiveness has made the exchange rate policies critical determinants of their economic performance. When not fully flexible – as in most developing countries – nominal exchange rates have been formulated by the governments with a view to target some real exchange rate. The policy of real exchange rate targeting, aiming at controlling the level of the real exchange rate, either in an effort to keep it at a constant level or to achieve a different (typically more depreciated) one, has shaped the development of Indian rupee and Chinese yuan for the past decade (Patel and Srivastava, 1997; Kohli, 2003; Lin and Schramm, 2003).

The movement toward a regime of market determined exchange rates in India began with the official devaluation of the rupee in July 1991. In March 1992, a dual exchange rate system was introduced in the form of the Liberalized Exchange Rate Management System (LERMS). Under this system all foreign exchange receipts on current account transactions were required to be submitted to the foreign exchange Authorized Dealers (ADs) in full, who in turn would surrender to the Reserve Bank of India (RBI) 40 percent of their purchases of foreign currencies at the official exchange rate announced by the RBI. The balance 60 percent could be retained for sale in the free market. The LERMS as a system in transition performed well in terms of creating the conditions for transferring an augmented volume of foreign exchange transactions onto the market (Udeshi, 2004). Subsequently, in March 1993, India moved from the earlier dual exchange rate regime to a single, market determined exchange rate system. The unification of exchange rates brought about the era of floating exchange rate regime of rupee. Another important step toward foreign exchange market liberalization was made in August 1994 when the current account convertibility was established by accepting Article VIII of the IMF's Articles of Agreement.

The different phases in India's exchange rate regime shifts have also been characterized by the implementation of recommendations from different high level committees (Reddy, 1999). The recommendations of the Rangarajan Committee (1991) on balance of payments provided the basic framework for policy changes in external sector, encompassing exchange rate management and current and capital account liberalization. While the Committee recommended complete current account convertibility, it suggested a very gradual approach towards capital account liberalization. The recommendations emphasized the need to shift away from debt creating to non-debt creating inflows, with emphasis on more stable long-term inflows in the form of foreign direct investment and portfolio investment. The Sodhani Committee (1995) on foreign exchange market made recommendations for the domestic banks to participate in the foreign exchange market with significant initiative and freedom. The recommendations include introduction of various products and removal of restrictions in foreign exchange markets to improve efficiency and increase integration of domestic exchange markets with foreign markets. The recommendations made by the Tarapore Committee (1997) on capital account convertibility included the liberalization measures undertaken on the capital account relating to foreign direct investment, portfolio investment, investment in joint ventures/wholly owned subsidiaries abroad, project exports, opening of Indian corporate offices abroad, and some other measures.

Figure 3 charts the nominal and CPI-based (base year: 2000=100) real exchange rates for the Indian rupee against the US dollar over the period of 1978-2002. The official rate of the rupee against US dollar fell continuously from about 8 in 1978 to 49 in 2002. Corresponding, the real exchange rate fell from 20 in 1978 to 47 in 2002. The depreciation of the nominal and the real rate was slow and steady before 1990 and became more drastic after the financial crisis in 1991 with an annual depreciation rate averaging about 20 percent for the period of 1991-1993. While the devaluations of the nominal rate continued after 1993, the depreciation of the real rate has slowed down. The real rupee rate appreciated and then depreciated modestly due to the offsetting effect of domestic inflation rates.

Figure 3—Nominal and CPI-Based Real Exchange Rates of Indian Rupee



Source: *Handbook of Statistics on Indian Economy*, Reserve Bank of India.

China launched its foreign exchange market reform in the late 1970s. The objectives were to rationalize the level of the exchange rate, to make full use of the exchange rate as an economic lever, and to establish a managed, uniform floating rate system while gradually rendering the Chinese currency convertible (Zhang, 2001). The first reform step took place in August 1979 when the State Council decided to adopt a dual exchange rate system that went into effect on January 1, 1981. The dual exchange rate system consisted of an Internal Rate for Trade Settlement in parallel to the official exchange rate, where the internal settlement rate was set for trade transactions, while the official rates continued to be used for non-trade transactions.[3] Once this internal rate was introduced, further efforts were directed to reforming the official exchange rate itself (Zhang, 2001). A number of devaluations took place in the early 1980s, which resulted in the official rate being at par with the internal rate by the end of 1984, effectively making the latter redundant. On January 1, 1985, the dual exchange rate was formally abandoned and the official exchange rate was devalued to the level of 2.80 yuan per US dollar.

[3] The internal settlement rate (2.80 yuan/dollar) was fixed on the basis of the cost of earning foreign exchange and had been lower than the official rates for the period of 1981-1984 (1.71 to 2.37 yuan/dollar).

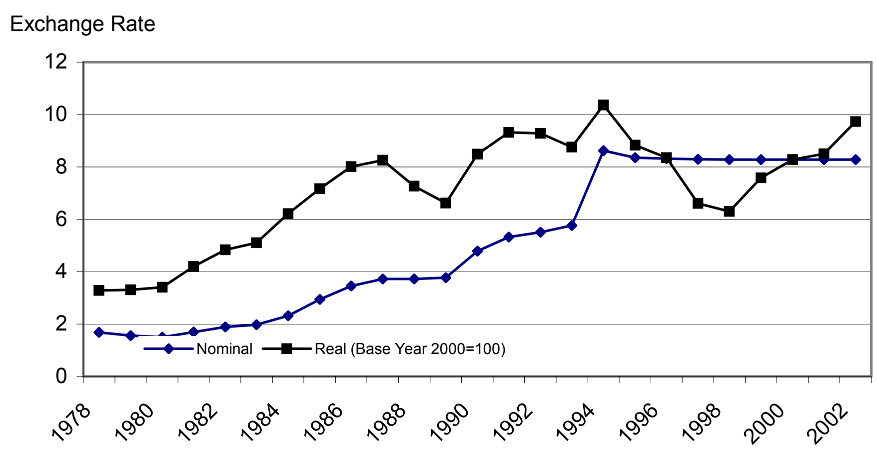
Accompanying the changes in exchange rate policies was the rapid development of the foreign exchange swap market. The basis for the swap market was foreign exchange retention schemes that allowed Chinese exporters to retain a portion of their export proceeds over which they had autonomy in spending. A market for the retained foreign exchange emerged first in 1980; from 1985 the momentum of development quickened (Lin and Schramm, 2003). In this market, surplus units swapped their entitlement to foreign exchange with deficit units at a price determined, more or less, by demand and supply. With the swap market, the effective exchange rate that Chinese exporters received was the weighted average of the official and the swap exchange rates, with the weights being determined by the retention ratio.

Since 1985, while the official exchange rate was pegged, the swap exchange rate was free to move to a certain extent, implying that the *de facto* exchange rate regime in China was somewhat flexible. The swap market has enabled a considerable proportion of foreign exchange, in its later days about 80% of China's trade transaction, to be allocated through the market. This undermined China's rigid system of exchange controls and resulted in a relatively free float of foreign exchange regulated by supply and demand forces. Moreover, the swap market facilitated the reform of the official exchange rate by providing exporters with a more depreciated secondary rate and information about the realistic level of the exchange rate. As a result, it improved the links between domestic and foreign prices and the effective exchange rate reflected domestic market conditions at the margin.

However, China only officially admitted to a managed floating exchange rate regime in April 1991, in which the official rate was allowed to adjust continuously in small steps. In January 1994, coupled with a move to partial convertibility on current account, the official rate was unified with the swap rate and the new rate was allowed to fluctuate within a range according to market forces. The foreign exchange retention scheme was abolished and the foreign exchange swap business terminated accordingly. In late 1996, China accepted the obligations under Article VIII of the IMF's Articles of Agreement and attained current account convertibility.

Figure 4 shows the development of the nominal and CPI-based (base year: 2000=100) real exchange rate of the Chinese yuan for the period 1978-2002. The fluctuations of the Chinese yuan exchange rate during the recent decades are less uniform and exhibit a different pattern than the Indian rupee. The inflation interacts with the nominal devaluations and has had some cyclical effects on the behavior of the real exchange rate. There are two distinct phases for the nominal exchange rate. The first phase is from 1978-1994 and it is characterized by repeated devaluations. In 1994, when the multiple exchange rates of the yuan were unified, a significant devaluation of the official rate occurred. The Yuan vis-à-vis US dollar rate fell almost 50 percent from 5.8 to 8.6. In the second phase starting from 1995, the official rate has been pegged at 8.3 Yuan/$ and fluctuates within a very narrow band. The real exchange rate, on the other hand, has followed a number of depreciation-appreciation cycles. Following the nominal devaluations, the real exchange rate depreciated corresponding from 1978-1987 and from 1990-1994. The depreciation continued even after the nominal rate was fixed (1999-2002). Two strong appreciations occurred in 1988-1989 and again in 1995-1997. Underlying these real exchange rate depreciation-appreciation cycles were the cyclical changes in China's inflation rate which peaked in the late 1980s and mid-1990s.

Figure 4—Nominal and CPI-Based Real Exchange Rates of Chinese Yuan



Source: *International Financial Statistics*, IMF, various years.

2.3 THE AGRICULTURE SECTOR

India has a large and diverse agriculture sector. It is one of the world's leading producers of many crops, including rice, wheat, coarse grains, pulses, and cotton. It has the largest bovine herd in the world and is the biggest producer of milk. Although agriculture in India has benefited indirectly from the exchange rate devaluation and liberalization of the industrial sector in the early 1990s, major changes in the agriculture sector following the 1991 crisis were notably absent (Pursell and Gulati, 1995). As agriculture grew more slowly than the other sectors both in the decades before and after the 1991 reforms, there has been a significant change in the structure of the economy. Between 1980 and 2001, agriculture declined from 38 percent to 25 percent of total GDP (Mullen, Orden and Gulati, 2005). Following reforms, growth has been strongest in the services sector, yet agriculture still employs nearly two-third of the total work force and contributes about 15 percent of the foreign export earnings (Mullen, Orden and Gulati, 2005).

Compared with India, China's agricultural sector experienced rapid growth rate during the early reform years, benefiting from the farm household responsibility system and the rising agricultural prices. But the growth rate of agriculture has decreased in recent years compared to other sectors of the economy. In the last two decades, China's economic structure has been adjusted with agricultural share of GDP and the ratio of agricultural labor in the total labor force dropping significantly, from 30 percent and 69 percent, respectively, in 1979 to 16 percent and 50 percent in 2000 (Sun, 2003). Although the rural sector's share of population and agriculture's share of employment in China are similar to those in India, China has become less agrarian than India as indicated by the index of revealed comparative advantage in agricultural products.[4] This figure has halved from 1.32 in 1990 to 0.68 in 2001 for China, but has increase from 1.60 in 1990 to 1.66 2001 for India (Anderson, 2003). China's trade pattern in agricultural commodities follows its comparative advantage: it tends to import land-intensive commodities (grains, soybeans, cotton) and export labor-intensive commodities (fish, fruits, vegetables,

[4] The revealed comparative advantage in agriculture is measured by agriculture's share of the country's exports relative to agriculture's share of global merchandise exports.

poultry, and processed agricultural goods). In 2002, China's agricultural exports totaled an estimated $13 billion and its agricultural imports totaled $10.8 billion.

Both India and China have emphasized the importance of the agriculture sector in the economy and undergone varying degrees of agricultural policy reforms. Despite their differences, India and China share a number of common features in terms of their domestic and foreign trade policies on agriculture in the pre- and post reform periods. As in many other developing countries with smallholder-dominated agricultural sectors and poorly developed market infrastructure and institutions in the pre-reform period, government interventions instead of the market were pursued to achieve the twin goals of self-sufficiency and low food prices for consumers. As discussed in Mullen, et al. (2004), a few basic similarities in agricultural policies are as follows:

(1) India and China pursued a series of closed economy policies and formed an autarkic environment for agriculture. Self-sufficiency was believed to be the necessary and sufficient condition for the nation's food security (Srinivasan, 1994; Lin, 1994).

(2) Both countries extremely restricted the market's role in balancing supply and demand of agricultural products. In India, a set of complicated agricultural price, procurement, distribution, storage and subsidy (mainly on inputs) policies were employed. The initial government interventions in the market in China were quite similar to those the Indian government pursued; the market-mistrust, combined with Communist orthodoxy, resulted in the entire economy being almost fully planned by the government.

(3) In India and China, agricultural trade policies served as complementary instruments to make the economy effectively closed. Even though exports of some agricultural products had to be encouraged in order for foreign exchange earnings to cover imports of capital equipment and industrial intermediates, trade in major agricultural products, often called strategic commodities, was highly restricted.

(4) India and China have utilized many trade policy instruments, such as import tariffs, quantitative restrictions, import and export licensing, and marketing restrictions to limit foreign trade in agriculture, and all these policies had to be implemented by the state

trading enterprises (STEs), which were extensions of the government bureaucratic system.

The policy reform processes in India and China with respect to agriculture display a gradual transition from an autarkic and state-led setting to a more deregulated market environment with greater integration into the world economy and a new and larger role for the private sector. The reform processes have not been uniform over time or across the two countries, and are marked by occasional policy reversals and setbacks.

The past decade of trade policy reforms in India that have altered incentives for farmers are more those affecting other parts of the economy than those directly affecting agriculture (Anderson, 2003). For example, the economic reforms introduced after the 1991 crisis initiated a partial liberalization of India's trade regime which enabled the abolition of restrictive import licensing on capital and intermediate goods. But the progress in phasing out quantitative restrictions (QRs) on consumer products, including agricultural products, was slow (Mullen, Orden and Gulati, 2005). Except for the liberalization of import licensing on sugar and cotton in 1994, the same year that exports of rice were opened up, most agricultural products remained subject to import controls. India's import policy reform did not begin in earnest until the abolition of QRs was required under the WTO in 2001. Export controls in agriculture were also slow to be removed ostensibly for the sake of food security.

There has been limited progress in reforming domestic agricultural policies since the economic reforms were launched in 1991. For example, steps have only recently been taken to removal several of the countless marketing restrictions that exist. Among these, the Milk and Milk Products Order (MMPO) was reformed in July 2001 and March 2002 to eliminate restrictions on investments in new processing capacity. In February 2002, the Government of India (GOI) removed licensing requirements, stocking limits, and movement restrictions of wheat, paddy/rice, coarse grains, edible oilseeds and edible oils under the Essential Commodities Act of 1955. In February 2003, it removed remaining restrictions on futures trading on 54 commodities, including wheat, rice, oilseeds and pulses, that had been prohibited under the Forward Contract (Regulation) Act of 1952. Domestic policy support for agriculture has been provided mainly through Minimum

Support Price (MSP) guarantees for basic staple commodities, provision of inputs subsidies for fertilizer, water and electricity, and a complex array of other policy instruments (Mullen, Orden and Gulati, 2005).

Compared to India, China's domestic agricultural policy reforms play a more important role in reshaping the agricultural sector. The agriculture sector in China was squeezed at early stages of industrialization with gross fiscal contributions to the sector being more than outweighed by implicit taxation in the form of depressed prices for farm products, neglect of public infrastructure in rural relative to urban areas, and capital outflows via the financial system (Huang and Ma, 1998). The domestic agricultural policy reforms started with the establishment of the farm household responsibility system and the introduction of non-strategic commodities such as vegetables, fruit, fish, livestock, and oil and sugar crops. Various agricultural support schemes exist in a number of broad areas including production, marketing, trade and rural development. However, these support policies are realized mainly through channels other than direct payments to the farmers. For example, most agricultural subsidies are paid to intermediate sectors, such as state-owned grains enterprises, the Agricultural Development Bank of China, state-owned chemical fertilizer plants, and seed companies.

In its WTO Protocol of Accession, China has agreed to have no agricultural export subsidies, and to limit its "de minimis" domestic support to farmers to 8.5 percent of the value of production (compared with 10 percent for other developing countries). China also committed to eliminate non-tariff barriers and apply science-based sanitary and phytosanitary standards to all agricultural goods, including grains, meats, and fruits. Tariff rate quotas (TRQs) will be retained only on wheat, rice, maize, edible oils, sugar, cotton and wool, domestic production of which in aggregate comprises about one-sixth of China's agricultural GDP. The in-quota tariff rate ranges from 1 percent for grains and fibers, 9 percent for vegetable oils, to 20 percent for sugar. The quota volumes were set to grow over 2002-2004 at annual rates ranging from 5 to 19 percent. A further commitment by China is that the STEs will phase out (except for tobacco): even though some STEs will continue to operate, there will be competition from private firms in the importing and exporting of farm products, at least within the tariff-rate-quotas (Anderson, 2003).

3. EXCHANGE RATE EQUILIBRIUM AND MISALIGNMENT

To address the effects of exchange rate misalignments on agriculture support levels measured by the PSE, the first task is to establish the exchange rate equilibrium. There is no simple answer to what determined the equilibrium exchange rate, and estimating equilibrium exchange rates and the degree of exchange rate misalignment remains one of the most challenging empirical problems in open-economy macroeconomics (Williamson, 1994). The fundamental difficulty is that the equilibrium value of the exchange rate is not observable while the exchange rate misalignment refers to a situation in which a country's actual exchange rate deviates from such an unobservable equilibrium. An exchange rate is labeled "undervalued" when it is more depreciated than this equilibrium, and "overvalued" when it is more appreciated than this equilibrium. But unless the "equilibrium" is explicitly specified, the concepts of exchange rate misalignment remain subjective.

The issue is further complicated by the fact that differences exist in the notion of exchange rate equilibrium and misalignment for which they are defined over different time horizons. At one level one might argue that since the actual exchange rate is determined continuously in foreign exchange markets by the supply and demand for currencies, the exchange rate will always be at its equilibrium value. This is clearly linked to what Williamson (1985) distinguishes as the "*market equilibrium exchange rate*", which is the one that balances demand and supply of the currency in the absence of official intervention. It is in this sense that the distinction between the actual exchange rate and the equilibrium exchange rate is not one between disequilibrium and equilibrium, but rather between different types of equilibriums (Hinkle and Montiel, 1999).

It is more informative to go beyond the actual exchange rate and define two other types of equilibrium exchange rates and misalignments which differ according to the time dimensions to which they apply. A *current equilibrium* is defined as the exchange rate which would pertains when its fundamental determinants are at their current settings after abstracting from the influence of random effects (for example from the effect of asset market bubbles). Williamson (1985) first introduced the term "*current equilibrium exchange rate*" which he argues will pertain if the market has full knowledge of the facts and reacts rationally. The current equilibrium value depends on short-run fundamentals at their actual values. At this time horizon, i.e., short-run, both nominal and real rigidities exist in determining equilibrium exchange rates. A *current misalignment* is defined as the difference between the actual exchange rate and the current equilibrium given by the current values of all the economic fundamentals.

A *long-run equilibrium* is defined as the point when stock-flow equilibrium is achieved for all agents in the economy. Nominal and real rigidities are washed out at this time horizon, and the equilibrium exchange rate is determined by the steady state values of the economic fundamentals. A *total misalignment* is thus defined as the difference between the actual exchange rate and the long-run equilibrium rate. Unless otherwise noted, the exchange rate equilibrium and misalignment in the following sections refer to long-run equilibrium and total misalignment which are determined by the long-run steady-state values of the economic fundamentals.

3.1 EQUILIBRIUM EXCHANGE RATE DETERMINATION

The Purchasing Power Parity (PPP) is a natural starting point to begin any consideration of equilibrium exchange rates because it is the basis of many structural exchange rate models and a good benchmark for comparing with more complex methodologies. The theoretical rationale behind the PPP is given as arbitrage in markets for *individual* commodities. If sufficient arbitrage exists, the forces of supply and demand will equalize prices, so that the law of one price (LOOP) holds. Since the PPP is based on general price levels, the conditions for PPP to hold often go beyond the single-commodity-based LOOP.[5] In reality, these conditions hardly hold, which leads to deviations of PPP. There are also reasons why the LOOP itself may not hold and this in turn could be linked to the failure of PPP.[6]

More sophisticated theory of exchange rate determination evolved rapidly after the World War II and major breakthroughs were made in the early 1960s, primarily by Mundell (1961, 1962, and 1963) and Fleming (1962), who extended the classical Keynesian IS-LM approach by introducing international trade and capital flows into the analysis. The Mundell-Fleming model played an important role in the exchange rate literature until the mid-1970s when efforts of exchange rate modeling switched toward the "monetary" or "asset" approaches that emphasized the importance of stock-flows in the determination of exchange rate (Frenkel, 1976; Dornbusch, 1976; and Frankel, 1979). For the past three decades, the flexible and sticky price versions of the monetary models and their other variants have been dominant in the theoretical literature of exchange rate modeling. However, the poor empirical performances of the monetary models, especially highlighted by the fact that they can hardly beat a random walk (Meese and Rogoff, 1983), as well as their lack of micro-foundations (Obstfeld and Rogoff, 1995), had led to other theoretical development, such as the "real equilibrium model" by Stockman (1980 and 1988), the "redux model" by Obstfeld and Rogoff (1995), and the "liquidity model" by Grilli and Roubini (1996).

While some of these exchange rate models remain largely theoretical, others have been used extensively in empirical analysis (see Sarno and Taylor, 2003 and Cheung, Chinn and Puscual, 2004). For example, the monetary models and their foundation PPP are widely used in operational applications to estimate equilibrium exchange rates in both industrial and developing countries, particularly when the data or time required for

[5] For PPP to hold, the consumption baskets should be identical, or equivalently, the consumer preferences are identical across countries, and countries produce the same goods. In addition, every good or service should be tradable so that LOOP holds for all commodities.
[6] The reasons include the existence of transport costs, tariff and non-tariff barriers, pricing-to-market and imperfect exchange rate pass-through, the existence of menu cost, and the entry and exit decisions of firms (MacDonald, 1999).

implementing more complex models are not available.[7] Typical in these analyses is the specification of a regression that links nominal exchange rate with monetary variables such as money supply, price levels, etc. Other models, such as the macroeconomic balance approach building upon the Mundell-Fleming framework, are also popular methods of estimating the equilibrium exchange rate. The macroeconomic balance approach calculates the equilibrium exchange rate that is consistent with the economy operating at capacity output and a sustainable current account position (or internal and external balance).[8]

One strand of the empirical literature that originates from the Stockman's real equilibrium model have gained prominence over the past decade and been frequently used in research and policy to address issues of exchange rate equilibrium and misalignment. Equilibrium exchange rates in the real equilibrium model are derived from a theoretical framework that maximizes representative agent's intertemporal utility subject to budget constraints (Stockman, 1980 and 1988; Agenor, 1998; Hinkle and Montiel, 1999). The reduced form solution of the model, or the so-called "single equation approach", relates the long-run equilibrium real exchange rate to a set of steady-state values of supply-side, demand-side and policy variables (real economic fundamentals).[9] Various time-series techniques can be employed in the estimation of equilibrium exchange rate using the single equation approach. One frequently used technique is the

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[7] Although early studies (e.g. Meese and Rogoff, 1983) found little support for these models based on data from the post-1973 period of floating exchange rates, the development of modern econometric techniques and the availability of better data have brought in new impetus. Using long span and/or panel data as well as different time series techniques, some recent studies (e.g. Lothian and Taylor, 1996; O'Connell, 1998; Mark and Sul, 2001) have reported success for the PPP and monetary models.

[8] The approach starts from the specification and estimation of equations in their structural forms (*i.e.* in terms of trade equations, pricing relationships, expenditure functions, current account relationships, etc.), and then inverts the model so that the real exchange rate is expressed in terms of fundamental variables. The Fundamental Equilibrium Exchange Rate (FEER) model by Williamson (1985 and 1994) is a representative macroeconomic balance model. The Natural Real Exchange Rate (NATREX) by Stein (1994) is closely related to the FEER approach.

[9] The Behavioral Equilibrium Exchange Rate (BEER) model developed by Clark and MacDonald (1999) is similar to the specification of the single equation model. But the theoretical underpinning for the BEER is the simple uncovered interest parity (UIP) condition, adjusted for the existence of a time varying risk premium (Clark and MacDonald, 1999).

cointegration analysis due to Johansen, which allows the variables to be modeled as a system and for the existence of cointegrating vector(s).

Although the single equation approach is not free from its own limitations, it has several methodological advantages over other approaches. First, unlike the PPP or the monetary models, the single equation approach allows the equilibrium real exchange rate to be determined by economic fundamentals and to change over time.[10] Second, the underlying theoretical model of the single equation approach is based on an explicit representative agent choice-maximization framework which incorporates both private and government intertemporal budget constraints. The built-in microfoundation makes this approach preferable to the *ad hoc* approaches such as the monetary models. Third, the approach requires fewer time series data making it empirically more appealing than the macroeconomic balance approach.[11] This paper adopts the reduced-form real equilibrium "single equation approach" and the following provides some details on the method.

3.2 THE SINGLE EQUATION APPROACH

Drawing on the analysis of Baffes, Elbadawi and O'Connell (1999), the single equation approach to equilibrium exchange rate determination can be expressed as:

$$(3.1) \qquad e_t^* = \boldsymbol{\beta}'\overline{\mathbf{F}}_t$$

where e_t^* is the long-run equilibrium real exchange rate, $\overline{\mathbf{F}}_t = (\overline{F}_{1t}, \overline{F}_{2t}, ..., \overline{F}_{nt})'$ is a $(n \times 1)$ vector of permanent or sustainable values of fundamentals, and $\boldsymbol{\beta}$ is a vector of long-run parameters to be estimated.[12] Correspondingly, the misalignment is defined as $(e_t - e_t^*)$, where e_t is the observed value of the exchange rate.

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[10] In contrast, the PPP or the monetary models assume that the real exchange rate is fixed or at leave stationary.

[11] The general-equilibrium framework for the macroeconomic balance approach involves a large amount of model simulations and parameter estimations, and usually a large data set is necessary.

[12] Since the actual values of the economic fundamentals themselves may be misaligned, their permanent or sustainable values are used in calculating the equilibrium exchange rate. There are different methods of obtaining permanent values of the fundamentals ranging from the simple moving average to the Hodrick-Prescott, the Beverige-Nelson, or the Gonzalo-Granger techniques (see Section 4).

The statistical model that relates the actual values of the exchange rate to the actual values of the fundamentals can be formulated as:

$$(3.2) \qquad e_t = \boldsymbol{\beta}'\mathbf{F}_t + \varepsilon_t$$

where $\mathbf{F}_t$ is a vector of actual values of fundamentals and ε_t is a white noise error term.

The set of fundamentals $\mathbf{F}_t$ that may be identified (by theory) as the long-run determinants of equilibrium exchange rate typically includes the following four categories: (1) Domestic supply-side factors and particularly the Balassa–Samuelson effect arising from faster productivity growth in the tradable good sector relative to the non-tradable good sector; (2) Fiscal policy, such as fiscal deficits as well as changes in the composition of government spending between tradable and non-tradable goods; (3) International economic environment, including capital inflows, external transfers, and terms of trade; (4) Commercial policy such as trade liberalization in terms of a reduction in import tariffs and export subsidies. See Hinkle and Montiel (1999) for a recent discussion of the analytical model.

Due to the non-stationary nature of most macroeconomic time series, an OLS estimation of (3.2) may produce a spurious regression. In cases where the exchange rate and the fundamentals are integrated and cointegrated, an error correction model is usually preferable to a simple OLS. The general error correction model consistent with the single equation approach is specified as follows

$$(3.3) \qquad \Delta e_t = \alpha(e_{t-1} - \boldsymbol{\beta}'\mathbf{F}_{t-1}) + \sum_{j=1}^{p} \mu_1 \Delta e_{t-j} + \sum_{j=0}^{p} \boldsymbol{\gamma}'_j \Delta \mathbf{F}_{t-j} + \omega_t$$

where the α , $\boldsymbol{\beta}$, μ , and $\boldsymbol{\gamma}$ are parameters to be estimated, p is the lag-length, and the ω is an error term.

Equation (3.3) indicates that the actual exchange rate gravitates towards its fundamental-determined equilibrium values over time, and for $\alpha < 0$, the equilibrium is dynamically stable. Various non-stationary time series techniques can be applied to estimate equation (3.3) (see Baffes, Elbadawi and O'Connell, 1999). The parameter estimates $\boldsymbol{\beta}$ and the permanent values of the fundamentals $\bar{\mathbf{F}}_t$ are then substituted back to equation (3.1) to derive both the equilibrium exchange rate and misalignment.

It is important to note that the statistical validity of equation (3.3) depends on the fundamentals being weakly exogenous for the parameters of interests. Such an assumption is reasonable in Baffes, Elbadawi and O'Connell's study, in which two countries (Cote d'Ivoire and Burkina Faso) are sufficiently "small" and relevant variables are likely to be determined outside the countries. The feature of weak exogeneity is verified through different tests in Baffes, Elbadawi and O'Connell (1999). However, if the assumption of weak exogeneity fails to hold, as is the case for larger economies, a multivariate system estimation such as the vector error correction (VEC) model will be more appropriate. This paper extends the estimation of the single equation approach by using Johansen's full-information maximum likelihood procedure (see Section 4 for details).

Baffes, Elbadawi and O'Connell's study is one among numerous empirical studies assessing equilibrium real exchange rates and misalignments in the developing countries using the single equation approach since the early applications of this approach by Edwards (1989)—see, for example, Elbadawi, 1994; Elbadawi and Soto, 1994 and 1997; Mongardini, 1998; Baffes, Elbadawi and O'Connell, 1999; Rahman and Basher, 2001; Paiva, 2001; Zhang, 2001; Zhang, 2002; Cerra and Saxena, 2002; Mathisen, 2003 and Cady, 2003. These studies differ primarily by their selection of fundamentals and econometric methods (see Edwards and Savastano, 1999 for a review). It is worth noting that among these studies only a few concern India and China, despite the fact that currencies in both countries have historically been misaligned.

Patnaik and Pauly (2000 and 2001) use the single-equation approach to model the equilibrium exchange rate in India. The exchange rate is assumed to be function of expected rate, real interest rate differential, the risk premium, the central bank intervention and a random noise.[13] Their results suggest that in the 1990s the rupee was

[13] Their specification of the empirical model is slightly different from the typical single equation approach.

essentially determined by equilibrium in the output market. However, due to slow adjustments in this market, the exchange rate was not always at the equilibrium rate. Deviations from the output-determined equilibrium rate were common. But despite periods when the rupee was overvalued or undervalued compared to the long run rate, usually in response to forces in financial markets, there appeared to be a clear tendency to revert to the equilibrium level. Cerra and Saxena (2002) apply the single equation approach to study whether the India rupee was misaligned before the 1991 crisis. They measure the rupee equilibrium exchange rate through an error correction model using the technique developed by Gonzalo and Granger (1995). The evidence of this study indicates that overvaluation played a significant role in the crisis and caused the sharp exchange rate depreciation. Cerra and Saxena also show that the error correction model performs better than a random walk model in terms of out-of-sample forecast.

Zhang (2001) uses the single equation approach to estimate the equilibrium exchange rate of the Chinese yuan for the period of 1952-1997. He finds that the yuan exchange rate was chronically overvalued during most of the central planning period. However, the cumulative effect of exchange reform has led to a substantial real depreciation of the currency which essentially brought the real exchange rate back to its equilibrium during the reform period since 1981. Furthermore, Zhang also shows that undervaluation frequently occurred from 1978 to 1997 indicating China now has a proactive exchange rate policy with the nominal exchange rate used as a policy tool to attain real targets. Zhang (2002) analyzes the yuan rate by using both a single equation and a behavior equilibrium exchange rate (BEER) models. The Hodrick-Prescott (H-P) filter and cointegration techniques are applied and the estimation results show that the currency has been through a series of episodes of overvaluation and undervaluation, but has moved closer to equilibrium in the late 1990s.

4. EQUILIBRIUM EXCHANGE RATES: INDIA AND CHINA

The empirical model in this study is based on the single equation real equilibrium approach. Given the nature of the underlying data series, the analysis closely follows the contemporary non-stationary time-series modeling paradigm. First, the augmented Dickey-Fuller (ADF) tests are applied to the univariate data series to establish their temporal properties. The tests also serve to examine the validity of univariate PPP hypothesis for the two currencies.[14] Second, a VEC model is specified and the Johansen cointegration method is used to determine if one or more long-run relationships exist among the system of variables. If cointegrated, one would expect the real exchange rate and its fundamental determinants to be related to each other in a systematic way, with the cointegrating equation capturing such a steady-state relationship. Third, considering that the current values of the economic fundamentals themselves may not be at their long-run equilibrium level, a Hodrick-Prescott (H-P) filtering method is used to estimate long-run or permanent component of the fundamentals by removing the cyclical component from the data.[15] Finally, the estimated cointegrating vector along with the permanent component of the economic fundamentals are used to calculate the long-run equilibrium real exchange rates and gauge the corresponding misalignments.

4.1 DATA DESCRIPTION

The sample period covers 1975-2002 for India and 1978-2002 for China, using annual data drawn from the *International Financial Statistics* of the IMF. The choice of the sample sizes are dictated by data availability. A system of variables,

$$\mathbf{x}_t = [LRER_t, LTECH_t, LGCON_t, LFER_t, LTOT_t, LOPN_t]$$

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[14] Alternatively, the Engle-Granger or the Johansen cointegration method can be used to test the bivariate or trivariate PPP hypotheses (see MacDonald, 1999).

[15] The H-P filtering technique has been used in estimating equilibrium exchange rate by a number of authors including Clark and MacDonald (1999); Zhang (2002); MacDonald and Ricci (2003) and Cady (2003). A moving average, a Beveridge-Nelson or a Gonzalo-Granger technique can also be used to extract permanent component from the fundaments (e.g. Elbadawi and Soto, 1997; Baffes, Elbadawi and O'Connell, 1999; Clark and MacDonald, 2000; Cerra and Saxena, 2002; and Mathisen, 2003).

is formulated with their constructions and composing data summarized in Table 5.[16] All variables are in logarithmic forms.

The real exchange rate (*LRER*) is ideally defined as the relative price of tradable to non-tradable goods. A common proxy is to construct the real exchange rate using the nominal rate multiplied by the ratio of the foreign wholesale price index (WPI) to the domestic consumer price index (CPI) (Zhang, 2001). In this study, such a proxy is adopted for calculating real exchange rates in India and China. It is important to note that the real exchange rate used in this study is a bilateral rate defined in terms of the domestic currency per US dollar, so that an increase in the real exchange rate represents a depreciation against this major currency.[17]

Table 5—Data Description and Variable Construction

Data	Description of data	Variable Construction
e	Nominal exchange rate	$LRER = \ln(e * \frac{WPI_{US}}{CPI})$
GCON	Government consumption	
FER	Foreign exchange reserves	$LTECH = \ln(\frac{IPI}{IPI_{-1}})$ (India)
XUV	Export unit value	$LTECH = \ln(\frac{FCF}{FCF_{-1}})$ (China)
IUV	Import unit value	
VX	Value of exports	$LGCON = \ln(\frac{GCON}{GDP})$
VM	Value of imports	$LFER = \ln(\frac{FER}{GDP})$
FCF	Fixed capital formation	
WPI	Wholesale price index	$LTOT = \ln(\frac{XUV}{IUV})$ (India)
CPI	Consumer price index	$LTOT = \ln(\frac{VX}{VX_{-1}})$ (China)
IPI	Industrial production index	
GDP	Gross Domestic Product	$LOPN = \ln(\frac{VX + VM}{GDP})$

Source: IMF, IFS, various years. The data frequency is annual.
Note: Variables *LTECH* and *LTOT* are constructed differently for India and China due to data constraints.

[16] The system of variables follows the theoretical development by Hinkle and Montiel (1999) as well as previous empirical exchange rate studies such as Zhang (2001) and Cerra and Saxena (2002).
[17] Also, note that the real exchange rates in this section are constructed using foreign WPI and domestic CPI and are slightly different from the CPI-based real exchange rates shown in Section 2.2.

The Balassa-Samuelson effect caused by differential productivity growth in the traded good vs. non-traded good sectors is approximated by the technological progress (*LTECH*). According to theory, an increase in the productivity in the tradable sector relative to the non-tradable sector appreciates the exchange rate because it creates excess demand in the non-tradable sector. This variable is proxied by the annual growth rate of the industrial production index for India and gross fixed capital formation for China (Cerra and Saxena, 2002; Zhang, 2001).

The government consumption (*LGCON*) as a percentage to the GDP is used to capture the effect of fiscal policies. Changes in the composition of government consumption affect the exchange rate in different ways, depending on whether the consumption is directed toward traded or non-traded goods. If an increase in government consumption is concentrated in non-traded goods, excess demand in this sector will lead to higher non-traded good price and thus real exchange rate appreciation. The opposite will happen if the government consumption is concentrated in traded goods.

Foreign Exchange Reserve (*LFER*) is defined as the ratio of total foreign exchange reserves (less official gold holding and SDR) to the GDP. The foreign exchange reserve accumulation captures the effect of net capital inflows. The increased spending on traded goods following capital inflows is accommodated through an increase in the trade deficit with no adverse impact on the real exchange rate, but the excess demand on non-traded goods will result in an increase in the price of these goods relative to that of traded goods, leading to a real appreciation. The price adjustment occurs either through an appreciation of the nominal exchange rate under a floating exchange rate system or through an increase in nominal prices of non-traded goods in a fixed exchange rate regime, or through a mixture of the two processes in an intermediate regime.

The terms of trade (*LTOT*) is defined as the ratio of export price index to import price index. However, no consistent export and import price data are available for China and this variable is proxied by its export growth rate (Zhang, 2001). The effect of terms of trade on the real exchange rate is ambiguous (Elbadawi and Soto, 1994). An improvement in the terms of trade increases national income which in turn increases demand for non-traded good leading to real exchange rate appreciation (income effect).

On the other hand, the improvement of terms of trade lowers the cost of imported inputs in the production of non-traded goods causing real exchange rate depreciation (substitution effect).

The openness (*LOPN*) is calculated as the ratio of the sum of imports plus exports to the GDP. Its use as a proxy for commercial policy is justified because of the difficulty of obtaining good time series data on import tariff and export tax and also because it may account not only for explicit commercial policy but also for implicit, though very important, factors such as quotas and exchange controls (Elbadawi and Soto, 1994).

4.2 THE UNIT ROOT AND COINTEGRATION TESTS

Unit root and cointegration tests are conducted for the system of variables identified earlier. Details on both tests are presented in the Appendix. The augmented Dickey-Fuller (ADF) test shows that the null hypothesis of a unit root is accepted for each variable (see Appendix Table A1). All series are then first differenced and the ADF regressions are reestimated. In each case, the ADF test statistics rose considerably, and the null hypothesis of a unit root is rejected at the 1 percent or 5 percent significance levels. It is concluded that all the variables in $\mathbf{x}_t$ are I(1) in levels and I(0) in differences.

The unit root test results also highlight the non-stationary feature of the real exchange rates. The hypothesis of PPP (weak form) is strongly rejected for both countries. Such a conclusion is broadly consistent with numerous other studies (see Rogoff, 1996 for a review). However, special care must be taken when interpreting this result. First, the sample sizes in this study are relatively small (28 and 25 observations for India and China respectively), but the PPP is essentially a long run condition. Second, structural changes in India and China in terms of exchange rate regime shifts during the sample periods are not taken into account. When there are such structural breaks, the ADF test statistics are biased toward the non-rejection of a unit root. Tests for unit roots with structural breaks can be conducted on individual variables, using the techniques suggested by Perron (1989), but were not undertaken in this study.

If each series is an I(1) process, common tests for the possibility of an equilibrium in a VEC model are the Johansen maximum likelihood method (Johansen, 1991). At 5 percent significance level for the trace test, the null hypothesis that $h = 0$ and $h \leq 1$ are rejected for India (see Appendix Table A2). However, the null hypothesis that the cointegrating rank is at most 2 is accepted. Hence, there is evidence that there are two cointegrating relationships among the variables. For China, $h = 0$ is rejected and the cointegrating rank of at most 1 is accepted, so there is evidence of only one cointegrating relationship among the variables. The unnormalized cointegrating coefficients are shown in Table 6.

Table 6—Unnormalized Cointegrating Coefficients

			India			
LRER	*LTECH*	*LGCON*	*LFER*	*LTOT*	*LOPN*	*C*
-1.56	-3.24	-0.24	-0.48	-0.56	2.89	11.30
-0.90	-4.57	-0.41	0.01	1.88	-0.08	-6.05
			China			
LRER	*LTECH*	*LGCON*	*LFER*	*LTOT*	*LOPN*	*C*
0.87	-1.02	1.17	0.22	2.29	-0.90	0.06

Note: *C* is a constant in the cointegrating vector.

As is well known, the existence of multiple cointegrating vectors complicates the interpretation of equilibrium for the exchange rate (Dibooglu and Enders, 1995; Clark and MacDonald, 1999). Indeed there is also the case in a single cointegrating vector context where it is unclear if the vector represents a structural or reduced form relationship. When interpreting the cointegrating vectors obtained from the Johansen procedure it needs to be noted that what the reduced rank regression provides is information on how many unique cointegrating vectors *span* the cointegrating space, while any linear combination of the stationary vectors is itself a stationary vector. Therefore in case of India where 2 cointegrating vectors exist, a useful method of treating the problem is to impose structural restrictions motivated by economic arguments and test whether the cointegrating vectors are identified (e.g. Clark and MacDonald, 1999 and Zhang, 2001). The identification tests are not undertaken in this analysis since the single equation approach reduced form estimation does not provide any structural identifying restrictions. Instead, the first cointegrating vector is utilized as the long-run real exchange rate relation and used later to form the cointegrating equation. Johansen and Juselius (1990) noted that "one would expect that the linear combination which is most canonically correlated with the stationary part of the model, namely, the first eigenvector, is of special interest". A similar approach (simplification) has been utilized among others by Cerra and Saxena (2002) and Mathisen (2003).

4.3 EXCHANGE RATE EQUILIBRIUM AND MISALIGNMENT

The residuals from the cointegrating relationships are commonly referred to as "disequilibrium residuals." Of interest in this study are both the cointegrating vectors and the disequilibrium residuals, with the former determining the long-run equilibrium relationship between real exchange rate and other economic fundamentals, and the later determining the real exchange rate misalignments. After normalization, the equilibrium real exchange rates (*LRER*) are calculated based on the following cointegrating equations with standard errors in parentheses:

India:

$$LRER = \underset{(1.02)}{7.27} - \underset{(0.61)}{2.08}LTECH - \underset{(0.14)}{0.16}LGCON - \underset{(0.05)}{0.31}LFER - \underset{(0.17)}{0.36}LTOT + \underset{(0.21)}{1.85}LOPN \quad (4.1)$$

China:

$$LRER = \underset{(1.35)}{-0.07} + \underset{(0.28)}{1.17}LTECH - \underset{(0.61)}{1.34}LGCON - \underset{(0.06)}{0.25}LFER - \underset{(0.60)}{2.63}LTOT + \underset{(0.16)}{1.03}LOPN \quad (4.2)$$

In general, the parameter estimates are consistent with the theoretical model underlying the single equation reduced form approach. The negative sign of the variable *LTECH* for India suggests that an increase in the productivity in the traded good sector relative to the non-traded good sector is associated with real exchange rate appreciation, which is consistent with the Balassa-Samuelson theory.[18] An increase in the government

[18] Similar to Zhang (2001), the sign of *LTECH* for China is positive which is not consistent with the theory. One possible reason for this result is the selection of an inaccurate proxy for the variable *LTECH*.

consumption (*LGCON*) tends to appreciate the currencies, since government consumption in both India and China tends to concentrate more on non-traded goods compared to the private sector (Cerra and Saxena, 2002; Zhang, 2001). The negative sign associated with *LFER* indicates that capital inflows and consequent rises in the foreign reserves appreciate the real exchange rates in both countries. This result is broadly consistent with pervious studies examining the effects of capital inflow on the developing countries (e.g. Elbadawi, 1994; Elbadawi and Soto, 1994 and 1997). The effect of shocks to the terms of trade (*LTOT*) on the real exchange rates is theoretically ambiguous, depending on the relative importance between substitution effect and income effect. The negative signs obtained for the two countries suggest the dominance of the income effect over the substitution effect and improvements in the terms of trade appreciate the currencies. The volume of trade, or degree of openness, as meas ured by the variable *LOPN* is an importance factor in determining the level of real exchange rate. In both countries, the positive signs confirm the findings in the literature that economic closedness is typically associated with overvaluation, and external liberalization aimed at reducing tariffs and eliminating trade restrictions causes currency depreciations.

In order to obtain the "long-run", "steady state" or "permanent" values of the economic fundamentals in each country, the Hodrick-Prescott (H-P) decomposing technique is applied (Hodrick and Prescott, 1997). The H-P filter decomposes the time series into a trend μ_t and stationary component $x_t - \mu_t$ by minimizing:

$$\sum_{t=1}^{T}(x_t - \mu_t)^2 + \lambda\sum_{t=2}^{T-1}[(\mu_{t+1} - \mu_t) - (\mu_t - \mu_{t-1})]^2 ,$$

where λ is an arbitrary constant reflecting the penalty of incorporating fluctuations into the trend. If $\lambda = 0$, the sum of squares is minimized when $x_t = \mu_t$ and the trend is x_t itself. As $\lambda \to \infty$, the trend approaches linearity. Hodrick and Prescott (1997) suggested a λ to be 1600 for quarterly data. However, different numbers should be used depending on the data frequencies. This number is much larger when the data set is monthly ($100,000 < \lambda < 140,000$), and much smaller when the data set is annual ($6 < \lambda < 14$) (see Hodrick and Prescott, 1997). In this analysis, λ is chosen to be equal to 10 to match our annual data set. Based on the filtered values of the economic fundamentals as well as the cointegrating vectors, the equilibrium exchange rate and misalignment (in percentage) can be calculated for both countries and they are shown in Table 7.

Table 7—Actual Exchange Rate, Equilibrium and Misalignment, India and China

	India			China		
Year	Actual	Equilibrium	%Misalignment	Actual	Equilibrium	%Misalignment
1975	18.3	20.3	-9.9			
1976	22.2	22.5	-1.6			
1977	21.2	21.4	-0.9			
1978	20.9	21.4	-2.6	3.3	3.2	3.8
1979	22.0	23.1	-4.9	3.3	3.2	3.4
1980	21.7	25.6	-15.1	3.4	3.4	0.0
1981	23.1	28.0	-17.4	4.2	3.8	11.7
1982	23.9	29.6	-19.2	4.8	4.3	13.4
1983	23.1	29.4	-21.4	5.1	4.8	5.8
1984	24.5	28.0	-12.3	6.2	5.5	12.5
1985	25.2	26.3	-4.3	7.2	6.4	12.1
1986	22.9	25.0	-8.4	8.0	7.0	14.3
1987	22.2	24.7	-10.1	8.3	7.3	13.8
1988	22.7	25.7	-11.7	7.3	7.4	-1.5
1989	26.2	28.8	-9.1	6.6	7.4	-10.9
1990	26.8	30.6	-12.3	8.5	7.6	11.3
1991	30.7	31.9	-3.9	9.3	8.1	15.5
1992	31.5	32.9	-4.4	9.3	8.6	8.3
1993	35.3	32.5	8.7	8.8	8.9	-1.5
1994	33.4	31.6	5.8	10.4	8.8	18.5
1995	32.4	31.4	3.2	8.8	8.5	3.4
1996	33.3	31.8	4.7	8.4	8.2	1.8
1997	31.8	32.1	-1.1	6.6	7.7	-14.1
1998	31.1	32.5	-4.3	6.3	7.3	-14.2
1999	31.3	33.1	-5.5	7.6	7.1	7.2
2000	33.2	34.0	-2.4	8.3	7.0	17.9
2001	34.0	35.0	-2.7	8.5	7.4	15.2
2002	33.8	35.2	-3.8	9.7	7.9	22.7

Source: Authors' calculation.

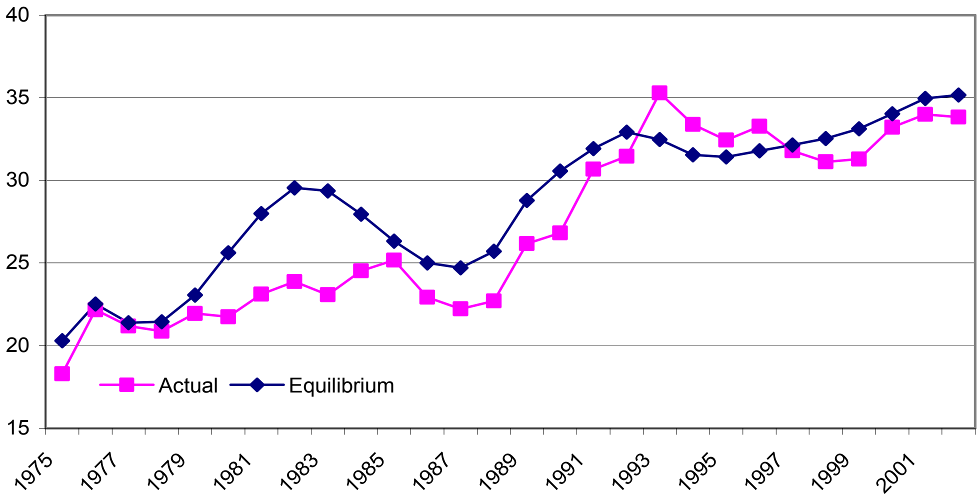
4.4 BRIEF ASSESSMENTS ON THE TWO CURRENCIES

The actual real exchange rate of the India rupee has largely increased (depreciated) from 1975-2002 (Figure 5).The depreciation accelerated following the financial crisis in 1991. In 1993, and after several major devaluations, the actual rate came into line with the equilibrium for the first time since the mid-1980s. The actual real rate of the Indian rupee has moved closely around the equilibrium since the mid 1990s. In recent years, the Indian rupee had stayed so close to its equilibrium values that very limited degree of misalignments is observable. Both series have been stable and stayed around 33, and in cases of misalignments, the actual rate has moved in the direction of restoring the equilibrium.

The real exchange rate of the Indian rupee is characterized by overvaluation for most of sample period (except for 1993-1996), especially during the 1980s and early 1990s. The first bout of substantial overvaluation started in 1980 and lasted for about 6 years (1980-1985). The second one started in 1986 and ended in 1993, two years after the financial crisis in 1991. In the official descriptions of the events, India's exchange rate overvaluation and crisis has been attributed to continued current account deficits and reserve depletion, made worse by problems related to the Gulf War; and a loss of confidence in the government as political problems compounded the weak credibility associated with high fiscal deficits (Rangaranjan, 1993). Such explanation is consistent with the model results, by which weak economic fundamentals are associated with depreciated currency, and given insufficient devaluation of the actual exchange rate, overvaluation occurs.

The post-crisis adjustment program in India featured macroeconomic stabilization and structural reforms, especially in the direction of trade and financial liberalization. The effects of these measures were evident on the external sector. In the years after the crisis, rising capital inflows and shrinking trade deficits have led to continued accumulation of foreign exchange reserves. Large steps of devaluation in the early stage of the reform have caused the actual exchange rate to "overshoot" its long-run equilibrium in our model estimation, resulting in an undervaluation for a number of years. In recent years, with a slight overvaluation, the rupee rate has remained close to its equilibrium values.

Figure 5—The Actual and Equilibrium Real Exchange Rates, India

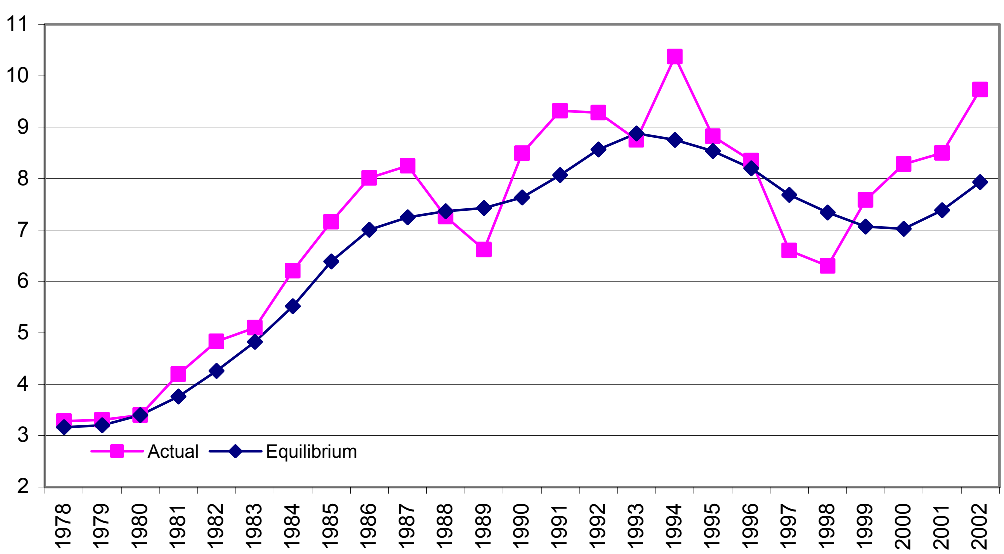


Source: Author's calculation.

In comparison to the Indian rupee, the actual real exchange rate movements of the Chinese yuan during the post-reform era are in general characterized by undervaluations (Figure 6). Since 1978, periods of overvaluation also occurred in a number of years but these overvaluations were short-lived. The more appreciated equilibrium exchange rate is associated with China's continuous current account and capital account surpluses. However, capital inflows to China still suffer from different degrees of volatility and sudden withdrawal risks, especially during times of crises in other countries. One factor underlying the movements of equilibrium exchange rate and periods of over- and under-valuation is the swing of the current and capital account and the irregular accumulation of the reserves.

It is also important to note that, starting from 1999, there has been a period of sustained undervaluation. The widening gap between the equilibrium and the actual rate in recent years has stimulated a heated debate on the issue of undervaluation of the Chinese yuan. The US in particular has expressed serious concerns on the undervaluation in face of its exploding trading deficits with China, which amounted to over $124 billion in 2003. A series of unfair trade practice petitions ("Section 301") against China have been filed by a coalition of industry and labor groups. Despite the lobbying efforts from the US government along with strong supports from the IMF with the aim to eliminate China's currency manipulation, the exchange rate of the Chinese currency remains fixed to the US dollar. The predicted degree of undervaluation in recent years (1999-2002) from this study averages about 20 percent which is broadly consistent with predictions from other recent empirical studies (see for example, Frankel, 2004; Goldstein, 2004).

Figure 6—The Actual and Equilibrium Real Exchange Rates, China



Source: Author's calculation.

5. EFFECTS OF EXCHANGE RATES ON THE PSE

It is widely agreed that exchange rate policy in a country is very important to its agricultural sector. The issue of how exchange rate depreciation might be used to give commercial advantage to the country's exports of agricultural products, or how appreciation might penalize producers often arises. Under the condition of perfect arbitrage, and in the absence of policy interventions that alter the prices farmers receive for their output or pay for their inputs, the law of one price holds. In local currency terms, the domestic price is identical to the world market price adjusted by transaction costs (referred to as the adjusted reference price). Hence all changes in the world market price are directly reflected in the domestic price, regardless of whether it is the world market price in foreign currency or the exchange rate that has changed (Melyukhina, 2002). In this case, exchange rate fluctuations affect the price incentives facing domestic producers, but the gap between domestic and world price is zero and not affected by the exchange rate. However, with policy interventions that affect domestic prices, a non-zero price gap is measured, and its level changes with variations in the exchange rate.

Focusing on such price gaps, a number of early studies have analyzed the effects of exchange rates on the agricultural sector using the nominal rate of protection (NRP) (e.g. Krueger, Schiff and Valdes, 1988 and 1991; Dorosh and Valdes, 1991; Pena and Norton, 1993; Bautista and Gehlhar, 1996 and Bojnec and Swinnen, 1997). The findings from these studies confirm that the exchange rate plays an important role in determining agricultural incentives, and in some cases, the effects from the exchange rate can overwhelm those from sectoral-specific policies. However, results based on the NRP do not fully address the effects of exchange rates on agriculture, because the NRP itself is only a partial indicator of agricultural policies. The NRP captures the price support to agriculture without taking into account other important factors such as direct payments to farmers linked to either outputs or inputs. More inclusive measures of protection, within a partial equilibrium or broader general equilibrium framework, provide fuller accounts of the protection to agriculture. One such measure, still partial in nature but widely used by

OECD and others, is the PSE. The effects of exchange rate measured by the PSEs are thus different from those measured by the NPRs.

In OECD's annual agricultural policy monitoring and evaluation, the effects of the exchange rate on the PSE are reported by a "decomposition approach." Such decomposition approach provides a measurement of the contribution of annual variation in different factors, including the exchange rate, to the overall annual PSE change. While the decomposition approach is useful in determining component changes in PSE over time, it does not consider the exchange rate misalignment at a particular point in time or make any adjustments necessary to account for it. The approach becomes less appealing when the actual exchange rate significantly deviates from its equilibrium and becomes severely misaligned, as the case for some developing or transition economies. In these cases, the degree of exchange rate misalignment should be explicitly taken into account when calculating the PSEs.

Applications of the various models of equilibrium exchange determination that have been used to examine exchange rate misalignment and test over or undervalued currencies to the PSE are very limited. Using a PPP approach, Liefert, et al. (1996) analyzed the effect of exchange rate on Russia's PSE. Their findings indicate that the ruble was substantially undervalued from its equilibrium in the sample year of 1994. The undervaluation created an opportunity for domestic output to price-compete with world trade. However, state controls and poor infrastructure "taxed" this opportunity and blocked the domestic producer incentive prices from rising to border prices leading to a high disprotection rate measured by the conventional PSE. The PSEs based on the PPP exchange rate generally indicate more agricultural support than calculations based on the official exchange rate. They also show that the appreciation of the ruble in later periods has eroded Russia's agricultural price competitiveness. In a similar study, Shick (2002) finds that the ruble was undervalued during the transition stage (1992-1994), became overvalued the year before the financial crisis in 1998 and was undervalued again after the crisis. Shick compared the conventional PSE evaluated at the official exchange rate with the PSE evaluated at an adjusted exchange rate based on Atlas conversion factor and concluded that the overvaluation and undervaluation had significant impacts on the level of Russia's PSE.[19] The results are consistent with those by Liefert et al. (1996).

Despite their plausible results, the calculations based on the PPP or Atlas adjusted exchange rates involved a high degree of discretion. For the PPP, the selection of a base year in which the exchange rate is considered to be in equilibrium is crucial in determining the degree of exchange rate over- or under-valuation over time, and hence the effect on the PSE. A different base year can lead to different PSE estimates. Harvey (1996) argues that other models of equilibrium exchange rates are preferred to the PPP approach in PSE estimation.

This section applies our model-based equilibrium exchange rate identified in Section 4 to PSE calculations. Building on the previous analytical framework, and drawing on recent PSE studies by Mullen, Orden and Gulati (2005) and Sun (2003), we examine the effects of exchange rate on the MPS and PSE for India and China.

5.1 EFFECTS ON MPS

Market price support (MPS) is an important component of the PSE. It is defined as "an indicator of the annual monetary value of gross transfers from consumers and taxpayers to agricultural producers arising from policy measures that create a gap between domestic market prices and border prices of a specific commodity measured at the farmgate level" (Portugal, 2002). The effects of exchange rate are directly reflected in the estimation of the MPS component of the PSE as an exchange rate is introduced to convert the world price into domestic currency. The MPS for a specific commodity (*j*) in monetary terms is defined as:

$$(5.1) \qquad MPS_j = (P_j^d - P_j^{ar}) \times Q_j$$

[19] The Atlas conversion factor exchange rate for any year is the average of Russia's exchange rate in that year and the two preceding years, adjusted for the difference between the rate of inflation in Russia and that in 5 developed countries (France, Germany, Japan, the UK and the US).

where:

P_j^d : domestic producer price of commodity j

P_j^{ar} : adjusted reference price of commodity j

Q_j : quantity of commodity j

The adjusted reference price P_j^{ar} is the world market price expressed in domestic currency and adjusted by various costs. The cost adjustment differs depending on whether the commodity is an importable or an exportable (see Mullen, et al., 2004 for details), but in either case, the adjusted reference price can be expressed as:

$$(5.2) \quad P_j^{ar} = P_j^{world} \times e + ADJ_j$$

where:

P_j^{world} : world market price of commodity j

e : nominal exchange rate

ADJ_j : domestic cost adjustment for commodity j

The MPS_j in percentage terms is:

$$(5.3) \quad \%MPS_j = (\frac{P_j^d - P_j^{ar}}{P_j^{ar}}) \times 100$$

The $\%MPS_j$ is equivalent to the traditional nominal rate of protection (NRP).

Following the terminology of Krueger, Schiff and Valdes (1988), we define the "direct effect" that is induced by sector-specific policies as the $\%MPS_j$ calculated using the actual nominal exchange rate e:

$$(5.4a) \quad \text{Direct Effect} = \%MPS_j(e) = \left[\frac{P_j^d - P_j^{ar}(e)}{P_j^{ar}(e)}\right] \times 100$$

where:

$P_j^{ar}(e)$: adjusted reference price of commodity j evaluated at e

The direct effect measures the proportionate excess of the domestic price from the adjusted reference price evaluated at the actual exchange rate. Similarly, the "total effect" that is induced by both sectoral and exchange rate policies is defined as the $\%MPS_j$ calculated using the equilibrium exchange rate $e*$:

$$\text{(5.4b)} \quad \text{Total Effect} = \%MPS_j(e^*) = \left[\frac{P_j^d - P_j^{ar}(e^*)}{P_j^{ar}(e^*)}\right] \times 100$$

where:

e^* : nominal equilibrium exchange rate

$P_j^{ar}(e^*)$: adjusted reference price evaluated at e^*

The difference between the total and direct effect captures the "indirect effect" of misalignment of the exchange rate:

$$\text{(5.4c)} \quad \begin{aligned} \text{Indirect Effect} &= \%MPS_j(e^*) - \%MPS_j(e) \\ &= \left\{\left[\frac{P_j^d - P_j^{ar}(e^*)}{P_j^{ar}(e^*)}\right] - \left[\frac{P_j^d - P_j^{ar}(e)}{P_j^{ar}(e)}\right]\right\} \times 100 \end{aligned}$$

It is evident from equation (5.4c) that the magnitude of the indirect effect is determined by the wedge between $\%MPS_j(e^*)$ and $\%MPS_j(e)$ caused by the exchange rate misalignment. When the exchange rate is overvalued, the indirect effect is negative; when the exchange rate is undervalued, the indirect effect is positive; and when there is no exchange rate misalignment, the indirect effect is zero.

Finally, Byerlee and Morris (1993) point out that the conventional methods of comparing the domestic price to an import or export adjusted reference price can sometimes lead to an incorrect estimate of protection. They argue that the selection of a relevant reference price (P_{ar}) depends on the relationship between the autarky equilibrium price (P^*) and the adjusted reference prices for imports (P_m) and exports (P_e). Because of international and domestic cost adjustments, it is always the case that $P_m > P_e$. When $P^* > P_m$, then P_m is the relevant P_{ar}; when $P_e > P^*$, then P_e is the relevant P_{ar}; and when $P_m > P^* > P_e$, then P^* is the relevant P_{ar}. This price relationship, not the observed trade under the policies in place, determines the level of protection or disprotection relative to the price level that would exist in the absence of the policy interventions (see Mullen, et al., 2004). If P^* is the relevant adjusted reference price both at the actual and equilibrium exchange rates then the exchange rate will not affect the $\%MPS_j$ estimates.

India

To evaluate these three effects for India, we draw on a recent analysis by Mullen, Orden and Gulati (2005). The actual nominal exchange rates are the annual average official rates and the nominal equilibrium exchange rates are derived from the corresponding real equilibrium rates in Section 4.[20] The calculations are undertaken for 11 commodities including wheat, rice, corn, sorghum, sugar, groundnut, rapeseed, soybeans, and sunflower, chickpeas, and cotton. Following Mullen, Orden and Gulati (2005), the $\%MPS_j$ for six commodities (wheat, rice corn, sorghum, groundnuts and sugar) are calculated using the Byerlee and Morris (1993) procedure in determining the reference prices, while rapeseed, soybeans, sunflower, chickpeas and cotton are assumed to be importable for all years. Table 8 shows the direct, indirect and total effects measured by commodity-specific $\%MPS_j$ for India for the period 1985-2002.

The sample period 1985-2002 is divided into four distinct subperiods for the presentation of our results. Period one (I) represents the sustained overvaluation period from 1985 to 1989. Period two (II) is the crisis period from 1990 to 1992 when the exchange rate was overvalued but under active adjustment. Period three (III) covers the slight undervaluation period of 1993-1997. The last period (IV) is the stable exchange rate period from 1998-2002 when the actual exchange rate is close to the equilibrium rate with a slight overvaluation. Average exchange rate misalignment for each period is presented in Table 8.

[20] Specifically, the nominal equilibrium exchange rate is obtained by multiplying the real equilibrium exchange rate by the ratio of India's CPI to US WPI.

Table 8—Direct, Indirect and Total Effects by %MPS_j, India

	1985-1989 (I)			1990-1992 (II)			1993-1997 (III)			1998-2002 (IV)		
	%Misalignment -8.7 [a]			%Misalignment -6.9			%Misalignment 4.3			%Misalignment -3.7		
Commodity	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Wheat	-0.7	-4.1	-4.8	-18.3	-4.7	-23.0	-20.2	4.4	-15.8	11.7	-1.1	10.6
Rice	-10.2	-5.8	-16.0	-30.7	-5.0	-35.7	-32.4	3.2	-29.2	-2.3	-3.3	-5.6
Corn	20.4	-7.9	12.5	-0.7	-3.5	-4.2	-5.4	1.7	-3.7	-0.6	-0.8	-1.5
Sorghum	41.5	-4.7	36.8	13.7	-3.3	10.4	9.2	0.9	10.1	15.0	-4.0	10.9
Groundnuts	65.2	-11.8	53.4	14.0	-1.5	12.4	2.7	2.0	4.7	9.2	-3.4	5.8
Sugar	61.8	-12.8	49.0	-3.5	-4.1	-7.6	-4.1	4.1	0.0	24.7	-4.6	20.1
Rapeseed	18.9	-9.0	9.9	23.8	-6.6	17.2	-4.3	3.9	-0.3	-4.8	-3.6	-8.4
Soybeans	-1.7	-7.9	-9.7	-8.2	-5.4	-13.6	-20.6	3.1	-17.5	-30.3	-2.7	-33.0
Sunflower	37.5	-11.3	26.1	29.9	-7.8	22.2	-10.3	3.6	-6.7	-19.0	-3.2	-22.2
Chickpeas	3.5	-8.9	-5.4	-8.9	-6.2	-15.1	-31.2	2.9	-28.4	-3.5	-4.2	-7.7
Cotton	19.8	-13.0	6.8	-1.2	-7.3	-8.5	-11.0	4.5	-6.5	-13.0	-4.1	-17.1
Average [b]	23.3	-8.8	14.4	0.9	-5.0	-4.1	-11.6	3.1	-8.5	-1.2	-3.2	-4.4

Note: a. Average of annual %misalignment from Table 7.
b. Simple unweighted average.
Source: Authors' calculation.

The numbers on the direct effect are equivalent to the conventional measures of %MPS or NRP. On average, the agricultural protection or disprotection measured by the direct effect has shown a counter-cyclical pattern in India. Specifically, the direct effect was generally positive when world commodity prices were low during the first period (I). It became almost neutral during the crisis years (period II), and turned to disprotection when the world prices strengthened in the mid-1990s (period III). The world prices have since then followed a downward trend, and in the most recent period (IV) an unweighted average indicates a slight disprotection. These results are consistent with Mullen, Orden and Gulati (2005), who report their commodity $\%MPS_j$ on an annual basis.[21]

The indirect effect caused by exchange rate misalignments has had quite different impacts on India's agriculture in comparison to the direct effect. On average, India's agricultural sector has been indirectly penalized by exchange rate overvaluation in periods I, II and IV, but subsidized by exchange rate undervaluation in period III. The averages in Table 8 also show that the effect of the exchange rate counteracted the direct effect in periods I, II and III, and reinforced the direct effect, on average, in period IV. The indirect effect was greater in the years before and during the crisis, when the exchange rate was continuously misaligned. In the post-crisis years, as the result of decreased magnitude of exchange rate misalignment following macroeconomic restructuring, the indirect effect has dampened down. Noticeably, the indirect effect of the exchange rate is smaller in absolute value than the direct effect in periods I and III, indicating the dominance of sectoral-specific policies over economy-wide policies (exchange rate in this case). The opposite happened in periods II and IV. This result is somewhat different from that of Krueger, Schiff and Valdes (1988 and 1991) in which they found that the economy-wide policies such as the exchange rate play a more dominant role across a range of developing countries (not including India and China) in an earlier period up to the mid-1980s.

[21] Some slight differences exist since the actual exchange rates used in this study are calendar-year average exchange rates while they are often harvest season average rates in Mullen, Orden and Gulati (2005). Also, the simple unweighted average can be misleading because relative importance in production differs among the crops.

It is worth noting that embedded in the average numbers are significant variations in the magnitude and direction of protection among various commodities and for specific commodities across years. Figure 7 shows the annual direct and total effect for three key commodities (wheat, rice and sugar) over the period of 1985-2002.[22] For wheat the direct effect fell from 7 percent in 1986 to -20 percent in the early 1990s and around -35 percent in 1996 and 1997, then became positive, peaking at 40 percent in 2000.[23] There has been continuous disprotection for rice for most of the years, while for sugar average protection was above 80 percent in the late 1980s but dropped to around neutrality in the 1990s. In most recent years, as a result of drop in world prices, the direct effect shows an increase in support for all these key commodities.

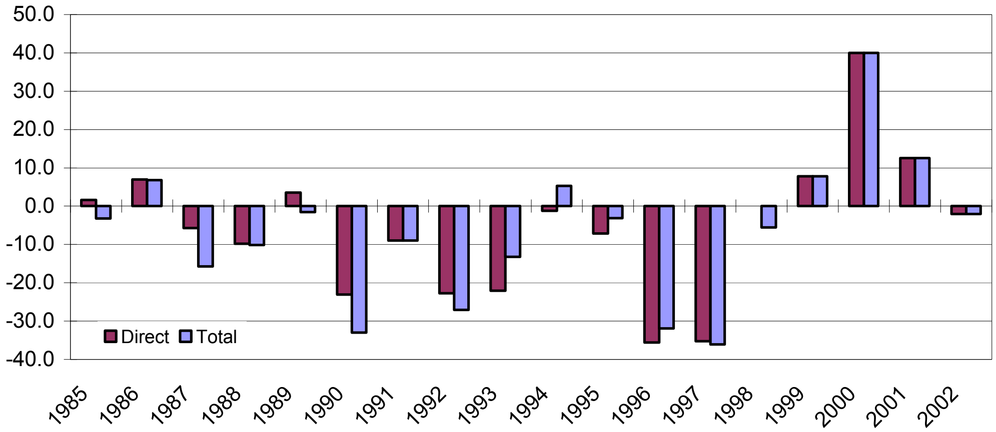
The total effect has been either larger or smaller in magnitude (different signs in some years) than the direct effect, but more or less followed a similar pattern. The difference between the total and direct effects, or the indirect effect, also exhibits variations across various years and commodities. There are a number of reasons for the variations. First, due to differences in domestic and world prices across commodities and in degrees of exchange rate misalignment across years, the levels of $\%MPS_j$ can be different resulting in differences in the indirect effect. Second, the domestic cost adjustments (ADJ_j) not affected by the exchange rate can lead to disproportionate change in the adjusted reference price relative to the exchange rate, which causes differences in the indirect effect among commodities for the same year in which the degree of exchange rate misalignment facing each commodity is the same.

[22] These three commodities account for nearly 75 percent of total value of production for the eleven commodities.

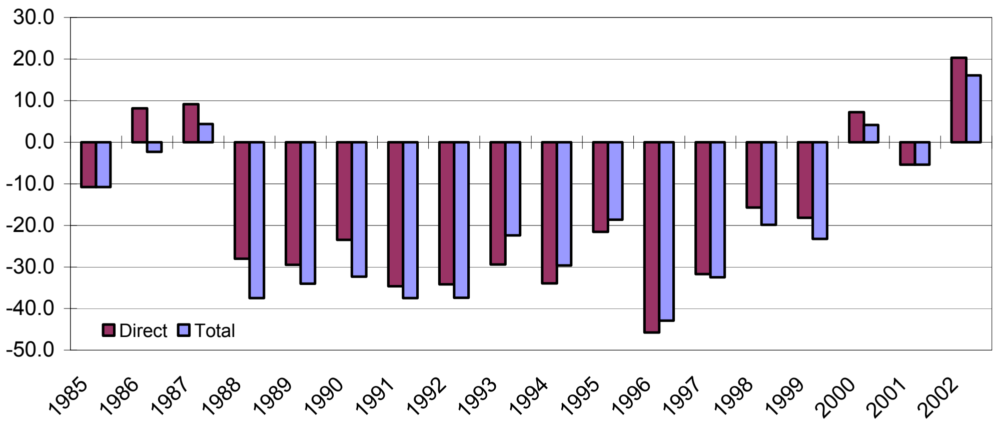
[23] For wheat, rice and sugar our results are based on the Byerlee and Morris (1993) procedure as applied by Mullen, Orden and Gulati (2005). When the relevant reference prices are the autarky equilibrium prices at both the actual and equilibrium exchange rates, the direct and total effects are the same because the exchange rate does not play a role in determining reference prices. However, the autarky prices are only relevant for a limited number of years for these commodities (see Figure 7).

Figure 7—Direct and Total Effects by %MPS$_j$ for Wheat, Rice and Sugar, India

Wheat



Rice



Sugar

Source: Authors calculations.

China

For China, we base our evaluation on the PSE analysis by Sun (2003), which is limited to the years 1995-2001. The $\%MPS_j$ is based on 9 commodities: wheat, rice, corn, sorghum, peanut, cotton, rapeseed, soybeans and sugar.[24] The nominal equilibrium exchange rates used for the calculations are again derived from the corresponding real equilibrium exchange rates in Section 4. Due to data constraints, we do not apply the Byerlee and Morris (1993) procedure in China: rice, corn, sorghum and peanut are assumed to be exportable and wheat, cotton, soybeans, rapeseed and sugar are assumed to be importable. For presentation of the results, the sample period is divided in the two subperiods (I and II), representing, respectively, periods of slight currency overvaluation (1995-1998) and more intense undervaluation (1999-2001). Table 9 shows the direct, indirect and total effect by commodity-specific $\%MPS_j$ in China.

Except for rice, the direct effect of price interventions measured by $\%MPS_j$ has shown decreased protection or increase disprotection on the representative commodities in 1999-2001 compared to 1995-1998. The commodity-specific results are similar to those reported in Sun (2003) and Mullen, et al. (2004).[25] The unweighted average disprotection rate increased from -0.3 in period I to -8.6 in period II.[26] As demonstrated for India, exchange rate misalignment in China has either indirectly taxed or subsidized the agricultural sector. The indirect effect of exchange rate overvaluation is relatively small and averages about -1.2 percent in period I. However, the exchange rate undervaluation in period II has had a much greater impact on the agricultural sector. It indirectly subsidized agricultural prices by 10.3 percent, on average, counteracting the direct effect and resulting in a positive total effect of 1.5 percent.

[24] This represents a subset of the 21 commodities covered by Sun (2003). However, by including only the major agricultural commodities, we avoid the difficulties of computing an appropriate adjusted reference price for some highly differentiated horticulture and livestock products, for which only very limited data is available. See also Mullen et al. (2004) for discussion of five major commodities.

[25] Mullen, et al. (2004) report the results only for five commodities (wheat, soybeans, sugar, rice and corn).

[26] In a longer term context, there appears to be a move toward lessened disprotection of agriculture in China (see Mullen et al. (2004) and Cheng and Sun (1998).

Table 9—Direct, Indirect and Total Effect by %MPS_j, China

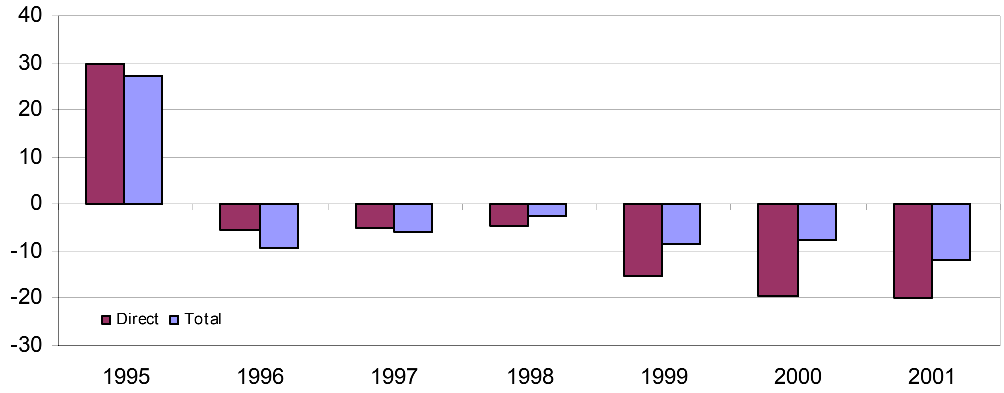
	1995-1998 (I)			1999-2001 (II)		
	%Misalignment -5.8 [a]			%Misalignment 15.8		
Commodity	Direct	Indirect	Total	Direct	Indirect	Total
Rice	-10.0	-0.9	-10.9	1.7	11.4	13.1
Corn	7.1	-1.0	6.1	5.5	11.7	17.2
Sorghum	-18.1	-0.9	-19.0	-32.6	7.6	-25.0
Peanut	-39.1	-0.8	-39.9	-39.2	6.7	-32.5
Wheat	3.8	-1.4	2.4	-18.2	9.0	-9.2
Cotton	-7.6	-1.2	-8.8	-28.0	8.1	-19.9
Soybeans	18.9	-1.5	17.4	15.5	12.7	28.2
Rapeseed	11.5	-1.5	10.0	2.8	11.2	14.0
Sugar	31.0	-1.7	29.3	15.1	12.8	27.9
Average [b]	-0.3	-1.2	-1.5	-8.6	10.1	1.5

Note: a. Average of annual %misalignment from Table 7.
b. Simple unweighted average.
Source: Authors' calculation.

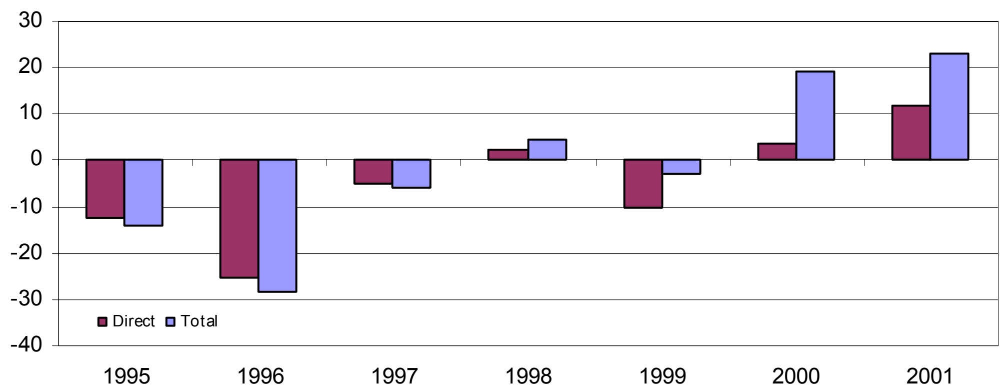
Again, the unweighted averages reported in Table 9 mask different patterns of protection and disprotection for individual commodities across various years. The annual direct and total effects by %MPS_j for wheat, rice and sugar are shown in Figure 8. In China, wheat was protected only in 1995 and the rate of disprotection measured by the direct effect increased in later years peaking in 2001 at about -20 percent. The pattern of protection of rice is similar to India, with disprotection when world prices were high in 1996 turning to protection when world prices were lower in 2000 and 2001. Sugar has been protected in China for the whole period, but the level of protection decreases. For all three commodities, exchange rate undervaluation in most recent years have led to either smaller disprotection (e.g. wheat) or greater protection (e.g. rice and sugar) as measured by the total %MPS_j effects as compared to the direct effects.

Figure 8—Direct and Total Effects by %MPS_j for Wheat, Rice and Sugar, China

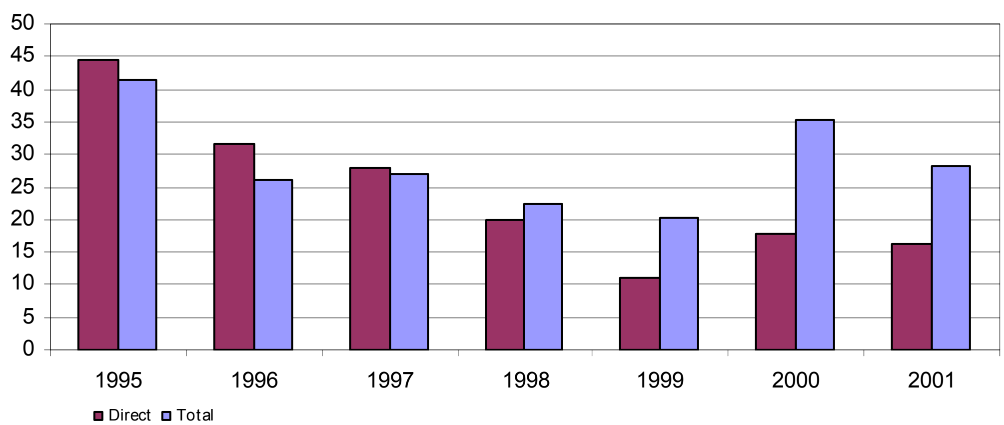
Wheat



Rice



Sugar



Source: Authors' calculation.

5.2 EFFECTS ON COMMODITY-SPECIFIC PSE

According OECD's definition, the PSE is categorized into eight components including the MPS and seven categories of budgetary outlays for various types of government payments that support farmers. Thus, the calculation of product-specific PSE requires that budgetary payments be allocated across commodities to determine the budgetary support for a given product, BP_j, where "*j*" denotes a specific commodity. If such payments are reported by commodity, the procedure is straightforward. However, for payments such as input subsidies or general subsidies such as tax or capital grants, allocation across commodities can be more complicated. Following Mullen, Orden and Gulati (2005), we distribute the payments on the basis of such factors as each commodity's share in total value of production, total fertilizer usage, or total irrigated area.

Once budgetary payments are allocated among commodities, the product-specific PSE_j is the sum of the MPS_j and BP_j. Similar to the MPS_j, the PSE_j measures can also be expressed on a percentage basis. One definition makes the percentage PSE_j the proportion of gross farm income:

$$(5.5) \quad \%PSE_j = \left[\frac{MPS_j + BP_j}{VOP_j + BP_j} \right] \times 100$$

where:

VOP_j : value of production of commodity j at domestic producer price = $P_j^d \times Q_j$

BP_j : budgetary payments to commodity j

The percentage PSE_j (or $\%PSE_j$) gives a "subsidy counter's" measure of support relative to domestic farm revenue for a particular commodity. For this measure, the direct, total and indirect effects are given in equations (5.6a-c):

(5.6a)

$$\text{Direct Effect} = \%PSE_j(e) = \left[\frac{MPS_j(e) + BP_j}{VOP_j + BP_j}\right] \times 100$$

$$= \left\{\frac{\left[P_j^d - P_j^{ar}(e)\right] \times Q_j + BP_j}{VOP_j + BP_j}\right\} \times 100$$

(5.6b)

$$\text{Total Effect} = \%PSE_j(e^*) = \left[\frac{MPS_j(e^*) + BP_j}{VOP_j + BP_j}\right] \times 100$$

$$= \left\{\frac{\left[P_j^d - P_j^{ar}(e^*)\right] \times Q_j + BP_j}{VOP_j + BP_j}\right\} \times 100$$

(5.6c)

$$\text{Indirect Effect} = \%PSE_j(e^*) - \%PSE_j(e)$$

$$= \left\{\frac{\left[P_j^d - P_j^{ar}(e^*)\right] \times Q_j + BP_j}{VOP_j + BP_j} - \frac{\left[P_j^d - P_j^{ar}(e)\right] \times Q_j + BP_j}{VOP_j + BP_j}\right\} \times 100$$

$$= \left\{\frac{\left[P_j^{ar}(e) - P_j^{ar}(e^*)\right] Q_j}{VOP_j + BP_j}\right\} \times 100$$

It is, however, not straightforward to directly compare the different effects measured by $\%PSE_j$ in equations (5.6a-c) with those measured by $\%MPS_j$ in equations (5.4a-c), since the two sets of measures are based on different denominators.

Following Mullen, et al. (2004), we define an alternative measure of $\%PSE_j$ (using a "trade economist's denominator") that expresses support received by farmers as a percentage of the value of their output at adjusted reference price:

$$(5.7) \quad \%PSE_j^{ar} = \left(\frac{MPS_j + BP_j}{VOP_j^{ar}}\right) \times 100$$

where:

VOP_j^{ar}: value of production of commodity j at adjusted reference price = $P_j^{ar} \times Q_j$

Corresponding, the direct, total and indirect effects are given in equations 5.8a-c:

$$\text{Direct Effect} = \%PSE_j^{ar}(e) = \left[\frac{MPS_j(e) + BP_j}{VOP_j^{ar}}\right] \times 100$$

(5.8a)
$$= \left[\frac{P_j^d - P_j^{ar}(e)}{P_j^{ar}(e)} + \frac{BP_j}{P_j^{ar}(e)Q_j}\right] \times 100$$

$$= \left[\%MPS_j(e) + \frac{BP_j}{P_j^{ar}(e)Q_j}\right] \times 100$$

$$\text{Total Effect} = \%PSE_j^{ar}(e^*) = \left[\frac{MPS_j(e^*) + BP_j}{VOP_j^{ar}}\right] \times 100$$

(5.8b)
$$= \left[\frac{P_j^d - P_j^{ar}(e^*)}{P_j^{ar}(e^*)} + \frac{BP_j}{P_j^{ar}(e^*)Q_j}\right] \times 100$$

$$= \left[\%MPS_j(e^*) + \frac{BP_j}{P_j^{ar}(e^*)Q_j}\right] \times 100$$

$$\text{Indirect Effect} = \%PSE_j^{ar}(e^*) - \%PSE_j^{ar}(e)$$

(5.8c)
$$= \left\{\left[\%MPS_j(e^*) - \%MPS_j(e)\right] + \frac{BP_j}{Q_j}\left[\frac{1}{P_j^{ar}(e^*)} - \frac{1}{P_j^{ar}(e)}\right]\right\} \times 100$$

It can be seen from the above definitions that the direct, total and indirect effects measured by $\%PSE_j^{ar}$ are different from those measured by $\%MPS_j$. When the budgetary payment is positive, the direct and total effects of $\%PSE_j^{ar}$ indicate more protection (or less disprotection). However, the impact of inclusion of budgetary payment on the indirect effect depends on the direction of exchange rate misalignment. As for the indirect %MPS effect itself, if the exchange rate is overvalued, $\left[\frac{1}{P_j^{ar}(e^*)} - \frac{1}{P_j^{ar}(e)}\right] < 0$, the indirect effect is negative (i.e. shows less protection or more disprotection). If the exchange rate is undervalued, $\left[\frac{1}{P_j^{ar}(e^*)} - \frac{1}{P_j^{ar}(e)}\right] > 0$, the indirect effects is positive (shows more protection or less disprotection).

<u>*India*</u>

Using the same commodity set and sample periods as in the $\%MPS_j$, Table 10 presents the direct, indirect and total effects by commodity specific $\%PSE_j^{ar}$ for India. On average, the direct effect on representative commodities exhibits the same counter-cyclical pattern as found in $\%MPS_j$: support to agriculture drops from a relatively high level in period I to near neutrality in period III, and then rose in period IV. However, the direct effect measured by the $\%PSE_j^{ar}$ indicates more agricultural protection than the $\%MPS_j$, due to the inclusion of positive budgetary payments in the calculation. Mullen, Orden and Gulati (2005) show that the budgetary payments in India have become more important in the aggregate support to farmers in the last decade, and in recent years, they have been larger in magnitude than the market price support. The increasing importance of the budgetary payment has had great impacts on the measured support levels. For instance, the difference between the unweighted average direct effect measured by $\%PSE_j^{ar}$ and $\%MPS_j$ during period IV is more than 17 percent.

The inclusion of budgetary payment in $\%PSE_j^{ar}$ has made the effect of exchange rate misalignment larger for each commodity in each period than for the $\%MPS_j$. The indirect effect shows more disprotection during periods of overvaluation (I, II and IV), and more protection during period of undervaluation (III). In each period, the indirect effect of exchange rate misalignment again counteracts the direct effect. Specifically, exchange rate overvaluation has indirectly taxed agriculture in periods I, II and IV, but undervaluation has subsidized agriculture in period III. The indirect effect is, on average, less than the direct effect in absolute values (except period III), reflecting again the more dominant role of sectoral policies.

Table 10—Direct, Indirect and Total Effect by $\%PSE_j^{ar}$, India

	1985-1989 (I)			1990-1992 (II)			1993-1997 (III)			1998-2002 (IV)		
	%Misalignment -8.7 [a]			%Misalignment -6.9			%Misalignment 4.3			%Misalignment -3.7		
Commodity	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total	Direct	Indirect	Total
Wheat	15.6	-4.7	10.9	5.6	-6.1	-0.5	3.4	5.7	9.1	45.0	-1.5	43.5
Rice	-1.7	-6.5	-8.1	-20.1	-5.7	-25.9	-21.0	3.7	-17.3	15.9	-4.2	13.7
Corn	27.5	-8.5	19.1	7.7	-3.9	3.8	4.2	1.9	6.1	11.6	-0.9	10.6
Sorghum	45.7	-4.8	40.9	20.7	-3.5	17.2	18.3	0.9	19.2	27.9	-4.3	23.5
Groundnuts	69.8	-12.2	57.7	18.4	-1.6	16.8	8.8	2.2	11.0	20.0	-3.7	16.4
Sugar	71.8	-13.6	58.2	4.5	-4.4	0.1	5.3	4.5	9.8	37.4	-5.1	32.4
Rapeseed	30.0	-9.9	20.1	35.9	-7.3	28.5	8.0	4.4	12.4	16.8	-4.4	12.4
Soybeans	6.4	-8.6	-2.2	-3.2	-5.7	-8.8	-17.2	3.2	-14.0	-25.2	-2.9	-28.1
Sunflower	46.5	-12.2	35.3	35.5	-8.1	27.4	-4.0	3.8	-0.2	-6.1	-3.6	-9.7
Chickpeas	8.2	-9.3	-1.1	-1.1	-6.7	-7.8	-23.6	3.2	-20.4	8.4	-4.7	3.6
Cotton	58.0	-17.9	40.1	30.6	-10.0	20.6	16.7	7.3	24.0	27.1	-6.2	20.9
Average [b]	34.3	-9.8	24.6	12.2	-5.7	6.5	- 0.1	3.7	3.6	16.3	-3.8	12.6

Note: a. Average of annual %misalignment from Table 7.
b. Simple unweighted average.
Source: Author's calculation.

It is also worth noting that the magnitude of the indirect effect on $\%PSE_j^{ar}$ over time is determined by the degree of exchange rate misalignment and by changes in budgetary payments (see equation (5.8c)). In India, the combined effect of increasing budgetary payments and decreasing exchange rate misalignment has led to a less pronounced indirect effect in the later periods than the earlier periods. This in turn indicates that the exchange rate alignment plays a more dominant role than the budgetary payments in the evolution of the indirect effect in India during the sample period.

<u>China</u>

Table 11 shows the direct, indirect and total effects measured by commodity-specific $\%PSE_j^{ar}$ in China. It is important to note that there have been little explicit policy instruments for direct payments or subsidies to farmers in China (Sun, 2003). Instead, there have been various taxes and fees by the local and central governments targeted at specific agricultural commodities. Following Sun (2003), these taxes and fees were treated as negative payments to farmers.[27] Nonetheless, the budgetary payments including the taxes and fees represent only a small proportion of aggregate support to the farmers. When allocated to each representative commodity according to its share in the total value of production, they are less than 10 percent of the price support (MPS) in most cases (Sun, 2003).

Because of the dominance of the MPS component in the aggregate support, the inclusion of small budgetary payments in the calculation of $\%PSE_j^{ar}$ has had little impact on the direct, total and indirect effects in China. Similar to the $\%MPS_j$, the direct effect of agricultural policies on unweighted average has disprotected the farmers of these covered commodities for the whole period and the rate of disprotection increased from -0.2 in 1995-1998 to -7.7 in 1999-2002. The indirect effect of exchange rate misalignment has

[27] Starting in 2000, China launched its pilot reforms on rural tax and fee system, and one of the reforms is to lower, exempt or abolish the taxes on the farmers (Sun, 2003). However, these reform measures were still in their experimental stages during 2000-2001 and their impacts were little on this analysis.

amplified the direct effect in the first period but counteracted the direct effect in the second period. The indirect effect is more pronounced in the second period due to greater exchange rate undervaluation, which indirectly subsidized the agricultural sector, on average, by 10.2 percent. Furthermore, the small budgetary payments (or taxes) have also made the change of indirect effect over time primarily determined by the degree of China's exchange rate misalignment.

Table 11—Direct, Indirect and Total Effect by $\%PSE_j^{ar}$, China

	1995-1998 (I)			1999-2001 (II)		
	%Misalignment -5.8 [a]			%Misalignment 15.8		
Commodity	Direct	Indirect	Total	Direct	Indirect	Total
Rice	-9.9	-0.9	-10.8	2.5	11.4	13.9
Corn	7.2	-1.1	6.1	6.8	11.7	18.5
Sorghum	-18.2	-0.8	-19.0	-31.7	7.5	-24.2
Peanut	-39.0	-0.8	-39.8	-38.5	6.8	-31.7
Wheat	3.8	-1.3	2.5	-17.2	9.0	-8.2
Cotton	-7.5	-1.2	-8.7	-27.2	8.2	-19.0
Soybeans	19.1	-1.6	17.5	16.9	12.7	29.6
Rapeseed	11.6	-1.4	10.2	4.0	11.3	15.3
Sugar	31.0	-1.7	29.3	15.2	12.8	28.0
Average [b]	-0.2	-1.2	-1.4	-7.7	10.2	2.5

Note: a. Average of annual %misalignment from Table 7.
b. Simple unweighted average.
Source: Authors' calculation.

5.3 EFFECTS ON TOTAL PSE

The total PSE expressed in nominal terms for all agricultural producers is the sum of total MPS and aggregate budgetary payments. The calculation of total MPS, according to the OECD approach consists of three steps. First, a nominal value of MPS is estimated for individual products, the set of which is known as the covered "MPS commodities." The second step is to sum the product-specific MPS results into an MPS_c for the covered commodities. In the third step the MPS_c for covered commodities is "scaled up" to all products based on the share (k) of the covered commodities in the total value of agricultural production. The final step or "MPS extrapolation procedure" can be expressed as $MPS = MPS_c/k$, where MPS is the estimated total market price support. With the scaling-up, the OECD "Total PSE" is calculated as $PSE = MPS + BP$. Without the scaling-up the total PSE is $PSE_c = MPS_c + BP$. Similar to commodity-specific PSEs, total PSE measures can be expressed on a percentage basis (denoted by $\%PSE$) using $(VOP + BP)$ or VOP^{ar} as the denominator, where VOP and VOP^{ar} are the total value of agricultural production at domestic producer prices and world reference prices, respectively, and BP is the total budgetary payments. In the following analysis, the total $\%PSE$ is calculated using the OECD denominator $(VOP+BP)$ as commonly reported.

For developing countries, feasible commodity coverage is likely to be less than for the OECD countries, and the assumption imposed by scaling-up may be unrealistic if price support is concentrated among those products included in the analysis. On the other hand, if price support applies to all agricultural commodities, then the scaling-up procedure is relevant and necessary. The scaling-up effect on the total PSE depends crucially on the magnitude of the price support relative to budgetary payments in the aggregate support. Using India's total PSE as an example, Mullen, Orden and Gulati (2005) have shown that the scaling-up procedure does not make too much difference in the calculated support levels when MPS_c component of the PSE is relatively small, but has a pronounced effect when MPS_c is relatively larger in absolute value.

Again, we define the direct, total and indirect effect in terms of %PSE. The three effects in the non-scaled-up case can be adapted from the $\%PSE_j$ by replacing the MPS_j and $(VOP_j + BP_j)$ in equations (5.6a-c) with MPS_c and $(VOP + BP)$. With scaling-up, the effects are given in equations (5.9a-c):

$$\text{(5.9a)} \quad \text{Direct Effect} = \%PSE(e) = \left[\frac{MPS_c(e)/k + BP}{VOP + BP} \right] \times 100$$

$$\text{(5.9b)} \quad \text{Total Effect} = \%PSE(e^*) = \left[\frac{MPS_c(e^*)/k + BP}{VOP + BP} \right] \times 100$$

$$(5.9c)\quad \text{Indirect Effect} = \%PSE(e^*) - \%PSE(e) = \frac{1}{k}\left[\frac{MPS_c(e^*) - MPS_c(e)}{VOP + BP}\right] \times 100$$

It is evident that the direct, indirect and total effects in the scaled-up version are different from those in the non-scaled-up version. The impact of scaling-up on the support level (direct and total effects) depends on the sign of MPS: if MPS is negative, then the scaling-up will indicate more disprotection and if MPS is positive, the scaling-up will indicate more protection. The scaling-up can lead to different degrees of change in the direct and total effects depending on the relative magnitude of MPS and BP. However, the scaling-up magnifies the indirect effect by exactly $1/k$, the inverse of the share of covered commodities in the total value of agricultural production.

India

Table 12 shows the three effects in India without and with scaling-up. The covered commodities are the same as those used in the previous calculations. In general, the support to agriculture (direct and total effect), scaled-up or non-scaled-up, indicates a similar counter-cyclical pattern, rising when world prices are low (as in periods I and IV) and falling when world prices strengthen (as in period II and III).[28]

Table 12—Direct, Indirect and Total Effect by %PSE, India

	Non-scaling-up (%PSE$_c$)			Scaling-up (%PSE)		
	Direct	Indirect	Total	Direct	Indirect	Total
1985-1989 (I)	6.8	-3.0	3.8	9.7	-6.4	3.3
1990-1992 (II)	-0.9	-3.3	-4.1	-9.4	-7.0	-16.4
1993-1997 (III)	-4.4	2.1	-2.3	-19.5	5.0	-14.5
1998-2002 (IV)	8.2	-1.1	7.1	8.8	-2.5	6.3

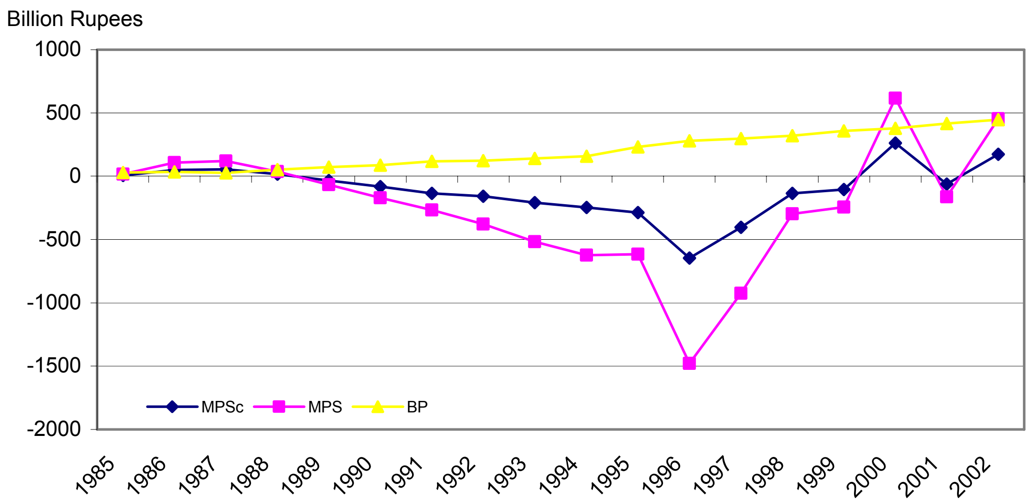
Source: Authors' calculation.

[28] Again, the results are very similar to those reported by Mullen, Orden and Gulati (2005).

In period I and IV, the MPS_c component of the PSE is relatively small (Figure 7), and the scaling-up does not have a significant impact on support levels indicated by direct and total effects. In contrast, when the MPS_c becomes more important in period II and III, the scaled-up direct and total effects are much larger than their non-scaled-up counterparts. The direct effect decreased more than 8 percent from -0.9 to -9.4 in period II. The change in the direct effect is larger in period III, dropping more than 15 percent from -4.4 to -19.5. The scaling-up also causes the total effect to decrease from -4.1 to -16.4 in period II, and from -2.3 to -14.5 in period III. The impact of scaling-up on the direct and total effects in India also depends on the sign of MPS. In terms of the direct effect, where the MPS is evaluated at the actual exchange rate, the scaling-up has led to higher protection rates in periods I and IV when the MPS is positive, but higher disprotection rates in periods II and III when the MPS is negative. The results are different for the total effect since the MPS in this case is evaluated at the equilibrium exchange rate.

The scaled-up and non-scaled-up indirect effects show different impact of exchange rate misalignment on India's agriculture during different periods. The exchange rate effects are consistent with the previous commodity-specific analysis: when the exchange rate was overvalued (periods I, II and IV), the indirect effect works against the agricultural sector. The opposite happens when the exchange rate was undervalued in period III. The scaling-up has had a uniform impact on the indirect effect for each period, which more than doubles in the scaled-up than the non-scaled-up case. The reason for this is that the share of covered commodities in total value of production is about 0.45 for each of the periods.

Figure 9—MPS_c, MPS and BP, India (Billion Rupees)

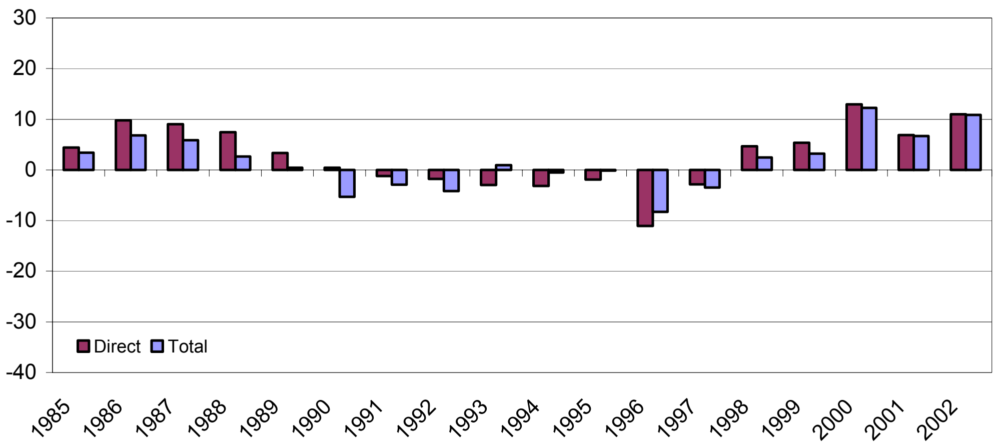


Note: MPS_c and MPS are based on the actual exchange rate.
Source: Authors' calculation.

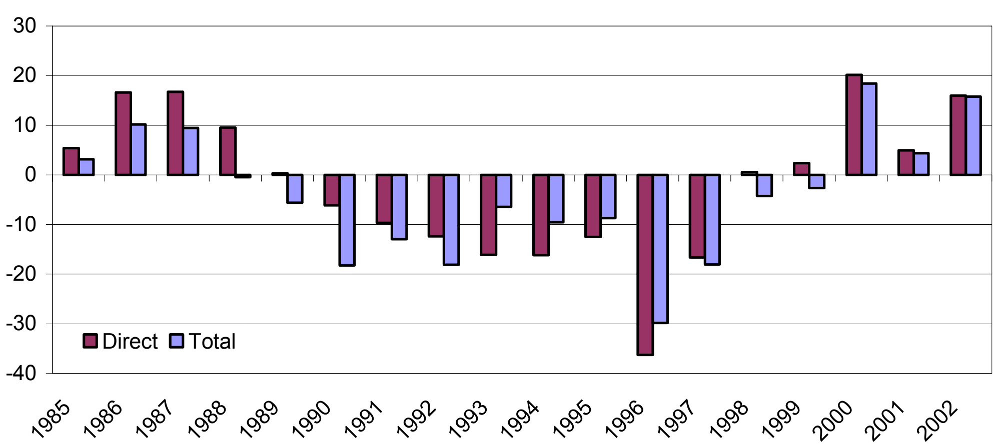
Similar to commodity specific measures, the averages of total PSE in Table 12 include sub-periods of higher protection and disprotection (Figure 10). The direct PSE without scaling-up peaked at 10 percent in 1986 as compared to an average of less than 7 percent during 1985-1989, and bottomed at -11 percent in 1996 as compared to an average of -4.4 percent during 1993-1997. In recent years (1998-2002), the positive direct effect averaged about 8 percent but peaked in 2000 at 13 percent. Following a similar pattern as the non-scaling-up total PSE, the scaling-up version shows even greater fluctuations over time between protection and disprotection measured by the direct and total effects. In particular, the direct effect with scaling-up dropped to -36 percent in 1996 and later rose to 20 percent in 2000. Overvaluation increases the disprotection measured by total %PSE in the early 1990s but undervaluation decreases disprotection in the mid 1990s.

Figure 10—Direct and Total Effect by %PSE, India

Non-scaling-up



Scaling-up



Source: Authors' calculation.

China

Table 13 shows the direct, indirect and total effect in China without and with the scaling-up. The scaled-up or non-scaled-up direct effect measured by total PSE indicates that China's support to the agriculture has remained negative in each period and level of discrimination against agriculture increased over the short time period covered. This result is somewhat different from Sun (2003) and Mullen, et al. (2004) who report the annual %PSE based on different sets of commodities. The indirect effect of exchange rate shows slight disprotection in period I but greater protection in period II.

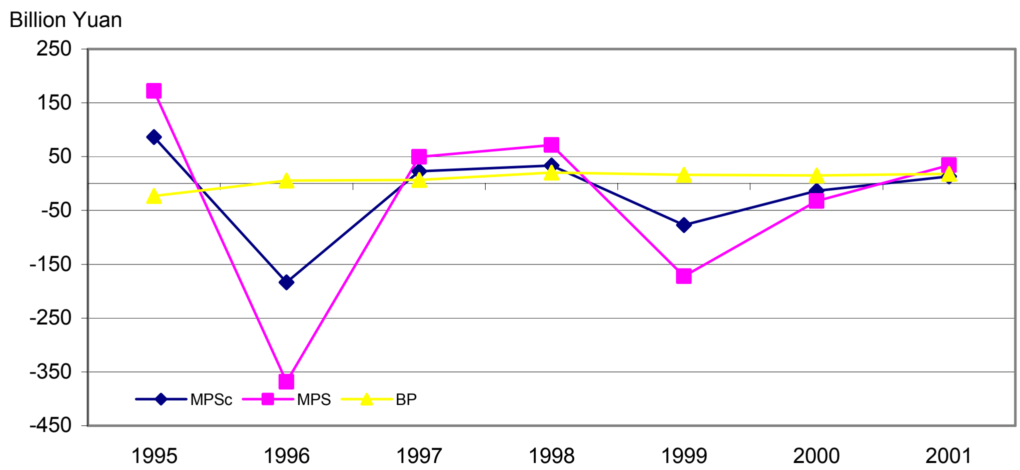
Table 13—Direct, Indirect and Total Effect by %PSE, China

	Non-scaling-up (%PSE_c)			Scaling-up (%PSE)		
	Direct	Indirect	Total	Direct	Indirect	Total
1995-1997 (I)	-0.4	-0.9	-1.3	-0.8	-1.9	-2.7
1998-2001 (II)	-0.7	7.0	6.3	-3.0	16.8	13.8

Source: Authors' calculation.

The MPS_c (evaluated at the actual exchange rate) in China is a more important component of PSE than the budgetary payments for most of the years (Figure 11). In contrast to India, the magnitude of the MPS_c in China is small in both periods, resulting in a less pronounced impact of scaling-up on the direct and total effect. Since the MPS_c evaluated at the actual exchange rate is negative on average in each period, the scaling-up has uniformly led to more disprotection indicated by the direct effect (Table 13). However, when the MPS_c becomes positive if calculated using the equilibrium exchange rate in period II (not shown in Figure 11), the total effect with scaling-up indicates more protection than that without scaling-up. Similar to India, the scaling-up in China has a uniform impact on the indirect effect, which is about twice as large as the non-scaled-up counterpart. This again corresponds to the fact that the share of covered commodities in total value of production averages about 0.45 in the two periods.

Figure 11—MPS_c, MPS and BP, China (Billion Yuan)

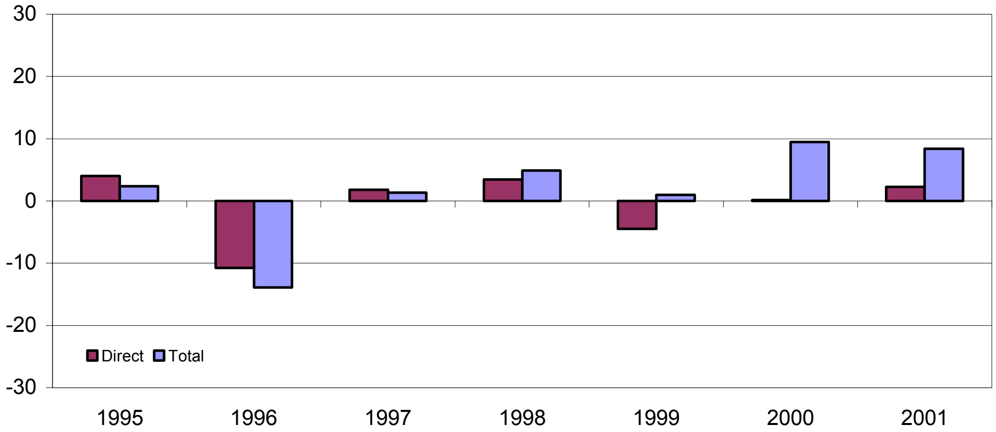


Note: MPS_c and MPS are based on the actual exchange rate.
Source: Authors' calculation.

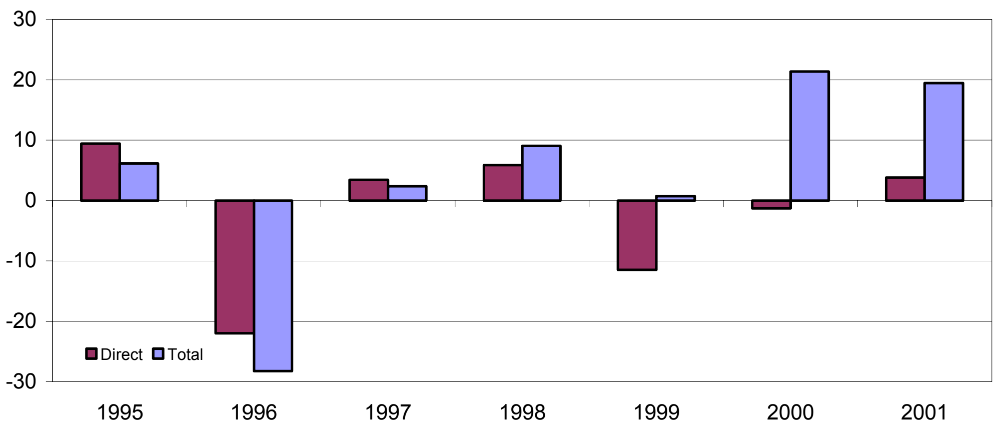
Figure 12 shows the annual direct and total effect by %PSE for 1995-2001. Although the average direct effect without scaling up indicates close-to-neutral support in both periods, the annual direct effect indicates more disprotection in 1996 at -10 percent and more protection in 1998 at 4 percent. The total effect without scaling-up reached -14 percent in 1996 while the average for the period (1995-1997) is only -1 percent. Similar comparisons can also be made between the annual and average numbers for the %PSE with scaling-up.

Figure 12—Direct and Total Effect by %PSE, China

Non-scaling-up



Scaling-up



Source: Authors' Calculation.

6. SUMMARY AND CONCLUSIONS

The level of the exchange rate and its disequilibrium can have significant impacts on the agricultural sector. In particular, there is widespread agreement that exchange rate misalignments can lead to inaccurate calculations of agricultural support measures. Empirical studies on the issue have mainly focused on the effects of exchanges rate on the nominal rate of protection (NRP). There have been attempts to consider the role the exchange rate plays in more comprehensive agricultural policy indicators such as the PSE, but the calculations are usually based on simple exchange rate adjustment approaches such as the PPP. In this analysis, we utilize an alternative approach to determining equilibrium exchange rates and apply the resulting measures of exchange rate misalignment in evaluating the MPS and the PSE.

The estimation of the equilibrium exchange rates is based on a theoretical framework in which the equilibrium value of the real exchange rate is determined by a set of economic fundamentals. The empirical proxies for the fundamentals used in this analysis include ones for technological progress (Balassa-Samuelson effect), government consumption, the terms of trade, foreign exchange reserves, and openness. Base on contemporary time series techniques, including the unit root and Johansen cointegration procedures, sensible long-run relationships are identified between the real exchange rate and the economic fundamentals in India and China.

The equilibrium exchange rates are used to assess the development of actual exchange rates in both countries. The real exchange rate of the Indian rupee is found to be overvalued during the 1980s and early 1990s. The post-crisis adjustment program featured macroeconomic stabilization and structural reforms, especially in the direction of trade and financial liberalization. In the years after the crisis, rising capital inflows and shrinking trade deficits have led to continued accumulation of foreign exchange reserves, and after a short period of undervaluation in the mid-1990s, the rupee rate has been close to its equilibrium values with a slight overvaluation. Since 1978, the real exchange rate of Chinese yuan is characterized by undervaluation (overvaluation occurs in a number of years but these periods are short-lived). Strong economic fundamentals, a rigid nominal exchange rate, and low inflation rates in recent years have led to substantial undervaluation in China.

Nominal equilibrium exchange rates corresponding to estimated real equilibrium rates are applied to the MPS and the PSE calculations in the two countries based on earlier analyses of agricultural support by Mullen, Orden and Gulati (2005) and Sun (2003). Our results indicate that the indirect effect of exchange rate overvaluation has potentially taxed the agricultural sector in India during the period of 1985-1992 and 1998-2002. However, the magnitude of these indirect effects is smaller in the later periods when the actual exchange rate moves closer to its equilibrium value. The indirect effect of exchange rate misalignment is, in general, smaller than the direct effect from sectoral-specific policies. For China, the indirect effect of exchange rate undervaluation in the period of 1999-2001 has had a much greater impact on the measured support level than overvaluation in 1995-1998. It has more than offset the direct disprotection to agriculture and led to a positive total effect.

The relative importance of different PSE components also affects the estimates of the direct, indirect and total effects. First, the inclusion of budgetary payments in the analysis changes the effects of agricultural and exchange rate policies measured by the $\%MPS_j$. Commodity-specific $\%PSE_j^{ar}$ using the value of production at international prices as the denominator show that such changes are more pronounced in India where the budgetary payments have become a more important component of the PSE. The direct and total effects measured by the commodity-specific $\%PSE_j^{ar}$ indicate more protection and less disprotection. But the impact of including budgetary payment on the indirect effect can be different depending on the direction of exchange rate misalignment: more disprotection (less protection) when the exchange rate is overvalued and more protection (less disoprotection) when the exchange rate is undervalued. In contrast to India, China has had little explicit budgetary payments to farmers and the effects measured by the $\%PSE_j^{ar}$ do not differ much from those measured by the $\%MPS_j$.

Second, the magnitude of the MPS and budgetary components has had important impacts on the different effects measured for the total %PSE with and without the scaling-up procedure. In India, the scaling-up leads to more significant changes in the direct and total effects during periods when the MPS becomes larger in magnitude. In contrast, changes in the direct and total effects in China are less pronounced in the sample period since the MPS is relatively small. The effect of scaling-up on support levels depends on the sign of MPS: if MPS is negative, then scaling-up leads to more disprotection and if MPS is positive, the scaling-up leads to more protection. In addition, the impact of scaling-up on the indirect effect is directly related to the share of covered commodities in the total value of agricultural production. In India and China, based on the underlying studies we draw upon, the scaling-up leads to indirect effects essentially double the non-scaled-up counterparts.

In general, our equilibrium real exchange rate estimation results are consistent with previous studies. There are a number of factors, however, that might affect the use of these measures applied to agricultural support measures. First, the exchange rate instability within a particular year is ignored. Standard PSE measurement offers per year estimations using annual average exchange rates. Obviously, in developing countries where exchange rate can change significantly during the year, average rates may only provide an approximation of the actual exchange rate behavior. During periods of drastic exchange rate movements, it would be more adequate to use exchange rates of shorter periods (for example, the harvest season) when calculating the PSE effects. Second, the results are highly dependent on the modeling strategy of equilibrium exchange rates. Alternative models of equilibrium exchange rates exist and it would be ideal to conduct a sensitivity analysis of the PSE where results from different approaches to equilibrium exchange rates are compared. Third, the above measures of different effects assume that the domestic price of the relevant commodity remains unchanged when comparisons are made between actual and equilibrium exchange rates. In other words, this study, like many others assessing exchange rate effects on the NPR, ignores the “pass-through” of exchange rates on domestic prices. However, such an assumption is questionable. Over time, nominal exchange rates have been closely linked to levels of a country's prices. Since both India and China have a considerable degree of openness to foreign trade, domestic commodity prices cannot remain immune to external price shocks, i.e. exchange rate depreciation or appreciation and changes in import (or export) prices. Future research efforts should be directed toward addressing these considerations in order to better disentangle how exchange rate realignment effects are distributed between actual returns to farmers versus measures of the extent to which they are protected or disprotected.

REFERENCES

Agenor, P. 1998. "Capital Inflows, External Shocks, and the Real Exchange Rate." *Journal of International Money and Finance*, 17, pp.713-40.

Anderson, K. 2003. "Agriculture and Agricultural Incentives in China and India Post-Uruguay Round." Paper presented at the international conference on "Agricultural Policy Reform and the WTO: Where Are We Heading?" Capri, Italy.

Baffes, J., I. Elbadawi, and S. O'Connell. 1999."Single-Equation Estimation of the Equilibrium Real Exchange Rate." World Bank, Policy Research Department, Washington, DC.

Bautista, R. and C. Gehlhar. 1996. "Price Competitiveness and Variability in Egyptian Cotton: Effects of Sectoral and Economy-wide Policies." *Journal of African Economies*, 5(1).

Bojnec, S. and J. Swinnen. 1997. "The Pattern of Agricultural Price Distortions in Central and Eastern Europe." *Food Policy*, 22(4), pp.289-306.

Byerlee, D. and M. Morris. 1993. "Calculating Levels of Protection: Is It Always Appropriate to Use World Reference Prices Based on Current Trading Status?" *World Development*, 21(5), pp.805-15.

Cady, J. 2003. "The Equilibrium Real Exchange Rate of the Malagasy Franc: Estimation and Assessment." *IMF Working Paper*, WP/03/28.

Cerra, V. and S. Saxena. 2002. "What Caused the 1991 Currency Crisis in India?" *IMF Staff Papers*, 49 (3).

Cheng, G. and D. Sun, 1998. "An Analysis of the Effect of China's Agricultural Policy Reform." *Economic Research Journal* (4).

Cheung, Y., M. Chinn and A. Pascual. 2004. "Empirical Exchange Rate Models of the Nineties: Are any fit to survive?" *IMF Working Papers*, WP/04/73.

Clark, P. and R. MacDonald. 1999."Exchange Rates and Economic Fundamentals: a Methodological Comparison of BEERS and FEERS." in R. MacDonald and J. Stein (eds.) *Equilibrium Exchange Rates*, Kluwer Academic Publishers, Boston.

Clark, P., and R. MacDonald. 2000. "Filtering the BEER: A Permanent and Transitory Decomposition." *IMF Working Paper*, WP/00/144.

Dibooglu, S. and W. Enders. 1995. “Multiple Cointegrating Vectors and Structural Economic Models: An Application to the French Franc/U.S. Dollar Exchange Rate.” *Southern Economic Journal*, 64(4), pp.1098-1116.

Dickey, D. and S. Pantula. 1987. “Determining the Order of Differencing in Autoregressive Processes.” *Journal of Business and Economic Statistics*, 15, pp.455-61.

Dornbusch, R. 1976. “Expectations and Exchange Rate Dynamics.” *Journal of Political Economy*, 84, pp.1161-76.

Dorosh, P. and A. Valdes. 1990. *Effects of Exchange Rate and Trade Policies on Agriculture in Pakistan*. Research Report, International Food Policy Research Institute, Washington, D.C.

Edwards, S. 1989. *Real Exchange Rates, Devaluation and Adjustment: Exchange Rate Policy in Developing Countries*, MIT Press, Cambridge, Massachusetts.

Edwards, S. and M. A. Savastano. 1999. “Exchange Rates in Emerging Economies: What Do We Know? What Do We Need to Know?” *NBER Working Paper,* W7228.

Elbadawi, I. 1994. “Estimating Long-run Equilibrium Real Exchange Rates,” in *Estimating Equilibrium Exchange Rates*, J. Williamson, (ed.), Institute for International Economics, Washington, DC.

Elbadawi, I. and R. Soto. 1994. “Capital Flows and Equilibrium Real Exchange Rates in Chile.” *Policy Research Working Paper* 1306, The World Bank, Washington DC.

Elbadawi, I. and R. Soto. 1997.“Real Exchange Rate and Macroeconomic Adjustment in Sub- Saharan Africa and Other Developing Countries.” in Elbadawi, I. and R. Soto, (eds.), *Foreign Exchange Market and Exchange Rate Policies in Sub-Saharan Africa*, Supplementary Edition of the *Journal of African Economies.*

Engle, R. and C. Granger. 1987. “Cointegration and Error-Correction: Representation, Estimation, and Testing.” *Econometrica*, 55, pp.251-76, 1987.

Fleming, M. 1962. “Domestic Financial Policies under Fixed and Floating Exchange Rates.” *IMF Staff Papers*, 9, pp369-80.

Frankel, J. 1979. “On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials” *American Economic Review*, 69 pp.601-22.

Frankel, J. 2004. “On the Yuan: The Choice between Adjustment under a Fixed Exchange Rate and Adjustment Under a Flexible Rate.” Paper presented at IMF seminar on the Foreign Exchange System, Dalian, China, May..

Frenkel, J. 1976. “A Monetary Approach to the Exchange Rate: Doctrine Aspects and Empirical Evidence.” *Scandinavian Journal of Economics*, 78, pp.200-24.

Goldstein, M. 2004. “Adjusting China’s Exchange Rate Policies.” Paper presented at IMF seminar on the Foreign Exchange System, Dalian, China, May.

Gonzalo, J. and C. Granger. 1995. “Estimation of Common Long-Memory Components in Cointegrated Systems.” *Journal of Business and Economic Statistics*, 13, pp.27-35.

Grilli, V. and N. Roubini. 1996. “Liqidity Models in Open Economies: Theory and Empirical Evidence.” *European Economic Review*, 40(3), pp.847-59.

Harley, M. 1996. “Use of the Producer Subsidy Equivalent as a Measure of Support to Agriculture in Transition Economies.” *American Journal of Agricultural Economics*, 78, pp.799-804.

Hinkle, L. and P. Montiel. 1999. *Exchange Rate Misalignment: Concepts and Measurement for Developing Countries*. Oxford University Press, New York.

Hodrick, R. and E. Prescott. 1997. “Postwar U.S. Business Cycles: An Empirical Investigation.” *Journal of Money, Credit, and Banking*, 29, pp.1-16.

Huang, Y. 2002. “The Benefits of FDI in a Transitional Economy: The Case of China.” Global Forum on International Investment: New Horizons for Foreign Direct Investment, OECD.

Huang, J. and H. Ma. 1998. “The 20-Year Reform and the Role of Agriculture in China: Capital Flow from Rural to Urban and from Agriculture to Industry.” *Reform*, 5, pp.56-63.

Johansen, S. 1991. “Estimation and Hypothesis Testing of Cointegrating Vectors in Gaussian Vector Autoregressive Models.” *Econometrica*, 59, pp.1551-80.

Johansen, S. and K. Juselius. 1990. “Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money.” *Oxford Bulletin of Economics and Statistics*, 52, pp.169-210.

Josling, T. and A. Valdes. 2004. “Agricultural Policy Indicators.” *ESA Working Paper*, No. 04-04, FAO.

Kohli, R. 2003. “Real Exchange Rate Stabilization and Managed Floating: Exchange Rate Policy in India, 1993-2001.” *Journal of Asian Economics*, 14, pp.369-87.

Krueger, A., M. Schiff, and A. Valdes. 1988. “Agricultural Incentives in Developing Countries: Measuring the Effect of Sectoral and Economy-wide Policies.” *World Bank Economic Review*, 2(3): pp. 255-72.

Krueger, A., M. Schiff, and A. Valdes. 1991. *The Political Economy of Agricultural Pricing Policy*, The Johns Hopkins University Press, Baltimore.

Liefert, W., D. Sedik, R. Koopman, E. Serova, and O. Melyukhina. 1996. “Producer Subsidy Equivalents for Russian Agriculture: Estimation and Interpretation.” *American Journal of Agricultural Economics*, 78, pp.792-98.

Lin, J. 1994. “Chinese Agriculture: Institutional Changes and Performance.” in T.N. Srinivasan (ed.) *Agriculture and Trade in China and India Policies and Performance Since 1950*, International Center for Economic Growth, San Francisco.

Lin, G. and R. Schramm. 2003. “China’s Foreign Exchange Rate Policies Since 1979: A Review of Developments and an Assessment.” *China Economic Review*, 14, pp.246-80.

Lothian, J. and M. Taylor. 1996. “Real Exchange Rate Behavior: The Recent Float from the Perspective of the Past Two Centuries.” *Journal of Political Economy*, 104, pp.488-510.

MacDonald, R. 1999. “Exchange Rate Behavior: Are Fundamentals Important?” *The Economic Journal*, 109, pp.673-91.

MacDonald, R. and L. Ricci. 2003. “Estimation of the Equilibrium Real Exchange Rate for South Africa.” *IMF Working Paper*, WP/03/44.

Mark, N. and D. Sul. 2001. "Nominal Exchange Rates and Monetary Fundamentals: Evidence from a Small Post-Bretton Woods Panel", *Journal of International Economics* 53, pp.29-52.

Mathisen, J. 2003. “Estimation of the Equilibrium Real Exchange Rate for Malawi.” *IMF Working Paper*, WP/03/104.

Meese, R. and K. Rogoff. 1983. “Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?” *Journal of International Economics*, 14, pp. 3-24.

Melyukhina, O. 2002. "The Measurement of the Level of Support in Selected Non-OECD Countries." In China and the World Economy: Agricultural Policy Adjustments in China after WTO Accession, OECD.

Mongardini, J. 1998. "Estimating Egypt's Equilibrium Real Exchange Rate." *IMF Working Paper*, WP/98/5.

Mullen, K., D. Orden, and A. Gulati. 2005. "*Agricultural Policies in India: Producer Support Estimates, 1985-2002*." Markets, Trade and Institutions Discussion Paper, International Food Policy Research Institute, Washington, DC. Forthcoming.

Mullen, K., D. Sun, D. Orden, and A. Gulati. 2004. "*Producer Support Estimates (PSEs) For Agriculture in Developing Countries: Measurement Issues and Illustrations for India and China*." Markets, Trade and Institutions Discussion Paper 74, International Food Policy Research Institute, Washington D.C.

Mundell R. 1961. "A Theory of Optimum Currency Areas." *American Economic Review*, 51, pp.657-65.

Mundell R. 1962. "The Appropriate Use of Monetary and Fiscal Policy for Internal and External Stability." *IMF Staff Papers*, 12, pp.70-9.

Mundell, R. 1963. "Capital Mobility and Stabilization Policy under Fixed and Flexible Exchange Rates." *Canadian Journal of Economic and Political Science* 29, pp.475-85.

Nguyen H. and U. Grote. 2004. *Agricultural Policies in Vietnam: Producer Support Estimates 1986-2002.* Markets, Trade and Institutions Discussion Paper 79, International Food Policy Research Institute, Washington, DC.

Obstfeld, M. and K. Rogoff. 1995. "Exchange Rate Dynamics Redux." *Journal of Political Economy*, 103(3), pp.624-60.

O'Connell, P. 1998. "The Overvaluation of Purchasing Power Parity." *Journal of International Economics*, 44, pp.1-19.

Paiva, C. 2001. "Competitiveness and the Equilibrium Exchange Rate in Costa Rica." *IMF Working Paper*, WP/01/23.

Patel, U. and P. Srivastava. 1997. "Some Implications of Real Exchange Rate Targeting in India." *Working Paper*, Indian Council for Research on International Economic Relations, New Delhi.

Patnaik, I. and P. Pauly. 2000. "The Equilibrium Exchange Rate of the Indian Rupee." *Discussion Paper*, No. 12, National Council of Applied Economic Research, New Delhi.

Patnaik, I. and P. Pauly. 2001. "The Indian Foreign Exchange Market and the Equilibrium Real Exchange Rate of the Rupee." *Global Business Review*, 2(2).

Pena, P. and G. Norton. 1993. "The Effects of Sectoral and Economy-wide Policies on Tobacco Production in the Dominican Republic." *Journal of Agricultural and Applied Economics*, 25(1), pp.151-64.

Perron, P. 1989. "The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis." *Econometrica*, 57, pp.1361-1401.

Portugal, L. 2002. "Methodology for the Measurement of Support and Use in Policy Evaluation." OECD, Paris.

Pursell, G. and A. Gulati. 1995. "Agriculture and the Economic Reforms." in R. Cassen and V. Joshi (eds) *India: The Future of the Economic Reforms*, New Delhi: Oxford University Press.

Rangaranjan, C. 1993. "India's Balance of Payment Problems." in *Indian Economy Since Independence*, 4th Edition, Uma Kapila, New Delhi.

Rahman, A. and S. Basher. 2001. "Real Exchange Rate Behavior and Exchange Rate Misalignment in Bangladesh: A Single Equation Approach." *Bangladesh Development Studies*, 27(2).

Reddy, Y. 1999. "Development of Forex Markets: Indian Experience." Paper presented at the 3rd South Asian Assembly, Katmandu, Nepal.

Rogoff, K. 1996. "The Purchasing Power Parity puzzle." *Journal of Economic Literature*, 34, pp.647-68.

Sarno, L. and M. Taylor. 2003. *The Economics of Exchange Rate*. Cambridge University Press.

Shick, O. 2002. "Adjustment of the Conventional PSE's Methodology for the Economy in Transition." Paper presented to the Russian Congress, Analytical Center of Agri-Food Economics, Moscow, August.

Srinivasan, T. N. 1994. "Indian Agriculture: Policies and Performance." in T.N. Srinivasan (ed.) *Agriculture and Trade in China and India Policies and*

Performance Since 1950, International Center for Economic Growth, San Francisco.

Stein, J. 1994. "The Natural Real Exchange Rate of the US Dollar and Determinants of Capital Flows." in Williamson, J. (ed.), *Estimating equilibrium exchange rates*, Institute for International Economics, Washington D.C.

Stockman, A. 1980. "A Theory of Exchange Rate Determination." *Journal of Political Economy*, 88(4), pp.673-98.

Stockman, A. 1988. "Real Exchange Rate Variability under Pegged and Floating Nominal Exchange Rate Systems: An Equilibrium Theory." *Carnegie-Rochester Conference Series on Public Policy*, 29, pp.259-94.

Sun, D. 2003. "China's Agricultural Policies and Calculation of Aggregate Measurement of Support (AMS) and Producer Support Estimate (PSE)." Mimeo, International Food Policy Research Institute, Washington, D.C.

Thomas, M. and D. Orden. 2004. *Agricultural Policies in Indonesia: Producer Support Estimates 1985-2003.* Markets, Trade and Institutions Discussion Paper 78, International Food Policy Research Institute, Washington, DC.

Udeshi, K. 2004. "Development of Forex Markets in India: Review and Prospects." Paper presented at the 15th Forex Assembly, Colombo, Sri Lanka, August.

U.S. Department of Agriculture. 2004. Economic Research Service. Briefing Room: India. <<http://www.ers.usda.gov/Briefing/India/>> [October,10, 2004].

Williamson, J. 1985. *The Exchange Rate System*, 2nd Edition, Institute for International Economics, Washington, DC.

Williamson, J. 1994. *Estimating Equilibrium Exchange Rates*, Institute for International Economics, Washington, DC.

Zhang, X. 2002. "Equilibrium and Misalignment: An Assessment of the RMB Exchange Rate from 1978 to 1999." *Stanford University Working Paper*, No. 127.

Zhang, Z. 2001. "Real Exchange Rate Misalignment in China: An Empirical Investigation." *Journal of Comparative Economics*, 29, pp.81-94.

APPENDIX: UNIT ROOT AND COINTEGRATION TESTS

The Unit Root Test

The order of integration for each univariate series is determined using the augmented Dickey-Fuller (ADF) test. The ADF test statistic is obtained from the following regression model:

$$\text{(A.1)} \quad \Delta x_t = \alpha_0 + \alpha_1 x_{t-1} + \gamma t + \sum_{i=1}^{p} \beta_i \Delta x_{t-i} + \varepsilon_t$$

where Δ is the first difference, x_t represents each of the variables in the vector $\mathbf{x}_t$, and p is the lag length.

Following a general to specific procedure, equation (A.1) is an overspecified ADF regression where p starts from a relatively large number and a drift and deterministic time trend have been included. It is important to note that the test for unit root is conditional on the lag length and presence of the deterministic regressors. A battery of diagnostic tests are employed to refine the specification for each series.[29] To test for multiple roots, the same procedure is applied to test for stationarity in first differencing series (Dickey and Pantula, 1987). Table A1 reports the test specification, the AIC and the ADF statistics.

[29] Various techniques can be used including the usual t- or F- tests, the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC), and Jarque-Bera and Ljung-Box tests (for residuals). Only the AIC is reported in Table 4.

Table A1—The ADF Test Results

Country/Variable	Levels			First Differences		
	Specification	AIC	ADF Statistic	Specification	AIC	ADF Statistic
India						
LRER	(*d*,0,0)	-5.85	-0.95	(*d*,*t*,1)	-5.30	-3.73***
LTECH	(*d*,0,2)	-8.18	-0.69	(*d*,*t*,1)	-8.27	-3.31**
LGCON	(*d*,0,1)	-6.58	-1.63	(*d*,0,0)	-6.43	-5.27***
LFER	(*d*,0,1)	-2.55	-0.70	(*d*,0,1)	-2.83	-3.56**
LTOT	(*d*,0,1)	-5.11	-1.85	(*d*,0,0)	-4.95	-4.91***
LOPN	(*d*,*t*,0)	-5.53	-1.41	(*d*,0,0)	-5.66	-3.63**
China						
LRER	(*d*,*t*,1)	-4.25	-2.22	(*d*,0,0)	-4.47	-3.86***
LTECH	(*d*,0,1)	-5.63	-1.12	(*d*,0,2)	-6.65	-4.37***
LGCON	(*d*,0,1)	-5.24	-1.48	(*d*,*t*,1)	-5.20	-3.45**
LFER	(*d*,*t*,1)	-2.87	-1.96	(*d*,0,1)	-4.84	-3.36**
LTOT	(*d*,0,1)	-4.33	-1.46	(*d*,0,0)	-5.36	-3.84***
LOPN	(*d*,*t*,2)	-4.30	-1.28	(*d*,0,0)	-4.81	-4.77***

Note: 1) **1% significance level, *5% significance level.
2) All test specifications include a drift *d*. In some cases a deterministic time trend *t* is included. The lag length *p* varies from 0 to 2.

The Cointegration Test

The Johansen procedure is based on the following *p*th-order VAR model:

$$\text{(A.2)} \quad \mathbf{x}_t = \mathbf{A}_1\mathbf{x}_{t-1} + \mathrm{A}_2\mathbf{\Delta x}_{t-2} + \ldots + \mathbf{A}_p\mathbf{x}_{t-p} + \boldsymbol{\alpha} + \boldsymbol{\varepsilon}_t$$

where $\mathbf{x}_t$ is a $(n\times 1)$ vector of non-stationary I(1) variables, $\mathbf{A}_i$ is a $(n\times n)$ coefficient matrix, $\boldsymbol{\alpha}$ is a $(n\times 1)$ intercept vector and $\boldsymbol{\varepsilon}_t$ is vector of error terms. The VAR(*p*) in (A.2) can be rewritten as

$$\text{(A.3)} \quad \mathbf{\Delta x}_t = \mathbf{\Gamma}_1\mathbf{\Delta x}_{t-1} + \mathbf{\Gamma}_2\mathbf{\Delta x}_{t-2} + \ldots + \mathbf{\Gamma}_{p-1}\mathbf{\Delta x}_{t-p+1} + \mathbf{\Psi x}_{t-1} + \boldsymbol{\alpha} + \boldsymbol{\varepsilon}_t$$

where $\mathbf{\Gamma}_i = -\sum_{j=i+1}^{p} \mathbf{A}_j$ and $\mathbf{\Psi} = \sum_{i=1}^{p} \mathbf{A}_i - I$ are $(n\times n)$ coefficient matrices.

If the matrix $\mathbf{\Psi}$ in equation (A.3) contains all zeros, or equivalently, $rank(\mathbf{\Psi}) = 0$, there are no cointegrating relationships among the variables in $\mathbf{x}_t$ and all sequences are unit root processes. If $\mathbf{\Psi}$ is of full rank, $rank(\mathbf{\Psi}) = n$, then there are *n* long-run equilibrium relationships which is essentially a convergent system of *n* stationary sequences. Suppose that $rank(\mathbf{\Psi}) = h,\ 0 < h < n$ and there are h cointegrating relationships in $\mathbf{x}_t$. It implies that $\mathbf{\Psi}$ can be written in the form

$$\text{(A.4)} \quad \mathbf{\Psi} = \mathbf{AB}'$$

for **A** an $(n \times h)$ matrix and $\mathbf{B}'$ an $(h \times n)$ matrix. The matrix **B** contains h cointegrating vectors, and **A** is the matrix of weights with which each cointegrating vector enters the n equations of the VAR. Matrix **A** is also viewed as the speed of adjustment.

The Johansen procedure provides two tests for the number of linearly independent cointegrating relationships among the series in $\mathbf{x}_t$. Both tests are based on an eigenvalue-eigenvector decomposition of the matrix $\mathbf{\Psi}$. The test statistics are labeled the "trace statistic" and the "maximal eigenvalue statistic" defined as

$$\text{(A.5)} \quad \lambda_{trace}(h) = -T \sum_{i=h+1}^{n} \ln(1 - \hat{\lambda}_i)$$

$$\text{(A.6)} \quad \lambda_{\max}(h, h+1) = -T \ln(1 - \hat{\lambda}_{h+1})$$

where $\hat{\lambda}_i$ are the estimated eigenvalues of matrix $\mathbf{\Psi}$.

To economize on degrees of freedom, the Johansen test in this analysis starts with a specification of an unrestricted VAR(p) model (A. 2) which contains relatively small number of lags for each of the endogenous variables. [30] A presence of a linear trend is verified in the model and an intercept in the cointegrating vector.[31] After the lag-length and the deterministic term are determined, a VEC(p) model in the form of equation (A.3) is specified and estimated. The Johansen test results are shown in Table A2.

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[30] The lag length is set at $p = 2$ for India and $p = 1$ for China since the data is annual. The diagnostic tests for lag length involve F-tests that the i-period lag is zero and that there is no serial correlation or heteroskedasticity, and χ^2 -tests for residual normality (results are not reported).

[31] The likelihood ratio test indicated support for the inclusion of a deterministic term (an intercept) in the VEC model.

Table A2—The Johansen Cointegration Test Results

Null Hypothesis	Eigenvalue	Trace Statistic	5% Critical Value
India			
$h = 0$*	0.88	149.71	102.14
$h \leq 1$*	0.79	91.07	76.07
$h \leq 2$	0.56	47.07	53.12
$h \leq 3$	0.35	24.24	34.91
$h \leq 4$	0.26	12.32	19.96
$h \leq 5$	0.13	4.04	9.24
China			
$h = 0$*	0.78	106.80	102.14
$h \leq 1$	0.67	70.80	76.07
$h \leq 2$	0.60	44.04	53.12
$h \leq 3$	0.38	22.33	34.91
$h \leq 4$	0.25	10.86	19.96
$h \leq 5$	0.15	3.87	9.24

Note: *h* is the cointegrating rank. Only the trace statistics are reported.
* denotes rejection of the hypothesis at 5% significance level.

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