

## **Nominal and Real Exchange Rate Change by China: Global Impacts on Agricultural Prices**

Stephen MacDonald  
Senior Economist  
Economic Research Service, USDA  
[stephenm@ers.usda.gov](mailto:stephenm@ers.usda.gov)

Ralph Seeley  
Senior Economist  
Economic Research Service, USDA  
[rseeley@ers.usda.gov](mailto:rseeley@ers.usda.gov)

*Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland OR, July 29-August 1, 2007.*

*Copyright 2007 by Stephen MacDonald and Ralph Seeley. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.*

## Abstract

China's exchange rate policy has become an important factor in world agricultural trade. The renminbi, while no longer fixed in U.S. dollar terms, is subject to significant intervention, and is widely regarded as undervalued. In the long run, an undervalued exchange rate is self-correcting, as increases in the money supply raise inflation, revaluing the currency in real terms. Adjusting a real exchange rate through inflation has different consequences for China's economy compared with an adjustment in the nominal exchange rate. The consequences for world agricultural production and trade are also different. To capture these differences, a static, partial equilibrium model was extended to include macro-economic effects. Parameter values for the model were derived from USDA's Country-Link System (CLS) for 39 regions and 24 agricultural commodities, and from the literature on exchange rate pass-through to inflation and output. The results illustrate how standard partial equilibrium analysis overstates the impact of China's nominal exchange rate adjustment by overlooking the impacts on inflation.

## Introduction

The importance of China to world commodity markets has become salient in recent years. Along with India, China's surging economy has been cited as a factor in increasing global petroleum prices. Prices of metals have soared in recent years, an increase that has been even more directly tied to industrial investment in China. In agriculture, China is the world's largest producer and consumer of cotton and of both food grains and feed grains. It is also the world's largest consumer and importer of soybean meal and vegetable oils. China's domestic support and agricultural trade policy has been a factor in swings in world agricultural prices for decades. The correlation between variation in world cotton prices and China's net cotton imports has been a crucial factor in world cotton markets since the mid-1970s. The flow and ebb of China's net grain imports was an important factor in the run-up and subsequent collapse in world grain prices during the mid- and late-1990's.

China's extraordinary income growth in recent years stems from the confluence of several factors. The reform of China's centrally planned economy and opening to the outside world has afforded many opportunities for technology transfer and economic restructuring, enabling China to recover from inefficiencies that developed in the decades after 1949. The rest of the world has responded to this opportunity by providing the capital investments that have harnessed China's abundant labor to process increasingly sophisticated intermediate products into exportable consumer products.

China's domestic income has also been directed towards investment rather than consumption. To some extent, this is a function of the government role in lending decisions, but also reflects China's limited social safety net, and its macro-economic policies. Among these policies are capital controls—including a lack of renminbi convertibility on the capital account—and intervention in support of specific nominal exchange rate targets. After a significant official devaluation in 1994, China largely fixed its U.S. dollar exchange rate for more than a decade. During that time, steady investment increased China's productivity, driving its equilibrium exchange rate upward. Since July 2005, China has allowed the renminbi to fluctuate with respect to the U.S. dollar, but has significantly constrained its ability to adjust in nominal terms.

China is in balance of payments disequilibrium, accumulating larger and larger foreign exchange reserves. The magnitude of exchange rate adjustment necessary to correct this disequilibrium has been measured between 12 and 35 percent in recent years (Shi). It is not clear that China's policy-makers would share the same interpretation of an equilibrium U.S./China exchange rate, but, it is not implausible that China's policy-makers could permit a large change the exchange rate over the next decade. On the other hand, policy-makers could continue to post-pone the adjustments associated with exchange rate adjustment. China has been sterilizing its exchange rate interventions, replacing domestic money supply with bonds. China's inflation has been increasing relative to U.S. inflation, and is forecast to continue to do so in the coming years (GlobalInsight). Economic theory says that eventually larger foreign exchange reserves will drive the money supply and inflation higher, revaluing the renminbi in real terms even in the absence of nominal adjustment (Frankel). This paper will compare the impacts these two adjustment paths—in the medium run, the impacts on world prices of real exchange rate

adjustment by China via inflation or via nominal exchange rate changes are equivalent, but there are differences in the long run. This paper will also examine how traditional micro-economic models overstate the impacts of nominal exchange rate adjustment by excluding the impact of exchange rate adjustment on prices and output.

Renminbi appreciation with respect to the U.S. dollar would increase China's excess demand, and decrease the excess demand of its trading partners. This would drive offsetting adjustments of supply and demand around the world. Despite these offsetting adjustments there would still be price increases for agricultural commodities in U.S. dollar terms, and increased China's imports, but there would be responses for different commodities, and the changes would be smaller than traditional models indicate.

#### Models of Exchange Rate Impacts on Agriculture

Prices of goods are almost invariably stated in terms of a currency, and an exchange rate is itself a price, indicating that exchange rates and goods' prices are deeply intertwined. By changing relative prices between countries, exchange rates are a channel for the international transmission of economic shocks. Depreciations are typically inflationary and appreciations deflationary, a generalization intuitively illustrated with a statement of the "law" of one price (LOP) for country  $i$  and commodity  $j$ . If the numeraire country is the United States, then the U.S. dollar price of commodity  $j$  is  $P_j$ , and, with an exchange rate  $e_i$  of local currency (LC) units per U.S. dollar, the local price of commodity  $j$  is :

$$P_{ij} = P_j e_i$$

Totally differentiating,

$$dP_{ij} = dP_j e_i + P_j de_i$$

For a small country's depreciation,  $de_i > 0$ ,  $dP_j = 0$ , and, therefore,  $dP_{ij} > 0$ . The LOP applies to traded goods, and relies on actual or potential international product flows to arbitrage between international price differences. Inflation will rise directly more or less depending, in part, on the share of traded goods in the economy. Non-tradable goods and services comprise a substantial portion of most economies, and their prices increase indirectly due to traded goods prices, and the increase in economic activity stemming from increased net exports.<sup>1</sup>

There is a strand of "export pessimism" in the literature regarding the ability of exchange rate changes to influence net exports, but it is generally accepted that the intuitive expectations for trade are born out in reality. There are certain circumstances under which depreciations can be contractionary even given an increase in net exports (see Frankel, 2004). The inflationary impact of depreciation (and deflationary impact of appreciation) is however widely accepted, and is even an important factor behind export pessimism.

The initial framework for our model was initially developed by Ridler and Yandle (1972). Bredahl, (1976), Collins, et al (1979), Chambers and Just (1979), Gilbert (1989), and Sjaastad and Scacciavillani (1996) variously extended the theoretical framework and developed empirical applications. Totally differentiating the expression for global excess demand for a given

---

<sup>1</sup> This interaction is captured in the Mundell-Fleming-Dornbusch model of an open economy. This model, and its variants, is the basis for much of the world's applied macro-economic policy modeling, despite its lack of microeconomic foundations. The shortcomings of the Keynesian foundations of these "workhorse" models are well known, but they remain useful (see Obstfeld and Rogoff (1996) for discussion). In this framework, assuming non-zero, but imperfect, capital mobility, and an upward sloping aggregate supply (AS) schedule in country *i*, then, given that output is increasing in net exports, exchange rate changes lead to changes in income and inflation.

commodity reveals the relationship between exchange rate changes and changes in real U.S. dollar prices. Given  $I$  countries and  $J$  commodities, the following relationship holds for commodity  $j$  in country  $i$  (assuming the law of one price holds, and using the U.S. dollar as the numeraire currency):

$$\begin{aligned}
 & \text{If,} \\
 & \sum_i (D_{ij} - S_{ij}) = 0 \\
 & D_{ij} = f(R_{ij}) \quad \text{for all } J \\
 & S_{ij} = g(R_{ij}) \quad \text{for all } J \\
 & R_{ij} = e_i P_j \\
 & \eta_{ikj} = \frac{\partial f_i}{\partial R_{ij}} \frac{e_i P_j}{D_{ij}} \quad \varepsilon_{ikj} = \frac{\partial g_i}{\partial R_{ij}} \frac{e_i P_j}{S_{ij}} \quad \text{where } k \in J \\
 & \phi_{ikj} = \eta_{ikj} D_{ij} - \varepsilon_{ikj} S_{ij} \\
 & \text{Then,} \\
 & \sum_i \left( \sum_k \phi_{ikj} \left( \frac{dP_j}{P_j} + \frac{de_i}{e_i} \right) \right) = 0
 \end{aligned}$$

In this framework, a given country's excess demand is affected equally by either changes in the U.S. dollar price of a good ( $P_j$ ) or by changes in its exchange rate with respect to the U.S. dollar ( $e_i$ ). In this specification, inflation has been abstracted away: assumed to equal zero, or incorporated through the use of real prices and real exchange rates. Inflation can be explicitly included, and exogenous, the approach taken by Collins. The result of this approach is to add a third term to the final equation above, including percent change in country  $i$ 's general price level as another equivalent source of change in excess demand. If,

$P_i^o$  = price level economy-wide in country  $i$  (e.g. a consumer price index, or CPI)

$\hat{P}_i^o = \frac{dP_i^o}{P_i^o}$  (and similar notation for percentage changes of  $e_i$  and  $P_j$ ), and  $Q_{ij} = D_{ij} - S_{ij}$ , then,

$$dQ_{ij} = \sum_k \phi_{ikj} \left( \hat{P}_j + \hat{e}_i - \hat{P}_i^o \right)$$

Overlooked in this traditional approach is that the impact of exchange rates on inflation can be profound, and can vary widely across countries. Exchange rates can also affect output, but the magnitude, direction, and channels of the impact are more complex than those for inflation.

While domestic economies include their own sources of inflation, international transmission of economic shocks to a large extent occur through the exchange rate's effect on prices. The traditional micro-economic model can be extended by incorporating the impacts on real commodity prices of exchange rate-driven inflation, and the shifts in domestic demand stemming from exchange rate-driven changes in income. This model represents an important advance by integrating the macro-economic effects of exchange rates into an accepted micro-economic framework for analyzing the impact of exchange rates on global commodity markets.

Adding the macro-economic impacts to the model can be accomplished with two simple equations. If,

$ERI_i$  = real effective exchange rate of country  $i$ .

$Y_i$  = real income (gross domestic product, or, GDP) of country  $i$

$MS_i$  = monetary shocks (exogenous inflation)

Then,



$$P_i^o = h(MS_i, ERI_i)$$

$$Y_i = y(ERI_i)$$

$$S_{ij} = g(R_{ij}) \text{ for all } J$$

$$D_{ij} = f(R_{ij}, Y_{ij}) \text{ for all } J$$

$ERI_i$  is a much more complex measure of exchange rates than  $e_i$ , and introduces a significant degree of endogeneity among the inflation rates of every country into the model.<sup>2</sup>  $ERI_i$  is a weighted average of different inflation-adjusted nominal exchange rates, and these nominal exchange rates differ from the exchange rate of  $e_i$  used in the simpler model. Rather than stemming directly from  $e_i$ ,  $ERI_i$  utilizes country  $i$ 's cross-rates with respect to country  $z$ , represented by  $e_{iz}$ . That is, given,

$$e_i = \frac{LC_i}{US\$}$$

$$e_z = \frac{LC_z}{US\$}$$

Then,

$$e_{iz} = \frac{LC_i}{LC_z} = \frac{e_i}{e_z}$$

Total differentiation of the extended model results in an expression for excess demand in country  $i$  more complex than the traditional model's. In addition to being a function of country  $i$ 's U.S. dollar exchange rate ( $\hat{e}_i$ ), and of U.S. dollar commodity prices ( $\hat{P}_j$ ), excess demand is also a function of every country's U.S. exchange rate ( $\hat{e}_z$ ) and every country's inflation ( $\hat{P}_i^o$ ).

---

<sup>2</sup> See MacDonald and Seeley for a definition of  $ERI_i$ .

Additional complications include additions to the parameters for  $\hat{e}_i$  and  $\hat{P}_i^o$  to include an income elasticity ( $\psi_{ij}$ ) of demand for commodity  $j$  in country  $i$ . Furthermore,  $\hat{P}_i^o$ 's endogeneity adds an additional equation to the system. The result is,

$$dQ_{ij} = \sum_k \phi_{ikj} \hat{P}_j + \sum_k (\phi_{ikj} + \psi_{ij} D_{ij} \theta_i) \left( \hat{e}_i - \hat{P}_i^o \right) - \sum_z \psi_{ik} D_{ij} \theta_{ik} A_{iz} \left( \hat{e}_z + \hat{P}_z^o \right)$$

$$\hat{P}_i^o = \frac{MS_i}{(1 + \lambda_i)} + \frac{\lambda_i \hat{e}_i}{(1 + \lambda_i)} + \sum_z \left[ \left( \hat{P}_z^o - \hat{e}_z \right) \frac{\lambda_i A_{iz}}{(1 + \lambda_i)} \right]$$

Where,

$\psi_{ij}$  = income elasticity of demand for  $j$  in country  $i$ .

$\theta_i$  = elasticity of income with respect to exchange rate in country  $i$

$$\phi'_{ijk} = \sum_k \phi_{ikj} + \psi_{ij} D_{ij} \theta_i$$

$A_{iz}$  = exchange rate weight (country  $z$ 's initial share of  $ERI_{iz}$ )

$\lambda_i$  = elasticity of CPI with respect to exchange rate ( $ERI$ ) in country  $i$

The most direct differences between this and the traditional model is that exchange rates and inflation no longer have effects on excess demand equivalent to the effects of changes in U.S. dollar prices. Recall that for country  $i$ 's depreciation,  $de_i > 0$ , and that  $1 > \lambda_i > 0$ . Thus, while in the traditional model,

$$\frac{\partial dQ_{ij}}{\partial e_i} \approx \sum_k \phi_{ikj}$$

In the extended model,

$$\frac{\partial dQ_{ij}}{\partial e_i} \approx \sum_k \phi_{ikj} \left( \frac{\lambda_i}{1 + \lambda_i} \right) < \sum_k \phi_{ikj}$$

## Sources of Elasticities

The empirical version of the model used in this study has 39 regions and 24 commodities, and therefore relies on more than 36,000 commodity price elasticities. Developing this empirical application would probably be impossible without the rich source of elasticity estimates provided by simulations using the models developed by USDA's Economic Research Service (ERS) to help derive the Department's long run commodity projections. ERS's Country-Link System of models (CLS) contains 40 foreign country and regional models, and the Food and Agricultural Policy Simulator (FAPSIM) model of U.S. agriculture. The country models account for policies and institutional behavior, such as tariffs, subsidies, and trade restrictions for a subset of 24 commodities. A rest-of-world model handles any missing country/commodity coverage. In general, production, consumption, imports, and exports in the models depend on world prices (determined by the system), on macroeconomic projections (determined outside the system), and on domestic and trade policies (determined inside or outside the models). The CLS is large, containing about 18,000 equations per year of projection, and incorporates an extensive amount of USDA country and commodity analysts' expertise.

The CLS countries and regions included in this model are,

Argentina, Australia, Bangladesh, Brazil, Canada, China, EU-25, Egypt, Indonesia, India, Japan, Korea (South), Malaysia, Mexico, Other Subsaharan Africa, Pakistan, Russia, Thailand, Turkey, Taiwan, Ukraine, Vietnam, United States.

The CLS commodities included in this model are:

Corn, sorghum, barley, other coarse grains, wheat, rice, soybeans, soyoil, soymeal, rapeseed, rapeoil, rapemeal, sunseed, sunoil, sunmeal, other oilseeds, other oils, other meals, cotton, sugar, beef & veal, pork, poultry meat, and eggs.

USDA's long run commodity projections are updated annually, a process which involves updating the CLS models to account for developments in, among other things, technology and policy within individual countries. Elasticities with respect to permanent changes in world prices two years earlier are generated from each non-U.S. country model in the course of updating the global commodity projections. In many cases, these elasticities are zero due to the absence or relative unimportance of a given commodity to the economy of that country. But in some cases, the elasticities are zero for commodities of with significant and active markets within that country.

For example, out of 529 possible own- and cross-price consumption elasticities for China, 457 are zero (Table 1). In some cases this represents the impact of local agricultural policy, as with wheat. China produces, consumes, and often trades substantial quantities of wheat, and domestic producers and consumers respond to domestic prices. Simulation of the CLS China model with respect to domestic prices results in a demand elasticity of -0.23. China's WTO accession agreement included a tariff-rate quota for wheat, but in some years TRQ administration may have hindered importers' access to world markets, and in other years changes in direct agricultural subsidies and agricultural taxes may have offset world price movements. China's history of such policies, and the likely path of future policies, has resulted in a specification of the China model that has no consumption response of wheat to shifts in world wheat prices.

The smaller number of elasticities required for the macro-economic aspects of the model permits the use of directly estimated parameters. The elasticity of inflation with respect to exchange rates ( $\lambda_i$ ) has been the subject of considerable analysis, reflecting intense interest by policy-makers and private investors. A survey of published estimates is therefore possible, which is the basis of the estimates used here.

Multiple estimates covering different periods of time are available for major countries, and studies applying a consistent methodology and sample period across a large number of countries have also been published recently.<sup>3</sup> When estimates were available for every country in a region, the regional estimate is a GDP-weighted average. Published estimates are available for virtually every major country. For countries for which no published estimate could be found, estimates were derived based on Taylor's (2000) widely adopted model relating passthrough to: GDP (size), trade as a share of GDP (openness), and average inflation (independence of monetary authorities).

Exchange rate changes affect prices in an economy directly through changes in traded goods prices and indirectly through changes in output. In developed countries each percentage change in the effective exchange rate results in a very small change in consumer prices, 0.03 percent or less for the United States, Japan, and France.<sup>4</sup> Countries with higher and more volatile exchange rates, and more open economies, realize a larger impact of exchange rates on consumer prices.

---

<sup>3</sup> Choudri, Ehsan, and Hakura, Dali, (2001), "Exchange Rate Pass-through to Domestic Prices: Does Inflationary Environment Matter?," International Monetary Fund Working Paper, WP/01/194.

<sup>4</sup> Joseph E. Gagnon And Jane Ihrig (2004). "Monetary Policy And Exchange Rate Pass-Through," *International Journal Of Finance And Economics*, 9: 315–338

Indonesia and Turkey have 40 to 50 percent of exchange rate changes reflected in their consumer prices within a year, and most developing and transition countries fall somewhere between this level and the much lower levels for developed countries.<sup>5</sup> A country's elasticity is by no means necessarily constant. Political, legal, and other institutional and economic developments can alter how exchange rate changes transmit price changes to non-traded goods. Recent years have seen a secular trend of diminishing elasticities around the world. The elasticity used for China in this study (0.3) is from Choudri and Hakura. Devereux and Yetman's estimate was lower (0.2), but a more recent study estimated the elasticity as high as 0.8 after 2 years.

For the elasticity of income with respect to exchange rates ( $\theta_i$ ), neither as clear a consensus of the impact, nor as rich a set of published estimates is available. As mentioned above, a long-standing question in international economics is whether devaluation can improve a country's trade balance. The conventional answer is that it can, and that, in other words, the Marshall-Lerner condition for the elasticity of a country's exports and imports holds. But, the importance of this question, the changing particular circumstances of policy-makers struggling to ascertain appropriate exchange rate targets, and advances in economic techniques have resulted in a steady stream of results in this field. Goldstein and Khan's (1985) survey indicated empirical support for the Marshall-Lerner condition, and provided some insights for the impacts of exchange rates on prices. They noted that import prices fully adjust to exchange rate changes in 6 months, except "perhaps for the largest industrial countries which have significant buying power on the international market," They also noted that within 2 years after a devaluation, countries' export prices have typically fully adjusted to offset the devaluation, except for the larger, relatively

---

<sup>5</sup> Choudhri E, Faruqee H, Hakura D. 2002. "Explaining the exchange rate pass-through in different prices." Working Paper WP/02/224, International Monetary Fund.

closed economies (e.g. Japan and the United States), and that the degree of adjustment falls as the share of manufactured products in a country's exports rises. More recent advances in structurally-specified aggregate export- and import-demand models (e.g., Clarida (1994), Riehart (1995), and Seinfeld, et al. (1998)) have confirmed the responsiveness of trade to relative prices, even if they have not specifically addressed the role of exchange rates.

Accordingly, in the standard macro-economic model of an open economy, depreciations are expansionary and appreciations are contractionary. However, depreciations by developing countries during currency crises have been shown to be contractionary within the first year, with the role of foreign-currency borrowing a key variable in determining the extent of this response.<sup>6</sup> For marginal exchange rate adjustments not associated with a balance of payments crisis, the standard model can be assumed to apply. For developed countries, each percent depreciation of the effective exchange rate is expected to boost gross domestic product (GDP) by 0.02 to 0.06 percent, and the midpoint of this range was used as the elasticity of developing countries in this scenario.<sup>7</sup>

## Results

While the traditional model does offer theoretical simplicity and has more limited empirical demands, it overstates the impact of exchange rate changes. Using the traditional model, elasticities of world prices in U.S. dollars with respect the renminbi/U.S. dollar exchange rate

---

<sup>6</sup> Luis Felipe Céspedes, Roberto Chang, And Andrés Velasco. (2003). "IS-LM-BP in the Pampas," *IMF Staff Papers*, Vol. 50, Special Issue

range between -0.06 and -0.17 for major field crops and livestock products (Table 2). This is reasonable given that the elasticities for U.S. dollar commodity prices with respect to global exchange rate changes are typically estimated between -0.5 and -0.8. MacDonald and Seeley found global elasticities for corn, soybeans, and wheat of -0.6, -0.7, and -0.8, respectively. Batten and Belongia (1986) found a real agricultural export value elasticity of -0.7; Krissoff and Morey (1986) found similar price elasticities; Gilbert (1989) suggested that -0.6 to -0.8 was appropriate for price elasticities; Orden and Fackler (1989) found an agricultural price elasticity of -0.9; and, Borzensztejn and Reinhart (1994) found -0.6 for commodity prices in general. While China is the largest producer and consumer of a number of agricultural products, it still only accounts for about 20 percent world production and consumption of corn and rice, and considerably less for other commodities. Therefore, elasticities about one-tenth the response to a global exchange rate change are reasonable.

Table 2--Elasticities of price with respect to exchange rate

	Traditional Model	Extended Model	Difference Percent
Corn	-0.07	-0.05	-27
Wheat	-0.08	-0.06	-26
Rice	-0.14	-0.10	-30
Soybeans	-0.08	-0.05	-37
Cotton	-0.18	-0.11	-37
Beef	-0.05	-0.03	-41
Pork	-0.17	-0.07	-58
Poultry meat	-0.14	-0.08	-41

Variation of elasticities between commodities corresponds to the relative importance of the roles China and the United States play in the adjustments each commodity market makes to shocks.

Recall that the response of excess demand of commodity  $j$  with respect to exchange rates (in the

---

<sup>7</sup> Ahmed, Shaghil, Gust, Christopher J., Kamin, Steven B., Huntley, Jonathan (2002) "Are Depreciations as Contractionary as Devaluations? A Comparison of Selected Emerging and Industrial Economies," Board of Governors of the Federal Reserve System International Finance Division Number 737



traditional model) is a function of the sum of the excess demand cross elasticities (with respect to the  $k$  commodities) multiplied by excess demand for each product.

$$\frac{\partial dQ_{ij}}{\partial e_i} \approx \sum_k \phi_{ikj}$$

Thus, a country's role in world commodity market adjustment is a function of its supply and demand elasticities and the magnitude of its supply and demand. When, either due its large size or particularly high elasticities, the United States' excess demand has a considerably larger role in allowing the world market for a commodity to adjust to shocks than the role of China, then a shock to China's exchange rate will have a smaller impact on the U.S. dollar price as the U.S. role in global adjustment is smaller than China's. The average ratio of the  $\sum_k \phi_{ikj}$ 's for the United States and China for commodities in Table 1 with elasticities above the median is 15.3, while the average for commodities below the median is 0.4

Table 3--China's excess demand change with 10 percent appreciation

	Traditional Extended		Difference
	Model	Model	
	Tons (bales)		Percent
Corn	137,000	54,000	-61
Wheat	748,000	441,000	-41
Rice	357,000	213,000	-40
Soybeans	192,000	94,000	-51
Cotton	514,000	287,000	-44
Beef	6,000	2,000	-67
Pork	37,000	12,000	-68
Poultry meat	67,000	35,000	-48

China's trade or excess demand also adjusts to exchange rates. The largest change is in wheat, which is the commodity with the strongest supply response to world prices, and a relatively high level of trade.

The addition of macro-economic effects to the traditional model reduces the response of prices and trade to exchange rates. As expected, the price elasticity is reduced by CPI pass-through. Given a pass-through elasticity for China of  $\lambda = 0.3$ , then  $\lambda/(1 - \lambda) = 0.43$ . This is close to the average adjustment for the commodities in Table 1 of 0.37. While the direct CPI elasticity is 0.3, once the global interactions among exchange rates and inflation are accounted for, a 10 percent nominal currency appreciation reduces prices in China by 4.2 percent. This reduces the effective appreciation in real terms, which is another way of understanding why the commodity price response estimated with the extended model is lower than the traditional model. In real terms, China's 10 percent nominal appreciation is only 5.8 percent.

Policy-makers in China could induce an equivalent real exchange rate change by allowing the CPI to rise 5.8 percent, with the nominal exchange rate remaining fixed. The short run effects on world prices and trade would be exactly the same. However, the long term effects would be different. Inflation tends to persist, and policy-makers find it easier to increase inflation than reduce it due to the dynamic inconsistency problem identified by Kydland and Prescott.

Policy-makers would likely overshoot their objectives if they pursued appreciation via inflation, and induce long-run impacts on prices larger than shown here. How much larger is beyond the scope of this model. Conceivably, omniscient policy-makers could anticipate this effect, but this would entail a longer time horizon for the adjustments. Given the heightened interest of China's trading partners in its exchange rate policy, an adjustment over a longer period of time could lead to increased tensions between China and its trading partners.

## References

- Batten, Dallas S., and Belongia, Michael T., (1986) "Monetary Policy, Real Exchange Rates, and U.S. Agricultural Exports," *American Journal of Agricultural Economics* 68: 422-427.
- Bredahl, Maury. (1976). *Effects of Currency Adjustments Given Free Trade, Trade Restrictions and Cross Commodity Substitution*, Staff Paper P76-35, University of Minnesota.
- Borenzsztein, Eduardo, and Carmen Reinhart, (1994), "The Macroeconomic Determinants of Commodity Prices," *IMF Staff Papers*, 41(2): 236-261.
- Ca'Zorzi, Michele, Hahn, Elke and Sanchez, Marcelo, (2007) "Exchange Rate Pass-Through in Emerging Markets". ECB Working Paper No. 739
- Céspedes, Luis Felipe, Chang, Robert, and Velasco, Andres (2003), "IS-LM-BP in the Pampas," *IMF Staff Papers* 50: 143-157.
- Clarida, Richard H., (1994), "Cointegration, Aggregate Consumption, and the Demand for Imports: A Structural Econometric Investigation," *American Economic Review*, 84(1): 298-308
- Chambers, Robert G., and Richard E. Just. (1979). "A Critique of Exchange Rate Treatment in Agricultural Trade Models," *American Journal of Agricultural Economics* 61: 249-57.
- Choudri, Ehsan U., and Hakura, Dalia S., (2001), "Exchange Rate Pass-through to Domestic Prices: Does the Inflationary Environment Matter?" IMF Working Paper WP/01/194.
- Choudri, Ehsan U., Faruquee, Hamid, and Hakura, Dalia S., (2003), "Explaining the Exchange Rate Pass-Through in Different Prices," International Monetary Fund WP/02/224.
- Collins, K.J., W.H. Meyers, and M.E. Bredahl. (1980). "Multiple Exchange Rate Changes and U.S. Agricultural Commodity Prices." *American Journal of Agricultural Economics* 62: 656-665.
- Devereux, Michael B. and James Yetman (2002). "Price-Setting and Exchange Rate Pass-Through: Theory and Evidence." Bank of Canada 2002 Conference.
- Goldstein, Morris and Mohsin S. Kahn, 1985. "Income and Price Effect in Foreign Trade," in R.W. Jones and P.B.Kenen, ed., *Handbook of International Economics*, vol. II.
- Gilbert, Christopher L., (1989), "The Impact of Exchange Rates and Developing Country Debt on Commodity Prices," *The Economic Journal*, 99: 773-84.
- Gupta, Poonam, Mishra, Deepak , and Sahay, Ratna (2003), "Output Response to Currency Crises," IMF Working Paper WP/03/230.

Frankel, Jeffery. (2004), "Contractionary Currency Crashes in Developing Countries," The Fifth Mundell-Fleming Lecture, IMF Annual Research Conference.

Frankel, Jeffery. (2005). "On the Renminbi: The Choice between Adjustment under a Fixed Exchange Rate and Adjustment under a Flexible Rate," NBER Working Paper No. 11274.

GlobalInsight, *World Overview: Tables*, May 11, 2007.

Gagnon, Joseph, and Jane Ihrig, (2004), "Monetary policy and exchange rate pass-through," *International Journal of Finance & Economics*, 9(4): 315-338.

Kydland, F. and E. Prescott (1977), "Rules rather than discretion: The inconsistency of optimal plans", *Journal of Political Economy*, 85, 473-490.

Krissoff, Barry, and Morey, Art, (1986) "The Dollar Turnaround and U.S. Agricultural Exports," U.S. Department of Agriculture, Economic Research Service, ERS Staff Report No. AGES861128.

MacDonald, S., and R. Seekey, (2006), "Exchange rates, agricultural prices, and trade," IATRC, St. Petersburg, Fl.

Obstfeld, M. and K. Rogoff, (1996), *Foundations of International Macroeconomics*, MIT Press.

Orden, David, and Paul Fackler (1989), "Identifying Monetary Impacts on Agricultural Prices in VAR Models," *American Journal of Agricultural Economics*, 71(2): 495-502.

Reinhart, Carmen M. 1995. "Devaluation, Relative Prices, and International Trade." *IMF Staff Papers* 42(2): 290-312.

Ridler, Duncan, and Christopher A. Yandle. (1972). "A Simplified Method for Analyzing the Effects of Exchange Rate Changes on Exports of a Primary Commodity," *International Monetary Fund Staff Papers*, 19(3): 569-75.

Senhadji, Abdelhak, and Montengro Claudio, (1998), "A Time Series Analysis Of Export Demand Equations: A Cross-Country Analysis," IMF Working Paper WP/98/149.

Shi, Hianhaai (2006), "Are Currency Appreciations Contractionary in China?" NBER Working Paper 12551.

Sjaastad, Larry A. and Scacciavillani, Fabio, (1996) "The Price of Gold and the Exchange Rate." *Journal of International Money and Finance*, 15(6): 879-97.

Taylor, John B. (2000). "Low Inflation, Pass-Through, and the Pricing Power of Firms," *European Economic Review* 44, 1389-1408.

Table 1--China's implied price of elasticities of demand given sustained shocks to world prices for 2 years

1 percent shock price to:																									
	CORN	SORGHUM	BARLEY	O. COARSE	WHEAT	RICE	SOYBEANS	SOYLOI	SOYMEAL	RAPESEED	RAPEOIL	RAPEMEAL	SUNSEED	SUNOIL	SUNMEAL	O. OILSEEDS	O. OILS	O. MEALS	COTTON	SUGAR	BEEF	PORK	POULTRY		
Induces demand response of:	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	
CORN	-0.01	0	0	0	0	0	-0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SORGHUM	0	-0.01	0	0	0	0	0	-0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
BARLEY	0	0	-0.27	0	0	0	-0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
O. COARSE GR	0	0	0	0	-0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
WHEAT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.01	0	0	0	
RICE	0	0	0	0	-0.02	-0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
SOYBEANS	0	0	0	0	0	0	-0.06	0	0.02	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	
SOYLOI	0	0	0	0	0	0	-0.02	0	0.02	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	
SOYMEAL	0	0	0	0	0	0	0	-0.02	0	0	0	0	0	0	0	0	0	0.01	0	0	0	0	0	0	
RAPESEED	0	0	0	0	0.02	0	0.02	0	0	-0.12	0.02	0	0	0	0	0	0	0.02	0	0	0	0	0	0	
RAPEOIL	0	0	0	0	0.01	0	0.02	0	0	-0.1	-0.12	0	0	0	0	0	0	0.05	0	0	0	0	0	0	
RAPEMEAL	0	0	0	0	0.02	0	0.02	0	0	-0.13	0.02	0	0	0	0	0	0	0.02	0	0	0	0	0	0	
SUNSEED	0	0	0	0	0	0	0.04	0	0	0	0	0	-0.02	0	0	0	0	0.01	0	0	0	0	0	0	
SUNOIL	0	0	0	0	0	0	0.1	0	0	0.02	0.03	0	-0.01	0	0	0	0	0.12	0	0	0	0	0	0	
SUNMEAL	0	0	0	0	0	0	0.1	0	0	0.02	0.03	0	-0.01	0	0	0	0	0.11	0	0	0	0	0	0	
O. OILSEEDS	0	0	0	0	-0.01	0	0.02	0	0	0	0	0	0	0	0	0	-0.02	0.01	0	0.03	0	0	0	0	
O. OILS	0	0	0	0	-0.01	0	0	0	0	0	0	0	0	0	0	0	-0.01	-0.21	0	0.01	0	0	0	0	
O. MEALS	0	0	0	0	-0.01	0	-0.01	0	0	0	0	0	0	0	0	-0.01	0.02	-0.07	0.04	0	0	0	0	0	
COTTON	0	0	0	0	-0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.13	0	0	0	0	
SUGAR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.25	0	0	0	
BEEF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.01	0	
PORK	0	0	0	0	0	0	-0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.01	
POULTRY	-0.01	0	-0.01	0	-0.01	0	-0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-0.06	

Source: Simulation of ERS Country Linked System (CLS) China model reconciled for 2004/05 USDA baseline projections.