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Estimated Macroeconomic Effects of a Chinese Yuan Appreciation

RAY C. FAIR*

This paper uses a multicountry macroeconometric model to estimate the macroeconomic effects of a Chinese yuan appreciation against the U.S. dollar. The estimated effects on U.S. output and employment are modest. Positive effects on U.S. output are roughly offset by negative effects from a decrease in Chinese output and an increase in U.S. import prices.
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Many have argued recently that the U.S. economy is being hurt by the Chinese policy of essentially pegging the yuan to the dollar. For example, Krugman [2010] states that his "back-of-the-envelope" calculations suggest that if there is no appreciation of the yuan, then over the next couple of years what he calls "Chinese mercantilism" "may end up reducing U.S. employment by around 1.4 million jobs." He notes that the standard arguments against protectionism do not hold in a world of less than full employment.

The question of what a Chinese appreciation of the yuan would do to the world economy is complicated. There are many economic links among countries, and these links need to be accounted for in analyzing the effects of exchange rate changes. This paper uses a multicountry econometric model, denoted the "MC model," to estimate the effects of a yuan appreciation. It will be seen that when all links are taken into account, the effects on U.S. output and employment are modest. Krugman's job loss estimate does not appear accurate.

The main message from analyzing the model's results regarding the overall effect on U.S. output from a yuan appreciation is that there are two negative effects that turn out to be quantitatively important and roughly offset the positive effects. The first negative effect is that the yuan appreciation leads to a decrease in Chinese output, which has a negative effect on Chinese imports, some of which are from the United States. The second negative effect is that the rise in U.S. import prices (from the rise in Chinese export prices) leads to an increase in U.S. domestic prices. The increase in U.S. domestic prices results in a decrease in real wealth and real wages and an increase in the short-term interest rate, all of which have—other things being equal—a negative effect on U.S. aggregate demand and output. It will be seen that the net effect of the yuan appreciation on U.S. output and employment is close to zero—in fact slightly negative.

1. The MC Model

The MC model is presented in Fair [2004], and it has been updated for purposes of this paper (version dated January 30, 2010). The updated version is on the author's website [fairmodel.econ.yale.edu/]. The U.S. part of the MC model will be denoted the "U.S. model," and the rest of the world's model will be denoted the "ROW model." Sometimes the U.S. model is analyzed by itself, but in this paper the entire MC model is used. The methodology behind this modeling is compared with the methodology of dynamic stochastic general equilibrium (DSGE) modeling in Fair [2009]. The MC model is completely estimated by two-stage least-squares regression. There is no calibration.

*Ray C. Fair is the John C. Musser Professor of Economics and a Fellow at the International Center for Finance at Yale University. He has been at Yale and associated with the Cowles Foundation for Research in Economics since 1974. From 1968 to 1974, he was an assistant professor at Princeton University. He was elected to be a Fellow of the Econometric Society in 1977. His teaching and research interests have emphasized macroeconomics and macroeconometric models. He holds a B.A. in economics from Fresno State University and a Ph.D. from the Massachusetts Institute of Technology.

The U.S. model

In the U.S. model, there are three estimated consumption equations, three investment equations, an import equation, four labor supply equations, two labor demand equations, a price equation, a nominal wage equation, two term-structure-of-interest-rate equations, and an estimated interest rate rule of the Federal Reserve, among others. In the interest rate rule, the U.S. Federal Reserve responds to inflation and unemployment.

There are a total of 28 estimated equations and about 100 identities in the U.S. model. The unemployment rate is determined by an identity; it equals unemployment divided by the labor force. In the identities, all flows of funds among the sectors (household, firm, financial, state and local government, federal government, and foreign) are accounted for. The federal government deficit is determined by an identity, as is the federal government debt. There is an estimated equation determining the interest payments of the federal government as a function of interest rates and the government debt.

There are important real wealth effects in the U.S. model. An increase in household wealth, say from an increase in stock prices or housing prices, leads to an increase in consumption. Spending out of real wealth is about 4 percent per year of the wealth change. Real disposable income is an explanatory variable in the consumption equations.

DSGE models like the Galí and Gertler [2007] model have the property that a positive price shock is explosive unless the U.S. Federal Reserve raises the nominal interest rate more than the increase in the inflation rate. In other words, positive price shocks with the nominal interest rate held constant are expansionary (because the real interest rate falls). In the U.S. model, however, they are contractionary. If there is a positive price shock, the real wage initially falls because nominal wages lag prices. This has a negative effect on consumption demand (because real income is an explanatory variable in the consumption equations). In addition, household real wealth falls because nominal asset prices don't initially rise as much as the price level. This has a negative effect on consumption through the wealth effect. There is little if any offset from lower real interest rates because households appear to respond more to nominal rates than to real rates. Positive price shocks are thus contractionary even if the U.S. Federal Reserve keeps the nominal interest rate unchanged. An increase in the price of imports of 10 percent in the MC model with the nominal interest rate unchanged leads to a decrease in real GDP of about 0.4 percent after four quarters. A tighter monetary policy would add to the contraction.

The ROW model

The ROW model consists of estimated equations for 37 countries. There are up to 13 estimated equations per country and 16 identities. There are a total of 274 estimated equations in the ROW model. The estimated equations explain total imports, consumption, fixed investment, inventory investment, the domestic price level, the demand for money, a short-term interest rate, a long-term interest rate, the spot exchange rate, the forward exchange rate, the export price level, employment, and the labor force. The specifications are similar across countries. The short-term interest rate for each country is explained by an estimated interest rate rule for that country. In some cases, the U.S. interest rate is an explanatory variable in the estimated rule, where the U.S. Federal Reserve is estimated to have an effect on the decisions of other monetary authorities. The exchange rates are relative to the dollar or the euro. The two key explanatory variables in the exchange rate equations are a relative interest rate variable and a relative price level variable.

The two key explanatory variables in the domestic price equation are a demand pressure variable and a cost-shock variable—the price of imports. In the price of exports equation, the price of exports in local currency is a weighted average of the domestic price level and a variable measuring the world export price level (translated into local currency using the exchange rate). The weights are estimated. These two equations for China are important for the present results. There is no estimated exchange rate equation for China: the yuan/dollar exchange rate is exogenous.

Although there are 37 countries that have estimated macroeconomic structural equations, 59 countries in the MC model (counting an "all other" category) have estimated trade share equations, and the trade share matrix is 59×59. Data permitting, a trade share equation is estimated for each country pair. In a trade share equation, the fraction of country i's exports imported by country j is a function of the price of country i's exports in dollars relative to a weighted average of all other countries' export prices in dollars (excluding

oil-exporting countries). The weights are trade shares lagged one quarter. A total of 1,302 trade share equations are estimated. Trade shares for which there are no estimated equations are still used in the solution of the MC model; they are simply taken as exogenous. The trade share data are from the IFS Direction of Trade data. Quarterly data are available back to 1960. Although the trade share equations are all quarterly, the structural equations for some countries are estimated using annual data. Interpolation is used when necessary to convert annual variables to quarterly variables.

There are many links among countries. The use of the trade shares means that the differential effects of one country's total demand for imports on other countries' exports are accounted for. There are interest rate links through the U.S. interest rate affecting some other countries' rates in the estimated interest rate rules. In a few cases, the euro (earlier German) interest rate affects other countries' interest rates. Exports are endogenous for each country, since they depend on the imports of other countries, which are endogenous. The price of exports in local currency of each country is endogenous, since it depends, as noted above, on the domestic price level and the world price level. The price of exports in dollars is endogenous because the price of exports in local currency is endogenous and the exchange rate is (for most countries) endogenous. The price of imports in each country is endogenous because it depends on the price of exports of the other countries weighted by the trade shares. Since, as noted above, the price of imports affects the domestic price level in each country's estimated domestic price equation, there are price links among countries. An increase in the price of exports in dollars in one country leads to increases in other countries' import prices, which affects their domestic and thus export prices, which feeds back to the original country, and so on.

Equations for China and robustness checks

The structural equations for China are estimated using annual data, for the period 1984–2008. Because the data are not as good and the estimation period is smaller, less confidence can be placed on the Chinese estimated equations than on the U.S. estimated equations. Because of this, some robustness checks are reported in Section 3 using alternative specifications for the Chinese model.

The first check concerns the estimated import equation for China. In this equation, the price of imports relative to the domestic price level is not a significant variable, and its coefficient estimate has the wrong sign. This is contrary to the import equation for the United States and for many other countries. In the regular version of the MC model the relative price of imports variable is excluded from the Chinese import equation, which means that an increase in the relative price of imports in China does not affect Chinese imports. This is what the data say, but this, of course, could be wrong. For the first robustness check the relative price of imports variable was added to the equation, and its coefficient was constrained to be similar to coefficient estimates for other countries. The equation was re-estimated with this constraint imposed. The first robustness check is to rerun the experiment using this constrained equation.

The second check concerns the response of Chinese export prices to the appreciation. Direct data on a price index of exports for China are not available, and a series was constructed using U.S. export prices and the yuan/dollar exchange rate. Because of this, the weight on the domestic price level was not estimated in the price of exports equation for China. It was simply imposed to be 0.5, which is in line with estimated weights for other countries. For the second robustness check, the weight was change to 0.8.

The third check concerns the effect of the price of imports on the domestic price level. The price of imports is an explanatory variable in the domestic price equation, and it will be seen that the estimated effect is large. The Chinese appreciation leads to a fairly large fall in the Chinese domestic price level. For the third check this effect was turned off by simply dropping the Chinese domestic price equation and taking the domestic price level to be exogenous.

The fourth check concerns the effect of a change in the domestic price level on real output. For the United States, as discussed above, an increase in the domestic price level is contractionary, other things being equal, because of the fall in real wealth and real wages. Similarly, a decrease in the domestic price level is expansionary, other things being equal. This effect is not in the Chinese model because there are no data on wealth and wages in the model. If China is in fact like the United States in this respect, the fall in Chinese output from the appreciation is overestimated in the basic experiment because the expansionary effects from the fall in the Chinese domestic price level are not taken into account. In the basic experiment, Chinese

output simply falls because of the decrease in exports. For the fourth check, it was assumed that Chinese government spending, which is exogenous in the basic case, is changed enough to completely offset the fall in output. In other words, it is assumed that the appreciation has no effect on Chinese output.

2. The Basic Experiment and Results

For the version of the MC model used in this paper, trade share data are available through 2008:Q4. The simulation period was taken to be 1999:Q1–2008:Q4. There are a total of 1,604 estimated equations in the model counting the trade share equations, and the first step was to add the estimated residuals to these equations and take them as exogenous. This means that when the model is solved, a perfect tracking solution is obtained. The second step was to decrease the yuan/dollar exchange rate by 25 percent from its actual value for each quarter. For example, the actual yuan/dollar exchange rate in 1999:Q1 was 8.2787, and the new value was taken to be 0.75 times this, or 6.6090. This was done for each of the 40 quarters.

The model was then solved with this change imposed. No other changes were made. For example, all the estimated exchange rate equations were left in. To the extent that the predicted values from these equations are not affected much, the exchange rates relative to the dollar do not change much, which means there is also an appreciation of the yuan relative to other currencies. For exchange rates that are exogenous, there is an exact 25 percent appreciation of the yuan relative to these currencies since the exchange rates are relative to the dollar.

Because of the many links among countries, the results are not easy to explain. The following is a step-by-step discussion, but the actual story is in fact more complicated because of the simultaneity. The results referred to below are presented in Table 1. The variables are defined at the bottom of the table and are defined in the text in the order they are listed in Table 1. When a variable is said to increase or decrease, this always refers to the new solution value relative to the base value. Results are presented for the fourth quarter of each year. When the variable is only annual, the results are for the year.

The appreciation of the yuan leads to a decrease in Chinese import prices (PM_{ch}) which through the domestic price equation leads to a decrease in Chinese domestic prices (PY_{ch}). After four years, domestic prices are down 15.15 percent, which is a large change. The decrease in domestic prices and the decrease in the world price of exports in yuan (because of the appreciation) leads through the export price equation to a decrease in Chinese export prices in yuan (PX_{ch}). After four years, export prices are down 20.10 percent, which is also a large change. The dollar price of Chinese exports ($PX\$_{ch}$) increases, but by less than it would have had Chinese export prices in yuan not fallen. The initial increase is 10.81 percent, and after four years the increase is down to 6.53 percent.

The higher dollar price of Chinese exports relative to the dollar price of other countries' exports leads through the trade share equations to a decrease in the demand for Chinese exports. For example, exports to the United States ($X_{ch,us}$)are down 3.48 percent initially and 8.34 percent after four years. Total Chinese exports (EX_{ch}) are down 1.50 percent initially and 4.85 percent after four years. The fall in exports has a negative effect on Chinese GDP (Y_{ch}) which in turn has a negative effect on total Chinese imports (IM_{ch}).

Turning to the United States, the import price deflator (PM_{us}) is higher because of the higher price of Chinese imports. This leads to an increase in U.S. domestic prices (PY_{us}) through the domestic price equation. This in turn leads to an increase in the price of U.S. exports (PX_{us}) through the export price equation. The increase in the U.S. price level leads to a decrease in real wealth (AA_{us}) and a decrease in real disposable income (YD_{us}). There is a slight increase in the short-term interest rate (RS_{us}). According to the U.S. estimated interest rate rule, RS_{us} responds positively to an increase in inflation and negatively to a fall in output. The fall in output is small (discussed below), and the inflation effect dominates in that the short-term interest rate is up slightly.

There are both positive and negative effects on U.S. GDP. Total U.S. imports (IM_{us}) are down, in large part because of the fall in imports from China, which is a positive effect. U.S. exports to China ($X_{us,ch}$) are down because of the decreased demand from China due to the contraction of the Chinese economy. Total U.S. exports (EX_{us}) are, however, down only slightly, so there is only a small effect on U.S. output from export changes. U.S. consumption (C_{us}) is down because of the fall in real wealth and real income, which is a negative effect on U.S. output. The increase in the short-term interest rate also has a negative effect on U.S.

Table 1. Chinese Appreciation of 25 Percent

(Regular version of MC Model. Deviations from base in percentage points)

Qtr	PM_{ch}	PY_{ch}	PX_{ch}	$PX\$_{ch}$	$X_{ch,us}$	EX_{ch}	Y_{ch}	IM_{ch}
1999:Q4	−24.91	−8.06	−16.89	10.81	−3.48	−1.50	−0.50	−0.16
2000:Q4	−24.90	−11.93	−18.65	8.47	−5.75	−3.01	−1.23	−0.53
2001:Q4	−24.88	−13.94	−19.56	7.25	−7.32	−4.10	−1.75	−1.02
2002:Q4	−24.85	−15.15	−20.10	6.53	−8.34	−4.85	−2.30	−1.59
2003:Q4	−24.81	−16.07	−20.50	6.00	−8.90	−5.50	−2.97	−2.27
2004:Q4	−24.77	−16.75	−20.78	5.63	−9.23	−5.84	−3.43	−2.95
2005:Q4	−24.74	−17.37	−21.03	5.29	−9.32	−6.14	−3.97	−3.63
2006:Q4	−24.71	−17.83	−21.21	5.05	−9.30	−6.29	−4.32	−4.25
2007:Q4	−24.68	−18.11	−21.30	4.93	−9.29	−6.62	−4.45	−4.72
2008:Q4	−24.66	−18.35	−21.39	4.82	−9.11	−7.14	−4.64	−5.12

Qtr	PM_{us}	PY_{us}	PX_{us}	AA_{us}	YD_{us}	RS_{us}	IM_{us}	$X_{us,ch}$	EX_{us}	C_{us}
1999:Q4	0.64	0.11	0.18	−0.14	−0.12	0.02	−0.21	−0.32	−0.01	−0.06
2000:Q4	0.53	0.15	0.20	−0.15	−0.11	0.01	−0.32	−0.99	−0.03	−0.08
2001:Q4	0.56	0.18	0.24	−0.16	−0.11	0.01	−0.35	−1.70	−0.01	−0.09
2002:Q4	0.66	0.23	0.29	−0.19	−0.12	0.02	−0.36	−2.50	0.01	−0.10
2003:Q4	0.82	0.28	0.36	−0.22	−0.15	0.02	−0.39	−3.56	−0.01	−0.11
2004:Q4	0.95	0.34	0.43	−0.25	−0.17	0.03	−0.44	−4.76	0.04	−0.13
2005:Q4	1.04	0.40	0.49	−0.28	−0.19	0.03	0.49	−5.75	0.00	−0.15
2006:Q4	1.19	0.47	0.57	−0.30	−0.21	0.03	−0.54	−6.54	0.07	−0.16
2007:Q4	1.26	0.53	0.64	−0.34	−0.22	0.04	−0.58	−6.93	0.08	−0.18
2008:Q4	1.31	0.59	0.69	−0.42	−0.22	0.03	−0.59	−7.15	0.18	−0.19

Qtr	Y_{us}	J_{us}	J_{us}[a]
1999:Q4	−0.05	−0.03	−40.8
2000:Q4	−0.05	−0.05	−68.0
2001:Q4	−0.04	−0.05	−67.1
2002:Q4	−0.03	−0.05	−57.1
2003:Q4	−0.04	−0.05	−58.7
2004:Q4	−0.04	−0.05	−60.8
2005:Q4	−0.05	−0.05	−68.2
2006:Q4	−0.04	−0.05	−64.0
2007:Q4	−0.03	−0.04	−54.1
2008:Q4	−0.02	−0.03	−43.8

Simulation period 1999:Q1–2008:Q4.

PM = import price level, PY = domestic price level, PX = export price level, $PX\$$ = export price level in dollars, $X_{i,j}$ = exports from i to j, EX = total exports, Y = real output, IM = total imports, AA = real wealth, YD = real disposable income, RS = short-term interest rate, C = consumption, J = employment.

[a]Units in thousands of jobs.

output, although this effect is small because the change in the interest rate is small.

The net effect on U.S. output is negative but small. The decrease is 0.05 percent after one year and 0.03 percent after four years. The net effect on U.S. jobs is correspondingly small: a decrease of 0.03 percent (40,800 jobs) after one year and 0.05 percent (57,100 jobs) after four years.

To summarize, the main expansionary effect on U.S. output from the appreciation of the yuan is the fall in U.S. imports from China. The main contractionary effect is through higher U.S. prices and the fall in exports to China. The net effect on U.S. output could go either way, and it is in fact slightly negative. The net effect is, however, very small, and as a rough approximation one might say that the Chinese appreciation is a wash relative to U.S. output and employment.

The present results are certainly at odds with Krugman's estimate of 1.4 million fewer jobs if the

yuan does not appreciate. (This may show the danger of back-of-the-envelope calculations when it comes to exchange rate effects!) They suggest that even if the United States convinced China to appreciate the yuan, there would be little effect on U.S. output and employment.

3. Robustness Checks

As discussed at the end of Section 1, four robustness checks were made. For the first, the relative import price variable was added to the Chinese import equation. No other changes were made. The results are presented in Table 2. In this case Chinese imports, IM_{ch}, are initially higher as the substitution toward imports dominates the negative income effect. Chinese output falls more than it does in Table 1 because of the substitution into imports. U.S. exports to China, $X_{us,ch}$, are now initially higher rather than lower, as they are in Table 1. The price effect on the United States is slightly smaller in Table 2 than in Table 1. This is because the lower Chinese output in Table 2 vs. Table 1 leads to a larger fall in the Chinese price level and thus a smaller increase in the Chinese export price in dollars. The net difference on U.S. output and jobs is modest, compared with Table 1. U.S. output and employment are down slightly less in Table 2, but the main conclusions from Table 1 are not changed.

For the second check, the weight on the domestic price level in the Chinese export price equation was changed from 0.5 to 0.8. No other changes were made from the Table 1 experiment. The results are presented in Table 3. In this case the price of exports in yuan falls less and so the price of exports in dollars rises more. The initial increase in $PX\$_{ch}$ is now 17.59 percent compared with 10.81 percent in Table 1. This results in Chinese exports, output, and imports all falling more. Also, U.S. import prices rise more due to the larger increase in Chinese export prices, which leads to U.S. domestic prices rising more. U.S. imports from China are down more because of the higher Chinese export price. U.S. output and employment are down slightly more in this case, but again the output and employment effects are modest.

For the third check, reported in Table 4, the Chinese domestic price equation is dropped. No other changes were made from the Table 1 experiment. This leads to a smaller decrease in the Chinese export prices in yuan because, unlike in Table 1, there is no effect from a fall in the domestic price level on export prices. The increase in Chinese export prices in dollars is thus larger. Tables 3 and 4 are thus similar relative to Table 1 in that Chinese export prices in dollars are higher. The increase is larger in Table 4 (except for the first year). The story for Table 4 is thus similar to that for Table 3, only the differences between Tables 4 and 1 are larger than those between Tables 3 and 1. U.S. output falls by 0.09 percent after four years, and employment falls by 137,300 jobs. These effects are still quite small.

For the fourth check, reported in Table 5, the output effect on China was turned off by having government spending offset any contractionary effects. No other changes were made from the Table 1 experiment. In this case, Chinese domestic prices do not fall as much as in Table 1 because there is no negative demand effect from lower output. This leads to a smaller fall in Chinese export prices in yuan and so a larger rise in export prices in dollars. The price effect on the United States is thus somewhat larger. Chinese imports do not fall, and so U.S. exports are larger in Table 5 vs. Table 1. The positive effect from higher U.S. exports is roughly offset by the negative effect from higher U.S. prices, and the effects on U.S. output and employment are similar to those of Table 1. The estimated effects thus continue to be small.

The results are thus all similar in showing small effects on U.S. output and employment. Remember that the results in Table 1 are the ones most supported by the data, although the Chinese model is based on a short sample period. Fortunately, the results are not sensitive to various changes in the Chinese model. One other check that is interesting to make is to combine the changes made for Tables 2 and 5—relative import price variable in the Chinese import equation and no change in Chinese output. These results are presented in Table 6. In this case the effects on U.S. output and employment are still small, although now U.S. output and employment are slightly higher at the end of the period. Comparing Tables 1 and 6, one might ask why, given that U.S. exports to China, $X_{us,ch}$, are so much larger in Table 6 than in Table 1, the U.S. output differences are so small? The main reason is the negative price effect on U.S. output. It is larger in Table 6 because the more expansive Chinese economy has led to a smaller fall in the Chinese price level and thus a larger rise in the Chinese price of exports in dollars. The price effect on U.S. output is clearly an important property of the MC model.

Table 2. Chinese Appreciation of 25 Percent

(Relative import price added to Chinese import equation. Deviations from base in percentage points)

Qtr	PM_{ch}	PY_{ch}	PX_{ch}	$PX\$_{ch}$	$X_{ch,us}$	EX_{ch}	Y_{ch}	IM_{ch}
1999:Q4	−24.91	−8.81	−17.22	10.38	−3.33	−1.44	−1.69	3.54
2000:Q4	−24.90	−13.48	−19.35	7.54	−5.31	−2.81	−3.23	3.92
2001:Q4	−24.87	−15.91	−20.47	6.04	−6.55	−3.72	−3.91	3.06
2002:Q4	−24.83	−17.33	−21.11	5.18	−7.26	−4.26	−4.51	1.80
2003:Q4	−24.80	−18.35	−21.57	4.58	−7.57	−4.70	−5.17	0.41
2004:Q4	−24.77	−18.95	−21.83	4.23	−7.71	−4.88	−5.44	−0.83
2005:Q4	−24.75	−19.35	−22.00	4.00	−7.68	−5.06	−5.66	−1.84
2006:Q4	−24.73	−19.55	−22.07	3.90	−7.60	−5.14	−5.71	−2.60
2007:Q4	−24.72	−19.55	−22.05	3.94	−7.57	−5.39	−5.56	−3.05
2008:Q4	−24.71	−19.56	−22.04	3.95	−7.43	−5.83	−5.59	−3.34

Qtr	PM_{us}	PY_{us}	PX_{us}	AA_{us}	YD_{us}	RS_{us}	IM_{us}	$X_{us,ch}$	EX_{us}	C_{us}
1999:Q4	0.63	0.11	0.18	−0.14	−0.11	0.03	−0.20	5.55	0.06	−0.06
2000:Q4	0.51	0.16	0.21	−0.14	−0.09	0.02	−0.28	6.17	0.10	−0.08
2001:Q4	0.53	0.19	0.24	−0.16	−0.09	0.02	−0.29	4.46	0.14	−0.08
2002:Q4	0.61	0.23	0.28	−0.18	−0.10	0.02	−0.31	2.43	0.15	−0.09
2003:Q4	0.72	0.27	0.33	−0.20	−0.12	0.02	−0.34	0.41	0.14	−0.10
2004:Q4	0.81	0.32	0.39	−0.22	−0.14	0.03	−0.37	−1.48	0.15	−0.11
2005:Q4	0.88	0.36	0.43	−0.23	−0.15	0.02	−0.41	−3.01	0.10	−0.12
2006:Q4	0.41	0.49	−0.25	−0.17	0.03	−0.45	−4.08	0.14	−0.13	0.98
2007:Q4	1.04	0.46	0.54	−0.27	−0.18	0.03	−0.47	−4.55	0.14	−0.14
2008:Q4	1.09	0.50	0.59	−0.34	−0.18	0.03	−0.48	−4.76	0.21	−0.15

Qtr	Y_{us}	J_{us}	J_{us}[a]
1999:Q4	−0.04	−0.02	−25.0
2000:Q4	−0.03	−0.03	−38.1
2001:Q4	−0.02	−0.03	−33.8
2002:Q4	−0.02	−0.02	−28.6
2003:Q4	−0.02	−0.03	−33.0
2004:Q4	−0.02	−0.03	−35.4
2005:Q4	−0.03	−0.03	−42.8
2006:Q4	−0.02	−0.03	−38.6
2007:Q4	−0.02	−0.02	−30.9
2008:Q4	−0.01	−0.02	−23.7

Simulation period 1999:Q1–2008:Q4.

PM = import price level; PY = domestic price level; PX = export price level; $PX\$$ = export price level in dollars; $X_{i,j}$ = exports from i to j; EX = total exports; Y = real output; IM = total imports; AA = real wealth; YD = real disposable income; RS = short-term interest rate; C = consumption; J = employment.

[a]Units in thousands of jobs.

Table 3. Chinese Appreciation of 25 Percent

(PY_{ch} weight of 0.8 for PX_{ch}. Deviations from base in percentage points)

Qtr	PM_{ch}	PY_{ch}	PX_{ch}	$PX\$_{ch}$	$X_{ch,us}$	EX_{ch}	Y_{ch}	IM_{ch}
1999:Q4	−24.86	−8.22	−11.81	17.59	−5.58	−2.36	−0.79	−0.25
2000:Q4	−24.85	−12.39	−15.02	13.31	−9.01	−4.61	−1.88	−0.82
2001:Q4	−24.82	−14.64	−16.76	10.99	−11.24	−6.12	−2.62	−1.55
2002:Q4	−24.77	−16.08	−17.87	9.50	−12.55	−7.09	−3.39	−2.38
2003:Q4	−24.72	−17.24	−18.76	8.32	−13.12	−7.90	−4.28	−3.33
2004:Q4	−24.68	−18.08	−19.40	7.47	−13.33	−8.21	−4.85	−4.26
2005:Q4	−24.65	−18.84	−19.98	6.70	−13.18	−8.49	−5.51	−5.15
2006:Q4	−24.61	−19.37	−20.38	6.16	−12.87	−8.51	−5.86	−5.91
2007:Q4	−24.58	−19.65	−20.57	5.91	−12.59	−8.78	−5.93	−6.46
2008:Q4	−24.57	−19.86	−20.72	5.70	−12.14	−9.33	−6.09	−6.88

Qtr	PM_{us}	PY_{us}	PX_{us}	AA_{us}	YD_{us}	RS_{us}	IM_{us}	$X_{us,ch}$	EX_{us}	C_{us}
1999:Q4	1.02	0.18	0.28	−0.23	−0.19	0.03	−0.34	−0.51	−0.03	−0.10
2000:Q4	0.81	0.24	0.32	−0.23	−0.17	0.02	−0.49	−1.54	−0.05	−0.13
2001:Q4	0.83	0.28	0.36	−0.24	−0.16	0.02	−0.53	−2.59	−0.03	−0.13
2002:Q4	0.94	0.33	0.42	−0.28	−0.17	0.03	−0.53	−3.73	−0.01	−0.14
2003:Q4	1.12	0.40	0.50	−0.31	−0.20	0.03	−0.55	−5.22	−0.05	−0.15
2004:Q4	1.26	0.47	0.59	−0.34	−0.23	0.04	−0.59	−6.86	0.03	−0.17
2005:Q4	1.35	0.55	0.65	−0.36	−0.25	0.03	−0.63	−8.13	−0.02	−0.19
2006:Q4	1.50	0.62	0.74	−0.39	−0.27	0.04	−0.67	−9.07	0.08	−0.21
2007:Q4	1.57	0.69	0.82	−0.42	−0.27	0.04	−0.70	−9.44	0.10	−0.22
2008:Q4	1.60	0.75	0.88	−0.53	−0.26	0.04	−0.70	−9.57	0.24	−0.23

Qtr	Y_{us}	J_{us}	J_{us}[a]
1999:Q4	−0.09	−0.05	−66.0
2000:Q4	−0.08	−0.09	−108.4
2001:Q4	−0.07	−0.08	−104.8
2002:Q4	−0.05	−0.07	−86.3
2003:Q4	−0.06	−0.07	−83.0
2004:Q4	−0.05	−0.06	−81.6
2005:Q4	−0.06	−0.07	−86.4
2006:Q4	−0.04	−0.06	−76.8
2007:Q4	−0.04	−0.05	−60.5
2008:Q4	−0.02	−0.04	−45.2

Simulation period 1999:Q1–2008:Q4.

PM = import price level; PY = domestic price level; PX = export price level; $PX\$$ = export price level in dollars; $X_{i,j}$ = exports from i to j; EX = total exports; Y = real output; IM = total imports; AA = real wealth; YD = real disposable income; RS = short-term interest rate; C = consumption; J = employment.

[a]Units in thousands of jobs.

Table 4. Chinese Appreciation of 25 Percent

(Chinese PY equation dropped. Deviations from base in percentage points)

Qtr	PM_{ch}	PY_{ch}	PX_{ch}	$PX\$_{ch}$	$X_{ch,us}$	EX_{ch}	Y_{ch}	IM_{ch}
1999:Q4	−24.88	0.00	−13.29	15.61	−4.98	−2.12	−0.71	−0.22
2000:Q4	−24.83	0.00	−13.25	15.66	−9.21	−4.58	−1.86	−0.79
2001:Q4	−24.77	0.00	−13.20	15.73	−12.81	−6.75	−2.84	−1.59
2002:Q4	−24.69	0.00	−13.13	15.83	−15.68	−8.53	−3.99	−2.62
2003:Q4	−24.59	0.00	−13.03	15.96	−17.79	−10.25	−5.46	−3.93
2004:Q4	−24.50	0.00	−12.92	16.11	−19.47	−11.40	−6.66	−5.37
2005:Q4	−24.41	0.00	−12.80	16.27	−20.69	−12.62	−8.12	−6.93
2006:Q4	−24.30	0.00	−12.67	16.44	−21.69	−13.50	−9.23	−8.47
2007:Q4	−24.18	0.00	−12.52	16.65	−22.62	−14.80	−9.95	−9.81
2008:Q4	24.10	0.00	12.40	16.80	23.11	16.62	10.77	11.04

Qtr	PM_{us}	PY_{us}	PX_{us}	AA_{us}	YD_{us}	RS_{us}	IM_{us}	$X_{us,ch}$	EX_{us}	C_{us}
1999:Q4	0.91	0.16	0.25	−0.20	−0.17	0.03	−0.30	−0.45	−0.02	−0.09
2000:Q4	0.94	0.25	0.35	−0.26	−0.20	0.02	−0.52	−1.49	−0.05	−0.14
2001:Q4	1.13	0.33	0.44	−0.31	−0.21	0.02	−0.65	−2.69	−0.04	−0.17
2002:Q4	1.44	0.45	0.58	−0.40	−0.27	0.04	−0.76	−4.16	−0.04	−0.20
2003:Q4	1.89	0.59	0.76	−0.48	−0.35	0.05	−0.92	−6.25	−0.12	−0.25
2004:Q4	2.27	0.75	0.96	−0.57	−0.43	0.06	−1.10	−8.76	−0.07	−0.31
2005:Q4	2.63	0.93	1.15	−0.67	−0.51	0.06	−1.29	−11.07	−0.19	−0.37
2006:Q4	3.14	1.12	1.39	−0.78	−0.60	0.08	−1.48	−13.15	−0.09	−0.43
2007:Q4	3.41	1.33	1.62	−0.89	−0.64	0.08	−1.65	−14.49	−0.09	−0.48
2008:Q4	3.72	1.51	1.83	−1.17	−0.66	0.08	−1.76	−15.50	0.11	−0.53

Qtr	Y_{us}	J_{us}	J_{us}[a]
1999:Q4	−0.08	−0.05	−58.7
2000:Q4	−0.09	−0.09	−112.6
2001:Q4	−0.10	−0.11	−132.3
2002:Q4	−0.09	−0.11	−137.3
2003:Q4	−0.12	−0.13	−161.4
2004:Q4	−0.13	−0.15	−186.8
2005:Q4	−0.16	−0.17	−222.2
2006:Q4	−0.16	−0.18	−239.9
2007:Q4	−0.16	−0.18	−241.7
2008:Q4	−0.15	−0.18	−228.8

Simulation period 1999:Q1–2008:Q4.

PM = import price level; PY = domestic price level; PX = export price level; $PX\$$ = export price level in dollars; $X_{i,j}$ = exports from i to j; EX = total exports; Y = real output; IM = total imports; AA = real wealth; YD = real disposable income; RS = short-term interest rate; C = consumption; J = employment.

[a]Units in thousands of jobs.

Table 5. Chinese Appreciation of 25 Percent

(No Change in Chinese output. Deviations from base in percentage points)

Qtr	PM_{ch}	PY_{ch}	PX_{ch}	$PX\$_{ch}$	$X_{ch,us}$	EX_{ch}	Y_{ch}	IM_{ch}
1999:Q4	−24.91	−7.74	−16.74	11.01	−3.54	−1.52	0.00	0.00
2000:Q4	−24.90	−11.05	−18.23	9.02	−5.97	−3.10	0.00	0.00
2001:Q4	−24.86	−12.49	−18.88	8.17	−7.79	−4.33	0.00	0.00
2002:Q4	−24.82	−13.13	−19.13	7.83	−9.13	−5.25	0.00	0.00
2003:Q4	−24.76	−13.39	−19.20	7.74	−10.06	−6.13	0.00	0.00
2004:Q4	−24.70	−13.49	−19.18	7.76	−10.79	−6.70	0.00	0.00
2005:Q4	−24.64	−13.52	−19.12	7.84	−11.30	−7.29	0.00	0.00
2006:Q4	−24.56	−13.51	−19.04	7.94	−11.71	−7.73	0.00	0.00
2007:Q4	−24.48	−13.47	−18.95	8.07	−12.11	−8.41	0.00	0.00
2008:Q4	−24.42	−13.44	−18.87	8.18	−12.29	−9.35	0.00	0.00

Qtr	PM_{us}	PY_{us}	PX_{us}	AA_{us}	YD_{us}	RS_{us}	IM_{us}	$X_{us,ch}$	EX_{us}	C_{us}
1999:Q4	0.65	0.11	0.18	−0.15	−0.12	0.02	−0.22	−0.07	−0.01	−0.06
2000:Q4	0.56	0.16	0.22	−0.16	−0.12	0.01	−0.33	−0.15	−0.01	−0.09
2001:Q4	0.64	0.20	0.26	−0.18	−0.12	0.02	−0.37	−0.18	0.03	−0.10
2002:Q4	0.79	0.26	0.33	−0.23	−0.14	0.03	−0.41	−0.22	0.07	−0.11
2003:Q4	1.04	0.34	0.44	−0.27	−0.18	0.04	−0.47	−0.26	0.11	−0.13
2004:Q4	1.26	0.44	0.55	−0.32	−0.22	0.05	−0.56	−0.32	0.20	−0.17
2005:Q4	1.48	0.54	0.67	−0.37	−0.26	0.06	−0.66	−0.38	0.21	−0.20
2006:Q4	1.77	0.67	0.81	−0.44	−0.30	0.08	−0.76	−0.44	0.37	−0.24
2007:Q4	1.93	0.79	0.95	−0.50	−0.32	0.08	−0.85	−0.50	0.43	−0.27
2008:Q4	2.13	0.91	1.08	−0.66	−0.33	0.08	−0.91	−0.54	0.56	−0.30

Qtr	Y_{us}	J_{us}	J_{us}[a]
1999:Q4	−0.05	−0.03	−40.9
2000:Q4	−0.05	−0.05	−68.3
2001:Q4	−0.04	−0.05	−67.1
2002:Q4	0.03	−0.05	−56.9
2003:Q4	−0.04	−0.05	−57.7
2004:Q4	−0.03	−0.04	−56.3
2005:Q4	−0.04	−0.05	−62.0
2006:Q4	−0.02	−0.04	47.1
2007:Q4	−0.01	−0.02	−29.5
2008:Q4	−0.01	−0.01	−15.9

Simulation period 1999:Q1–2008:Q4.

PM = import price level; PY = domestic price level; PX = export price level; $PX\$$ = export price level in dollars; $X_{i,j}$ = exports from i to j; EX = total exports; Y = real output; IM = total imports; AA = real wealth; YD = real disposable income; RS = short-term interest rate; C = consumption; J = employment.

[a]Units in thousands of jobs.

Table 6. Chinese Appreciation of 25 Percent

(Experiments in Tables 2 and 5 combined. Deviations from base in percentage points)

Qtr	PM_{ch}	PY_{ch}	PX_{ch}	$PX\$_{ch}$	$X_{ch,us}$	EX_{ch}	Y_{ch}	IM_{ch}
1999:Q4	−24.91	−7.74	−16.73	11.03	−3.54	−1.52	0.00	4.20
2000:Q4	−24.88	−11.04	−18.20	9.07	−5.96	−3.10	0.00	5.91
2001:Q4	−24.83	−12.48	−18.82	8.24	−7.78	−4.31	0.00	6.54
2002:Q4	−24.76	−13.10	−19.05	7.93	−9.13	−5.22	0.00	6.73
2003:Q4	−24.69	−13.36	−19.11	7.85	−10.08	−6.09	0.00	6.76
2004:Q4	−24.61	−13.45	−19.08	7.89	−10.82	−6.64	0.00	6.73
2005:Q4	−24.54	−13.47	−19.02	7.98	−11.33	−7.21	0.00	6.68
2006:Q4	−24.45	−13.45	−18.93	8.09	−11.74	−7.63	0.00	6.64
2007:Q4	−24.37	−13.41	−18.85	8.20	−12.13	−8.28	0.00	6.60
2008:Q4	−24.32	−13.38	−18.77	8.30	−12.30	−9.18	0.00	6.57

Qtr	PM_{us}	PY_{us}	PX_{us}	AA_{us}	YD_{us}	RS_{us}	IM_{us}	$X_{us,ch}$	EX_{us}	C_{us}
1999:Q4	0.67	0.12	0.19	−0.15	−0.11	0.03	−0.21	6.59	0.07	−0.06
2000:Q4	0.61	0.18	0.25	−0.17	−0.11	0.03	−0.31	9.35	0.15	−0.09
2001:Q4	0.71	0.24	0.31	−0.20	−0.11	0.03	−0.36	9.67	0.26	−0.10
2002:Q4	0.90	0.31	0.40	−0.26	−0.14	0.05	−0.41	9.51	0.33	−0.12
2003:Q4	1.17	0.41	0.51	−0.30	−0.18	0.06	−0.49	9.70	0.49	−0.15
2004:Q4	1.41	0.52	0.64	−0.35	−0.21	0.08	−0.59	9.95	0.55	−0.18
2005:Q4	1.64	0.64	0.78	−0.40	−0.26	0.08	−0.69	9.64	0.63	−0.22
2006:Q4	1.94	0.77	0.93	−0.46	−0.29	0.11	−0.79	9.25	0.81	−0.25
2007:Q4	2.09	0.91	1.07	−0.52	−0.30	0.11	−0.86	8.64	0.87	−0.28
2008:Q4	2.28	1.03	1.21	−0.69	−0.32	0.11	−0.92	8.09	0.95	−0.31

Qtr	Y_{us}	J_{us}	J_{us}[a]
1999:Q4	−0.04	−0.02	−24.9
2000:Q4	−0.02	−0.03	−36.6
2001:Q4	−0.02	−0.02	−28.6
2002:Q4	−0.01	−0.02	−19.5
2003:Q4	−0.01	−0.01	−17.0
2004:Q4	0.00	0.00	−5.7
2005:Q4	0.00	0.00	−4.4
2006:Q4	0.03	0.02	26.6
2007:Q4	0.04	0.04	50.8
2008:Q4	0.04	0.05	61.6

Simulation period 1999:Q1–2008:Q4.

PM = import price level; PY = domestic price level; PX = export price level; $PX\$$ = export price level in dollars; $X_{i,j}$ = exports from i to j; EX = total exports; Y = real output; IM = total imports; AA = real wealth; YD = real disposable income; RS = short-term interest rate; C = consumption; J = employment.

[a]Units in thousands of jobs.

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