THE MACROECONOMIC IMPACTS OF CHINESE CURRENCY APPRECIATION ON CHINA AND THE REST OF THE WORLD: A GLOBAL COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS

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ABSTRACT

There has been contentious debate surrounding the issue of undervaluation of the Chinese Renminbi, with continuous international political pressure on China to appreciate its currency and the Chinese government resisting significant changes in its policy. A key question underlining the debate is whether a Renminbi appreciation would deliver substantial gains for exports and employment as the United States has argued or a significant slowdown of Chinese economy as feared by the Chinese government, and if so to what extent. This paper analyzes the *ex-ante*, short-term impacts of the Chinese Renminbi appreciation on the Chinese and world economies using the novel approach of modeling nominal exchange rate adjustment in the Global Trade Analysis Project, a global computable general equilibrium model. Scenario results show that the Chinese economy will be affected negatively, with lower real gross domestic product, lower employment rates, and a decline in the trade surplus. Chinese currency appreciation has a positive impact on the GDP of the major countries and regions, but by a small margin. With a higher Chinese exchange rate, trade balances for other trading partner countries, with the exception of the United States, improve.

Keywords: China, computable general equilibrium model, economic impacts, exchange rate, Renminbi appreciation

1. INTRODUCTION

There has been tremendous international political pressure on China, led mainly by the United States (US), to revalue its currency. The United States has argued that the competitive undervaluation of the Chinese Renminbi (RMB) and several neighboring Asian countries[1] has a substantial impact on the US economy (Bergsten 2010). It was estimated that an appreciation of 25–40 percent of RMB would produce a reduction of US$100 billion to US$150 billion in the annual US current account deficit (Cline and Williamson 2009). Meanwhile, other proponents believe that it is also in the interest of China to use currency appreciation as a tool to address the rising inflation problem and renewed overheating by lowering the price of imports and dampening the demand for exports (Goldstein and Lardy 2006; Bergsten 2010; Tyers et al. 2008; Tung and Baker 2004). Within China, however, there are widespread concerns that a major RMB appreciation would slow down China's economic growth and induce adverse employment effects on labor-intensive export sectors (Xu et al. 2011; Tang 2011; Lin 2011; Duan 2011).

There has been a lot of academic debate surrounding the question of whether RMB is undervalued or not and by how much. There are two approaches in the literature to estimating the undervaluation or overvaluation of currency (Subramanian 2010). The first approach relies on macroeconomic models to define the equilibrium exchange rate (ER) and computes the departure of the actual ER from this equilibrium (Subramanian 2010). The second approach relies on the Balassa (1964)–Samuelson (1964) hypothesis, which suggests that as countries grow over time, their real ER should appreciate if the productivity growth in the tradable goods sector exceeds the productivity growth in the non–tradable goods sector.

The Chinese economy has demonstrated remarkable capacity for growth in the past two decades. Gross domestic product (GDP) growth rates between 1998 and 2008 were consistently high and averaged 9.6 percent per year (World Bank 2009). Following the Balassa-Samuelson proposition, the consistently high GDP growth rate experienced by the Chinese economy should have been reflected in the path for the Chinese real ER. Another macroeconomic variable that is crucial in this discussion is the relative current account balance as a percentage of GDP because it is a symptom of the balance-of-payments disequilibrium with other countries. Relative to those of other countries, such as India, Japan, Germany, and the United States, the Chinese current account balance as a percentage of GDP is positive, is persistently high, and has been steadily increasing since 2002, reaching 9.8 percent in 2008 (World Bank 2009). This is seen as a reflection of the undervaluation of the Chinese ER (Willenbockel 2006). Consistent with the Balassa-Samuelson expectation, a number of studies propose that the Chinese currency is undervalued by 15–41 percent (for example, Zhang and Pan 2004; Chang and Shao 2004; Chang 2008; Subramanian 2010; Goldstein and Lardy 2006; Cline and Williamson 2009; Frankel 2004; Goldstein 2004; Coudert and Couharde 2005).

On the contrary, other studies find little evidence of undervaluation (for example, Cheung, Chinn, and Fujii 2007; Yang and Bajeux-Besnainou 2004; Funke and Rahn 2005; Goh and Kim 2006), and some even argue that the currency is actually overvalued. For instance, Tyers et al. (2008) suggest that growth shocks tend to cause real appreciations in the short run, due primarily to the aggregate demand boost associated with financial capital influx, and real depreciations in the long run, the scale of which depends critically on the performance of the services sector. McKinnon (2006) calls for credibly fixing the central RMB/US dollar rate into the indefinite future, provided that China's money wages have to grow in line with its rapid productivity growth. McKinnon (2006) and Qiao (2005) argue that ER appreciation, or the threat of it, causes macroeconomic distress without having any predictable effect on the trade surpluses of creditor economies, such as China's.

Most prior studies of the effects of currency adjustments have focused on real ER, but with varying entry points for introducing shocks. For example, Zhang and Fung (2006) use the Global Trade Analysis Project (GTAP) model (Hertel 1997) to examine the effect of Chinese RMB revaluation by

[1] They maintain currency undervaluation of roughly the same magnitude to avoid losing positions competitive to China's.

[2] MONASH model is a dynamic computable general equilibrium model of the Australian economy designed for forecasting

introducing various shocks to the real ER of China. Willenbockel (2006) analyzes the impact of real ER appreciation by shocking the model to generate an endogenous 4 percent reduction in the current-account surplus to GDP ratio that is required to re-establish the current balance-of-payment equilibrium, as suggested by Goldstein (2004). Yu, Chao, and Wang (2003) shock the real ER by 5 percent, an estimated rate of real ER devaluation that would be sufficient for China to reattain its precrisis competitiveness in the global market based on a study by Noland et al. (1998). The results among these studies vary remarkably, even being contradictory in some cases, mainly because of their different implementations of the ER shock.

Whereas the real ER reflects the purchasing power of two currencies relative to each other, nominal ER is observable and can be directly controlled by the government as a macroeconomic policy instrument. Therefore, predictions of the impacts of nominal ER change are more straightforward to interpret and more relatable to policymakers and the general public.

This study aims to improve our understanding of the *ex-ante*, short-term impact of Chinese RMB appreciation on the macroeconomic performance of the broader economy in China and other major countries, using the novel approach of modeling nominal ER adjustment in the GTAP model. Specifically, this study aims to achieve three objectives. First, we assess the impact of Chinese ER appreciation on the macroeconomic performance of China and other major countries (particularly the United States). Second, we assess the impact of Chinese ER appreciation on the performance of the main sectors in China. Third, we draw implications about the debate over what an RMB appreciation might entail and whether the policy measure lives up to the expectations of the US government of boosting export and employment.

To meet these objectives, the rest of the paper is organized as follows. Following the introduction, we describe our method of modeling currency adjustment in the GTAP model framework and how this approach contributes to the economic modeling literature. We then present the model results on the macroeconomic and sectoral impacts of Chinese currency appreciation. Finally, we discuss the implications of our findings, identify key caveats, and suggest future research directions.

2. METHODS AND SCENARIOS

We adopt the GTAP model to simulate the effects of RMB appreciation on the Chinese and world economies. GTAP is a well-known computable general equilibrium (CGE) model that has been used widely for international trade analysis (Hertel 1997). GTAP also has been used for currency revaluation impact analyses due to the distinguished characteristics of its global general equilibrium model (that is, including all sectors in an individual economy and countries/regions across the world) compared to other modeling tools.

As mentioned above, most of the previous studies of the effects of currency revaluation have focused on the real ER. Since all value terms in the GTAP database have been converted into US dollars, there is not a nominal ER in the model. There is, however, a real ER, which is represented by the composite price index weighted by primary factors such as labor, capital, land, and natural resources. To examine the effects of nominal ER adjustment with the GTAP model, we modify the standard model to bring nominal ER explicitly into the analytical framework.

In the GTAP model, there are three distinct channels through which each country interacts with the rest of the world. These include the following: (1) trade of commodities and service, (2) usage of service provided by the international transportation sector, and (3) investments. Correspondingly, we add nominal ER in the price transitions of all flows of commodities and services for each country (See Appendix for details). This modification allows us to examine the effects of nominal ER adjustment using a GTAP framework, which has not been done in previous research, as far as we know.

In this paper, we simulate the implementation of a one-time shock to the nominal ER of Chinese RMB for 2010 and examine the associated short-term effects. Since the latest version of the GTAP model (V7) uses a database from 2004, we first adopt the recursive dynamic method to update the base data from 2004 to 2010 by running the model for the period of 2004 to 2010. Such a method has been used widely in the literature to calibrate the model to a new base year (Walmsley, Betina, and Robert 2000; Van Meijl and Van Tongeren 2002; Van Tongeren and Huang 2004; Yang et al. 2011).

We adopt a short-run closure regarding nominal wages. Due to the commonly recognized rigidity of nominal wages to shocks in the short term (Zhang 2010; Wang and Zhao, 2007), we assume that nominal wages are fixed in all countries in the short term and thus that employment levels are determined endogenously. In our Discussion and Conclusions section, we discuss the impact of ER appreciation under a fixed real wage assumption in the model (as opposed to fixed nominal wages), which assumes that labor markets are efficient and nominal wages will adjust quickly and fully while real wages remain the same.

Chinese officials have indicated that the Chinese government does not favor a drastic revaluation of Chinese currency over a short period of time. Instead, gradual, small-step changes to the ER may be more acceptable. Therefore, in addition to the baseline scenario (with no change to the nominal ER), we include three alternative scenarios that correspond to three levels of nominal ER appreciation (5, 10, and 15 percent increases from the existing level) to explore the effects of alternative currency adjustment strategies.

In an effort to validate our modeling approach to introduction of the nominal ER in the GTAP model, we compare our model results to those from the China General Equilibrium model (CHINAGEM). The CHINAGEM model is a dynamic country CGE model of China, developed based on the MONASH model[2] by the Centre of Policy Studies of Monash University (Mai, Dixon, and Rimmer 2010). The national model adopts a similar approach to modeling of nominal ER. Whereas the standard CHINAGEM model assumes that government consumption is fixed, we modify this model assumption by aligning the rate of change in government consumption to the rate of change in private consumption such that the results from the CHINAGEM model are more comparable to those from the GTAP model used in this analysis.

[2] MONASH model is a dynamic computable general equilibrium model of the Australian economy designed for forecasting and for policy analysis (Dixon and Rimmer, 2002).

3. RESULTS

Macroeconomic Effects of RMB Appreciation on the Chinese Economy

The Chinese economy would shrink significantly as a result of RMB appreciation. Table 3.1 presents the short-term effects of the ER shock on key Chinese macroeconomic indicators in percentage change from the baseline. As can be seen, most macroeconomic indicators respond negatively to the currency appreciation, excepting the real wage of labor and GDP deflator (decreased GDP deflator means reduced inflationary pressure). This holds for all three of the ER adjustment scenarios, with the impacts' growing deeper with the rise in the degree of ER change. The setback in macroeconomic performance is of a wide spectrum, even for the 5 percent increase scenario, the smallest increment considered in the study. Specifically, when the nominal ER increases by 5 percent, the real GDP and total exports are estimated to decline by 3.1 percent and 3.5 percent, respectively. The GDP deflator declines by 3.4 percent, implying a 1.6 percent change of the real ER. Scenario results on changes in employment confirm the concerns raised by the Chinese government with the consideration of nominal wage rigidity (Zhang 2010; Wang and Zhao, 2007). Employment is expected to be hit hard, with a 6.3 percent reduction as a result of merely a 5 percent increase in the nominal ER. This is mainly because of the decline in demand for labor due to the rising real wage. Returns to capital, natural resources, and land also fall as economic activities decline. With labor demand going down, the ratio of capital to labor goes up, and the return to capital goes down. Consequently, investment drops by 2 percent. Overall, our scenario results show that the Chinese economy will shrink at a rather significant magnitude. Except for real labor prices, all factor prices (land, capital, and natural resources) will decline. Although the overall economy loses, the only winners are those who remain employed, as their real wages go up. This gain, however, will hardly offset the employment loss, given the critical role of employment to the country's economic and social stability.

Table 3.1—The impacts of Chinese currency appreciation on Chinese macroeconomic indicators, assuming fixed nominal wage (percentage change relative to baseline).

	Increasing by 5%	Increasing by 10%	Increasing by 15%
Real gross domestic product	–3.1	–6.0	–8.8
Gross domestic product deflator	–3.4	–6.4	–9.3
Total exports	–3.5	–6.7	–9.6
Total imports	–2.2	–4.3	–6.2
Trade balance	–5.7	–10.5	–14.6
Trade balance (billion US$)	–9.7	–17.9	–25.0
Current rate of return on capital	–2.4	–4.8	–7.2
Investment	–2.0	–4.0	–6.0
Real wage of labor	4.4	8.8	13.0
Employment	–6.3	–12.1	–17.4
Land rents	–11.6	–21.5	–30.0
Return to capital	–5.5	–10.5	–15.2
Return to natural resources	–15.4	–28.1	–38.7

Source: Authors' simulation results from the Global Trade Analysis Project (GTAP) model.

Both imports and exports would drop with the shrinking economy. As shown in Table 3.1, total exports of China would decline by 3.5 percent if the ER were to increase by 5 percent. This is not surprising given that currency appreciation makes exported commodities more expensive and less competitive in the global market. However, our results also indicate that the total imports of China would

also decline if the ER were to rise. This is a bit counterintuitive because it is often expected that imported commodities become cheaper when the ER rises and that the country imports more. There are two reasons for the reduction in imports. First, whereas imported commodities are indeed cheaper due to the currency appreciation, Chinese domestic prices are also lower (as seen in the decline in GDP deflator). Second, the total demand in the Chinese economy shrinks with the sharp fall of GDP and income. The net effect on imports, therefore, is negative, which means that the reduction in imports due to a slowdown of the economy outweighs the growth in imports driven by cheaper foreign goods. Finally, the Chinese trade surplus would decline significantly, by 5.7, 10.5, and 14.6 percent, if the ER were to increase by 5, 10, and 15 percent, respectively (see Table 3.1).

Sectoral Effects of Chinese Currency Appreciation

The effects of RMB appreciation on output are negative across all sectors in China, and output drops almost evenly across sectors (see Table 3.2). However, the extent of output and price change differs slightly between the agricultural and nonagricultural sectors. It is caused mainly by the reallocation effect of production resources. As compared to the industrial sector, the agricultural sector is more land and natural resource intensive. Since land and natural resources are sluggish factor endowments in the model, which could not move freely among sectors, their prices drop more relative to the perfectly mobile factors (for example, capital) when facing the same negative shocks. As shown in Table 3.1, the rents of land and natural resources decrease much more than those of capital. Consequently, the prices of agricultural commodities are estimated to drop more than those of nonagricultural commodities due to lower input costs (see Table 3.2).

Table 3.2—The impacts of Chinese currency appreciation on different sectors of the Chinese economy, assuming fixed nominal wage (percentage change relative to baseline)

	Price	Output	Exports	Imports	Trade Balance (Million US$)
			Increasing by 5%		
Rice	–4.5	–2.0	–0.1	–1.8	6
Wheat	–4.9	–2.4	3.1	–3.6	70
Coarse grains	–5.4	–2.5	2.6	–3.3	19
Vegetables and fruit	–5.2	–2.0	1.9	–3.6	111
Oilseeds	–4.4	–2.5	–0.4	–2.5	322
Sugar	–3.9	–3.1	–3.2	–1.3	3
Cotton	–5.7	–2.7	6.7	–5.2	259
Wool	–5.0	–3.3	5.2	–3.3	135
Other crops	–4.6	–1.2	0.7	–3.0	31
Beef and mutton	–4.1	–3.3	–3.3	–1.7	16
Pork and poultry	–4.3	–2.6	–1.3	–2.2	33
Milk	–4.1	–3.4	–3.5	–1.6	12
Fish	–10.9	–1.5	13.3	–9.4	109
Processed food	–4.6	–2.1	0.3	–2.5	217
Natural resources	–5.8	–1.4	13.5	–7.3	6,798
Textile and apparel	–3.7	–3.5	–3.2	–0.9	–4,582
Natural resource–related sectors	–4.1	–3.2	–1.7	–2.1	273
Metal and machinery	–3.7	–4.8	–5.9	–0.6	–8,582
Transport equipment	–3.6	–3.9	–5.5	–0.3	–1,394
Electronic products	–4.0	–3.7	–3.3	–2.4	–2,761
Manufactures	–3.9	–3.4	–3.3	–0.9	–1,089
Services	–3.6	–3.0	–2.0	–1.4	–421

Table 3.2—Continued

	Price	Output	Exports	Imports	Trade Balance (Million US$)
Increasing by 10%					
Rice	–8.5	–4.0	–0.7	–3.3	9
Wheat	–9.3	–4.8	5.3	–6.8	131
Coarse grains	–10.2	–4.9	4.6	–6.3	36
Vegetables and fruit	–9.8	–4.0	3.3	–6.7	204
Oilseeds	–8.4	–5.0	–1.1	–4.8	622
Sugar	–7.4	–6.1	–6.3	–2.6	6
Cotton	–10.7	–5.3	12.8	–9.8	486
Wool	–9.5	–6.6	9.0	–6.2	251
Other crops	–8.7	–2.6	1.0	–5.7	55
Beef and mutton	–7.8	–6.4	–6.5	–3.3	30
Pork and poultry	–8.2	–5.1	–2.9	–4.2	51
Milk	–7.7	–6.6	–7.0	–3.1	23
Fish	–19.6	–3.0	25.9	–17.0	203
Processed food	–8.7	–4.2	0.3	–4.8	387
Natural resources	–10.9	–2.9	27.4	–13.6	12,833
Textile and apparel	–7.2	–6.7	–6.1	–1.8	–8,952
Natural resource–related sectors	–7.9	–6.2	–3.3	–4.2	536
Metal and machinery	–7.1	–9.1	–11.2	–1.2	–15,962
Transport equipment	–6.9	–7.5	–10.4	–0.7	–2,592
Electronic products	–7.8	–7.0	–6.3	–4.7	–5,103
Manufactures	–7.6	–6.6	–6.2	–1.9	–2,050
Services	–6.9	–5.9	–3.9	–2.9	–703
Increasing by 15%					
Rice	–12.2	–5.9	–1.6	–4.6	10
Wheat	–13.2	–7.2	6.6	–9.6	184
Coarse grains	–14.4	–7.2	6.2	–8.9	50
Vegetables and fruit	–13.8	–6.0	4.3	–9.5	281
Oilseeds	–12.0	–7.5	–2.2	–7.0	904
Sugar	–10.6	–8.9	–9.2	–3.9	9
Cotton	–15.1	–7.8	18.1	–13.8	687
Wool	–13.5	–9.9	11.3	–8.7	350
Other crops	–12.4	–4.1	0.9	–8.2	73
Beef and mutton	–11.2	–9.3	–9.6	–4.8	44
Pork and poultry	–11.8	–7.6	–4.8	–6.1	58
Milk	–11.1	–9.7	–10.4	–4.4	34
Fish	–26.7	–4.6	37.6	–23.2	283
Processed food	–12.4	–6.2	0.1	–6.9	517
Natural resources	–15.6	–4.4	41.3	–19.2	18,184
Textile and apparel	–10.4	–9.8	–8.9	–2.7	–13,103
Natural resource–related sectors	–11.4	–9.0	–4.9	–6.1	786
Metal and machinery	–10.2	–13.1	–15.8	–1.9	–22,287
Transport equipment	–10.0	–10.9	–14.7	–1.2	–3,618
Electronic products	–11.2	–9.9	–8.9	–6.8	–7,070
Manufactures	–11.0	–9.4	–8.7	–3.1	–2,895
Services	–10.1	–8.6	–5.5	–4.4	–857

Source: Authors' simulation results from the Global Trade Analysis Project (GTAP) model.

The trade balance improves slightly for agricultural commodities due to deeper falling prices. As shown in Table 3.2, although imports decline in all sectors, imports of agricultural commodities decline much greater than nonagricultural commodities because of the greater reduction in prices. In the meantime, exports of agricultural commodities decline only moderately or even increase for some commodities (see Table 3.2). As a result, the trade balance for the agricultural sector is improved.

The effects of ER appreciation on industries and services are quite different. The exports of these sectors drop much more significantly than do the imports. The trade balances deteriorate, especially for industries that are heavily export oriented (for example, textile and apparel, metal and machinery). The exception is the natural resources sector, whose trade balance improves considerably by US$6.8 billion. China is currently heavily dependent on imports of natural resources to meet its rapidly growing industrial demand. When industrial output drops significantly, demand for the imports of natural resources declines steeply.

Impacts on the Economy of the United States and Other Major Regions

Table 3.3 reports our results on the impacts of Chinese currency appreciation on the economy of selected major countries or regions, including the United States, the European Union (EU), Australia and New Zealand, the Association of Southeast Asian Nations, Japan and Korea, and the rest of the world. Generally, as the Chinese ER increases, Chinese exports become more expensive, and the trade balance of other trading partner countries tends to improve. However, our results show that whereas this is generally true for the EU, Australia and New Zealand, the Association of Southeast Asian Nations, Japan and Korea, and the rest of the world, it is not the case for the United States. In fact, the trade balance of the United States is estimated to decrease by US$8.2 billion, US$15.4 billion, and US$22 billion under the scenarios of 5, 10, and 15 percent increases in Chinese ER, respectively. Our results show that the overall US economy improves as a result of RMB appreciation. The real GDP increases by 0.7, 1.3, and 1.8 percent for Chinese ER increase of 5, 10, and 15 percent, respectively, under our short-run closure. This is translated to higher income and therefore higher imports relative to the baseline. Under the 5 percent ER increase scenario, for instance, whereas US exports increase by 0.2 percent, imports increase even more, by 0.5 percent, leading to a deteriorated trade balance. The higher imports are driven by higher demand by private consumption induced by rising income as well as higher demand for inputs required by the higher output. In regions other than the United States, imports will also increase with rising income, but the increases are never large enough to deteriorate the trade balance.

Table 3.3—The impacts of Chinese currency appreciation on the macroeconomic indicators of the United States and other major regions, assuming fixed nominal wage (percentage change relative to baseline)

	United States	European Union 27	Australia and New Zealand	Association of Southeast Asian Nations	Japan and Korea	Rest of World
Increasing by 5%						
Real gross domestic product	0.7	0.4	0.1	0.1	0.2	0.2
Gross domestic product deflator	0.2	0.2	0.1	0.1	0.1	0.2
Total exports	0.2	0.4	0.5	0.2	0.6	0.4
Total imports	0.5	0.3	–0.2	0	–0.2	0.1
Trade balance (billion US$)	–8.2	2.9	0.7	1.4	5.5	7.3
Current return rate of capital	0.8	0.4	0.1	0	0.2	0.2
Investment	0.5	0	–0.3	–0.5	–0.2	–0.2
Real wage of labor	–0.2	–0.2	–0.1	–0.2	–0.1	–0.2
Employment	0.9	0.7	0.3	0.3	0.4	0.4
Land rent	0.9	1.1	–0.2	0.3	0.4	0.6
Return to capital	0.7	0.5	0.2	0.3	0.3	0.3
Return to natural resources	0.5	0.2	–0.4	–0.2	–0.4	–0.1
Increasing by 10%						
Real gross domestic product	1.3	0.7	0.3	0.3	0.4	0.4
Gross domestic product deflator	0.4	0.4	0.2	0.3	0.2	0.3
Total exports	0.4	0.8	0.9	0.4	1.1	0.7
Total imports	0.9	0.6	–0.3	–0.1	–0.3	0.2
Trade balance (billion US$)	–15.4	5.2	1.3	2.6	10.5	13.8
Current return rate of capital	1.5	0.8	0.2	0.1	0.4	0.4
Investment	0.9	0.1	–0.5	–0.9	–0.5	–0.4
Real wage of labor	–0.4	–0.4	–0.2	–0.4	–0.3	–0.4
Employment	1.8	1.2	0.5	0.6	0.7	0.8
Land rent	1.7	2	–0.2	0.5	0.9	1.2
Return to capital	1.3	0.9	0.4	0.5	0.5	0.7
Return to natural resources	0.9	0.4	–0.7	–0.4	–0.7	–0.2

Table 3.3—Continued

	United States	European Union 27	Australia and New Zealand	Association of Southeast Asian Nations	Japan and Korea	Rest of World
Increasing by 15%						
Real gross domestic product	1.8	1	0.4	0.4	0.5	0.5
Gross domestic product deflator	0.5	0.6	0.2	0.4	0.3	0.5
Total exports	0.6	1.1	1.3	0.5	1.5	1.0
Total imports	1.3	0.8	–0.4	–0.1	–0.5	0.3
Trade balance (billion US$)	–22	7.1	1.8	3.7	14.9	19.5
Current return rate of capital	2.1	1.1	0.3	0.1	0.5	0.6
Investment	1.4	0.2	–0.8	–1.3	–0.7	–0.6
Real wage of labor	–0.6	–0.6	–0.3	–0.5	–0.4	–0.5
Employment	2.5	1.8	0.7	0.8	0.9	1.2
Land rent	2.4	2.9	–0.3	0.7	1.2	1.8
Return to capital	1.9	1.3	0.6	0.7	0.7	0.9
Return to natural resources	1.3	0.6	–1.0	–0.5	–1.0	–0.3

Source: Authors' simulation results from the Global Trade Analysis Project (GTAP) model.

In general, Chinese currency appreciation has a positive impact on the GDP of the major countries and regions, although by a small margin (see Table 3.3). With the appreciation of RMB, the terms of trade of other countries deteriorate, increasing the demand for goods produced by them in global markets. Thus, countries/regions such as the United States, the EU, and Australia expand their exports to fill the void in global markets left by the decline in Chinese exports. Consequently, their GDPs grow.

Employment in these countries also increases between 0.3 and 0.9 percent since the demand for labor increases in these countries due to declining real wage. Since this is a short-term effect study, nominal wage is assumed to be fixed. Thus, real wage declines when domestic price increases. With real wage declining, ratio of capital to labor declines. As the short-run capital is fixed, employment increases in response to lower real wage. Although the employment gain in the United States is the largest across all countries and regions, it is expected to rise by only 0.9 percent as a result of 5 percent Chinese currency appreciation.

Although the Chinese RMB is now stronger against the US dollar as compared to the baseline, this does not necessarily mean that the currencies of other countries are also stronger against the US dollar. As a result, when the United States starts to buy more from other countries (because China now exports less), the United States may end up paying higher prices than before. In addition, the United States might lose some of its previous comparative advantage because it was using cheaper Chinese inputs to produce goods. With Chinese imports becoming more expensive, the final output produced in the United States is likely to become more expensive (and less competitive), which is partly reflected in the higher GDP deflator.

To better understand the impact on trade balances, we further look into bilateral trade between China and other countries/regions. As shown in Table 3.4, trade diversion effects are evident. Chinese exports to all countries decline, as expected, with the EU seeing the largest decline in volume. US exports to China would in fact decline rather than increase, although US exports to other countries and regions would increase. Similarly, other countries and regions also would export less to China due to lower Chinese demand for goods (due to lower GDP) whereas its exports to other countries would increase due to the reduction of exports from China and higher demand for goods (because of higher GDP).

Table 3.4—The impacts of Chinese currency appreciation on bilateral trade, assuming fixed nominal wage (percentage change relative to baseline).

	China	United States	European Union 27	Australia and New Zealand	Association of Southeast Asian Nations	Japan and Korea	Rest of World
Increasing by 5%							
China	0.0	–2.1	–3.1	–3.1	–2.8	–2.5	–3.3
United States	–1.8	0.0	0.7	0.4	0.7	0.6	0.5
European Union 27	–1.3	1.1	0.7	0.4	0.6	0.7	0.6
Australia and New Zealand	–3.4	1.5	1.3	0.8	1.2	1.0	1.1
Association of Southeast Asian Nations	–2.2	1.7	0.9	0.6	0.9	0.9	0.8
Japan and Korea	–1.0	1.7	1.2	0.7	1.4	1.2	1.0
Rest of world	–2.8	1.4	0.8	0.5	0.6	0.5	0.7
Increasing by 10%							
China	0.0	–4.1	–5.9	–5.8	–5.4	–4.8	–6.3
United States	–3.6	0.0	1.3	0.7	1.4	1.0	1.0
European Union 27	–2.5	2.2	1.4	0.8	1.2	1.3	1.1
Australia and New Zealand	–6.5	2.9	2.4	1.6	2.2	1.9	2.1
Association of Southeast Asian Nations	–4.4	3.3	1.8	1.1	1.7	1.8	1.5
Japan and Korea	–2.0	3.2	2.3	1.3	2.7	2.3	1.9
Rest of world	–5.3	2.6	1.6	0.9	1.2	0.9	1.2
Increasing by 15%							
China	0.0	–5.9	–8.4	–8.3	–7.8	–7.0	–9.0
United States	–5.2	0.0	1.9	1.0	2.0	1.5	1.4
European Union 27	–3.8	3.1	2.0	1.1	1.7	1.9	1.5
Australia and New Zealand	–9.3	4.1	3.4	2.3	3.2	2.7	3.0
Association of Southeast Asian Nations	–6.4	4.8	2.6	1.6	2.4	2.5	2.1
Japan and Korea	–3.1	4.5	3.3	1.9	3.8	3.3	2.7
Rest of world	–7.7	3.7	2.3	1.3	1.7	1.2	1.8

Source: Authors' simulation results from the Global Trade Analysis Project (GTAP) model.

Comparison of the Results from the GTAP Model and the CHINAGEM Model

Table 3.5 shows that the results from the two models are remarkably consistent. Specifically, the directions of changes are the same, and the magnitudes of estimated effects are close for most of the macroeconomic indicators. For example, the real GDP of China is projected to decline by 3.1 percent and 3.3 percent in the GTAP and CHINAGEM models, respectively; the GDP deflator is projected to decline by 3.4 percent and 3.0 percent in the GTAP and CHINAGEM models, respectively. The remaining differences in the results are consistent with the general expectation and can be explained well by the distinguishing characteristics of the global GTAP model and the country model CHINAGEM. The consistency in the results of the GTAP and the country CGE model CHINAGEM demonstrates that our modeling approach to nominal ER changes is plausible. This comparison also confirms the advantage of using a global model such as GTAP to examine the effects of Chinese currency appreciation at a multi-country/multi-region scale.

Table 3.5—The impacts of Chinese currency appreciation by 5 percent on Chinese macroeconomic indicators, assuming fixed nominal wage: Comparing the results from the Global Trade Analysis Project (GTAP) model and the CHINAGEM model (percentage change relative to baseline)

	GTAP	CHINAGEM
Real gross domestic product	–3.1	–3.3
Gross domestic product deflator	–3.4	–3.0
Total exports	–3.5	–4.8
Total imports	–2.2	–2.7
Trade balance	–5.7	–6.1
Rental rate on capital	–5.5	–5.7
Price of investment goods	–3.8	–3.4
Investment	–2.0	–2.5
Real wage of labor	4.4	4.1
Employment	–6.3	–5.3

Source: Authors' simulation results from the GTAP and CHINAGEM.

4. DISCUSSION AND CONCLUSIONS

Our scenario results show that most of the Chinese macroeconomic indicators would be affected negatively by the RMB appreciation in the short term, except for real wage of labor and the GDP deflator. Specifically, real GDP, exports, employment, and investment would decline. Overall, the Chinese economy would shrink significantly in the short term. The effects on output (production) are negative and relatively evenly distributed across sectors. Chinese imports from other countries would not rise, as many have hoped, if the ER were to rise—due to lower Chinese domestic prices and lower total demand associated with the recession in the Chinese economy. Furthermore, the Chinese trade surplus would be lowered significantly.

Although the trade balance would be improved in many countries and regions as a result of RMB appreciation, this would not be the case for the United States. In fact, the US trade balance toward China is projected to deteriorate by US$8.2 billion given a 5 percent increase in Chinese nominal ER. This is because US imports would increase more than exports due to higher GDP and higher demand.

One of the central findings of our results is that global trade balance issues cannot be resolved simply by the ER adjustments of the surplus countries. This study specifically shows that changing the Chinese ER in hopes of improving the US trade balance not only is ineffective but also can be counterproductive. At the same time, such a policy would come at a high cost to the Chinese economy and consumers. A more effective solution to global trade imbalance should be based on a combination of policies that includes boosting Chinese domestic consumption, increasing the savings rate of US consumers, and reducing US domestic consumption. Since RMB revaluation is costly to the Chinese economy at least in the short term, the Chinese government should carefully consider the consequences of any drastic adjustment in ER policy. For a small improvement in US GDP, which is accompanied by a deteriorated US trade balance, Chinese consumers and producers would pay a significant price.

Although our analysis has focused on short-term effects of nominal ER appreciation, assuming fixed nominal wages, our model demonstrates that the ER adjustment would have no effects on the real economy of any country if the real wages had been fixed and nominal wages were allowed to adjust. As shown in Table 4.1, there is no change in any real terms of the Chinese economy (for example, GDP, trade, investment, and employment) under a fixed real wage assumption. The only changes are the nominal prices paid to factor endowments (for example, land, capital, and natural resources) as well as the GDP deflator. This implies that a nominal ER adjustment would not have any impact on the Chinese economy if the labor market were efficient enough to make full adjustment and keep the real wage constant (which is typically considered unrealistic in the short term). This reinforces that using the nominal ER as a policy tool to deal with the trade surplus or deficit issues may not be the best solution.

Table 4.1—The impacts of Chinese currency appreciation on Chinese macroeconomic indicators, assuming fixed real wage (percentage change relative to baseline)

	Increasing by 5%	Increasing by 10%	Increasing by 15%
Real gross domestic product	0.0	0.0	0.0
Gross domestic product deflator	–4.1	–7.9	–11.4
Total exports	0.0	0.0	0.0
Total imports	0.0	0.0	0.0
Trade balance (billion US$)	0.0	0.0	0.0
Current return rate of capital	0.0	0.0	0.0
Investment	0.0	0.0	0.0
Real wage of labor	0.0	0.0	0.0
Employment	0.0	0.0	0.0
Land rents	–4.5	–8.5	–12.2
Return to capital	–4.5	–8.5	–12.2
Return to natural resources	–4.5	–8.5	–12.2

Source: Authors' simulation results from the Global Trade Analysis Project (GTAP) model.

This paper examines the short-term effects of a one-time RMB appreciation. We note that the long-term dynamic effects of currency adjustment policies, especially a gradual adjustment policy, remain an important issue to explore. In addition, it might be advisable to combine a major RMB alignment with active policy measures that would lead to a reduction in China's high savings rate and simultaneously support the shifts in employment from manufacturing to services, along the lines suggested by Blanchard and Giavazzi (2005). We suggest that future research is needed to examine the effect of a combination of simultaneous policies that include, but do not rely on solely, ER adjustment.

APPENDIX

Modifications to the Standard GTAP Model Necessary for Examining the Effect of Nominal Exchange Rate Change

In the standard GTAP model, a new variable for nominal exchange rate is added. The variable could be made two-dimensional to reflect bilateral exchange rates. In this study, the variable only includes one dimension to capture the appreciation of Chinese RMB relative to all other currencies valued in US dollar.

Variable (all,r,REG) nex(r) # nominal exchange rate #;

Then, the nominal exchange is added into the following equations.

(1) Import and export price

Equation EXPRICES # eq'n links agent's and world prices (HT 27) #

(all,i,TRAD_COMM)(all,r,REG)(all,s,REG) pfob(i,r,s) = pm(i,r) - tx(i,r) - txs(i,r,s)+nex(r);

Equation MKTPRICES # eq'n links domestic and world prices (HT 24) #

(all,i,TRAD_COMM)(all,r,REG)(all,s,REG) pms(i,r,s) = tm(i,s) + tms(i,r,s) + pcif(i,r,s)-nex(s);

(2) Transport price contributing to "Global Transportation" sector

Equation PTRANSPORT # generate price index for composite transportation services #

(all,m,MARG_COMM)

*pt(m) = sum{r,REG, VTSUPPSHR(m,r) * [pm(m,r)+nex(r)]};*

Equation TRANSVCES # generate demand for regional supply of global transportation service (HT 61) #

(all,m,MARG_COMM)(all,r,REG) qst(m,r) = qtm(m) + {pt(m) - [pm(m,r)+nex(r)]};

(3) Investment price contributing to "Global Bank" sector in GTAP

Equation PRICGDS # eq'n generates a price index for the aggregate global cgds composite (HT 60) #

*pcgdswld = sum(r,REG, [NETINV(r) / GLOBINV] *(pcgds(r)+nex(r));*

Equation SAVEPRICE # savings price #

(all,r,REG)

*psave(r) = pcgds(r)+sum(s,REG, [[NETINV(s) - SAVE(s)] / GLOBINV] * (pcgds(s)+nex(s))+ psaveslack(r)*

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