Real Exchange Rate and Economic Growth in China

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Abstract: By proposing a real exchange rate augmented Cobb-Douglas production function, it is demonstrated that the real exchange rate exerts multiple effects on economic growth. If a real appreciation has negative effects on growth by deteriorating international competitiveness in the tradable sector and by causing job losses, at the same time it exercises positive effects on economic growth by favoring capital intensity, human capital and by exerting pressure for efficiency improvements. The function is estimated by using the GMM system estimation approach and a panel data for the 29 Chinese provinces over the period from 1987 to 2008. The results show that the real exchange rate appreciation had a negative effect on economic growth, which was more marked in coastal provinces than in inland provinces, contributing to a reduction in the difference in GDP per capita between the two kinds of provinces.

Keywords: China, economic growth, real exchange rate.

JEL: F3, F4, P2.

1. INTRODUCTION

Since the beginning of the 2000's, China has suffered from international pressure in favor of a rapid revaluation of the renminbi[1]. However, the Chinese government has not surrendered to this insistent pressure because of the increased amount of social unrest. Recently, Prime Minister Wen argued that "forcing Beijing to revalue its currency would lead to a disaster for the world, because many exporting companies would have to close down, migrant workers would have to return to their villages. If China saw social and economic turbulence, then it would be a disaster for the world."

The worries of the Chinese government are understandable, because there is significant economic literature regarding the negative impact of real exchange rate overvaluation on per capita growth rates, particularly for developing countries; and this negative effect is seen mainly in the size of the tradable sector (especially manufacturing industry) (Rodrik, 2008) and employment (Hua 2007, Chen & Dao, 2011). Dollar (1992) and Benaroya & Janci (1999) argued that the relative undervaluation of the Asian currencies compared with those in Latin America and Africa explained the higher growth in the Asian region. Hausmann, Pritchett & Rodrik (2005) showed that real exchange rate depreciation is one of the factors associated with acceleration of growth. Eichengreen (2008) explained that a depreciated real exchange rate together with low volatility favors the growth process. Rodrik (2008) and Berg & Miao (2010) argued that not only are overvaluations bad, but undervaluation is good for growth, particularly in developing countries. MacDonald & Vieira (2010) found that a depreciated (appreciated) real exchange rate helps (harms) long-run growth, especially in developing and emerging countries.

Up to now no study, to my knowledge, has analyzed the impact on growth of the real exchange rate in China (even with the plethora of literature on the determinants of China's growth). China's exchange rate policy has been very active in accompanying its exports-led growth strategy. The very success of this strategy implied the reversal of the exchange rate policy (the Balassa-Samuelson effect). After a long period during which the Chinese government systematically devalued the renminbi relative to the U.S. dollar, in 1994 it decided to stabilize it, and in 2005 to progressively revalue it. This policy led to a depreciation of the real effective exchange rate of the Chinese currency against the currencies of its trade partners during the first period, especially strongly from 1990 to 1993, and an appreciation from 1994 to 1998, in 2001, 2008 and 2009[2].

The objective of this study is to extend the literature by investigating the multiple impacts of the real exchange rate on China's economic growth, *via* its indirect effects on the determinants of the production function and *via* its direct action on the efficiency of

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[1]China's currency is the renminbi. Its unity is the yuan.

[2]See Figure **2** in section 2.

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workers and managers. To capture these effects, a real exchange rate augmented Cobb-Douglas production function is proposed. It shows, as well as the well-known negative effects of real exchange rate appreciation on the size of the tradable sector (Rodrik 2008), on private enterprises (Chen & Feng 2000) and on employment (Hua 2007, Chen & Dao 2011), that real exchange rate appreciation may contribute positively to growth *via* its favorable impact on capital intensity (Leung & Yuen 2005), human capital (Wang & Yao 2003) and efficiency (Guillaumont, Jeanneney & Hua 2011).

The rest of this study is organised as follows: In section 2, a statistical analysis shows a negative relationship between real exchange rate appreciation and economic growth in China, which is stronger in coastal provinces than in inland provinces. To understand this negative relationship, in section 3, a real exchange rate augmented Cobb-Douglas production function of real GDP per capita is proposed. It provides a theoretical explanation for how real exchange rate may have (positive or negative) multiple effects on economic growth; if real exchange rate appreciation has a negative effect on economic growth by deteriorating international competitiveness in the tradable sector and by causing job losses (following traditional arguments), it may exert a positive effect on economic growth by giving incentives for efficiency improvements *via* workers' motivation and by favoring human capital and capital intensity. The total effect of real exchange rate on economic growth is theoretically ambiguous, and only an empirical analysis can reveal it. In section 4, the function is estimated by using a panel data which combines the time dimension represented by annual data from 1987 to 2008, and the spatial dimension represented by the 29 Chinese provinces. In conclusion, some policy implications are given.

2. REAL EFFECTIVE EXCHANGE RATE AND ECONOMIC GROWTH IN CHINA: THE FACTUAL EVIDENCE

A description of the evolution of China's real exchange rate and of its economic growth suggests that real exchange rate appreciation has a negative impact on economic growth, which is more marked in coastal provinces than in inland provinces.

2.1. The Evolution of the Real Effective Exchange Rates in China as a Whole and in the Provinces

Real exchange rate conditions the international competitiveness of a country relative to its trade partners, and exerts multiple effects on the real economy. It is the key variable in this study. It can be measured by a real effective exchange rate index, calculated here as the product of China's nominal effective exchange rate (weighted average of the renminbi exchange rates against the currencies of the main foreign trade partners of China or province) and the ratio of the consumer price index of China or province to the weighted average consumer price index of the same main trade partners. According to this calculation, a rise in the real effective exchange rate corresponds to an appreciation of the Chinese currency.

From 1987 to 1993, the real effective exchange rate decreased at an annual rate of 7% on average with a total depreciation of 43% during the seven years. The fall was particularly strong in 1993 (17%). From 1994 to 1998, the real effective exchange rate appreciated strongly (at an annual rate of 9% on average, 52 % in total during these five years). Since then, it has generally experienced weak depreciation except for 2001 when it appreciated 6.4%. The real effective exchange rate appreciated again by 12% in 2008 and by 6% in 2009. This led a total real appreciation of 62.5% during the period from 1994 to 2009; that is an annual rate of 1.59% on average (Figure **1**).

The change in the real effective exchange rate varied from one province to another in China, because each province has different pre-1994 nominal exchange rate (Khor, 1993), foreign trade partners and inflation (Guillaumont Jeanneney & Hua 2001). From 1987 to 1993, the annual average depreciation of the real effective exchange rate in Chinese provinces varied from 6.9% for Guizhou to 2.8% for Beijing, while during the period from 1994 to 2008, the average appreciation varied from 1.14% for Guangdong to 3% for Qinghai (Table **1**)[3]. The real depreciation during the period from 1987 to 1993, as well as the real appreciation during the recent period from 1994 to 2008, was slightly lower in the coastal provinces than in the inland provinces: the annual average rate of the real depreciation was 4.41% in coastal provinces versus 4.84% in inland provinces; and the real appreciation was 1.77% in the coastal provinces versus 2.01% in the inland provinces. Depending on the impact of the real exchange rate on economic growth,

[3]One exception concerns Yunnan which did not experience an appreciation of its real exchange rate during the recent period, mainly due to having inflation lower than Myanmar (its 4th most important partner).

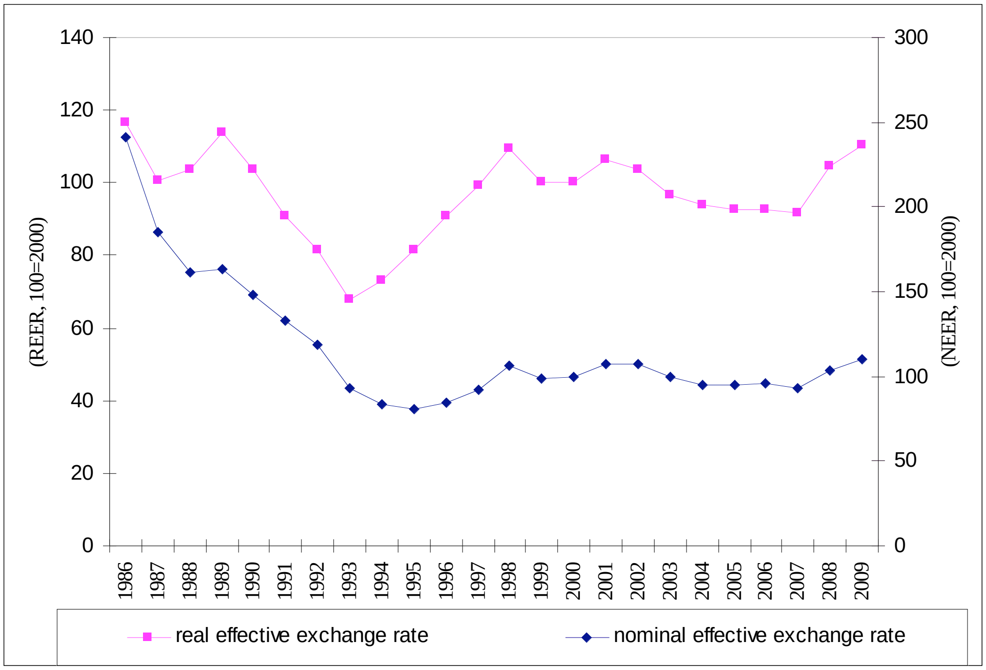

Figure 1: Evolution of nominal and real effective exchange rates in China.
Note: A rise in the curve is an appreciation of renminbi and a fall is depreciation.
Sources: *China Statistical Yearbook, IMF International Financial Statistics* and Khor (1993).

Table 1: Nominal and Real Effective Exchange Rates, Inflation and Economic Growth in the Provinces (Annual Average Rate of Variations, %)

	1987-1993				1994-2008			
Province	**Nominal effective exchange rate**	**Real effective exchange rate**	**Consumer price index**	**Real GDP per-capita**	**Nominal effective exchange rate**	**Real effective exchange rate**	**Consumer price index**	**Real GDP per-capita**
Beijing	-8.11	-2.81	12.73	7.53	2.35	2.32	3.13	7.55
Tianjin	-9.96	-4.44	10.98	5.20	0.96	1.60	2.38	11.02
Hebei	-10.23	-6.43	9.07	8.65	0.78	1.40	2.29	10.63
Liaoning	-10.67	-4.79	10.61	6.49	1.00	1.97	2.30	9.95
Shanghai	-10.29	-2.85	12.46	7.09	0.86	2.27	2.79	8.57
Jiangsu	-10.53	-4.74	10.67	9.98	0.77	1.88	2.49	11.89
Zhejiang	-4.89	-4.77	10.54	9.78	0.98	1.57	2.45	11.15
Fujian	-8.91	-4.59	10.18	11.24	0.75	1.73	2.25	10.79
Shandong	-10.58	-3.20	10.16	9.46	0.93	2.07	2.55	11.75
Guangdong	-9.42	-4.81	11.07	13.17	0.64	1.14	1.76	9.65
Hainan	-7.05	-5.13	13.65	13.22	0.93	1.42	1.67	7.77
Coastal (simple average)	**-9.15**	**-4.41**	**11.10**	**9.26**	**1.02**	**1.77**	**2.37**	**10.07**
Shanxi	-8.83	-5.04	10.43	5.40	1.93	1.94	2.77	10.55
Inner Mongolia	-8.01	-5.48	12.49	6.50	1.58	2.54	2.86	14.07
Jilin	-10.03	-5.31	10.80	6.45	1.66	1.96	2.41	10.29
Heilongjiang	-10.32	-5.34	10.83	5.86	1.67	2.17	2.13	9.37

(Table 1). Continued.

	1987-1993				1994-2008			
Province	**Nominal effective exchange rate**	**Real effective exchange rate**	**Consumer price index**	**Real GDP per-capita**	**Nominal effective exchange rate**	**Real effective exchange rate**	**Consumer price index**	**Real GDP per-capita**
nhui	-9.93	-6.77	10.63	4.33	1.34	1.98	2.57	10.59
Jiangxi	-7.83	-5.66	9.63	7.31	3.62	2.12	2.40	9.92
Henan	-9.73	-4.11	8.57	7.40	0.82	1.94	2.65	10.95
Hubei	-9.78	-5.05	10.67	5.96	1.29	1.73	2.73	10.70
Hunan	-9.03	-2.88	11.20	5.89	1.54	2.49	3.16	10.42
Guangxi	-1.06	-3.45	10.46	7.90	1.04	1.37	2.26	9.95
Sichuan	-6.02	-4.49	10.50	7.61	2.39	2.73	3.17	10.88
Guizhou	-6.97	-6.91	10.04	5.51	1.65	2.46	3.04	9.10
Yunnan	-5.63	-4.96	10.62	7.87	1.37	-0.94	3.07	8.31
Shannxi	-6.91	-4.87	10.21	7.55	3.14	1.63	2.66	9.17
Gansu	-9.69	-4.71	10.17	6.95	1.38	2.72	3.04	9.74
Qinghai	-10.12	-3.64	10.75	3.62	1.22	2.99	3.58	9.42
Ningxia	-8.96	-5.41	11.02	5.16	1.00	1.96	2.78	8.93
Xinjiang	-9.47	-3.06	10.48	8.26	1.02	2.30	2.70	7.33
Inland (simple average)	**-8.24**	**-4.84**	**10.53**	**6.42**	**1.65**	**2.01**	**2.78**	**9.98**

Source: China Statistical Yearbooks.

these differences might have contributed to increasing or decreasing the difference in growth between the two kinds of provinces.

2.2. Evolution of Per Capita Real GDP Growth in China as a Whole and in the Provinces

Economic growth is calculated in this study as the ratio between the GDP expressed in year 2000 constant prices and total population. Figure **2** shows the evolution of economic growth in China as a whole since 1978, the year which marked the beginning of China's internal economic reforms and of its policy of openness to the outside. Economic growth in China increased dramatically, with GDP increasing from 1 267 yuans per capita in 1978 to 20 296 yuans in 2009. It multiplied by sixteen over these 31 years; which corresponds to an annual average growth of 9.4%. China's economic growth accelerated from 8.01% during the period 1979-1993 to 10.68% during the period 1994-2009.

Economic growth did not increase at the same rate in the different Chinese provinces and in the different periods. The annual average rate of economic growth varied from 7% for Qinghai to 12% for Zhejiang during the period from 1979 to 2008. It varied from 5.5% for Qinghai to 12.1% for Guangdong during the period from 1987 to 1993, and from 7.3% for Xinjiang and 14% for Inner Mongolia during the period from 1994 to 2008 (Table **1**).

All the Chinese provinces (except Fujian, Guangdong, Hainan and Xinjiang) have experienced an acceleration of economic growth since 1994, but at different rates (Table **1**). The acceleration of economic growth is more pronounced in inland provinces (with their annual average growth rate increasing from 7.6% during the 1987-1993 period to 9.98% during the 1994-2008 period), than in coastal provinces (from 9.3% to 10.1% respectively). Economic growth during the recent period is more than doubled than that during the 1987-1993 in three inland provinces (Anhui, Qinghai and Inner Mongolia) and in one coastal province (Tianjin). On the contrary, among the four provinces whose growth did not accelerate during the period from 1994 to 2008, Guangdong and Hainan suffered from a strong deceleration of economic growth which passed respectively from 13% to 9.7% and from 13% to 7.8%.

This difference in economic growth between provinces is not surprising as the factors affecting economic growth have not evolved similarly in the different provinces and in the different periods (Liu & Li,

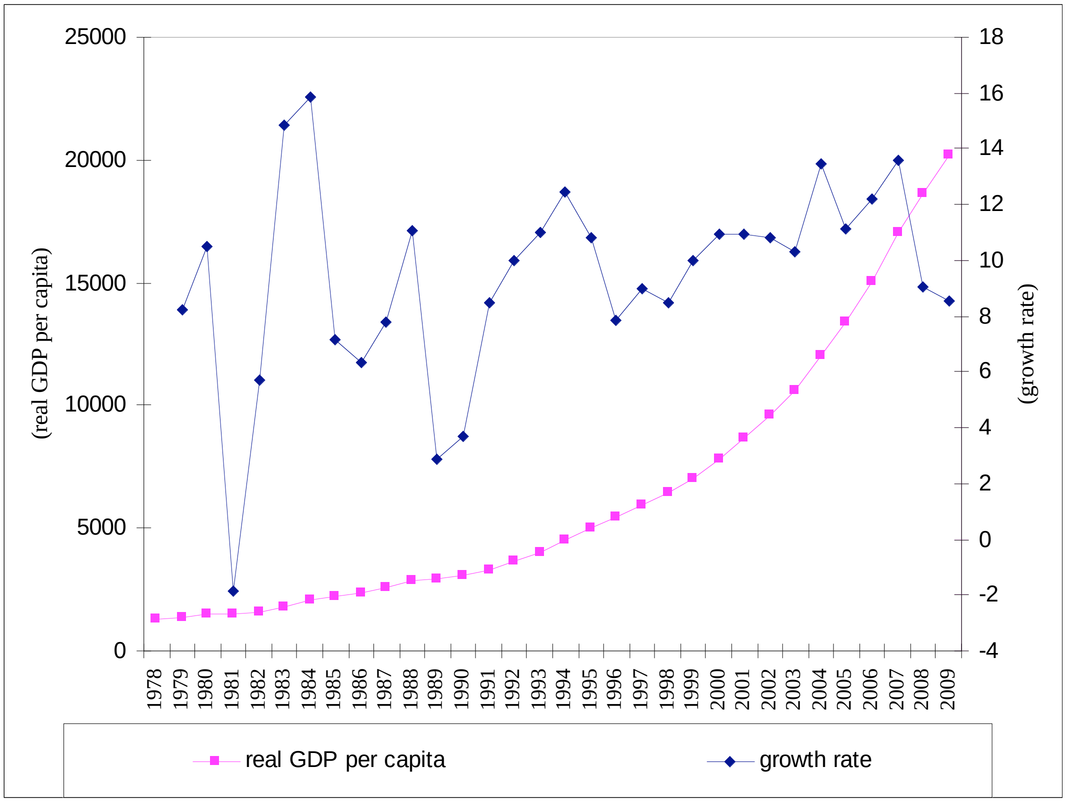

Figure 2: Evolution of China's real GDP per capita and its annual growth rate.

2006). The coastal provinces, in particular Guangdong province, benefited from many advantages relative to the tradable sector, especially in the first period of high real depreciation. They have a dynamic industrial sector producing mainly light industrial goods which is largely oriented towards exports, receive more FDI, suffer from less constraint of credit and foreign exchange in order to import machinery and equipment, have more private industrial enterprises, and attract more educated labor. We would expect that the economic growth in coastal provinces suffers more from real appreciation than that in the inland provinces in which the tradable sector is smaller.

2.3. The Negative Relationship Between Real Exchange Rate Appreciation and Growth

Figure **3** presents the relationship between real exchange rate appreciation and economic growth in China during the period from 1987[4] to 2009. We observe a negative relationship between real exchange rate appreciation and the growth rate of real GDP per capita. During the years when the renminbi appreciated, economic growth slowed down. Inversely, during the years when the renminbi depreciated, economic growth increased.

Figure **4** shows the relationship between the real effective exchange rate and real GDP per capita on average over the period from 1987 to 2008 for the Chinese provinces. As expected, we observe that the negative impact of real exchange rate appreciation on the real GDP per capita is stronger in coastal provinces than in inland provinces. The strong depreciation during the period from 1987 to 1993 may have stimulated economic growth more in coastal provinces than in inland provinces; while during the recent period from 1994 to 2008 the real appreciation may have slowed the economic growth more in coastal provinces than in inland provinces. This observation encourages us to identify the transmission channels through which the real exchange rate could have been acting on economic growth in the two categories of Chinese provinces during the last twenty-two years.

3. REAL EXCHANGE RATE APPRECIATION AND ECONOMIC GROWTH IN CHINA: A THEORETICAL ANALYSIS

According to the methodology of growth accounting, output growth is essentially divided into a component

[4]1987 was chosen as the first year in the econometric analysis because the swap market rate replaced the administrated one in that year.

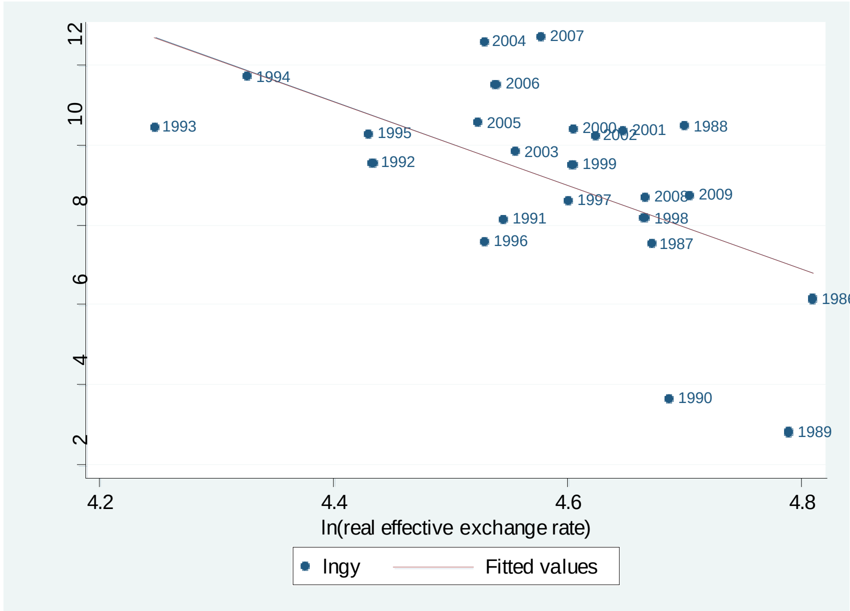

Figure 3: Real exchange rate appreciation and economic growth in China, 1987-2009.
Note: A rise of real effective exchange rate means the renminbi appreciation; vice versa.
Sources: *China Statistical Yearbook, IMF International Financial Statistics*, and Khor (1993).

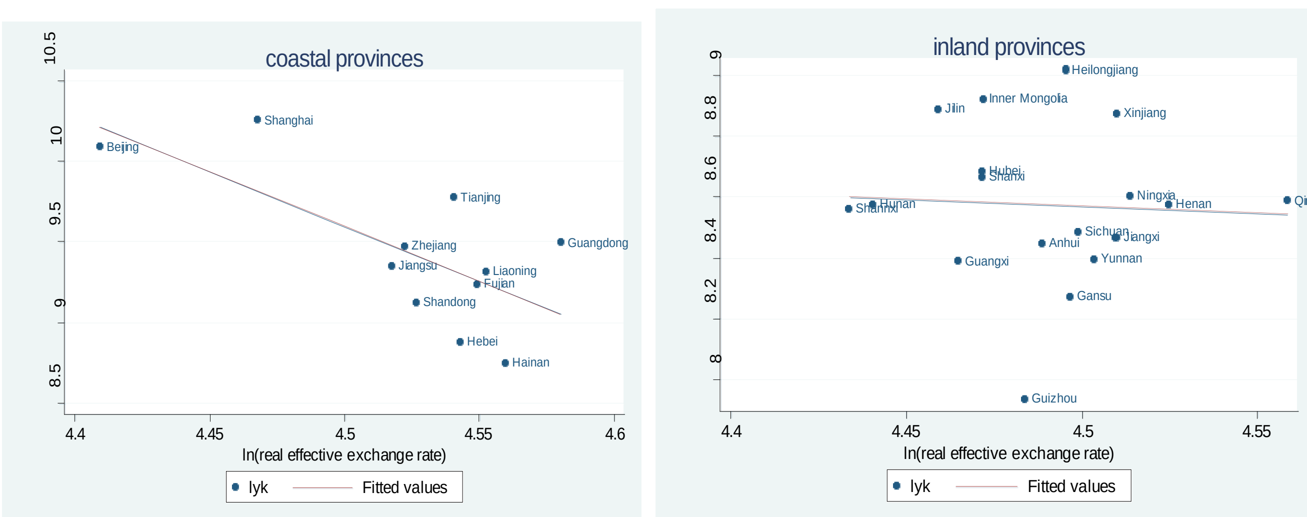

Figure 4: Average real exchange rate appreciation and economic growth in Chinese provinces over the period from 1987 to 2008.
Note: A rise means appreciation of the renminbi and a fall is depreciation.
Sources: *China Statistical Yearbook, IMF International Financial Statistics*, and Khor (1993).

that can be explained by input growth and a 'residual' which captures changes in productivity. Consider the following human capital augmented Cobb-Douglas production function:

$$Y = AK^{\alpha}(HL)^{1-\alpha}$$

Where Y represents real GDP, A is total factor productivity, K is real capital stock, H is human capital stock and L is total employed population. Hence HL is a skill-adjusted measure of labor input. By dividing the above function by total population, we get the function of per capita GDP as following:

$$y = AKL^{\alpha}H^{(1-\alpha)}EM$$

Where y represents the real GDP per capita, KL represents capital intensity, and EM represents the share of employed population relative to total population. Thus, the GDP per capita depends on total factor productivity (A), input factors such as capital intensity (KL), human capital (H), and the share of employed population (EM). The main factors which improve total productivity are the size of the tradable sector, such as external openness leading to the development of manufactured exports (Fu & Balasubramanyam 2005, Kraay 2006), the rapid expansion of industry (Lin & Liu, 2008), foreign direct investments and the promotion of the private sector against the interests of state-owned enterprises (SOEs) (Jefferson & Su 2006, Dougherty *et al.* 2007). The above growth function can be written as follows (with the expected signs):

$$y = f(\underset{+}{X}, \underset{+}{IN}, \underset{+}{FI}, \underset{-}{SOE}, \underset{+}{KL}, \underset{+}{H}, \underset{+}{EM})$$

Where, X represents export share, IN share of industrial production, FI contribution of foreign direct investments to gross formation of fixed capital, SOE relative importance of state-owned enterprises. The expected signs of these factors are positive except for SOE.

The main hypotheses which will be developed in this section are that real exchange rate can affect economic growth *via* its impact on the factors identified above, which can be considered to be the transmission channels (indirect effects), and *via* its direct effect on work efficiency by changing the real remuneration of workers, and increasing competition (Guillaumont, Jeanneney & Hua 2011).

3.1. Real Exchange Rate Appreciation and the Size of the Tradable Sector

The traditional argument in favor of a negative effect of real exchange rate appreciation on the size of the tradable sector is based on the assumption that real exchange rate appreciation causes deterioration in the international competitiveness of domestic enterprises relative to their foreign competitors and leads to a reduction in exports. This deterioration reduces the profits of the export sector (which in the case of China approximates to the industry of manufactured goods) in favor of services and agriculture, which are largely protected from foreign competition. It decreases industrial self-financing and the will to invest in the industrial sector, and more generally in the tradable goods sector. If the tradable goods sector is the most efficient and innovative sector, real exchange rate appreciation may affect growth negatively, in addition to its impact on exports-led firms.

Real exchange rate appreciation is particularly bad for growth in developing countries, because it does not allow promotion of their small and inefficient tradable sectors, which suffer disproportionately from institutional and market failures, the converse is also true (Rodrik 2008). The strong real depreciation of the renminbi during the 1980's at the beginning of China's open door policies strongly stimulated the development of the tradable sector. In 2010 China became the world's biggest exporter.

The negative effect of real appreciation on the size of tradable sector is also seen in the decrease in foreign direct investments (FDI). In China, as in other developing countries, foreign investments are concentrated in the tradable goods sector. Foreign firms bring technological improvements and their know-how to China. This positive action occurs through the creation of foreign companies or joint-ventures which are more productive than domestic firms, suppliers or customers of the foreign enterprises (Sun 1998). Several studies[5] show that this positive effect exists in China, in particular in the manufactured goods sector where most foreign direct investments are made.

In China, the tradable sector is particularly concentrated in coastal provinces, whose exports represented 91% of total exports, and whose FDI represented 84% of total FDI in 2009. So it could be expected that the negative effect of real appreciation on the tradable sector would be more acute in coastal provinces than in inland provinces.

Finally, real appreciation exerts a negative impact on the size of the tradable sector by increasing the relative importance of state-owned enterprises, which are mainly heavy industry and public services, and due to being protected from outside competition mainly produce non-tradable goods.

The above arguments concerning the negative effects of real exchange rate appreciation on the size of the tradable sector can be therefore captured by the following equations (with the expected signs):

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[5]Sun, Hone & Doucouliagos (1999) showed that trade and financial openness is a factor of industry efficiency. Li, Liu & Parker (2001) and Buckley, Clegg & Wang (2002) showed the diffusion effect of FDI on Chinese manufacturing enterprises, and Liu, Parker & Wei (2001) on electronic enterprises; an FDI spill over effect was shown in Madariaga & Poncet (2007).

$X = f(\underset{-}{RER})$, $IN = f(\underset{-}{RER})$, $FI = f(\underset{-}{RER})$, $SOE = f(\underset{+}{RER})$

3.2. Real Exchange Rate, Capital Intensity, Human Capital and Employment

As well as the negative effects on the size of the tradable sector, real appreciation has an impact on the production input factors, such as capital intensity, human capital and employment.

First, a real appreciation reduces the relative cost of imported capital goods and increases wages relative to the price of capital. It encourages more capitalist forms of production and technological innovations (Leung & Yuen 2005) and so increases growth. The real appreciation may have favored investment-led growth in China since the 1990's.

Second, a real appreciation increases the real remuneration of workers as expressed in terms of tradable goods. We may suppose that the rise in wages incentivises young people to increase their education level and that it slows down the emigration of the most skilled workers (Harris 2001). China has suffered from a significant brain drain, and at present more and more Chinese educated workers can be observed returning, thanks to better remuneration. The improvement of the education level of workers is recognized as being an important factor for economic growth (Fleisher & Chen 1997, Chen & Feng 2000, Hua 2005, Liu & Li 2006).

Finally, a real exchange rate appreciation has negative effects on employment by decreasing the cost of imported inputs relative to real wages, by deteriorating the international competitiveness of a nation's firms and by exerting pressure on efficiency improvement (Hua 2007). The negative effect of real appreciation on employment extends even beyond the tradable sector in China because of the importance of services as an intermediate input in export production (Chen & Dao 2011).

The above arguments concerning the effects of real exchange rate appreciation on capital intensity, human capital and employment can be therefore resumed by the following equations with expected signs as follows (with the expected signs):

$KL = f(\underset{+}{RER})$, $H = f(\underset{+}{RER})$, $EM = f(\underset{-}{RER})$

3.3. Real Exchange Rate and Workers' Effort

A real exchange rate appreciation increases the real remuneration of unqualified workers as expressed in tradable goods. Guillaumont and Guillaumont Jeanneney (1992) show that this increase causes efficiency improvements by workers in a country where the wages of unskilled workers are still low. A labor remuneration that is too low might make workers unhealthy and reduce their capacity for work. The motivation of workers has an effect on efficiency, known as "X-efficiency" (Leibenstein 1957, 1966).

This hypothesis appears relevant in the case of China. Although the proportion of the poor population (defined as those with an income of no more than one U.S. dollar a day) has been decreasing rapidly since 1978 (from 16.6% in 2001, it fell to 10.3% in 2004, and to 4% in 2007), China has the second highest population classified as poor in the world after India (World Bank, 2009). The population just over the line of poverty remains highly vulnerable, notably in inland provinces where the wages are significantly lower than in coastal provinces. It can be expected that the impact of a real appreciation on workers' effort could be thus stronger in inland provinces than in coastal ones.

Second, a real appreciation could push firms to improve their technical efficiency in a context of monopoly or collusive oligopoly (Krugman 1989). The argument is as follows: managers only benefit from a part of the profit created by better management or by increased effort, since a part of the profit goes to the owners of the firm. In the case of monopoly, managers do not choose the effort which maximizes profit for reasons such as a preference for leisure over work, involvement in finding other profitable opportunities, and the power and satisfaction gained from having an excess number of employees (Baldwin 1995). As Marshall said, the best profit of a monopoly is a quiet life.

In a situation of oligopoly (due to foreign competitors and competitors situated in other provinces), the managers will choose a higher level of effort by eliminating excess labor, or possibly by introducing labor-saving techniques that were not fully exploited prior to the competitive disturbance. They do so not only because this behavior may increase the profit in the short run, but also because the reduction in costs dissuades competitors from entering into the market, and thus avoids the price falling. Due to this strategic outcome, there may be an additional benefit which is that of pushing management effort towards its optimum.

In a more general manner, in any market structure, the intensification of foreign competition due to real

Table 2: Expected Impacts of Real Exchange Rate Appreciation on Economic Growth

Effects	Waited signs			
Direct impacts	*Via* « work effort » of workers and *managers*			$\xrightarrow{+}$
Indirect impacts *via* transmission channels	Impact of real exchange rate appreciation on intermediary variables (a)		Impact of intermediary variables on growth (b)	Impact of exchange rate on economic growth (c)=(a)*(b)
	Size of tradable sector	$\xrightarrow{-}$ Export ratio	$\xrightarrow{+}$	$\xrightarrow{-}$
		$\xrightarrow{-}$ Industry share	$\xrightarrow{+}$	$\xrightarrow{-}$
		$\xrightarrow{-}$ FDI ratio	$\xrightarrow{+}$	$\xrightarrow{-}$
		$\xrightarrow{+}$ SOE ratio	$\xrightarrow{-}$	$\xrightarrow{-}$
	Input factors	$\xrightarrow{+}$ Capital Intensity	$\xrightarrow{+}$	$\xrightarrow{+}$
		$\xrightarrow{+}$ Human capital	$\xrightarrow{+}$	$\xrightarrow{+}$
		$\xrightarrow{-}$ Employment	$\xrightarrow{+}$	$\xrightarrow{-}$
Total impact of real exchange rate				$\xrightarrow{?}$

currency appreciation is favorable to the productivity of manufacturing firms, since some of them are obliged to close their poorer performing factories, or even to close down completely; it is a kind of Schumpeterian "creative destruction" which benefits the enterprises which perform best. This argument is realistic for China: under the pressure of the renminbi appreciation since 1994, and notably since China joined the WTO in 2001, Chinese firms have been more and more exposed to foreign competition, and a large number of firms (particularly public ones) were obliged to reform their management or to close down.

The positive effect of the real exchange rate on work efficiency can be captured by adding real exchange rate into the growth equation as follows:

$$y = f(\underset{+}{RER}, \underset{+}{X}, \underset{+}{IN}, \underset{+}{FI}, \underset{-}{SOE}, \underset{+}{KL}, \underset{+}{H}, \underset{+}{EM}).$$

As all the control variables are added into the equation, the coefficient of the real exchange rate measures only the effects that are not captured by the intermediary variables and notably the direct effects on work effort.

Table **2** summarizes the multiple effects that the real exchange rate variation is assumed to exert on economic growth in China. It distinguishes the direct effects of real exchange rate variations from those passing through intermediary variables, which are themselves affected by the real exchange rate. Three effects of the appreciation of the real exchange rate on economic growth are positive - work effort, capital/labor ratio, education level, while the others - exports, foreign direct investments, relative importance of industrial production, SOE and employment, are negative (see Table **2**, Column 3). The overall effect of the real appreciation of exchange rate on economic growth is therefore uncertain. An econometric estimation may reveal it.

3.4. Econometric Model

To apply the above theoretical analysis to the 29 Chinese provinces, we introduce a variable for real GDP per capita, lagged one period, to test an eventual convergence effect of economic growth between the provinces. We add a coastal dummy variable (C) to capture the comparative geographical advantages of the coastal provinces. Moreover, we suppose that the direct efficiency effect of the real exchange rate which is exerted through the workers' effort becomes more relevant when more workers are poor. Since the proportion of poor workers is higher in inland provinces than in coastal provinces, we test whether these direct effects are conditional on the geographical position of provinces, by introducing an interaction term between the dummy variable for coastal provinces and the real exchange rate. Finally, to capture the impact of the student movements in 1989 and 1990, we introduce a dummy variable (D) which is equal to 1 for 1989 and 1990, and 0 for other years[6].

The above growth function can be written in estimation form as follows:

$$\ln y_{it} = a_0 + a_1 \ln RER_{it} + a_2 \ln X_{it} + a_3 \ln IN_{it}$$
$$+ a_4 \ln FI_{it} + a_5 \ln SOE_{it} + a_6 \ln KL_{it}$$

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[6]I am grateful to the referee for this point.

$$+a_7 \ln H_{it} + a_8 \ln EM_{it} + a_9 \ln y_{it-1} + a_{10}C$$
$$+a_{11} \ln RER_{it} * C + a_{12}D + \eta_i + \gamma_t + \varepsilon_{it} \quad (1)$$

In which t represents the years, and i represents the Chinese provinces with i = 1….29. The variables, except for the dummy ones, are expressed in logarithms so that the coefficients represent elasticities. The disturbance term consists of an unobservable provincial fixed effect that is constant over time η_i, an unobservable period effect that is common across provinces γ_t and a component that varies both across provinces and periods which is assumed to be uncorrelated over time ε_{it}.

The expected elasticity signs of the variables in the equation are positive, except for those of public enterprises share, of the interaction term between the real exchange rate and the coastal dummy and of the dummy variable of the student movement, which are expected to be negative. The direct growth effect of real exchange rate is estimated by a_1 for inland provinces, and a_1+a_{11} for coastal provinces.

In the second step, we look for the growth effect of the real exchange rate which is exerted indirectly *via* the other variables that we have assumed to explain the growth: exports, industrial production, foreign direct investments, state-owned enterprises, capital intensity, human capital and employment (Table **2**). With this objective in mind, we need to estimate the impact of the real exchange rate on these factors. The coastal dummy variable is added to capture the comparative advantages of coastal provinces as explained above.

We estimate separately the following equations.

$$\ln X_{it} = b_0 + b_1 \ln RER_{it} + b_2 C + \eta_{i1} + \gamma_{t1} + \varepsilon_{it1} \quad (2)$$

$$\ln IN_{it} = c_0 + c_1 \ln RER_{it} + c_2 C + \eta_{i2} + \gamma_{t2} + \varepsilon_{it2} \quad (3)$$

$$\ln FI_{it} = d_0 + d_1 \ln RER_{it} + d_2 C + \eta_{i3} + \gamma_{t3} + \varepsilon_{it3} \quad (4)$$

$$\ln SOE_{it} = e_0 + e_1 \ln RER_{it} + e_2 C + \eta_{i4} + \gamma_{t4} + \varepsilon_{it4} \quad (5)$$

$$\ln KL_{it} = f_0 + f_1 \ln RER_{it} + f_2 C + \eta_{i5} + \gamma_{t5} + \varepsilon_{it5} \quad (6)$$

$$\ln H_{it} = g_0 + g_1 \ln RER_{it} + g_2 C + \eta_{i6} + \gamma_{t6} + \varepsilon_{it6} \quad (7)$$

$$\ln EM_{it} = h_0 + h_1 \ln RER_{it} + h_2 C + \eta_{i7} + \gamma_{t7} + \varepsilon_{it7} \quad (8)$$

The expected elasticity signs of equations 5, 6 and 7 are positive, while the rest of the equations are negative. The results allow knowing if these intermediate variables are effectively the transmission channels, through which real exchange rate affects GDP per capita.

The indirect effect of the real exchange rate on GDP per capita is calculated by multiplying the GDP per capita elasticity relative to the real exchange rate (a_1 in equation 1) respectively by the elasticities of the determinants of growth relative to the real exchange rate (b_1, c_1, d_1, e_1, f_1, g_1, h_1 in equations 2 to 8). In this way we can evaluate precisely the contribution of each intermediary variable to the effect exerted by real exchange rate on GDP per capita (Table **3**).

Finally, the total effect of real exchange rate is the sum of direct and indirect effects. This is $(a_1 + a_2b_1 + a_3c_1 + a_4d_1 + a_5e_1 + a_6f_1 + a_7g_1 + a_8h_1)$ for inland provinces, and $(a_1 + a_2b_1 + a_3c_1 + a_4d_1 + a_5e_1 + a_6f_1 + a_7g_1 + a_8h_1 + a_{11})$ for coastal provinces.

4. THE GROWTH IMPACT OF REAL EXCHANGE RATE IN CHINA: AN ECONOMETRIC ANALYSIS

In this section we present calculation of variables, estimation method and the results.

4.1. Estimation Period and Calculation of Variables

The panel data in this estimation concerns the 29 provinces, and covers the period from 1987 to 2008 during which the real effective exchange rate either depreciated or appreciated (Figure **1**). The means and standard deviations of the variables are given in Table **4**.

Per capita real GDP is calculated as real GDP (2000 = 100) divided by population. The real effective exchange rate indices of the Chinese provinces are calculated on the basis of year 2000 = 100, as is the ratio of the consumer price index of the province concerned to the average consumer price index of its fifteen foreign trade partners (defined by geographical import origins in 1998[7]), all prices being converted into the same currency. Given that from 1987 to 1993, China used two exchange rates (the official rate and the swap rate), the renminbi/dollar exchange rate is calculated for this period as a weighted average of these two exchange rates, taking the part of imports financed by the swap exchange market for weighting. The calculated weighted pre-1994 nominal exchange

[7]This is the only year for which we have obtained China's *General Administration of Customs* data on the origins of imports for different provinces.

Table 3: Direct and Indirect Effects of Real Exchange Rate Appreciation on Economic Growth

Effects		Coefficients according to equations 1 to 8	
Direct effects			
In inland provinces		a_1	0.08
In coastal provinces		$a_1 + a_{11}$	0.00
Indirect effects in all provinces			
Via tradable sector	*Via* exports/GDP	a_2b_1	-0.09
	Via industrial production share	a_3c_1	-0.002
	Via FDI/GFCF	a_4d_1	-0.02
	Via public investment ratio	a_5e_1	-0.07
Via input factors	*Via* capital intensity	a_6f_1	0.02
	Via human capital	a_7g_1	0.03
	Via employment ratio	a_8h_1	-0.02
Total effects			
In coastal provinces		$a_1 + a_{11} + a_2b_1 + a_3c_1 + a_4d_1 + a_5e_1 + a_6f_1 + a_7g_1 + a_8h_1$	-0.16
In inland provinces		$a_1 + a_2b_1 + a_3c_1 + a_4d_1 + a_5e_1 + a_6f_1 + a_7g_1 + a_8h_1$	-0.08

Table 4: Means, Standard Deviation and Levin-Lin-Chu Stationarity Test of Variables

	Mean	Standard deviation	Levin-Lin-Chu Panel unit roots test	P-value
Real GDP per capita in yuan 2000	8079.16	7709.34	-9.655	0.00
Real exchange rate 2000	100.70	31.01	-8.089	0.00
Export ratio (%)	2.38	15.31	-7.483	0.00
Share of industrial production (%)	38.20	10.02	-7.123	0.04
FDI/GFCF (%)	6.29	8.65	-10.31	0.00
Public investment ratio (%)	58.05	17.81	-6.573	0.05
Capital intensity in yuan 2000	29159	37476	-8.002	0.00
Human capital (%)	37.92	11.51	-8.998	0.01
Employment/population (%)	50.03	5.80	-6.135	0.05

rate of the renminbi versus the dollar is not the same for every province because swap rates differed between provinces. The data on provincial swap rates are available in Khor (1993).

Exports are related to GDP, and foreign direct investments to gross fixed capital formation. The share of industrial production is assumed to be the proportion of the secondary sector (except for construction) in GDP. The share of state-owned enterprises is the ratio of their investment to the total investment of enterprises.

Capital intensity is the ratio of capital stock to number of employees. We use the permanent inventory method to calculate the capital stock as $KR_t = (1-0.05)KR_{t-1} + IR_t$, where KR and IR represent respectively the capital stock and the investment (i.e. gross fixed capital formation) in constant prices and the annual depreciation rate is assumed to be 5% as in Lin & Liu (2008) and Zheng & Hu (2006). We assume that the initial capital stock in 1965 is equal to the real investment that year. This hypothesis does not influence capital stock calculation after 1986, because all the capital stock in 1965 had been amortized in 1985. Because capital depreciation data is available since 1993 for each province, the capital stock over the period from 1993 to 2008 is calculated as $KR_t = KR_{t-1} + IR_t - DR_t$, where DR represents real depreciations, which are equal to nominal depreciations deflated by the price index of the investment in fixed assets. Thus, the capital depreciations are different for each province and for each year, while previous studies have supposed a depreciation rate of 5% for every province, every year.

The real gross fixed capital formation is deflated by two series of prices (2000 = 100), which are available: the "price index of gross fixed capital formation", drawn from the historical data of China's *National Accounts* available up to 1995, and the "price index of investment in fixed assets" available since 1992 in *China Statistical Yearbook*. The first series is used for the period from 1972 to 1992, and the second series for the following years. This combination is not a drawback, because in the overlapping years the two price series differ only marginally, as also observed in Holz (2006).

Human capital is calculated as the ratio of the total number of graduates from secondary and higher level education to total population. The data for 1982, 1990 and 2000 are respectively obtained from the 4th and 5th Population Censuses of China. The data for other years is obtained from the annual survey of population changes. The employment ratio is the share of employed population to total population.

4.2. Econometric Method

The Levin-Lin-Chu panel unit root test is applied to all the variables. The results of these tests lead to rejection of the null hypothesis of non-stationarity (Table **4**). The principal potential econometric problem is the endogeneity of explanatory variables, a difficulty that is met in all the estimations on macroeconomic data due to simultaneity bias, to measurement errors of variables and to the risk of omitted variables. Moreover the introduction of the lagged dependent variable renders the OLS estimator biased and inconsistent, because the lagged dependent variable is correlated with the error term even in the absence of serial correlation between ε_{it}.

As a precaution against the risk of simultaneity of the dependent and explanatory variables, we have lagged by one year all these explanatory variables. Moreover, we have treated the problems of endogeneity and structural heterogeneity of the provinces, by using the system estimator of the one-step Generalized Moment Model (GMM) of Blundel & Bond (1998). This GMM system estimation approach combines an equation in levels in which lagged first-difference variables are used as instruments and a first-difference equation in which the instruments are lagged variables in levels[8]. The use of the lagged variables at least two periods for endogeneous variables as instruments permits a consistent estimation of the parameters even in the presence of measurement error and endogenous right-hand-side variables (Roodman 2009 a, b). These lagged variables were completed by the addition of one instrumental variable, which is the difference between the province's per capita GDP and the average per capita GDP of its foreign trade partners. This instrument results from the Balassa-Samuelson hypothesis (Guillaumont, Jeanneney & Hua, 2002). The validity of the instruments is tested by using the Hansen over-identification test, and by verifying the sensitivity of the estimated coefficients to reductions in the number of instruments (Roodman, 2009 a, b). The results do not allow us to reject the hypothesis on their validity. The instruments are therefore independent of error terms.

4.3. Results of Econometric Estimations

The econometric results are reported in Tables **5** and **6**. Before estimating respectively the direct and indirect effects of the real exchange rate on real GDP per capita, we regress the last one only on the real exchange rate lagged one period and the coastal dummy variable, dropping the other determinants of the real GDP per capita in order to obtain a first rough estimation of the total effect of real exchange rate (Table **5**, Column 1)[9]. Then we add the interaction term between the real exchange rate lagged one period and the dummy variable for coastal provinces (Table **5**, Column 2), in order to see if there is a difference between the two categories of provinces as the theoretical arguments suggest. The results obtained show that the real appreciation of the renminbi may exert a negative effect on economic growth, and that this effect would be more important in coastal provinces than in inland provinces.

The direct effect of the real exchange rate is estimated by adding the traditional determinants of economic growth (Table **5**, Column 3) and the interaction term between the real exchange rate and the dummy variable for coastal provinces (Table **5**, Column 4). All coefficients are statistically significant with expected signs. The coefficients of the real

[8]Blundel & Bond (1998) showed that this estimator is more powerful than the first-differences estimator derived from Arellano & Bond (1991), which gives biased results in small samples with weak instruments.
[9]The result may be biased by missing explanatory variables.

Table 5: Effects of Real Exchange Rate on China's GDP Per Capita: 1987-2008

	1	2	3	4	5
Per capita real GDP lagged one period			0.66*** (8.81)	0.66*** (8.78)	0.66*** (8.78)
Real exchange rate lagged one period	-1.63** (2.12)	-1.04** (-2.45)	-0.03 (-1.06)	0.08* (1.89)	-0.03** (-2.46)
Real exchange rate lagged one period * coastal provinces		-0.21* (1.99)		-0.08** (-2.32)	-0.08** (-2.32)
Coastal provinces	0.81*** (6.24)	1.79*** (3.66)	0.01 (0.48)	0.88** (2.04)	0.88** (2.06)
Exports/GDP lagged one period			0.05** (2.76)	0.07*** (4.65)	0.07*** (4.67)
Industrial production share lagged one period			0.04* (1.94)	0.04* (1.96)	0.04* (1.98)
FDI/GFCF lagged one period lagged one period			0.01* (2.08)	0.01* (1.88)	0.01* (1.98)
Public investment ratio lagged one period			-0.08*** (-3.88)	-0.09*** (-3.56)	-0.09*** (-3.66)
Capital intensity lagged one period			0.15** (2.86)	0.13** (2.57)	0.13** (2.47)
Human capital lagged one period			0.29*** (4.47)	0.34*** (4.70)	0.34*** (4.70)
Employee/population lagged one period			0.17* (1.96)	0.20** (2.04)	0.20** (2.04)
Dummy variable for 1989 and 1990			-0.09*** (5.78)	-0.09*** (5.69)	-0.09*** (5.98)
Number of observations	638	638	638	638	638
Arellano-Bond test for AR(2)	0.43	0.32	0.64	0.35	0.35
Hansen test of overid. Restrictions	0.20	0.24	0.56	0.61	0.61

Notes: - t-statistics corrected for heteroskedasticity by the white procedure are reported in parentheses.
-*, ** and *** indicate significance at the 10%, 5% and 1% levels of confidence, respectively.

Table 6: Estimation of the Channeling Variables of the Real Exchange Rate to GDP Per Capita: 1987-2008

	1	2	3	4	5	6	7
	Export ratio	**Industrial production share**	**FDI ratio**	**Public investment ratio**	**Capital intensity**	**Human capital**	**Employment/ Population**
Real exchange rate	-1.27*** (-11.4)	-0.05* (-2.01)	-2.36*** (-13.1)	0.75*** (3.57)	0.15*** (4.62)	0.08*** (5.15)	-0.11*** (-7.24)
Coastal provinces	1.48*** (7.60)	0.29*** (3.30)	1.94*** (7.10)	-0.32* (-1.76)	0.59*** (3.11)	0.22** (2.58)	0.07* (1.98)
Trend	0.04*** (7.50)	0.004* (1.72)	0.12*** (9.72)	-0.02*** (-6.20)	0.10*** (28.3)	0.04*** (7.50)	0.002 (1.19)
Number of observations	638	638	638	638	638	638	638
Arellano-Bond test for AR(2)	0.13	0.74	0.94	0.59	0.32	0.87	0.54
Hansen test of overid. Restrictions	0.39	0.97	0.96	0.78	0.24	0.97	0.11

Notes: - t-statistics corrected for heteroskedasticity by the white procedure are reported in parentheses.
-*, ** and *** indicate significance at the 10%, 5% and 1% levels of confidence, respectively.

exchange rate in columns 3 and 4 represent its direct impact on economic growth, which does not pass through intermediary variables. This effect has been identified as an incentive for workers and managers to make more effort. The coefficient of the real exchange rate is +0.08 for the inland provinces, and 0 for coastal provinces, the coefficient of the interaction term between the real exchange rate lagged one period and the coastal dummy is -0.08 (column 4). This result was anticipated, because income per capita is lower in inland provinces than in coastal provinces[10], so that the increase in the remuneration for work probably has a stronger impact on the behavior of the workers in inland provinces.

It can also be seen from Table **5** that all intermediary variables have positive effects on GDP per capita, except for the importance of state-owned enterprises. First, the progressive openness to the outside of the Chinese economy appears as a positive factor of economic growth, the coefficient of export ratio, industry share and FDI ratio are significantly positive (respectively 0.07, 0.04 and 0.01). Second, the higher the per capita real GDP the bigger the employment ratio, education and capital intensity, with the elasticities respectively estimated at 0.20, 0.34 and 0.13 (Table **5**, Column 4). Third, economic growth is lower the bigger the share of state-owned enterprises investments (coefficient -0.09). Moreover, the coefficient of GDP per capita lagged one period is below to 1, so economic growth is faster in inland provinces than in coastal provinces because the initial level in inland provinces is lower, which conforms with the usual growth theory convergence effect. Finally, as expected, the impact of the student movements in 1989 and 1990 had a negative effect on economic growth.

Table **6** presents the estimation results of the intermediary variables as a function of the real exchange rate and the coastal dummy. It shows, as expected, that the geographical position of the coastal provinces has a significant and positive impact on all the variables, apart from the importance of public enterprises (which are concentrated in inland provinces).

Again as expected, Table **6** also shows that real exchange rate has negative effects on export rate, industrial production share, foreign direct investment ratio and employment ratio by reducing international competiveness. It exerts positive effects on capital intensity (by decreasing the relative price of imported equipment), on education (by increasing its benefits) and on the relative investment of state-owned enterprises (which produce chiefly non-tradable goods). Thus all these variables are effectively transmission channels of the real exchange rate to GDP per capita.

Calculation of the total effect of the real exchange rate on economic growth is given in the last column in Table **3**. As seen in Table **6**, real appreciation exerts a negative effect on export ratio, industrial production share, and FDI (with coefficients respectively of -1.27, -0.05, -2.36) which themselves positively influence economic growth (with coefficients of 0.07, 0.04, 0.01); the indirect effects of the real exchange rate on export ratio, industrial production share, and FDI ratio are negative and equal respectively to -0.09, -0.002 and -0.02. At the same time, the real appreciation favors state-owned enterprises (coefficient of 0.75), which are a negative factor for economic growth (coefficient of -0.09): the indirect effect of the real exchange rate on SOEs is equal to -0.07 (Table **3**). The real exchange rate exerts a positive effect on capital intensity and education (with coefficients of 0.15 and 0.08 respectively), which themselves positively influence economic growth (with coefficients of 0.13 and 0.34 respectively); this leads to an impact of the real exchange rate which is equal to 0.02 for capital intensity and 0.03 for education (Table **3**). Finally, the real appreciation exerts a negative effect on employment ratio (coefficient of -0.11) which itself positively influences GDP per capita (coefficient of 0.20); consequently, the indirect effect of the real exchange rate on the employment ratio is negative (-0.02). In total, the contribution of the tradable sector is -0.182, superior to that of input factors (0.03). These results confirm the findings in the literature that the tradable sector is the main channel through which real exchange rate acts on growth.

In summary, the negative effects of real exchange rate appreciation through exports, industrial production share, foreign direct investments, state-owned enterprises and employment, prevail over its positive impacts through capital intensity, human capital and efficiency. The total effect is thus different from the direct effect. The negative impact of a real appreciation now appears in both categories of provinces; it is higher in coastal provinces (-0.16) than in inland

[10]In 2009, the GDP per capita in inland provinces was 45% of the GDP per capita in coastal provinces.

provinces (-0.08), due to the direct positive effect which mainly affects the inland provinces.

Not only are the coefficients of the real exchange rate significant, but the elasticity values also show that the results are economically relevant. During the period of the real depreciation from 1987 to 1993, the annual average rate of depreciation of the real exchange rate was 4.84% in inland provinces, and 4.41% in coastal provinces (Table **2**). It led to an increase in the annual average economic growth rate of 0.4% (0.08*4.84%) in inland provinces and of 0.7% (0.16*4.41%) in coastal provinces. The real depreciation during these seven years contributed to the economic growth, which was higher in coastal than in inland provinces. This caused the relative gap in their GDP per capita to increase. It increased from 1.97 in 1987 to 2.27 in 1993, an increase of 1.95% per year on average.

Conversely, during the period of the real appreciation and stabilization from 1994 to 2008, the annual average appreciation of the real exchange rate was 2.01% in inland provinces and 1.77% in coastal provinces (Table **2**). The annual average economic growth rate slowed by 0.2% (-0.08*2.01%) in inland provinces and 0.3 % (-0.16*1.77%) in coastal provinces, thereby minimizing the gap in economic growth between coastal and inland provinces, which decreased from 2.37 in 1994 to 2.28 in 2009, a decrease of 0.14% per year on average. Consequently, the phases of real depreciation of the renminbi significantly contributed to the increase of the ratio of GDP per capita in coastal provinces to GDP per capita in inland provinces, while conversely, the phases of real appreciation contributed to its decrease. The real appreciation appears to be a factor in the reduction of income inequality in China, and vice versa.

5. CONCLUSION

By proposing a real exchange rate augmented Cobb-Douglas production function, this study contributes to the recent literature on the growth impact of real exchange rate by identifying the precise transmission channels through which the real exchange rate exerts an effect on economic growth in China. Using a panel data for the 29 Chinese provinces and over the period from 1987 to 2008, we find that tradable sector size and employment are effectively the main transmission channels through which the real exchange rate appreciation exerts negative impacts on China's economic growth. The positive effects of the real appreciation on capital intensity, human capital and efficiency improvement are not enough to offset the negative effects. We find moreover that this negative impact is higher in coastal provinces than in inland ones, minimizing the costal/inland real GDP per capita difference.

In face of strong pressure from the international community, in particular the U.S.A. in favor of a rapid revaluation of the renminbi and from high domestic inflation, the Chinese government may revalue its currency to reduce its dependence on trade in the world market by encouraging domestic consumption and developing more non-tradable activities. The renminbi is generally considered as under-valued. The average undervaluation estimated by 14 studies for the period 2001 to 2007 is 19%, and as much as 26 % if limited to the period 2005 to 2007 (Cline and Williamson, 2007). A revaluation of the renminbi, which results in a rise of the real exchange rate by this amount, could after a period cause a reduction in growth of 4.16% in the coastal provinces and 2.08% in the inland ones[11] according to the results of this study. Consequently, a step-by-step revaluation policy is preferable, while exports, industry, FDI and job creation are slowed by the revaluation of the renminbi, and economic growth mainly depends on the export-oriented industrial sector; while the growth induced by efficiency improvement, human capital and the job creation in the non-tradable sector is not enough to compensate for the loss of international competitiveness.

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REFERENCES

Arellano, Manuel and Stephen Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equation", Review of Economic Studies 58 (2): 277-297. http://dx.doi.org/10.2307/2297968

Baldwin, Robert E. 1995. "The Effect of Trade and Foreign Direct Investment on Employment and Relative Wages." NBER Working Paper Series 5037.

[11] I.e. 26% * (-0.16) and 26% * (-0.08).

Benaroya, François and Didier Janci. 1999. "Measuring exchange rates misalignments with purchasing power parity estimates", Pp. 165-187, in Exchange rate policies in emerging Asian countries, edited by Stefan Collignon, Jean Pisani-Ferry and Yung Chul Park Routledge, New York.

Berg, Andrew and Yanliang Miao. 2010. "The Real Exchange Rate and Growth Revisited: The Washington Consensus Strikes Back?" IMF working paper WP/10/58.

Blundel, Richard and Stephen Bond. 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Models". Journal of Econometrics 87(1): 115-143. http://dx.doi.org/10.1016/S0304-4076(98)00009-8

Buckley, Peter. J, Jeremy Clegg. and Chengqi Wang. 2002. "The Impact of Inward FDI on Performance of Chinese Manufacturing Firms". Journal of International Business Studies 33(4): 637-655. http://dx.doi.org/10.1057/palgrave.jibs.8491037

Chen, Baizhu and Feng Yi. 2000. "Determinants of economic growth in China: Private enterprise, education, and openness," China Economic Review 11(1), 1-15. http://dx.doi.org/10.1016/S1043-951X(99)00014-0

Chen, Ruo and Dao Mai. 2011. "The Real Exchange Rate and Employment in China," IMF Working Paper 11/148.

Cline, William R. and John Willimson 2007 "Estimates of the Equilibrium Exchange rate of the Renminbi: Is there a Consensus and if not, Why not?" Pp. 151-154 in Debating China's Exchange Rate Policy, edited by Morris Goldstein and Nicholas Lardy, Peterson Institute for International Economics.

Dollar, David. 1992. "Outward-oriented developing economies really do grow more rapidly: Evidence from 95 LDCs, 1976–1985. Economic Development and Cultural Change 40(3): 523–544. http://dx.doi.org/10.1086/451959

Dougherty, Sean, Herd Richard and Ping He. 2007. "Has a private sector emerged in China's industry? Evidence from a quarter of a million Chinese firms". China Economic Review 18 (3): 309-334. http://dx.doi.org/10.1016/j.chieco.2007.02.006

Eichengreen, Barry. 2008. The Real Exchange Rate and Economic Growth. Commission on Growth and Development Working Paper, No. 4, the World Bank.

Fleisher, Belton M. and Jian Chen. 1997. "The Coast-Noncoast Income Gap, Productivity, and Regional Economic Policy in China". Journal of Comparative Economics 25(2): 220-236. http://dx.doi.org/10.1006/jcec.1997.1462

Fu, Xiaolan and Vudayagiri N. Balasubramanyam. 2005. "Exports, Foreign Direct Investment and Employment: The Case of China". The World Economy 28(4): 607-625. http://dx.doi.org/10.1111/j.1467-9701.2005.00694.x

Guillaumont, Patrick and Sylviane Guillaumont Jeanneney. 1992. "Exchange Rate Policies and the Social Consequences of Adjustment in Africa" Pp. 12-24, in Economic Reform in Sub-Saharan Africa, edited by Ajay Chhibber and Stanley Fischer, the World Bank, Washington D.C.

Guillaumont Jeanneney, Sylviane and Ping Hua. 2001. "How Does Real Exchange Rate Influence Income Inequality between Urban and Rural Areas in China?" Journal of Development Economics 64 (2): 529-545. http://dx.doi.org/10.1016/S0304-3878(00)00149-8

Guillaumont Jeanneney, Sylviane and Ping Hua. 2002. "The Balassa–Samuelson effect and inflation in the Chinese provinces". China Economic Review 13(2-3): 134-160. http://dx.doi.org/10.1016/S1043-951X(02)00069-X

Guillaumont Jeanneney, Sylviane and Ping Hua. 2004. "Why do more open Chinese provinces have bigger governments?" Review of International Economics 12(3): 525-542. http://dx.doi.org/10.1111/j.1467-9396.2004.00465.x

Guillaumont Jeanneney, Sylviane and Ping Hua. 2011. "How does Real Exchange Rate influence labour productivity in China?" China Economic Review 22(4): 628-645. http://dx.doi.org/10.1016/j.chieco.2010.04.008

Harris, Richard. G. 2001. "Is There a Case for Exchange Rate Induced Productivity Declines?" Pp. 277-309,in Re-Visiting the Case for Flexible Exchange Rates, edited by Lawrence Schembri, Bank of Canada, Ottawa.

Hausmann, Ricardo; Lant Pritchett; Dani Rodrik. 2005. Growth Accelerations. Journal of Economic Growth 10 (4), 303-329. http://dx.doi.org/10.1007/s10887-005-4712-0

Holz, Carsten. A. 2006. "New capital estimates for China". China Economic Review 17(2): 142-185. http://dx.doi.org/10.1016/j.chieco.2006.02.004

Hua, Ping. 2005. "How does education at all levels influence productivity growth: Evidence from the Chinese provinces" China Economic Quarterly 5(1): 147-166.

Hua, Ping. 2007. "Real exchange rate and manufacturing employment in China". China Economic Review 18 (3): 335-353. http://dx.doi.org/10.1016/j.chieco.2007.02.001

Jefferson, Gary. H. and Jian Su. 2006. "Privatization and restructuring in China: Evidence from shareholding ownership, 1995-2001".Journal of Comparative Economics 34(1): 146-166. http://dx.doi.org/10.1016/j.jce.2005.11.008

Khor, Hoe Ee 1993. "China's Foreign Currency Swap Market". IMF Paper on Policy Analysis and Assessment PPAA/94/1. December.

Kraay, Aart. 2006. "Exports and economic performance: Evidence from a panel of Chinese enterprises". Pp. 139-160, in Global Integration and Technology Transfer, edited by Hoekman, Beata and Smarzynska Javorcik, Washington DC: The World Bank.

Krugman Paul. 1989. "Surévaluation et accélération des productivités : un modèle spéculatif ». Pp.121-135, in Commerce international et concurrence parfaite, edited by Didier Laussei et Christian Montet, Paris, Economica.

Leung Danny and Terence Yuen. 2005. "Do Exchange Rates Affect the Capital-Labour Ratio? Panel Evidence from Canadian Manufacturing Industries", Bank of Canada.

Leibenstein Harvey 1957. Economic Backwardness and Economic Growth, New-York, Wiley.

Leibenstein Harvey 1966. "Allocative Efficiency versus X-Efficiency". American Economic Review 56(3): 392-415.

Li, Xiaoying; Xiaming Liu and David Parker. 2001. "Foreign Direct Investment and productivity Spillovers in the Chineses Manufacturing sector". Economic System 25(4): 305-321. http://dx.doi.org/10.1016/S0939-3625(01)00029-2

Liu, Tung and Li Kui-Wai 2006. "Disparity in Factor Contributions between Coastal and Inner Provinces in Post-reform China". China Economic Review 17(4): 449-470. http://dx.doi.org/10.1016/j.chieco.2006.06.001

Lin, Justin Yifu and Peilin Liu. 2008. "Development Strategies and Regional Income Disparities in China". Pp. 56-78, in Inequality and Growth in Modern China edited by Guanghua Wan, New York: Oxford University Press.

Liu, Xiaming., David Parker Kirit Vaidya, Yingqi Wei. 2001. "The impact of foreign direct investment on labor productivity in the Chinese electronics industry". International Business Review 10(4): 421-439. http://dx.doi.org/10.1016/S0969-5931(01)00024-5

MacDonald, Ronald R. and Flavio Vilela Vieira. 2010. A Panel Data Investigation of Real Exchange Rate Misalignment and Growth, May 1. CESifo Working Paper Series 3061.

Madariaga, Nicole and Sandra Poncet. 2007. "FDI in Chinese Cities: Spillover and Impact on Growth". World Economy 30(5): 837-862. http://dx.doi.org/10.1111/j.1467-9701.2007.01025.x

Rodrik, Dani. 2008. "The Real Exchange Rate and Economic Growth," Brookings Papers on Economic Activity 2, 365–412.

Roodman, David. 2009a. "How to do xtabond2: An introduction to difference and system GMM in Stata", The Stata Journal 9(1): 86-136.

Roodman, David. 2009b. "A Note on the Theme of Too Many Instruments", Oxford Bulletin of Economics and Statistics. 71(1): 135-158. http://dx.doi.org/10.1111/j.1468-0084.2008.00542.x

Sun, Haishun 1998, Foreign Investment and Economic Development in China 1979-1996, Ashgate.

Sun, Haishun; Phillip Hone and Hristos Doucouliagos. 1999. "Economic Openness and Technical Efficiency, a Case Study of Chinese Manufacturing Industries". Economics of Transition 7(3): 615-636. http://dx.doi.org/10.1111/1468-0351.00028

Wang, Yan and Yudong Yao. 2003. "Source of China's Economic Growth, 1952-99: Incorporating Human Capital Accumulation". China Economic Review 14(1): 32-52. http://dx.doi.org/10.1016/S1043-951X(02)00084-6

World Bank. 2009. "From poor areas to poor people: China's evolving poverty reduction agenda", in An assessment of poverty and inequality in China, Poverty Reduction and Economic Management Department, East Asia and Pacific Region.

Zheng, Jinghai and Angang Hu. 2006. "An Empirical Analysis of Provincial Productivity in China, 1979-2001". Journal of Chinese Economic and Business Studies 4(3): 221-239. http://dx.doi.org/10.1080/14765280600991917

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