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Real Effective Exchange Rate and Regional Economic Growth in China: Evidence from Provincial Data

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Abstract

Using data for the period 2000–2011, we construct province-level real effective exchange rate (REER) indices for China and test the effect of REER depreciation on regional economic growth in a generalized method of moments regression framework. Our results show that REER depreciation, in general, promotes regional economic growth, through increasing net exports and lowering FDI costs. After dividing the full sample into coastal and inland subsamples, we find that REER depreciation influences economic growth in inland areas but not in coastal areas. This is due to the fact that the inland areas have more surplus labor or other resources to expand their production capacity when REER depreciation leads to increased world demand. Furthermore, compared to inland areas, processing-and-assembly trade comprises a larger share of trade in the coastal areas, where traders import more raw materials and intermediate goods to process and assemble goods. When the exchange rate depreciates, the costs of imported materials and immediate goods increase. In this case, the benefits from REER depreciation in coastal areas are offset to some extent and are thus lower than in inland areas.

Key words: China, real effective exchange rate, regional economic growth
JEL codes: E5, F3, F4

I. Introduction

The effect of the real effective exchange rate (REER) on economic growth is frequently

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debated among researchers and policy-makers. There is overwhelming cross-country evidence supporting the view that overvaluation of the exchange rate impedes economic growth. Overvaluation is usually associated with unsustainably large current account deficits and balance of payments crises, both of which are harmful to growth (Easterly, 2005; Eichengreen, 2007; Li and Ouyang, 2011). However, evidence on the relationship between undervaluation of the exchange rate and economic growth is mixed. Some argue that mild undervaluation of the exchange rate stimulates economic growth (Edwards, 1989; Agénor, 1991; Gala, 2008). In particular, undervaluation of the exchange rate might enlarge a tradable sector that is originally depressed by disproportionate government and market failure (Rodrik, 2008). Agénor (1991) finds that an unexpected devaluation can increase output. Others provide contrasting evidence (Edwards, 1989; Morley, 1992). For example, Kamin and Rogers (2000) find that if exchange rate depreciation is permanent, the negative impact on output is durable. In addition to the evidence of positive and negative impacts of undervaluation of the exchange rate, some studies suggest that the effect is uncertain. Edwards (1989) uses annual data from 1965 to 1980 for 12 developing countries and finds that the depreciation of exchange rates has a tightening effect within 1 year, and reverses thereafter. In the long run, the effect of the REER depreciation is neutral. Mills and Pentecost (2001) analyze the effect of exchange rates on output using the conditional error correction model, and find that real exchange rate depreciation would stimulate economic growth in Poland, hinder economic growth in the Czech Republic, and have no significant effects in Hungary and Slovenia.

Studies that include within-country evidence are scarce. Rogers and Wang (1995) use a vector autoregressive model to study the case of Mexico, concluding that depreciation of the exchange rate will reduce output. Berument and Pasaogullari (2003) study the case of Turkey. Their results show that when external variables such as the world interest rate, international trade and capital flows are controlled, exchange rate depreciation is not expansionary.

However, given the data available, in the above studies REER is only analyzed at country level. Country-level data cannot capture the difference among provinces or industries within a country.[1] Taking China as an example, although in the past 30 years the Chinese economy has grown rapidly, a development gap among provinces still exists (Heshmati, 2004). Therefore, it is important to investigate how regional variation in the REER may affect regional economic growth. To the best of our knowledge, this paper is the first to provide empirical evidence of the link between China's province-level REER and economic growth. The results show that REER depreciation

[1]Goldberg (2004) first calculates the US real exchange rate at industry level.

promotes regional economic growth in general. In addition, for the inland and coastal subsamples, we find that the inland areas benefit more from REER depreciation than the coastal areas.

The remainder of the paper is organized as follows. Section II introduces the theoretical background on how exchange rates affect economic growth. In Section III province-level REER indices are constructed for China. Section IV sets out the empirical model specification. Section V discusses the results of our findings while Section VI concludes the paper.

II. Theoretical Background

As in the empirical literature on the effect of exchange rates on economic growth, in theoretical works the results are also mixed. For example, Dornbusch (1980) argues that real depreciation benefits balance-of-payments stabilization through its expenditure-switching effects and increases the production of tradables. Agénor (1991) focuses on the contractionary influence of a devaluation in the exchange rate through its effect on the costs of imported intermediate inputs, which has a negative impact on aggregate supply. Eichengreen (2007) provides a review of the various theoretical arguments.

The traditional view argues that a devaluation of the exchange rate has a positive effect on output, mainly through trade and foreign direct investment (FDI). As the real exchange rate depreciates, the relative prices of domestic export goods fall and, thus, world demand for these products increases. The increase in exports not only provides a boost to economic output and growth, but also stimulates the economy as a whole through technological spillovers and other externalities such as economies of scale. This export-led growth is the major mechanism through which exchange rate depreciation stimulates economic growth. The rapid growth of many emerging countries is widely attributed to the adoption of a competitive real exchange rate as a growth strategy. In addition to the expenditure-switching effect of increasing exports and output, real depreciation will reduce domestic investment costs and stimulate FDI and economic growth.

However, there are also well-founded theories, such as those of the new structuralist school (Krugman and Taylor, 1978; Van Wijnbergen, 1986), suggesting that depreciation is harmful to the economy. From the demand side, depreciation will transfer real income from workers, who receive a fixed nominal wage, to capitalists with higher propensity to save out of factor income, which will reduce demand and, thus, output. From the supply side, there are negative impacts of a devaluation in the exchange rate on output because the costs of intermediate inputs imported from foreign countries, which cannot easily be substituted, will increase. Besides, keeping the real exchange rate artificially low to gain export competitiveness might lead to competitive devaluation among competing countries, which will neutralize the effect of a devaluation in the exchange rate on exports.

III. Construction of China's Province-level Real Effective Exchange Rate and Data Description

1. Construction of Real Effective Exchange Rate

Since the mid-1970s the REER has been developed as an index to describe the relative strength of a currency relative to a basket of currencies (Maciejewski, 1983). Many studies have discussed the weighting schemes (McGuirk, 1986; Spilimbergo and Vamvakidis, 2003), price index choices (Wickham, 1987) and sample selections (Rosensweig, 1987) in the calculation of the REER. Two weighted average methods are commonly used to calculate the REER: arithmetically and geometrically weighted average methods. In practice, the latter, adopted by the BIS and the IMF, is believed to be more accurate. In this paper, we use the geometrically weighted average method to calculate each province's REER.

The REER is calculated as follows:

$$REER = \sum_{i=1}^{n} (RER_i)^{w_i}. \tag{1}$$

Here, RER_i is the real exchange rate calculated by $E_i \dfrac{P}{P^*}$, where E_i is the exchange rate, P is the domestic price and P^* is the price of the trading partner. We use the consumer price index (CPI) as a proxy for the price level. Hence, P is the CPI of different provinces in China and P^* is the CPI of the trading partner. n is the total number of a province's trading partners and i represents the ith trading partner. In Equation (1), w_i is the bilateral trade weight with $\sum_{i=1}^{n} w_i = 1$. To obtain w_i, we use weights based on bilateral trading volumes (this is also the method applied by the IMF):

$$\omega_i = \frac{M_{it} + X_{it}}{\sum_{i=1}^{n} M_{it} + X_{it}}, \tag{2}$$

where M_{it} is the province's import volume with trading partner i during year t, and X_{it} is the export volume.

While including all trading partners would be an ideal approach, it is not viable. The

IMF practice includes the top 20 trading partners according to bilateral trading volume. Instead, we intend to choose as many leading trading partners as possible to ensure the accuracy of the REER indices. In this paper, we select the top 40 trading partners to cover at least 80 percent of trading volume of the province. The trading partners included in the REER construction are listed in Table 1.

Table 1. List of Trading Partners Chosen to Calculate Real Effective Exchange Rate

Afghanistan	Estonia	Liberia	Senegal
Afrika	Ethiopia	Libya	Singapore
Albania	Europe	Luxemburg	Slovakia
Algeria	European Union	Chinese Macau	Slovenia
Angola	Finland	Macedonia	South Africa
Arabia and the United Arab Emirates	France	Madagascar	Spain
Argentina	Gabon	Malaysia	Sri Lanka
ASEAN	Gambia	Malta	Sultan
Australia	Garner	Mauritania	Sweden
Austria	Georgia	Mauritius	Switzerland
Azerbaijan	Germany	Mexico	Syria
Bahrain	Greece	Mongolia	Tajikistan
Bangladesh	Guatemala	Morocco	Tanzania
Belgium	Guinea	Nepal	Thailand
Benin	Guyana	New Caledonia	The British Virgin Islands
Brazil	Holland	New Zealand	The Ivory Coast
Britain	Chinese Hong Kong	Nicaragua	The Marshall Islands
Bulgaria	Hungary	Nigeria	The Republic of Czech
Burkina Faso	India	North Korea	The Republic of Korea
Burma	Indonesia	Norway	Togo
Cameroon	Iran	Oman	Turkey
Canada	Iraq	Pakistan	Turkmenistan
Canary Islands	Ireland	Panama	Ukraine
Chile	Israel	Papua New Guinea	Uruguay
Chinese Taipei	Italy	Paraguay	USA
Columbia	Jamaica	Peru	Uzbekistan
Congo	Japan	Philippines	Venezuela
Croatia	Jordan	Poland	Vietnam
Cuba	Kampuchea	Portugal	Yemen
Cyprus	Kazakhstan	Puerto Rico	Yugoslavia
Denmark	Kenya	Qatar	Zaire
Djibouti	Kuwait	Romania	Zambia
Dominica	Kyrgyzstan	Russia	Zimbabwe
Ecuador	Laos	Salvatore	
Egypt	Lebanon	Saudi Arabia	

2. Data Sources

We construct REER indices for 30 Chinese provinces (Table 2).[2] The data we use ranges from 2000 to 2011. Both the bilateral nominal exchange rate (E_i) and the CPI of trading partners (P^*) are from Datastream. The CPI of Chinese provinces (P) is obtained from the Economic Database established by the Development Research Center of the State Council. The bilateral trading data (M_{it} and X_{it}) is collected from multiple sources, including the National Bureau of Statistics of China website, Customs Statistics, the Statistical Yearbooks of Each Province, the China Economic and Trade Yearbook, the China Foreign Trade and Economic Cooperation Enterprise Yearbook, the China Business Yearbook, the China Development Report, the Economic Yearbook for Each Province and the China Commerce Yearbook.[3]

Table 2. List of Provinces Used in Calculating the Real Effective Exchange Rate

ID	Province	ID	Province	ID	Province	ID	Province
1	Anhui	9	Hebei	17	Liaoning	25	Sichuan
2	Beijing	10	Henan	18	Inner Mongolia	26	Tianjin
3	Fujian	11	Heilongjiang	19	Ningxia	27	Xinjiang
4	Gansu	12	Hubei	20	Qinghai	28	Yunnan
5	Guangdong	13	Hunan	21	Shandong	29	Zhejiang
6	Guangxi	14	Jilin	22	Shanxi	30	Chongqing
7	Guizhou	15	Jiangsu	23	Shaanxi		
8	Hainan	16	Jiangxi	24	Shanghai		

3. China's Province-level Real Effective Exchange Rate Indices

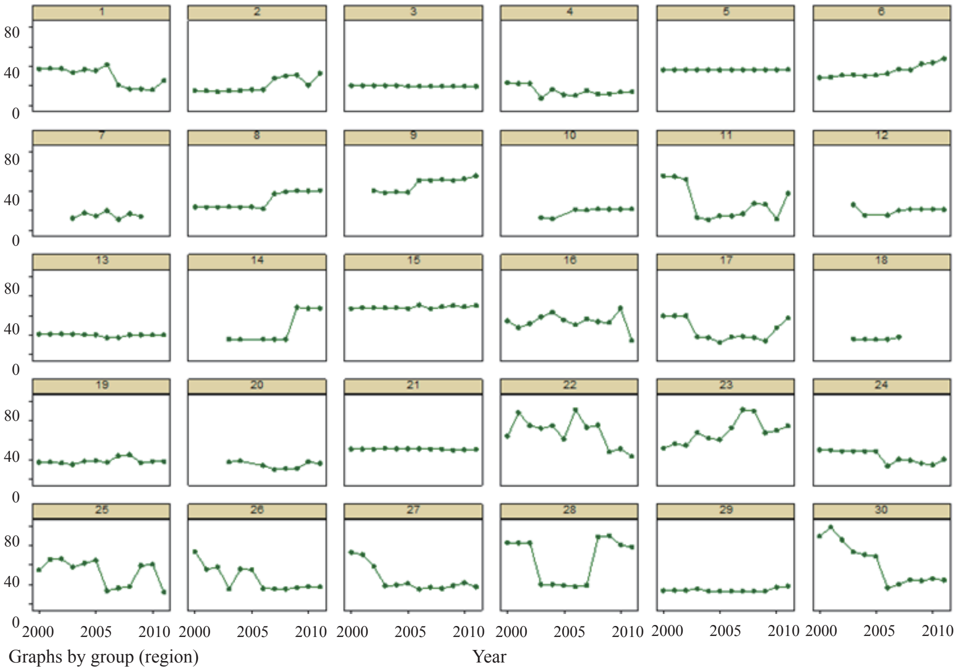
The fluctuations for the province-level REER indices over time are drawn in Figure 1. All 30 province-level REER indices can be roughly categorized into four groups. In the first group, the REER index trend lines of Fujian (3), Gansu (4), Guangdong (5), Guangxi (6), Guizhou (7), Hunan (13), Jiangsu (15), Neimenggu (18), Shandong (21) and Zhejiang (29) provinces are relatively flat. Among them, Gansu's (4) indices decrease slightly with tiny fluctuations. The values of Guangxi (6) increase smoothly with little fluctuation. The variation in the REER indices may be from two sources, the base of RER_i and the exponent of ω_i . The flatness of the REER indices is due to the fact that both the base and exponent might be close to constant.

The trend lines of Henan (10), Hubei (12), Ningxia (19) and Qinghai (20) demonstrate moderately low levels of fluctuation.

[2]Due to a lack of trading data, the province of Tibet is excluded. The Special Administrative Region of Hong Kong, Macau and Taiwan are not included.

[3]Due to space constraints, we do not list all the data details in the present paper. All the details for the data sources may be provided upon request.

Figure 1. The Real Effective Exchange Rate Calculated by the Geometric Weighted Average Method with the Bilateral Trade Weight



Source: Calculated by the authors.

Note: Presented in order, provinces 1–30 are Anhui, Beijing, Fujian, Gansu, Guangdong, Guangxi, Guizhou, Hainan, Hebei, Henan, Heilongjiang, Hubei, Hunan, Jilin, Jiangsu, Jiangxi, Liaoning, Inner Mongolia, Ningxia, Qinghai, Shandong, Shanxi, Shaanxi, Shanghai, Sichuan, Tianjin, Xinjiang, Yunnan, Zhejiang and Chongqing.

For the third group of Anhui (1), Beijing (2), Hainan (8), Hebei (9), Jilin (14) and Shanghai (24), the REER indices lines are smooth in the early stage but fluctuate wildly later. Before 2005, the exchange rate of the RMB was pegged to the US dollar, so that the exchange rate was stable. After 2005, reform of the exchange rate regime and further economic openness had greater impacts on this group of provinces, which may have caused the fluctuations in the REER indices.

We observe much fluctuation in some provinces' REER indices, including those of Heilongjiang (11), Jilin (14), Jiangxi (16), Liaoning (17), Shanxi (22), Shaanxi (23), Sichuan (25), Tianjin (26), Xinjiang (27), Yunnan (28) and Chongqing (30). The different locations, economic and business environments, and policies of these provinces' trading partners mean that there is great variety in the fluctuations. It is impossible to generalize the trend for all of the above 11 provinces' REER index curves.

Instead, we take both Shanxi (22) and Yunnan (8) as examples.

Shanxi (22) is a resource-based province. Mineral products, base metals, stone and petrochemical products are listed as the top four export commodities. Shanxi's export volume relies on the economic situation of its trading partners. During the Eleventh Five-Year Plan period from 2006 to 2010, Asia became Shanxi's main trading partner, replacing European countries. This change had a large impact on the REER, and led to greater volatility of the REER indices.

The REER of Yunnan (28) fell sharply before 2004 and then bounced back after 2006. Vietnam and Burma were the main trading partners of Yunnan, and its export volume to both countries accounted for 65 percent of total export volume to ASEAN in 2010. In 2003, these two countries experienced severe inflation. The official inflation rate exceeded 25 percent in May 2004. The corresponding high prices of its trading partners caused a sharp decline in Yunnan's REER index. In 2006, Vietnam's central bank lowered the exchange rate in response to the subprime crisis, and, as a result, brought back Yunnan's REER index to the same level as previously.

4. Other Variables

Conforming to the literature, other control variables include the GDP growth rate (*GDPG*), the FDI to GDP ratio (*FDI*),[4] the total import and export volume to GDP ratio (*TOPEN*), the total investment in fixed assets to GDP ratio (*FIXINV*), the government consumption to GDP ratio (*GOVC*) and the growth rate of the high school enrollment rate (*EDUG*).[5] The sources of these data are the China Macroeconomic Information Network and the CEInet Statistics Database.

Table 3 shows descriptive statistics for these variables. The minimum value and the maximum value of GDPG are 0.56 and 30.99 percent, respectively, with a standard deviation of 0.55, indicating that regional development is very unbalanced. The smallest ratio of the FDI to GDP ratio (FDI) is negligible, and the largest ratio is 14.6 percent. TOPEN ranges from 3.57 to 172.23 percent, with a standard deviation of 0.43. FIXINV is rather large. The minimum value and the maximum value of FIXINV are 25.77 and 93.39 percent, respectively, with a standard deviation of 0.16. GOVC ranges from 6.91 to 57.92 percent. EDUG ranges from –52.55 to 122.22 percent, with a standard deviation of 0.13.

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[4]The foreign capital actually utilized, used for calculating FDI, is missing for Shaanxi (23).

[5]Foreign direct investment, total imports and exports, total investment in fixed assets, and government consumption are in nominal terms. The ratios of these variables to nominal GDP are the same as the ratio of these in real term to real GDP.

Table 3. Summary Statistics

Variable	Observations	Average	Standard deviation	Minimum	Maximum
GDPG	318	0.1643233	0.0554692	0.0058657	0.3098758
FDI (% GDP)	318	0.0284979	0.0256088	0.0000042	0.1464662
TOPEN (% GDP)	318	0.3630186	0.43157	0.0357344	1.722281
FIXINV (% GDP)	318	0.497571	0.1571935	0.2576545	0.9339422
GOVC (% GDP)	318	0.1705636	0.0736964	0.0691258	0.5791708
EDUG	318	0.0528199	0.1261983	−0.5255172	1.222186

IV. Empirical Analysis

1. Empirical Methodology

The primary focus of this paper is to empirically examine the impact of the REER on regional economic growth. In applying the neoclassical growth model, two empirical approaches are usually adopted, which are the model of Mankiw (1992) and the informal growth regression model introduced by Barro (Barro, 1991; Barro and Sala-i-Martin, 2004). In this paper, we apply the informal growth regression model by estimating a model of the GDP growth rate with *REER* and a set of province-level control variables *X*:

$$\Delta y_{i,t} = \alpha + \beta \cdot REER + \delta X_{i;t} + \varepsilon_{i,t}, \qquad (3)$$

where $i = 1, ..., N$ $t = 1, ..., T$, and $\Delta y_{i,t}$ is the GDP growth rate for each province i and year t. We estimate this model using the generalized method of moments (GMM), which reduces the endogeneity problem and, thus, results in more efficient estimates of the above dynamic panel data model.

2. Control Variables

In the set of explanatory variables *X* in Equation (3), we include the commonly analyzed variables in the literature of economic growth. The vector *X* includes both *FIXINV*'s and *FDI*'s proportions of investment in GDP. The relation between the public investment to GDP ratio and economic growth is examined by Aisen and Veiga (2013). Chinese public investment mainly concentrates on fixed assets like infrastructure. Fleisher et al. (2010) consider FDI as a major force inducing regional economic growth in China by bringing in new production and managerial technologies. For Chinese provinces, both investments in fixed assets and FDI are key investment factors. Therefore, it is reasonable to add both variables of investment into the regression.

In the regression, we also incorporate the ratio of total import and export volume over GDP (*TOPEN*). While financial liberalization is still in progress, some countries tend to rely heavily on international trade to achieve economic growth (Hassan et al., 2011). The growing volume of total imports and exports has made an increasingly significant contribution to economic growth in China.

The fourth explanatory variable used in the study is total government consumption as a proportion of GDP (*GOVC*). Quite a few studies address the impact of government consumption on economic growth (e.g. Hassen et al., 2011; Aisen, 2013). Analyzing a panel of approximately 100 countries, Barro (1996) finds that nonproductive government spending slows economic growth for a given starting value of GDP. Afonso and Furceri (2010) also find that the government expenditure share of GDP is detrimental to growth in both OECD and EU countries. Therefore, we expect the sign of this variable to be negative.

Finally, we add high school enrollment rate (*EDUG*) as a measure of human capital that plays a special role in the model of endogenous economic growth. Some authors use high school enrollment rate as a proxy variable for human capital (Barro, 1991; Caselli, 1996; Bond, 2001). Several other studies have found that the high school enrollment rate helps to explain economic growth in particular regions (Mankiw, 1992; Chen and Fleisher, 1996; Fleisher and Chen, 1997; Demurger, 2002). In this study we use the growth rate of each province's high school enrollment rate rather than the high school enrollment rate to capture the growth rate of human capital.[6]

V. Results

1.Basic Empirical Results

Generalized method of moments estimation is adopted in order to reduce the endogeneity problem. The estimation results for province-level data are reported in Table 4. Shaanxi Province (23) is excluded from the sample because of missing values. The effective sample used includes 285 observations from 29 provinces.

The coefficient of the variable we are interested in, *REER*, is significantly negative, indicating that the REER and economic growth are negatively correlated. That is to say, REER depreciation would encourage economic growth. On one hand, REER depreciation implies that the prices of domestic commodities in terms of foreign

[6]Generally, the high school enrollment rate is measured as the number of students enrolled in high school relative to the total population of the corresponding age group. Yet, the latter is not accessible for most Chinese provinces. We have no choice but to use the total population instead.

Table 4. Regression Results Based on 29 Chinese Regions in 2000–2011

Variables	(1) *GDPG*	(2) *GDPG*	(3) *GDPG*	(4) *GDPG*	(5) *GDPG*	(6) *GDPG*
L. GDPG	0.0828	0.0323	0.0138	0.00410	0.00321	−0.0449
	(0.0552)	(0.0561)	(0.0563)	(0.0554)	(0.0556)	(0.0535)
REER	−0.00120***	−0.000883*	−0.000944**	−0.000879*	−0.000883*	−0.000810*
	(0.000459)	(0.000466)	(0.000466)	(0.000457)	(0.000464)	(0.000441)
FIXINV (% GDP)		0.152***	0.132***	0.149***	0.166***	0.104**
		(0.0250)	(0.0260)	(0.0264)	(0.0537)	(0.0524)
FDI (% GDP)			−0.927***	−0.885***	−0.950***	−0.891***
			(0.347)	(0.340)	(0.356)	(0.338)
TOPEN (% GDP)				0.0685**	0.0631**	0.0323
				(0.0276)	(0.0292)	(0.0283)
GOVC (% GDP)					−0.0696	−0.0585
					(0.170)	(0.161)
EDUG						−0.151***
						(0.0287)
Constant	0.190***	0.111***	0.153***	0.117***	0.124***	0.176***
	(0.0173)	(0.0218)	(0.0267)	(0.0300)	(0.0314)	(0.0314)
Observations	285	285	285	285	285	285
Number of regions	29	29	29	29	29	29

Note: The generalized methods of moments model is adopted with ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

currency decrease, which raises foreign demand. On the other hand, the price of imports in RMB increases for domestic consumers, which brings down domestic demand. The combined effects will shift domestic resources from producing non-tradable goods to tradable goods for which it has comparative advantage in the global market. The shift will further promote economic growth. The drop in the relative price of domestic investment goods brought by REER depreciation will also promote foreign investors' investment in the domestic market.

The coefficient on *REER* not only shows statistical significance, it is also economically important, although the coefficient seems to be small. According to column (1) in Table 4, a one-standard-deviation (value of 14.32) decrease in *REER* will cause the growth rate to increase by 14.32 * 0.00120 = 0.017 percent. While the mean value of *GDPG* is 0.16, a one-standard-deviation decrease in *REER* will cause the GDP growth rate to increase by 10.63 percent (equal to 0.017/0.16) relative to the mean level. The real effective exchange rate has both economical and statistical meaning for economic growth.

The coefficients of FIXINV are consistently and significantly positive from models (1) to (6). This implies that an increase in total investment in fixed assets will accelerate economic growth. This finding supports the existing evidence. Investment in fixed assets, including social public facilities and production equipment, promotes social productivity as a result of upgraded facilities and technology.

The coefficient of FDI is significantly negative, except in model (6) when EDUG is controlled. This indicates that FDI contributes to economic slowdown. This finding is not consistent with some existing empirical results of FDI contributing to economic growth in many countries, such as in Fleisher et al. (2010). FDI contributes to upgrading production equipment, mediating technology spillover across borders and increasing capital flow in the economy. All these factors are conducive to economic growth. Thus, the effect of FDI on economic growth is positive. However, the positive effect brought by FDI to economic growth encompasses several essential prerequisites, such as a sufficient absorptive capability of advanced technologies and a well-developed financial market of the nation (Borensztein et al., 1998; Alfaro et al., 2004). China has an incomplete financial system and its capability to absorb and assimilate the advanced technologies is not yet sufficient. Therefore, China barely meets these prerequisites (Zhang, 2001). This might be the reason why we can observe a negative impact of FDI on China's economic growth.

The positive coefficient of TOPEN indicates that greater trade openness is associated with a higher economic growth rate. This finding is consistent with a large number of published studies that regard trade shares in GDP as the basic measure of openness (Yanikkaya, 2003). As suggested by new growth theories, trade policy affects long-run growth through its impact on technological change and industrial structure. With trade liberalization, growing competition will push domestic companies to adopt advanced technology that will promote domestic productivity and further speed up economic growth.

In Table 4, the coefficient of control variable *GOVC* is negative but insignificant. Aisen and Veiga (2013) present a hypothesis that large government is expected to crowd out resources from the private sector and hurt economic growth. In their sample of 169 countries, the mean value of government spending as a portion of GDP is 0.21. By this quantitative criteria, 23 regions might be counted as the small or median government whose average *GOVC* is lower than 0.21. The existence of a few regions with higher *GOVC* than 0.21 may cause the coefficient to be negative.

We find that *EDUG* and economic growth are negatively correlated. As mentioned in the previous section, *EDUG* is defined as the growth rate of the high school enrollment rate rather than the high school enrollment rate. The negative correlation implies that a decreasing *EDUG*, which resembles the high level of the enrollment rate, predicts an increase in *GDPG*. This finding is consistent with the existing published literature.

The theoretical literature shows that the REER affects economic growth mainly through two channels: FDI and trade openness. Depending on the different levels of FDI flow or openness, the REER's contribution to economic growth might be quite different. To test these specific channels, two interaction terms, the interaction of *REER* and *FDI*,

Table 5. Regression Results with the Interaction Terms

Variables	(1) *GDPG*	(2) *GDPG*	(3) *GDPG*	(4) *GDPG*
L. GDPG	−0.0440	0.0111	−0.0684	−0.0193
	(0.0544)	(0.0568)	(0.0537)	(0.0562)
REER	−0.000294	−0.000307	−0.000677	−0.000749
	(0.000499)	(0.000530)	(0.000504)	(0.000535)
*REER*FDI (% GDP)*	−0.0230**	−0.0262**	−0.0269***	−0.0303***
	(0.0101)	(0.0107)	(0.00993)	(0.0105)
*REER*TOPEN (% GDP)*			0.00232***	0.00265***
			(0.000786)	(0.000831)
FIXINV (% GDP)	0.0983*	0.170***	0.0750	0.141***
	(0.0525)	(0.0541)	(0.0519)	(0.0536)
GOVC (% GDP)	−0.0593	−0.124	0.0613	0.0173
	(0.152)	(0.161)	(0.154)	(0.163)
EDUG	−0.158***		−0.152***	
	(0.0284)		(0.0278)	
Constant	0.170***	0.131***	0.154***	0.115***
	(0.0227)	(0.0230)	(0.0228)	(0.0229)
Observations	285	285	285	285
Number of regions	29	29	29	29

Note: The generalized methods of moments model is adopted with ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

and *REER* and *TOPEN*, are introduced into the baseline GMM specification model. The results of the estimations are reported in Table 5.

A negative value for the effect of the interaction between *REER* and *FDI* is found. This implies that the effect of REER indices on the economic growth rate is lower at higher levels of FDI (i.e. the higher the FDI, the lower the effect of REER on the economic growth rate).[7] The coefficient of the interaction term for *REER* and *TOPEN* is significantly positive. This signifies that the REER indices' impact on the economic growth rate is greater at higher levels of trade openness.

Economic disparity among regions in China is widely observed during the post-reform period. To investigate the effect of the REER on the imbalanced regions, we further decompose the dataset into two subsamples, inland and coastal areas. We follow the standard practice of classifying the provinces of Beijing, Liaoning, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejang, Fujian, Guangdong and Guangxi as coastal and the other provinces as inland. Table 6 provides a full list of all inland and coastal regions. The 285 observations in the full sample are then divided into 130 coastal observations from 12 coastal regions and 155 inland observations from 17 inland

[7]Similarly, it also implies the effect of FDI on the economic growth rate is lower at higher levels of REER.

Table 6. The Coastal and Inland Region List

Coastal regions		Inland regions		
Beijing	Jiangsu	Anhui	Hubei	Qinghai
Fujian	Liaoning	Chongqing	Hunan	Shanxi
Guangdong	Shandong	Gansu	Jiangxi	Sichuan
Guangxi	Shanghai	Guizhou	Jilin	Xinjiang
Hainan	Tianjin	Heilongjiang	Inner Mongolia	Yunnan
Hebei	Zhejiang	Henan	Ningxia	

Table 7. Regression Results of Coastal and Inland Subsamples

Variables	Coastal (1) *GDPG*	Coastal (2) *GDPG*	Coastal (3) *GDPG*	Inland (1) *GDPG*	Inland (2) *GDPG*	Inland (3) *GDPG*
L. GDPG	0.167**	0.171**	0.142*	−0.0892	−0.0824	−0.0993
	(0.0742)	(0.0763)	(0.0751)	(0.0659)	(0.0737)	(0.0667)
REER	0.00184**	0.00247***	0.00125	−0.000311	−0.000882	−0.00335***
	(0.000766)	(0.000945)	(0.00104)	(0.000483)	(0.000612)	(0.000787)
*REER*FDI*		−0.0123	−0.0134		0.00350	−0.00148
		(0.00892)	(0.00870)		(0.0280)	(0.0252)
REER TOPEN*			0.00187**			0.0279***
			(0.000734)			(0.00636)
FIXINV (%GDP)	0.324***	0.237***	0.284***	0.157***	0.180***	0.143**
	(0.0602)	(0.0544)	(0.0556)	(0.0580)	(0.0644)	(0.0589)
FDI (%GDP)	−0.488*			0.227		
	(0.296)			(0.776)		
TOPEN (%GDP)	0.0706***			0.693***		
	(0.0270)			(0.160)		
GOVC (%GDP)	−1.094***	−1.067***	−0.983***	−0.205	−0.249	−0.219
	(0.265)	(0.255)	(0.250)	(0.146)	(0.162)	(0.146)
EDUG	0.0251	−0.0549	−0.0185	−0.120***	−0.159***	−0.105***
	(0.0560)	(0.0489)	(0.0496)	(0.0340)	(0.0369)	(0.0355)
Constant	0.0414	0.103***	0.0747**	0.0725*	0.165***	0.165***
	(0.0454)	(0.0280)	(0.0294)	(0.0371)	(0.0318)	(0.0287)
Observations	130	130	130	155	155	155
Number of regions	12	12	12	17	17	17

Notes: The generalized methods of moments model is adopted with ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

regions. Table 7 lists the regression results for both coastal and inland groups.

Dividing the full sample into two subsamples, of coastal and inland regions, we find that REER depreciation may play different roles in regional economic growth. The result shows that REER depreciation is much less beneficial to coastal areas, compared with inland areas. There may be two reasons for this. First, for the underdeveloped inland regions, there still exist idle resources like surplus labor. REER depreciation increases Chinese exporters' international market competitiveness, which might bring greater world demand for Chinese exports. Expansion in the production capacity of Chinese exporters requires more inputs such as labor and other resources. However, it has been a while since the coastal regions have suffered from labor shortages and land scarcity. Meanwhile, labor and land can be much more plentiful in inland areas. Therefore, compared with inland areas, resource constraints may be more binding in the coastal areas when the REER depreciates. Second, the different trade structures in the coastal areas and inland may matter for the benefits of depreciation in different areas. Processing trade is more important in the coastal subregion than in the inland subregion. For processing trade, raw materials and intermediate goods are mainly imported from foreign countries, so that trade is much less sensitive to exchange rate changes.

As expected, the significantly negative coefficient of FDI in model (1) of the coastal subsample indicates that FDI slows economic growth. For both coastal and inland regions, trade openness positively correlates to economic growth. Comparing their sizes, we find that the impact of trade openness on economic growth is greater for the inland subregion than for the coastal subregion. Yanikkaya (2003) finds that trade benefits less developed countries through technology diffusion because of a smaller technology gap. Consistent with Yanikkaya (2003), the technology gap between the USA and Chinese coastal regions is much narrower than the gap between the USA and Chinese inland regions. The inland provinces might be able to benefit more from the technology transfer brought by trade openness. Therefore, with more liberalized trade, the inland provinces enjoy greater economic growth than the coastal provinces.

For both coastal and inland areas, total investments in fixed assets and economic growth are positively correlated. In addition, it seems that total investment in fixed assets matters more in the coastal subsample than in the inland subsample. Coastal regions have undergone faster economic development than inland areas. With the accompanied greater investment in infrastructure, production in coastal areas is more likely to lie on the efficient frontier. However, for the inland provinces, their fixed asset investments might not be enough to enjoy the benefits of scale economies.

Government consumption and economic growth are negatively correlated, but only significantly for the coastal provinces. The economies of the coastal provinces are more mature and marketized. Government interference may interrupt markets more by crowding out private investment in the coastal provinces. The growth rate of high school enrollment rates and economic growth are negatively correlated and this variable is significant only for the inland subgroup.

2. Robustness Tests

After examining the effects of the real exchange rate on economic growth, the endogeneity problem should be considered more carefully.

First, the endogeneity of the real exchange rate should be considered. The Chinese Government employs a variety of policies with the explicit goal of affecting the exchange rate, such as a specific managed floating exchange rate regime, interventions in currency markets and capital account policies. Although the exchange rate influenced by these policies is in nominal terms, one of the key findings of the open-economy macroeconomic literature suggests that except in highly inflationary environments, nominal exchange rates and real exchange rates move quite closely together. In this case, the real exchange rate is not determined purely by market forces and, thus, is not endogenous to the economy.

Second, the reverse causality cannot lead to the result that REER depreciation results in economic growth. Economic growth is expected to cause a real appreciation on standard Balassa–Samuelson grounds. It is unlikely that the negative coefficients reported above are from the reverse effect of growth on the real exchange rate.

Third, similar to reverse causality, shocks that cause a real depreciation tend to be shocks that are bad for growth on conventional grounds: a reversal in capital inflows or a terms of trade deterioration, for example. The negative coefficients on *REER* cannot be generated from these shocks.

In fact, the GMM model employed, which treats *REER* explicitly as an endogenous regressor, is a direct approach that can be applied to alleviate the endogeneity problem. In addition, a conventional instrumental variables approach is essentially ruled out here, because it is difficult, according to the vast literature, to think of exogenous regressors that influence the real exchange rate without plausibly also having an independent effect

Table 8. Regression Results of Robust Test: OLS Method

	(1)	(2)	(3)	(4)	Coastal	Inland
Variables	*GDPG*	*GDPG*	*GDPG*	*GDPG*	*GDPG*	*GDPG*
REER	−0.000767***	−0.000453**	−0.000466*	−0.000587**	−0.000137	−0.00210***
	(0.000248)	(0.000223)	(0.000239)	(0.000231)	(0.000392)	(0.000532)
FIXINV (%GDP)		0.134***	0.132***	0.139***	0.181***	0.0770**
		(0.0252)	(0.0249)	(0.0247)	(0.0357)	(0.0358)
*REER*FDI*			0.000822		−0.00165	0.00756
			(0.00429)		(0.00419)	(0.0142)
REER TOPEN*				0.000615*	0.000835***	0.0138***
				(0.000333)	(0.000319)	(0.00448)
FDI (%GDP)		−0.0501		−0.108		
		(0.157)		(0.157)		
TOPEN (%GDP)		0.00927	0.00761			
		(0.0108)	(0.0107)			
FIXINV (%GDP)		0.134***	0.132***	0.139***	0.181***	0.0770**
		(0.0252)	(0.0249)	(0.0247)	(0.0357)	(0.0358)
GOVC (%GDP)		−0.0685	−0.0605	−0.0705	−0.119	−0.0469
		(0.0623)	(0.0603)	(0.0612)	(0.0977)	(0.0854)
EDUG		–0.128***	–0.129***	–0.124***	–0.0797*	–0.122***
		(0.0240)	(0.0240)	(0.0233)	(0.0411)	(0.0301)
Constant	0.187***	0.128***	0.127***	0.129***	0.0876***	0.162***
	(0.00837)	(0.0167)	(0.0161)	(0.0153)	(0.0201)	(0.0206)
Observations	318	318	318	318	142	176
Number of regions	29	29	29	29	12	17

Note: ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

on economic growth. Based on this consideration, this paper employs the traditional OLS method to check the robustness of previous results. Table 8 presents the OLS results. Columns (1) and (2) correspond to the baseline result in Table 4. Columns (3) and (4) are the OLS results with interaction terms from Table 5. Columns (5) and (6) are OLS results for coastal and inland subsamples from Table 6.

The basic results are consistent with those shown in previous tables. That is, real depreciation will lead to high economic growth. The results are more significant than the basic result in Table 4. Although the *REER* coefficients in coastal and inland subsamples are now insignificant and significantly negative, respectively, the difference between the two subsamples is obvious: the economic growth in inland areas benefits more from real depreciation compared to that in coastal areas. This can be justified similarly as the above explanation.

In addition, the coefficients on *FIXINV* are consistently and significantly positive. Similarly, the effects on *EDUG* and *GOVC* are consistent with previous results. However, the interaction term of *REER* with *FDI* is now insignificant while the interaction term with *TOPEN* shows a consistent result as before but with weaker significance. Differently from before, *FDI* now has no significant results. This may be due to the incomplete financial system and insufficient absorptive capability for advanced technologies in China.

From the above analysis and OLS results, even if there exists endogenous mechanisms, it does not appear that the endogeneity issues would create a bias that would work against the findings. Overall, the results are robust when we take the endogeneity problem into account.

Some studies find that FDI has a certain lagged effect on economic growth (Borensztein et al., 1998; Durham, 2004). It allows us to carry out a robustness check of the lagged effects on economic growth. We replace *FDI* by the lagged *FDI* in the baseline specification in the test. Table 9 presents results of regressions with the lagged FDI.

The regression results are consistent with the regression results shown in Table 4. Our results are not sensitive to the specifications. The REER index is still negatively correlated with economic growth. When the REER depreciates, the purchasing power of the RMB will fall in relative terms, and the purchasing power of foreign currency will increase. This stimulates the reallocation of resources and further increases the rate of economic growth. Using the lagged *FDI* to replace *FDI*, the coefficient of *L.FDI* is still significantly negative, which means FDI in the previous period also slows economic growth. Our findings show that China has entered the stage where FDI decelerates economic growth.

Table 9. Regression Results of Robust Test: Lagged Foreign Direct Investment

Variables	(1) *GDPG*	(2) *GDPG*	(3) *GDPG*	(4) *GDPG*	(5) *GDPG*	(6) *GDPG*
L. GDPG	0.0828	0.0323	0.0307	0.0172	0.0167	−0.0301
	(0.0552)	(0.0561)	(0.0561)	(0.0551)	(0.0554)	(0.0536)
REER	−0.00120***	−0.000883*	−0.000902*	−0.000826*	−0.000835*	−0.000782*
	(0.000459)	(0.000466)	(0.000467)	(0.000457)	(0.000465)	(0.000443)
FIXINV (%GDP)		0.152***	0.139***	0.154***	0.168***	0.103*
		(0.0250)	(0.0261)	(0.0261)	(0.0539)	(0.0530)
L. FDI (%GDP)			−0.373*	−0.509**	−0.535**	−0.330
			(0.216)	(0.215)	(0.225)	(0.218)
TOPEN (%GDP)				0.0843***	0.0804***	0.0471*
				(0.0282)	(0.0292)	(0.0286)
GOVC (%GDP)					−0.0556	−0.00977
					(0.169)	(0.161)
EDUG						−0.145***
						(0.0293)
Constant	0.190***	0.111***	0.133***	0.0984***	0.104***	0.146***
	(0.0173)	(0.0218)	(0.0252)	(0.0273)	(0.0283)	(0.0283)
Observations	285	285	285	285	285	285
Number of regions	29	29	29	29	29	29

Notes: The generalized methods of moments model is adopted with ***$p < 0.01$, **$p < 0.05$ and *$p < 0.1$.

The relation between the share of fixed investment in GDP and the growth rate of real GDP is one of the most robust results obtained in the regression. The results support the statement that fixed investment acts as a source of ignition for economic growth (Barro, 1996). The positive coefficients of *TOPEN* confirm that trade liberalization brings a higher growth rate (Yanikkaya, 2003). The coefficient of *GOVC* is negative but insignificant. Government expenditure might follow non-market channels to allocate resources. This finding is consistent with Barro (1996), in the sense that nonproductive government spending slows economic growth. This is particularly true for large governments when the amount they spend is extremely high. *EDUG* and economic growth are negatively correlated, as expected.

VI. Concluding Remarks

In this paper, we construct China's province-level REER indices. These REER indices allow us to empirically examine the link between the REER and economic growth at province level in China. Using the full dataset, we find that REER depreciation stimulates regional economic growth. Because the REER generally affects economic growth through FDI and trade, we construct a model with two interaction terms. We find that the impact of the REER on the economic growth rate is greater at higher levels of trade openness and is lower at higher levels of FDI. Next, we decompose the full dataset when examining the impact of the REER on Chinese regions with different levels of development. Our results demonstrate that REER depreciation might have different effects on different regions in China. The GMM model shows that REER depreciation promotes economic growth in the inland provinces, while it functions as an impediment to economic growth in the coastal regions. Using the OLS method, real depreciation is found to stimulate economic growth in inland areas while having an insignificant effect in coastal areas. However, both of the results suggest that real depreciation benefits the inland areas more than the coastal areas.

The empirical results show that moderate depreciation of the REER not only stimulates economic growth in general because of the increase in net exports and lower FDI costs, but can also promote regional economic equality by having a larger beneficial effect on the inland areas. This is because inland areas have more surplus labor and other resources to expand production capacity when REER depreciation increases world demand. Furthermore, compared to inland areas, processing-and-assembly trade comprises a larger share of trade in the coastal areas, where traders import more raw materials and intermediate goods to process and assemble. When the exchange rate depreciates, the costs of imported materials and immediate goods increase. In this case, the benefits from REER depreciation in coastal areas are offset to some extent and are, thus, lower than in inland areas.

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