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DEPARTMENT OF ECONOMICS

Working Paper

**Correctly Analyzing the Balance of Payments
Constraint on Growth**

by

Arslan Razmi

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AMHERST**

Correctly Analyzing the Balance of Payments Constraint on Growth

Arslan Razmi*

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Abstract

The BPCG model provides an interesting hypothesis regarding economic growth. The main implication is that world *demand* places a constraint on individual country performance. I discuss this implication and argue that tests of the BPCG model have essentially been tests of the hypothesis that trade is balanced over the long run; a plausible hypothesis but one that need not hold mainly due to demand-side constraints. I then discuss the role of relative prices and investment, point out logical inadequacies in the traditional BPCG framework, and suggest an alternative theoretical framework to investigate its robustness. Our theoretical and empirical explorations contribute to reconciling evidence supporting the BPCG hypothesis with recent work that consistently finds an important role for the level of the real exchange rate and investment, independently of world demand growth.

JEL Codes: F41, F43, F32

Keywords: Balance of payments-constrained growth model, accumulation, demand-led growth, real exchange rates, terms of trade.

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1 Introduction

The idea of a balance of payments constraint on growth has been a staple of much demand side-oriented growth theory since Thirlwall (1979). Later work has incorporated capital flows, transitional dynamics, non-tradable goods, and sectoral issues.¹ Indeed, the idea of a foreign exchange constraint has been part and parcel of heterodox approaches and predates the Balance of Payments Constrained Growth (BPCG) model. However, it is the role of the demand side in defining the nature of the constraint that mainly distinguishes the BPCG model from other frameworks. The basic idea is generally expressed in three versions, one incorporating relative prices, albeit as exogenously given, while the others ignore this aspect (see the next section). The common thread binding the three versions is the idea that domestic growth is a positive function of world demand growth as mediated through the relevant demand elasticities.

Logically, the BPCG hypothesis can be said to incorporate three sub-hypotheses:

1. Growth is limited by the balance of payments (BP) constraint
2. The BP constraint originates from the *demand* side
3. Relative prices either do not matter or matter only in the form of rate of change rather than levels.

Hypothesis (1) is quite plausible, especially for developing countries due to their relative inability to borrow in own currency, limited monetary sovereignty, and lack of depth in financial markets. Indeed this feature was recognized and analyzed by earlier gap models in the context of developing countries. The constraint, however, need not come from world demand. For example, in traditional structuralist literature, where growth in the South is constrained by capital, Southern terms of trade may adjust to satisfy the constraint. Hypotheses (2) and (3), therefore, need to be theoretically and empirically examined. One implication that follows from hypothesis (2), as incorporated in the BPCG framework, is that domestic growth is a positive function of global growth (although the magnitude of the correlation may vary depending on the relevant elasticities). As discussed below, the data indicate that this rather intuitive prediction is frequently not verified. Moreover, contra to hypothesis (3), there is accumulating evidence in the literature that relative prices, especially the *level* of the real exchange rate – defined as the relative price of tradables – matter significantly.

This paper investigates the theoretical and empirical validity of the BPCG framework. I present and use a general framework to focus on hypotheses (2) and (3). The main assumptions that distinguish the BPCG model are identified and explored in light of existing literature, theory, and evidence. Existing econometric studies of the hypotheses are found lacking in several respects. A preliminary and far from exhaustive, econometric treatment is carried out to investigate the effect of alternative variables suggested by the general framework. Finally, based on the theoretical framework and econometric exercises, guidelines are laid out for future work to more robustly evaluate the nature of the BP constraint in general, and the validity of the BPCG framework in particular.

¹On capital flows, see, for example, Thirlwall and Hussain (1982) and Moreno-Brid (1998). Razmi (2010) and Araujo and Lima (2007) discuss aspects of the BPCG model in a multi-sector set-up.

2 The constraint and adjustment mechanisms

As mentioned earlier, the idea of an equilibrating mechanism to ensure that output growth does not exceed a pace defined by the external balance is an eminently plausible one. A look at regional data, as presented in Table 1, for example, reveals small average current account deficits for the period 1980-2013 for most regions.²

Table 1: Regional current account balances averaged over 1980-2012. Source: Author’s calculations based on the UNCTAD Handbook of Statistics

Developing	Of which				Developed	Of which			
	Africa	America	Asia	Oceania		America	Asia	Europe	Oceania
0.71	-0.32	-1.65	1.99	-3.05	-0.64	-2.59	2.45	0.27	-4.29

Given the relatively limited range in which the current account varies for most countries, the question is: what adjusts to maintain this range? One answer can be traced back to Chenery and Strout (1966). The gap models emerging from this seminal contribution generally identified two constraints on development: the saving gap and the foreign exchange gap. Since most developing countries rely on foreign exchange for needed capital goods and intermediate industrial inputs, successive current account deficits generated by growth become unsustainable over longer periods of time. Alternatively, a country may have adequate foreign exchange but insufficient savings to exploit available investment opportunities. Generally the foreign exchange constraint was seen as the binding one. Thus, the balance of payments rather than capacity utilization emerges as a constraint on growth. The need to import capital goods hinders accumulation given limited foreign exchange availability. Indeed countries were typically assumed to be producing at full capacity in earlier models, although Taylor (1994) and others later dropped this assumption in favor of more Keynesian closures.

Another strand of development literature – see, for example, Dutt (1990) – analyzes the effects of North-South trade on development. Balanced trade is often assumed. Again, this literature, even though mostly originating in non-mainstream circles, typically postulates capital as the binding constraint on the South, with the Southern terms of trade adjusting to equilibrate the goods market. Indeed, the Prebisch-Singer hypothesis, too has often been stated along the following lines: given *balanced trade*, unequal elasticities of demand for the two regions’ exports means that either the two regions grow at the same rate and the Southern terms of trade decline, or the terms of trade remain stable but the North grows faster. The potential complementarity of relative output and price changes is an issue that we return to in the next section.

Thus, a substantial body of development literature, not to mention international trade theory,³ has traditionally assumed balanced trade over the long run, with different variables adjusting to respect this constraint. The BPCG model follows in the same tradition except that the claim is not limited to developing countries.⁴ Moreover, output growth is postulated as the overwhelmingly

²The variation in values for individual countries is much larger, with extreme outliers ranging from an average current account deficit of 34 percent for Anguilla to a surplus of 166 percent for Timor-Leste, but most of these appear to be driven by short time series and/or other special circumstances. Most of the countries (106 out of 196) lie within the ± 5 percent range.

³In the standard Ricardian trade model, for example, relative wages (measured in the same currency) adjust in response to changes in international preferences, technologies, etc., to maintain balanced trade. See, for example, Dornbusch et al. (1977).

⁴Indeed the initial tests of the model involved developed countries only (see Thirlwall (1979)).

dominant adjusting variable, with (changes in) relative prices playing a secondary role. To see this, it might be useful to derive the basic hypothesis in the form that is typically tested.

Start with trade equations of the imperfect substitutes form,

$$X^D = g\left(\frac{P_X}{EP_M}, Y^*\right); g_1 < 0, g_2 > 0 \quad (1)$$

$$M^D = \gamma\left(\frac{P_X}{EP_M}, Y\right); \gamma_1, \gamma_2 > 0 \quad (2)$$

where X^D and M^D represent export and import demand, P_X and P_M are the corresponding prices, E is the nominal exchange rate (the price of foreign currency in terms of the domestic one), and Y and Y^* are domestic and foreign income, respectively. The assumption here is that each country/region makes one good that it consumes domestically and exports. Imposing the balanced trade condition, i.e.,

$$P_X X^D = EP_M M^D \quad (3)$$

yields, after log-differentiation to derive variables in growth rate form,

$$\hat{Y}_{BPCG1} = -\frac{\eta_X + \eta_M - 1}{\pi_M}(\hat{P}_X - \hat{P}_M - \hat{E}) + \frac{\pi_X}{\pi_M}\hat{Y}^* \quad (4)$$

where the hats or circumflexes denote growth rates, and η_i and π_i ($i = X, M$) represent the relevant price and income elasticities. We have one equilibrium condition to go with one adjusting variable, \hat{Y} , with the assumption of perfectly elastic export and import supply responses rendering relative prices *in domestic currency terms* exogenous (more on this later). Assuming that movements in the international terms of trade $\hat{P}_X - \hat{P}_M - \hat{E}$ are negligible helps simplify the expression to:

$$\hat{Y}_{BPCG2} = \frac{\pi_X}{\pi_M}\hat{Y}^* \quad (5)$$

The use of equation (1) in log-differentiated form – again with $\hat{P}_X - \hat{P}_M - \hat{E} = 0$ – helps derive an even more concise expression.

$$\hat{Y}_{BPCG3} = \frac{\hat{X}}{\pi_M} \quad (6)$$

Equations (5) and (6) capture the gist of the BPCG approach, and have formed the basis for much empirical work. The idea, as discussed in more detail below, is that producers set prices in domestic currency, nominal exchange rates are fixed by policy, and domestic output growth does the adjusting in the presence of external imbalances. Crucially, the adjustment of domestic output growth is in response to world output growth, either explicitly via equation (5), or implicitly, via equation (6).

Before we look more closely at the data, a few comments about existing empirical tests are in order. While testing the BPCG hypothesis, step 1 consists typically of estimating an import demand function:

$$\hat{M} = \hat{\alpha}_0 + \pi_M \hat{Y} + \eta_M(\hat{P}_X - \hat{P}_M - \hat{E}) + \xi$$

Now suppose, as in the small country case (see below), relative price changes are negligibly small ($\hat{P}_X - \hat{P}_M - \hat{E} \approx 0$). Then, the expression reduces to:

$$\hat{M} = \hat{\alpha}_0 + \pi_M \hat{Y} + \xi \quad (7)$$

Having estimated π_M , step 2 then typically consists of estimating equation (6). Consider the implications. Ignoring the residual term ξ , which is expected to have a mean of zero, $\pi_M = (\hat{M} - \hat{\alpha}_0)/\hat{Y}$. Plugging this into equation ((6) yields:

$$\hat{Y}_{BPCG3} = \frac{\hat{X}}{\hat{M} - \hat{\alpha}_0} \hat{Y}$$

or, in other words, as long as the trade balance is relatively stable over time, the BPCG growth rate will be highly correlated with the actual growth rate. Moreover, if changes in “autonomous” imports (α_0) are small, the correlation will approach unity.

Other studies base their tests on equation (5). This requires the additional estimation of an export demand equation.

$$\hat{X} = \hat{\beta}_0 + \pi_X \hat{Y}^* + \epsilon \quad (8)$$

Now eqs. (5), (7), and (8) imply that

$$\hat{Y}_{BPCG2} = \frac{\hat{X} - \hat{\beta}_0}{\hat{M} - \hat{\alpha}_0} \hat{Y}$$

Again, the structure of the test facilitates a high correlation between the two growth rates as long as the trade balance is stable over time. Put differently, the traditional approach to testing the BPCG model is really a test of whether or not trade is balanced!

As discussed earlier, nearly balanced trade over the long run is a plausible approximation. Better approaches are required to address the more interesting question: what *mechanisms* constrain growth *given* a balance of payments constraint? It is time now to pursue one such approach.

3 The nature of the constraint

Equation (5) directly presents a hypothesis; individual country growth rates are a positive function of world growth, the constant of proportionality depending on the relevant income elasticities of demand. This hypothesis is quite intuitive, and must by definition hold *on average* (since the world growth rate is an average of individual country growth rates). Moreover, it is easy to test. Perhaps surprisingly then, this prediction is negated in a significant number of cases. Using individual country data from the Penn World Tables (PWT 8.0), I calculated the world GDP as the sum of individual country GDPs. I then found geometric means for 5-year samples in order to minimize short-run cyclical movements. Figure 1 shows the resulting scatter plot between individual country growth rates and the world growth rate. The “wagon-wheel” pattern reveals something interesting; in many cases, as testified by the dense packing of near-vertical plots, individual country growth, *RGDPNA_GROWTH*, is largely independent of world growth, *WORLD_RGDPNA_GROWTH*. In almost a third of the cases (49 out of 167), the correlation is negative!

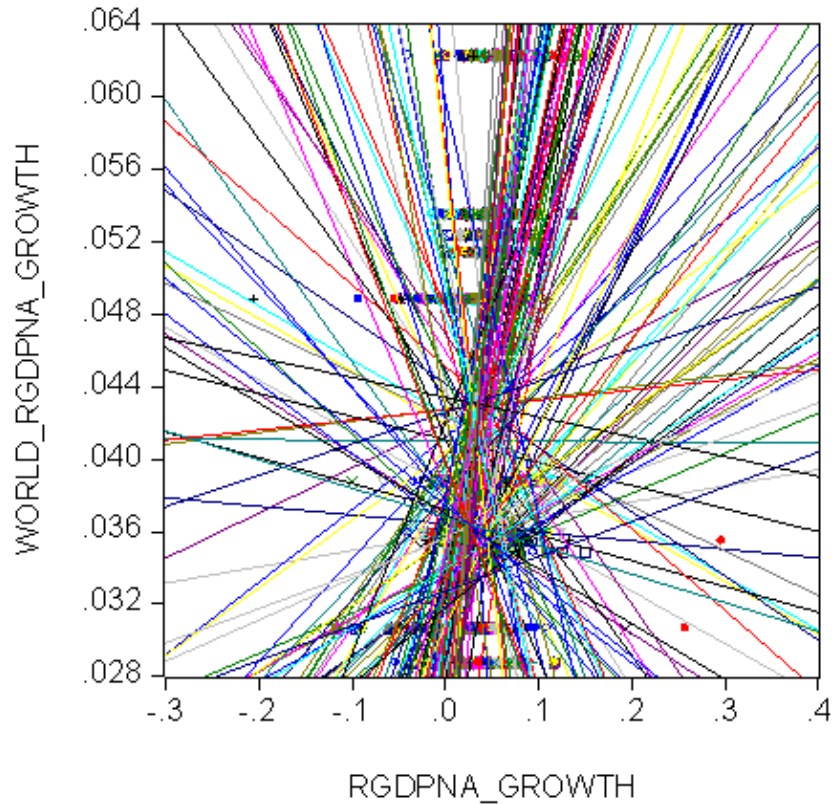


Figure 1: Inividual country versus world growth, 1950-20011. Source: PWT 8.0.

What is going on? Indeed, under certain conditions it is possible for income to *decline* following a rise in external demand for a country's products. This happens, for example, if the substitution elasticities are very low both on the supply and demand sides, or if there are common shocks to the non-tradable sector across the world.⁵ In reality, the reasons may vary from country to country, although the case of China, the most talked about recent success story, may be illustrative (see Figure 2). China grew relatively slowly when global growth was robust in the 1950s and 60s, and grew rapidly when global growth was less impressive in the 80s, 90s, and 2000s. Obviously the underlying story involves something more than the growth of world demand. The figure hints at one such story. The correlation between Chinese output and accumulation growth is robustly positive.

Figure 3 illustrates the Chinese story from a different angle. Notice once again how the periods of boom and low growth in China differ from similar ups and downs in global demand. In addition notice how periods of high (low) growth generally coincide with high (low) capital accumulation (*RKNA_GROWTH*). We will have more to say about capital accumulation in the next two sections.

⁵See Razmi (2010) for a more detailed discussion.

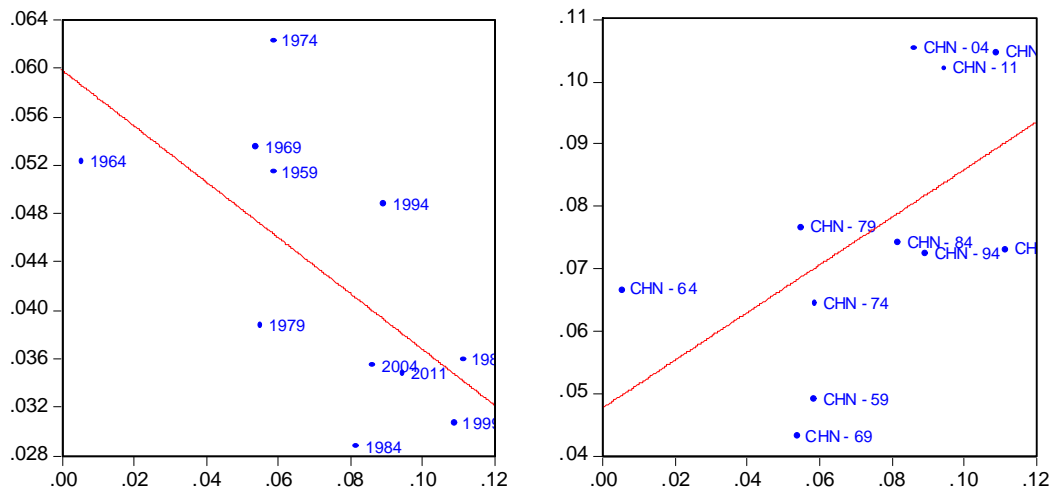


Figure 2: Chinese growth vs. (1) world growth, (2) accumulation. Calculations based on 5-year averages. Source: PWT 8.0.

4 The role of relative prices

Relative prices are often ignored in the BPCG framework on the grounds either that: (1) they change little over time, or (2) price elasticities of demand are low, or (3) since it is *changes* in relative prices that matter (see equation (4)), successful growth would involve continuous depreciation rather than a one time change; such a scenario is unsustainable. These three explanations are logically distinct, and in some circumstances (1) and (2) may even be mutually inconsistent.⁶ Point (2) may render impotent even large relative price changes. Large price elasticities of demand, on the other hand, may magnify the impact of small price changes. Thus, it is important to look at these assumptions in isolation.

As we show in the next section, (1) would imply the small country, price taking assumption, with infinitely elastic export *demand* and import supply elasticities. But in this case world demand growth becomes irrelevant! In a Keynesian price setting framework, with infinitely elastic export *supplies*, relative prices will change with the nominal exchange rate when measured in the same currency.⁷

Point (2), i.e., low demand elasticities, postulates that price elasticities of demand fail to satisfy the Marshall-Lerner condition. This does not render relative prices irrelevant. In fact, a logical implication that few economists would support as a policy implication – thanks to a large body of

⁶For example, as discussed later, the small country case involves small price changes exactly because elasticities are high.

⁷Which is why nominal exchange rate changes have proportional effects on the real exchange rate in rigid price Keynesian models.

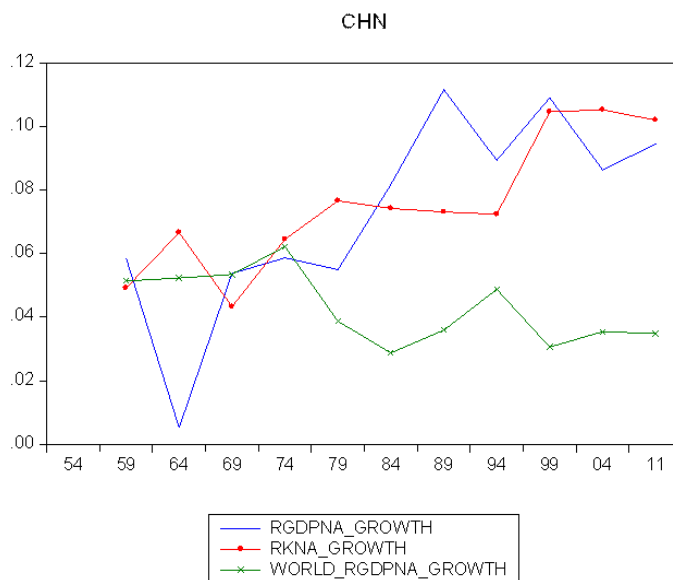


Figure 3: Trends in Chinese growth, capital accumulation, and global growth. Source: PWT 8.0.

empirical findings – is to maintain an appreciated real exchange rate. But suppose the magnitude of elasticities is indeed such that $\eta_X + \eta_M \approx 1$, dampening the effects of relative price changes. The magnitude of trade elasticities is an empirical question that could at least potentially be addressed econometrically. Empirical work to date has been inconclusive although recent studies have tended to find long-run demand elasticities high enough to satisfy the Marshall-Lerner condition.⁸ Moreover, it suffers from weaknesses such as the likely endogeneity of relative prices and the failure to take into account supply-side issues while estimating trade parameters.

Turning to supply-side price elasticities, both the BPCG framework and the Marshall-Lerner condition assume infinitely high export supply elasticities. But how plausible is this? One could argue that, for the typical country, it is quite reasonable to assume that the elasticity of supply from the rest of the world is infinitely high, i.e., the typical country is a price taker in the import market. The plausibility of high elasticities on the export supply side is much more questionable, especially once one thinks outside the very short run. It would require a deeply and permanently depressed economy with persistent underutilization of resources, especially capital. This is implausible for most advanced economies, not to speak of developing ones. In fact, traditional structuralist literature, even when coming from economists with Keynesian leanings, has emphasized low supply price elasticities for Southern countries.⁹ This is in direct contrast to the BPCG assumption. The former assumption is also more consistent with the assumption of full capacity utilization for the South typically made by structuralist models.¹⁰

The issue of supply-side elasticities is relevant to that of low estimated demand elasticities. As

⁸See, for example, Hooper et al. (2000) and Bahmani-Oskoei and Niroomand (1998) for studies with large numbers of countries.

⁹See Prebisch (1950), Singer (1950), and related literature, for example.

¹⁰See Blecker (1996), Dutt (1990), and Taylor (1983), for example.

discussed in the next section, with fully specified export and import good markets, relative prices are endogenous. Empirical studies of the BPCG model, however, do not estimate equations based on reduced form solutions. Instead, the assumption of an infinite price elasticity of supply removes the need to include supply-side variables. As Orcutt (1950) pointed out a long time ago, this is likely to introduce a significant downward bias in estimates of price elasticities. The reason is simple and can be intuitively explained. With an upward-sloping supply curve and a downward-sloping demand curve, demand-side shocks will create a positive correlation between export prices and equilibrium quantities while supply-side shocks will create a negative correlation. Econometric estimates that regress prices on quantities are likely to find the average effect, which, unless the former source of shocks is negligible, is likely to be misleadingly low. While the neglect of supply-side adjustments in estimating trade equations has traditionally been justified by the paucity of data, this argument is less tenable today, and recent studies – although none to my knowledge in the BPCG tradition – have begun to address this issue.¹¹

On a related note, a broader question emerging from our earlier discussion is that of whether it is the level or rate of change of prices that matters. Based on equation (4), modelers in the BPCG tradition have argued that, if anything, it is the latter. This, however, is in conflict with a growing body of theoretical and empirical literature that has shown that output growth and investment are a positive function of the degree of real undervaluation, although this result tends to hold much more robustly for developing countries. This literature typically defines the relevant price as that of tradables relative to non-tradables. The tradable sector is generally associated with industrial production while agricultural products – rendered non-tradable in many cases by country regulations – and services constitute the bulk of non-tradables. If there is anything *special* about the tradable sector, then shifting resources toward this sector through the appropriate relative price signal can have beneficial consequences. Rodrik (2008), for example, hypothesizes that the tradable sector is subject to market imperfections to a greater extent. Boosting profitability in this sector through a policy of undervaluation could, therefore, act as a second best policy to achieve growth. Razmi et al. (2012), on the other hand, focus more on the presence of underemployed labor in developing economies where a modern industrial sector exists along with the traditional non-tradable sector. Boosting profitability through real undervaluation in such an economy can generate accumulation, growth, and industrial employment. These studies find positive and statistically significant effects of undervaluation on growth and investment, respectively.¹² Once again, China is not a bad choice for illustration (see Figure 4 below). Continuously depreciating the real exchange rate may not be required to deliver the goods.¹³

In sum, reasons (1) and (2), as stated above, are logically distinct and should not be mixed up. Regarding (1), the role of relative prices is logically inconsistent in the BPCG model, since constant and exogenous relative prices, i.e., purchasing power parity (PPP), is a small country assumption. If actual historical data indicate minimal relative price changes, that arguably supports the PPP view of the world. Regarding (2), if supply and demand both matter, then relative prices are

¹¹See, for example, Cheung et al. (2009), who estimate that a one percent increase in the Chinese manufacturing capital stock – used as a proxy for export supply capacity – induces between a 2.2 -2.5% increase in real exports. Catão and Falcetti (2002) find an export supply elasticity nearing unity for Argentina.

¹²Other relevant works include Hausmann et al. (2005), Levy-Yeyati and Sturzenegger (2007), Polterovich and Popov (2002), Frenkel and Ros (2006), and Porcile and Lima (2010).

¹³No pun intended. On a related note, Freund and Pierola (2008) find, based on a comprehensive sample, that real depreciations are associated with export *accelerations*. Changes in relative price levels, in other words, may generate sustained changes in the growth rates of exports. We do not pursue this matter here in the interest of maintaining focus.

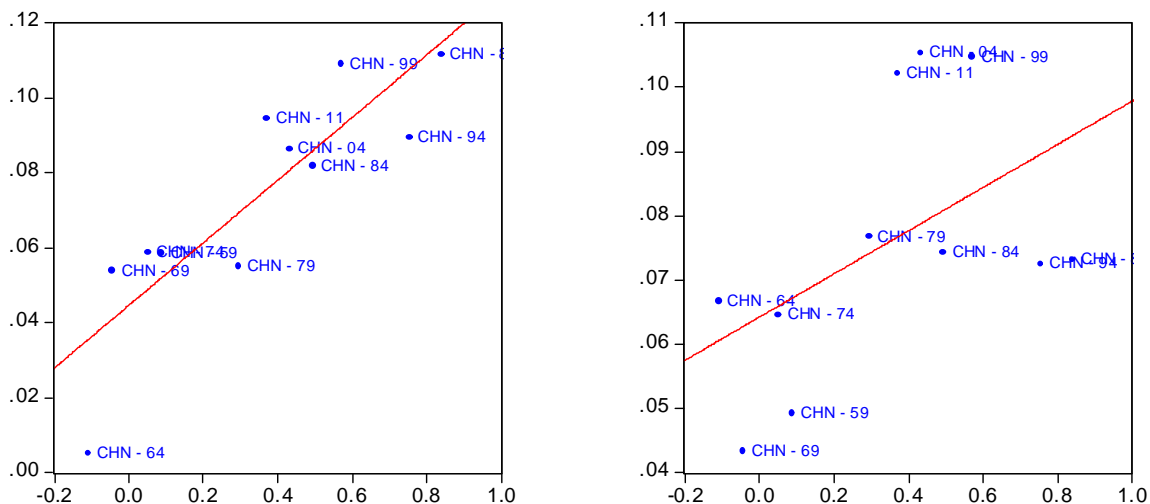
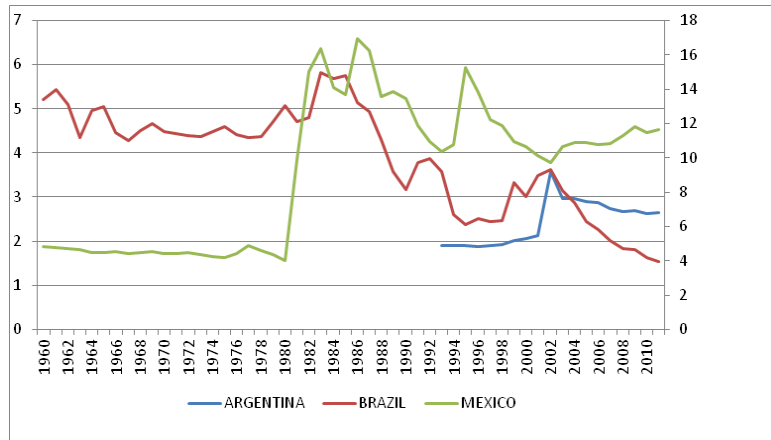


Figure 4: Scatter plots for China of the degree of undervaluation vs. (1) GDP growth (left panel), and (2) accumulation (growth of capital stock) (right panel). Source: PWT 8.0

endogenous, and there is likely to be a downward bias in the standard estimates of price elasticities. In any event, this is an empirical question. Most studies have only estimated demand side equations with relative prices treated as exogenous. The assumption required for this, i.e., infinite supply elasticities, is at least as strong as that underlying the PPP doctrine. Regarding (3), there is growing evidence that when it comes to relative prices the level rather than, or in addition to, changes may matter for profitability and investment.

Finally, we end this section on a broader note, by stepping back for one more look at the question of output versus relative price adjustment in the face of external imbalances. It is often argued that output adjustments tend to overwhelmingly dominate. As pointed out before, this runs counter to much structuralist literature concerning North-South interactions. Moreover, empirical data indicate, at least in the case of dramatic events, that relative prices do adjust. Figures 4 and 5 illustrate such adjustments. Notice the large real depreciation in Mexico coincident with the crises of 1981-82 and 1994, and similar developments in Brazil (1982 and 1999), and Argentina (2002). In the case of the two East/Southeast Asian economies, notice the large depreciations following the Asian crisis of 1997-8.



CPI-based real exchange rates. Source: World Development Indicators

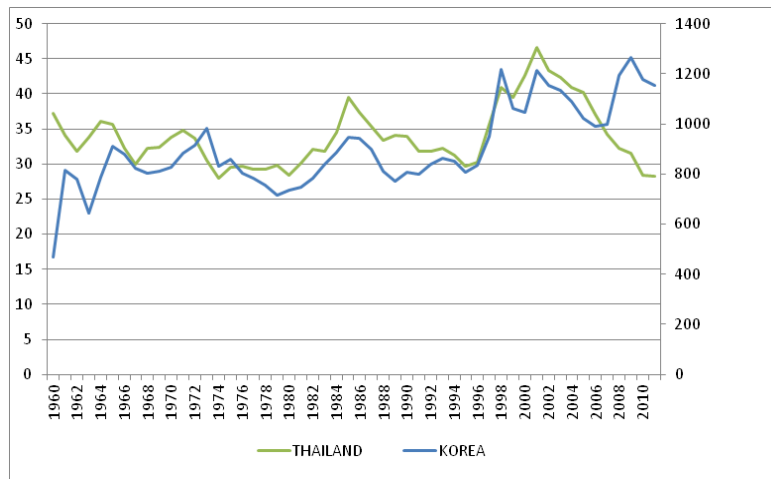


Figure 5: CPI-based real exchange rates. Source: World Development Indicators

Simultaneous adjustment in output and relative prices, dramatically illustrated here for the case of large movements, is not surprising. As argued by Krugman (1988), output and relative price adjustments are better seen as complements rather than substitutes.¹⁴ The reason can be intuitively explained with the aid of a simple example. Consider a two country world and suppose that removal of a trade imbalance between the two countries requires a transfer of expenditure equivalent to \$1 billion dollars from Country A to the rest of the world (ROW). Suppose further that the marginal propensity to spend on domestic goods is 0.8 in Country A. Then a \$1 billion cut in expenditure in Country A translates into a fall in demand for that country's good worth \$800 billion. What must be the marginal propensity to import in ROW to avoid an excess supply

¹⁴An earlier discussion of these issues, which came to be known as the "transfer problem" emerged from the debates between Keynes and Bertil Ohlin on the German reparation issue.

of goods in Country A? The answer obviously is 0.8.¹⁵ But such a high marginal propensity runs in the face of all evidence that points to a “home bias” in consumption (not to mention the fact that most domestic goods are typically non-traded). Suppose more plausibly instead that the marginal propensity to import in ROW too is 0.2. This means that the transfer of spending power increases ROW demand for the Home good by \$200 billion. We end up with an excess supply of Country A goods worth \$600 billion. Over time, faster growth in ROW may increase expenditure sufficiently to remove the excess supply, but barring the situation where ROW has high levels of excess capacity, relative prices will have to give during the transition. To borrow John Williamson’s evocative phrase, the idea of an “immaculate transfer” is too good to be true.

5 Issues of causation

It is now time to summarize the previous discussion, and expand on its implications, with the help of a simple framework that captures both supply and demand side issues. This section presents the framework and shows that relative prices are constant only in the small country case. Moreover, while it is the growth of world demand that matters for domestic output growth in the BPCG case (i.e., perfectly elastic supply with under-utilized resources), this is no longer true in the small country case where the relevant variable instead is the rate of domestic capital accumulation. The theoretical implications for the testing of the BPCG model are then drawn out as a segue to the preliminary empirical exploration carried out in the next section.

Consider trade supply and demand equations of the standard form:¹⁶

$$X^S = f(P_X, K); f_1, f_2 > 0 \quad (9)$$

$$X^D = g\left(\frac{P_X}{EP_M}, Y^*\right); g_1 < 0, g_2 > 0 \quad (10)$$

$$M^S = \alpha(P_M); \alpha' > 0 \quad (11)$$

$$M^D = \gamma\left(\frac{P_X}{EP_M}, Y\right); \gamma_1, \gamma_2 > 0 \quad (12)$$

where K denotes a scale variable, such as the level of the capital stock, that reflects the capacity to export.¹⁷ The inclusion of nominal rather than relative prices in the supply functions reflects the simplifying assumption that each country produces a single good and imports the other one, i.e., there is no substitution between exportables and importables on the production side.

The exportable market clearing condition then becomes:

$$X^S = X^D = X$$

which, after log-differentiating, yields

¹⁵I use a numerical exercise here for intuition but the conclusions will hold as long as the marginal propensities to import for the two areas add up to less than unity, that is, as long as there is some home bias in at least one country.

¹⁶Notice that equations (10) and (12) are the same as eqs. (1) and (2) defined earlier but we re-state them here for convenience.

¹⁷This could be interpreted as reflecting the stylized fact that the tradable industrial sector is generally the more capital-intensive one, especially in developing countries.

$$\hat{P}_X = \frac{\eta_X(\hat{P}_M + \hat{E}) - \sigma_K \hat{K} + \pi_X \hat{Y}^*}{\eta_X + \varepsilon_X} \quad (13)$$

where η_X is the price elasticity of demand for our exports, ε_X is the corresponding price elasticity of supply, and σ_K and π_X are the scale elasticities of supply and demand.

Similarly, the market equilibrium condition for importables yields,

$$\hat{P}_M = \frac{\eta_X(\hat{P}_X - \hat{E}) + \pi_M \hat{Y}}{\eta_M + \varepsilon_M} \quad (14)$$

Finally, the trade balance condition rounds out the framework:

$$P_X X = E P_M M$$

or, after log differentiating,

$$\hat{P}_M = \frac{1 + \varepsilon_X}{1 + \varepsilon_M} \hat{P}_X - \frac{1}{1 + \varepsilon_M} \hat{E} \quad (15)$$

Equations (13), (14), and (15) yield three equations in \hat{P}_X , \hat{P}_M , and \hat{Y} . Substituting the latter into (13) yields the reduced form solution for \hat{P}_X .

$$\hat{P}_X = \frac{\eta_X \varepsilon_M \hat{E} - (1 - \eta_X + \varepsilon_M) \sigma_K \hat{K} + (1 + \varepsilon_M) \pi_X \hat{Y}^*}{(\eta_X + \varepsilon_X) \varepsilon_M + (1 - \eta_X) \varepsilon_X} \quad (16)$$

Next, from equations (16) and (15),

$$\hat{P}_M = - \frac{(1 - \eta_X) \varepsilon_X \hat{E} - (1 - \eta_X) \sigma_K \hat{K} + (1 + \varepsilon_X) \pi_X \hat{Y}^*}{(\eta_X + \varepsilon_X) \varepsilon_M + (1 - \eta_X) \varepsilon_X} \quad (17)$$

Before we derive the expression for output growth, it would be worthwhile to highlight some implications:

1. First, with an infinite elasticity of world supply of our imports (i.e., $\varepsilon_M \rightarrow \infty$), an assumption shared by the BPCG and small country models,

$$\hat{P}_X = \frac{\eta_X}{\eta_X + \varepsilon_X} \hat{E} + \frac{\pi_X}{\eta_X + \varepsilon_X} \hat{Y}^* \quad (18)$$

$$\hat{P}_M = - \frac{(1 - \eta_X) \varepsilon_X \hat{E} - (1 - \eta_X) \sigma_K \hat{K} + (1 + \varepsilon_X) \pi_X \hat{Y}^*}{(\eta_X + \varepsilon_X) \varepsilon_M + (1 - \eta_X) \varepsilon_X} \quad (19)$$

2a Furthermore, with $\varepsilon_X \rightarrow \infty$ (i.e., the BPCG case), $\hat{P}_X = \hat{P}_M = 0$.

2b Alternatively, with $\eta_X \rightarrow \infty$ (the small country case), $\hat{P}_X = \hat{E}$, while $\hat{P}_M = 0$

Notice first that, in the general case, relative prices are endogenous and are constant *only* in the small country case.¹⁸ A nominal devaluation has no effect in the latter case on relative prices when measured in the same currency unit, i.e., the terms of trade are exogenous. In the BPCG case, 2a, $\hat{P}_X - \hat{E} - \hat{P}_M = -\hat{E}$, i.e., a nominal devaluation affects relative prices equiproportionately. Second, due to their different underlying assumptions, PPP cannot be used to justify the omission of relative prices while deriving the BPCG expression. Third, in the BPCG case, it is demand-side price elasticities (η_X, η_M) that come into play while in the small country case, it is the supply side elasticity ε_X that matters. This is *exactly* because, in the BPCG case, relative prices change, so that demand side substitution comes into play via eqs. (10) and (12). In the small country case, a nominal devaluation translates into a rise in the domestic export price but does *not* cause relative price changes, so that the supply of exportables rises (via equation (9)) without affecting demand.

Finally, turning to output growth, from (13), (14), and (17),

$$\hat{Y} = \frac{(\eta_X + \eta_M - 1)\varepsilon_M}{(\eta_X + \varepsilon_X)\varepsilon_M + (1 - \eta_X)\varepsilon_X} \frac{\varepsilon_X}{\pi_M} \hat{E} + \frac{(\eta_X + \eta_M - 1)\varepsilon_M}{(\eta_X + \varepsilon_X)\varepsilon_M + (1 - \eta_X)\varepsilon_X} \frac{\sigma_K}{\pi_M} \hat{K} + \frac{(\eta_M + \varepsilon_M)\varepsilon_X + (1 - \eta_M)\varepsilon_M}{(\eta_X + \varepsilon_X)\varepsilon_M + (1 - \eta_X)\varepsilon_X} \frac{\pi_X}{\pi_M} \hat{Y}^* \quad (20)$$

Implications under alternative scenarios:

1' With $\varepsilon_M \rightarrow \infty$ (both BPCG and small country case),¹⁹

$$\hat{Y} = \frac{\eta_X + \eta_M - 1}{\eta_X + \varepsilon_X} \frac{\varepsilon_X}{\pi_M} \hat{E} + \frac{\eta_X + \eta_M - 1}{\eta_X + \varepsilon_X} \frac{\sigma_K}{\pi_M} \hat{K} + \frac{\varepsilon_X + 1 - \eta_M}{\eta_X + \varepsilon_X} \frac{\pi_X}{\pi_M} \hat{Y}^*$$

2a' Furthermore, with $\varepsilon_X \rightarrow \infty$ (BPCG case),

$$\hat{Y} = \frac{\eta_X + \eta_M - 1}{\pi_M} \hat{E} + \frac{\pi_X}{\pi_M} \hat{Y}^*$$

2b' Alternatively, with $\eta_X \rightarrow \infty$ (small country case),

$$\hat{Y} = \frac{\varepsilon_X}{\pi_M} \hat{E} + \frac{\sigma_K}{\pi_M} \hat{K}$$

In the BPCG case, world growth (demand) matters whereas in the small country case, it is domestic capital accumulation via growth in the capacity to export.²⁰ To the extent that investment (normalized by the level of capital stock) is a function of the profit rate in the exportable/tradable sector, which in turn is a function of the relative price of the tradable/exportable product (Home doesn't produce the importable), the growth rate is a function of the *level* of relative prices. Thus,

¹⁸Notice from 2b that $\hat{P}_X - \hat{E} - \hat{P}_M = 0$.

¹⁹Recall that $\eta_X + \eta_M - 1$ is the Marshall-Lerner condition (which is derived assuming infinite export supply elasticities).

²⁰The appearance of the *nominal* exchange rate as a determinant of growth of real output may appear a bit puzzling. Recall that changes in the nominal exchange rate translate into real changes in the BPCG set-up. Since producers set prices in their own currency, a change in the nominal exchange rate turns into a change in the relative price facing consumers. In the small country case, by contrast, a nominal exchange rate change translates into a change in the domestic currency export price facing producers.

ultimately, it is the level of the real exchange rate that partly drives growth in the small country case. More realistically, it is a combination of these factors that drives growth, although one might argue that the drivers will vary across economies and with the time horizon under consideration.

If relative prices and investment matter, then arises the question of causation. Given output adjustment that respects the balance of payments constraint, at least two channels emerge:

(1) In the traditional BPCG story, causation is based on Case 2a' and flows from world demand growth to exports, and from there to income growth and the ability to import capital goods.

(2) In an alternative story, based on equation (2b'), the causation flows from accumulation (perhaps involving capital goods imports) to an increase in output growth and the capacity to export (and import), thus avoiding running into balance of payments problems.²¹

It is time for a preliminary look at the data.

6 Preliminary empirical exploration

Ideally, one would like to estimate reduced form equations such as eqs. (17) - (20) to gain some idea of the magnitudes of parameters. The scope of the present paper precludes such an effort. However, the previous section suggests five variables on which to base a preliminary empirical exploration: (1) world demand growth in real terms, (2) relative price changes, (3) capital stock growth, (4) real exchange rate levels, and of course, (5) real domestic income growth. I obtained data for these variables from the Penn World Tables (PWT 8.0). Table 2 provides a data dictionary. I have data for 167 countries for the period 1950-2011. All data are averaged over 5 year periods, except for the period (2005-11), which spans seven years.

Let's begin with a look at the correlation matrix (Table 3). The correlation that stands out with a magnitude of 0.60 is the positive one between the growth of domestic capital stock and domestic output. The correlation between domestic and world GDP growth is also positive but, at 0.17, much lower.²² Simple correlations may be misleading, of course. We need to dig deeper.

²¹This is essentially the mechanism at work in Razmi et al. (2012).

²²Notice that the variable capturing world growth, *WORLD_RGDPNA_GROWTH* includes data for the entire world, and hence has the same value for all countries in a given year. Changing the calculation of this variable so as to exclude the GDP data for each individual country for which the world growth rate is calculated makes no noticeable difference to any of our results. The correlation between the two growth rate series is almost perfect.

Table 2: Data definitions, sources, and coverage

Variable Name	Code	Definition	Source	Coverage
GDP	<i>RGDPNA</i>	Real GDP at constant 2005 national prices (in mil. 2005US\$)	PWT 8.0	1950-2011
GDP Growth	<i>RGDPNA_GROWTH</i>	$[(RGDPNA_t/RGDPNA_{t-1})^{0.2}] - 1$	PWT 8.0	1950-2011
World GDP	<i>WORLD_RGDPNA</i>	$\sum_{i=1}^N RGDPNA$	PWT 8.0	1950-2011
World GDP Growth	<i>WORLD_RGDPNA_GROWTH</i>	$= \left(\frac{WORLD_RGDPNA_t}{WORLD_RGDPNA_{t-1}} \right)^{0.2} - 1$	PWT 8.0	1950-2011
Capital stock	<i>RKNA</i>	Capital stock at constant 2005 national prices (in mil. 2005US\$)	PWT 8.0	1950-2011
Capital stock growth	<i>RKNA_GROWTH</i>	$[(RKNA_t/RKNA_{t-1})^{0.2}] - 1$	PWT 8.0	1950-2011
Exchange rate	<i>XR</i>	Units of domestic currency per unit of foreign currency	PWT 8.0	1950-2011
Export price	<i>PL_X</i>	Price level of exports, price level of USA GDP in 2005=1	PWT 8.0	1950-2011
Import price	<i>PL_M</i>	Price level of imports, price level of USA GDP in 2005=1	PWT 8.0	1950-2011
Relative export price	<i>RPLX</i>	$= PL_X/PL_M$		
Change in <i>RPLX</i>	<i>RPLX_CHANGE</i>	$[(RPLX_t/RPLX_{t-1})^{0.2}] - 1$		
Undervaluation	<i>LNUNDERVAL</i>	The log of real exchange rate undervaluation		

Table 3: Correlation matrix. Source: PWT 8.0

	<i>RGDPNA_GROWTH</i>	<i>WORLD_RGDPNA_GROWTH</i>	<i>RKNA_GROWTH</i>	<i>RPLX_GROWTH</i>	<i>LNUNDERVAL</i>
<i>RGDPNA_GROWTH</i>	1.00				
<i>WORLD_RGDPNA_GROWTH</i>	0.17	1.00			
<i>RKNA_GROWTH</i>	0.60	0.02	1.00		
<i>RPLX_GROWTH</i>	0.01	-0.05	0.07	1.00	
<i>LNUNDERVAL</i>	0.07	-0.02	0.04	0.02	1.00

Table 4 presents estimates from regressions based on the following general form of equation (20):

$$RGDPNA_GROWTH_i = \varphi_0 + \varphi_1 \times WORLD_RGDPNA_GROWTH + \varphi_2 \times RKNA_GROWTH_i + \varphi_3 \times RPLX_GROWTH_i + f_i + \epsilon \quad (21)$$

Column (1) presents estimates from a simple regression involving national growth rates, a constant term, and the world growth rate. Heterogeneity across cross-sections is addressed through a fixed effects specification, although I cannot control for time fixed effects due to the presence of the world growth rate term. Columns (2)-(4) introduce additional variables. Columns (5)-(8) incorporate lags and another control variable discussed earlier, i.e., the (log of) degree of real undervaluation (*LNUNDERVAL*).²³

Let's start with the simplest possible specification. Column (1) presents the estimates derived with *WORLD_RGDPNA_GROWTH* as the only regressor. The coefficient on the world growth rate is positive and significant at the one percent level. A one percentage point increase in the world growth rate increases average country growth by 0.55 percentage points. However, this coefficient declines somewhat once we add *RKNA_GROWTH* as an additional explanatory variable, which has a coefficient of 0.58, and is significant at the one percent level (see Column (2)). Indeed, column (3) shows that the standardized coefficient for accumulation is more than three times that of world growth.²⁴

Columns (4) and (5) introduce the growth of relative export price (*RPLX_GROWTH*) and *LNUNDERVAL*, respectively. As shown earlier, the former is an endogenous variable unless we make the small country assumption. In keeping with tests of the BPCG hypothesis, I treat it as exogenous here, although we relax this assumption shortly. Both variables are insignificant, even though the signs accord with prior expectations. The negative sign associated with *RPLX_GROWTH* is what one would expect if the Marshall-Lerner condition is satisfied. The positive sign associated with *LNUNDERVAL* is consistent with the literature on real undervaluation and growth discussed earlier, although some of the effect of this variable on growth via investment may already be captured by the inclusion of *RKNA_GROWTH*.

Columns (6) incorporates first lags of the regressors in order to address the issue of slow adjustment over time. The lower panel of the table shows the long-run coefficients (which in this case are simply the sum of the individual coefficients). Again, the long-run coefficients for both scale variables are positive and significant. However, as Column (7) shows, the effect of accumulation is much greater than that of world growth (standardized coefficients of 0.46 versus 0.11). The effects of relative export price changes and undervaluation remain negative and positive, respectively, although these are statistically insignificant in both cases.

²³Following other growth studies, I also included the lagged value of national GDP (*RGDPNA_AVE_{t-1}*) to capture convergence effects. This coefficient, although correctly signed, was statistically insignificant at the 10 percent level in this and other regressions. I subsequently dropped this variable.

²⁴One could argue, in the spirit of the BPCG framework, that world growth itself boosts investment, and that the results above reflect this channel. But if this is the case, then, in a regression of the form:

$$RGDPNA_GROWTH = \alpha_0 + \alpha_1 WORLD_RGDPNA_GROWTH + \alpha_2 RKNA_GROWTH + \alpha_3 WORLD_RGDPNA_GROWTH_{t-1} + \epsilon$$

the coefficient on α_2 should decline and turn insignificant since the effect of investment that originates from world demand growth would be captured, at least partially, by α_3 . However, running such a regression leaves α_2 unchanged, strongly suggesting that other mechanisms are at work.

As discussed while deriving eqs. (16), (17), and (20), some of the variables in our sample could potentially be endogenous in the sense that these are jointly determined with the dependent variable. For example, relative prices may not be exogenous to world income growth and domestic investment. Moreover, some of the variables are likely to exhibit hysteresis or persistence over time. To explore the robustness of the baseline OLS estimates to potential endogeneity/simultaneity issues, I therefore, carry out dynamic panel estimations using the Arellano-Bover General Method of Moments (GMM) approach. I specify the second and third lags of the dependent variable as instruments in addition to the third lags of the explanatory variables. Consistent with the earlier OLS strategy, I specify cross-section fixed effects. The Sargan test of overidentifying restrictions is employed to test the validity of the instruments. The long-run coefficients are now calculated as the sum of individual coefficients divided by one minus the coefficient on the lagged dependent variable.

Column (8) presents the GMM results. Coefficients for both scale variables continue to be positive, although that for *WORLD_RGDPNA_GROWTH* is smaller and no longer statistically significant (the p-value is 0.83). Moreover, controlling for endogeneity via the GMM approach makes both relative price variables statistically significant. The relative price of exports now appears with a large and negative coefficient while that of undervaluation is positive. Unlike the OLS estimates, both are statistically significant, perhaps reflecting the successful use of instruments.

Finally, let us return for a moment to an earlier reference to the relationship between the real exchange rate and growth. As mentioned earlier, there is some evidence pointing towards a positive effect of real undervaluation on growth. Do our data concur? A thorough investigation is beyond the scope of this study but Table 5, which presents (non-standardized and standardized) OLS and GMM estimates provides some preliminary support. A one standard deviation rise in the degree of undervaluation raises investment growth by 0.14 standard deviations. An implication is that investment may provide one of the underlying mechanisms through which real undervaluation boosts growth.

In sum, although both world growth and the growth of domestic accumulation have positive effects on country growth, the OLS and GMM estimates indicate that the effect of the latter is much larger. The component plus residual residual plot shown in Figure 6, which is based on column (5) of Table 4 helps illustrate this conditional effect. The GMM estimate for the long-run coefficient of *WORLD_RGDPNA_GROWTH* is statistically insignificant. Moreover, there is some preliminary evidence that the effect of investment growth partially originates from real undervaluation. These results were partly anticipated by the correlation matrix (Table 3) and the scatter plot presented in Figure 1.

6.1 The case of China

Finally, let's turn again to China in order to highlight the shortcomings that almost all existing empirical studies of the BPCG framework may be subject to. Given the limited number of degrees of freedom, I follow other BPCG studies in turning to annual data. Unsurprisingly, Figure 7 shows that the negative and positive correlations between Chinese growth and world growth on the one hand and Chinese growth and accumulation on the other that we first saw in Figures 2 survive the switch to annual data.

Table 4: OLS Growth regressions: 1950-2011

Dependent variable: <i>RGDPNA_GROWTH</i> (Growth rate of real GDP) ^a								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS	GMM
			Standardized				Standardized	
Constant	0.016 (0.007)	-0.005 (0.429)		-0.006 (0.328)	-0.005 (0.361)	0.007 (0.093)		
<i>RGDPNA_AVE</i> _{t-1}		-1.78E-09 (0.139)						
<i>WORLD_RGDPNA_GROWTH</i> _t	0.546 (0.003)	0.479 (0.005)	0.150	0.489 (0.003)	0.482 (0.003)	0.336 (0.062)	0.111	0.211 (0.111)
<i>RKNA_GROWTH</i> _t		0.583 (0.000)	0.553	0.586 (0.000)	0.581 (0.000)	0.695 (0.000)	0.719	0.899 (0.000)
<i>RPLX_GROWTH</i> _t				-0.016 (0.536)	-0.018 (0.492)	0.004 (0.796)	0.004	-0.267 (0.049)
<i>LNUNDERVAL</i> _t					0.004 (0.330)	0.013 (0.000)	0.169	0.086 (0.000)
<i>WORLD_RGDPNA_GROWTH</i> _{t-1}						0.001 (0.991)	0.001	-0.1667 (0.319)
<i>RKNA_GROWTH</i> _{t-1}						-0.247 (0.000)	-0.258	-0.499 (0.000)
<i>RPLX_GROWTH</i> _{t-1}						-0.021 (0.355)	-0.021	-0.387 (0.137)
<i>LNUNDERVAL</i> _{t-1}						-0.009 (0.048)	-0.118	-0.052 (0.000)
<i>RGDPNA_GROWTH</i> _{t-1}								0.228 (0.004)
Time Dummies	no	no	no	no	no	no	no	no
Country Dummies	yes	yes	yes	yes	yes	yes	yes	yes
Long-run coefficients								
<i>WORLD_RGDPNA_GROWTH</i>						0.337	0.112	0.057
<i>p-value</i>						(0.005)	(0.005)	(0.831)
<i>RKNA_GROWTH</i>						0.448	0.461	0.518
<i>p-value</i>						(0.005)	(0.005)	(0.016)
<i>RPLX</i>						-0.017	-0.017	-0.847
<i>p-value</i>						(0.499)	(0.499)	(0.031)
<i>LNUNDERVAL</i>						0.004	0.051	0.044
<i>p-value</i>						(0.159)	(0.159)	(0.009)
Adjusted R-squared	0.173	0.393	0.393	0.394	0.395	0.492	0.492	
J-statistic								10.953
Instrument rank								20
Sargan test (p-value)								0.447
Cross-sections included	167	167	167	167	167	167	167	144
Observations	1432	1423	1423	1420	1420	1253	1253	920

^a p-values in parentheses

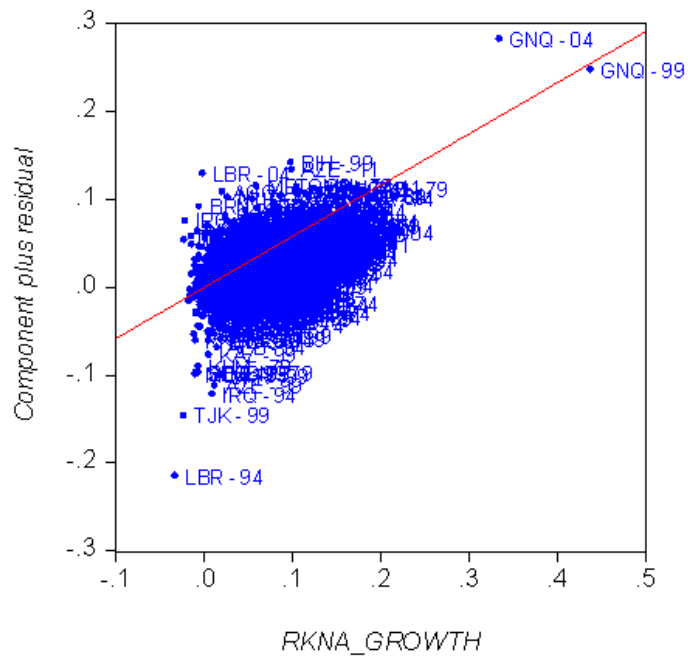


Figure 6: Component plus residual for *RKNA_GROWTH* based on Column (5) of Table Growth_OLS.

Table 5: The effect of real undervaluation on investment growth
 Dependent variable: *RKNA_GROWTH* (Growth rate of capital stock)^a

	(1)	(2)	(3)
	OLS	OLS	GMM
	Standardized		
Constant	0.043 (0.000)		
<i>RKNA_GROWTH</i> _{<i>t-1</i>}			0.656 (0.000)
<i>LNUNDERVAL</i> _{<i>t</i>}	0.004 (0.553)	0.046	0.006 (0.864)
<i>LNUNDERVAL</i> _{<i>t-1</i>}	0.006 (0.513)	0.081	0.055 (0.335)
<i>LNUNDERVAL</i> _{<i>t-2</i>}	0.001 (0.865)	0.012	-0.030 (0.222)
Time Dummies	yes	yes	yes
Country Dummies	yes	yes	yes
Long-run coefficients			
<i>LNUNDERVAL</i>	0.011 (0.010)	0.139	0.090 (0.029)
Adjusted R-squared	0.40	0.41	
J-statistic			
Instrument rank			
Sargan test (p-value)			
Cross-sections included	167	167	143
Observations	1238	1238	904

^a p-values in parentheses

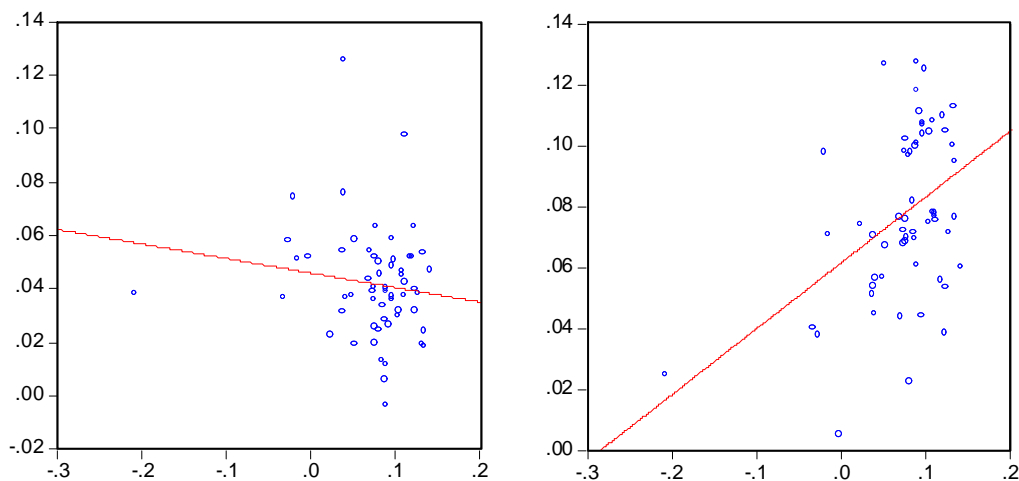


Figure 7: Scatterplots for annual Chinese GDP growth versus: (1) world GDP growth, (2) accumulation growth. Source: PWT 8.0.

Table 6 presents estimates of the determinants of Chinese growth. In keeping with the spirit of the BPCG model, my focus is long run. Now, however, I am using annual data so that the use of cointegration techniques – with variables defined in the form of log levels instead of growth rates – is an obvious choice. I, therefore, use three different cointegration techniques: (1) the dynamic OLS (DOLS) with two leads and lags, (2) the Fully Modified OLS (FMOLS) with two lags, and (3) the Canonical Cointegrating Regressions (CCR) technique, again with two lags. The results reveal something interesting. As seen from columns (1), (3), and (5), world growth has a positive effect on Chinese growth as long as the latter is the only explanatory variable used (in addition to a deterministic trend); in other words, as long as we follow a number of BPCG studies in estimating a version of equation (5). However, as soon as the other variables suggested by equation (20) are included, the statistical significance of world growth for Chinese growth collapses.²⁵ Capital accumulation remains significant throughout (see columns (2), (4), and (6)), and the coefficient is stable (it ranges from 0.99-1.17). The export and import price coefficients yield the expected signs with the exception of the FMOLS estimates, with greater price competitiveness being positively associated with growth, although in most cases the coefficient is statistically insignificant. Finally, the coefficient of *LNUNDERVAL* is consistently positive and highly precisely estimated. The coefficient varies from 0.26 to 0.39. The relative price of tradables plays an important role in the Chinese case, suggesting that this is the appropriate variable to investigate rather than the relative export price.

In sum, looking at the case of China in isolation, we find more evidence that excluding capital

²⁵Notice that, now that I have increased degrees of freedom thanks to annual data, I use individual prices instead of the relative export price. This does away with the assumption of homogeneity in relative prices. Using relative prices instead does not qualitatively affect the results regarding the scale variables.

accumulation and relative prices may yield misleading results about the robustness of world demand as a determinant of country growth.

Table 6: Estimates for China based on three different cointegration methods: 1950-2011

Dependent variable: <i>RGDPNA_GROWTH</i> (Growth rate of real GDP) ^a						
	(1)	(2)	(3)	(4)	(5)	(6)
	DOLS	DOLS	FMOLS	FMOLS	CCR	CCR
Constant	-17.082 (0.000)	-4.142 (0.196)	-2034564 (0.272)	-0.818 (0.790)	-16.347 (0.004)	-3.634 (0.226)
<i>LOG(WORLD_RGDPNA)</i>	1.809 (0.000)	0.139 (0.549)	0.173 (0.002)	-0.193 (0.411)	1.78 (0.000)	-0.023 (0.920)
<i>LOG(RKNA)</i>		0.987 (0.000)		1.172 (0.000)		1.153 (0.000)
<i>LOG(PL_X)</i>		-1.506 (0.010)		0.312 (0.455)		-0.149 (0.712)
<i>LOG(PL_M)</i>		1.325 (0.024)		-0.619 (0.129)		-0.312 (0.421)
<i>LNUNDERVAL</i>		0.386 (0.000)		0.259 (0.001)		0.330 (0.000)
Adjusted R-squared	0.936	0.998	0.792	0.994	0.934	0.990
Leads	2	2				
Lags	2	2	2	2	2	2
Observations	57	55	60	59	60	59

^a p-values in parentheses

7 Concluding remarks

Any test of the BPCG hypothesis is, at least partly, a test of whether or not the current account is balanced over the long run. Or, rather more interestingly, it is an exercise in identifying the adjustment mechanisms that ensure that the current account is balanced over the long-run. The adjustment mechanisms could arise from the demand or supply side. The BPCG tradition has emphasized the demand side. However, there is something unsatisfactory about testing the hypothesis that demand matters by estimating the demand side only. Doing so creates logical and econometric problems, as does the conceptual treatment of relative prices. It is arguably better to incorporate both supply and demand side factors in a broader framework and then explore mechanisms that drive adjustment so that the balance of payments constraint is satisfied (the latter being a plausible working hypothesis).

In this paper, I have made the case that a reasonable test of the BPCG hypothesis should:

- (1) incorporate both supply and demand side effects
- (2) treat both the changes and levels of prices seriously, the former as endogenous variables, and
- (3) study issues of causation, especially that between world demand growth, output growth, capital accumulation, and relative prices.

I presented a framework that attempts to satisfy these requirements. Using a different approach to the question of whether it is world demand that constrains growth through the trade balance

raises questions about the empirical validity of the BPCG framework. In particular, it highlights the expectation that factors other than world demand growth may be crucial in many countries, even though standard tests of the BPCG hypothesis may suggest otherwise. Future work should explore alternative mechanisms more carefully. Moreover, it would be interesting to explore the characteristics of countries that render different factors salient. Such work may help reconcile the accumulating evidence that real undervaluation and relative prices matter with empirical support for the BPCG hypothesis.²⁶

8 Appendix: Deriving the index of real exchange rate misalignment

I follow the three-step methodology pursued by Rodrik (2008) to obtain an index of real exchange rate undervaluation. Using data from Penn World Tables 8.0, I first calculate the real exchange rate (RER) as the inverse of $PLGDPE$ (price level of expenditure-side real GDP at current PPPs in mil. 2005US\$), which in turn is the ratio of the purchasing power parity conversion factor (PPP) to the nominal exchange rate (XR). The latter two variables are expressed as units of domestic currency per US dollar. All the variables are averaged over 5 year intervals. However, since PPP is calculated over the entire national output, the basket includes non-tradables for which we do not expect the law of one price to hold. Thus, in order to calculate equilibrium real exchange rates, in a second step I adjust for the Balassa-Samuelson (BS) effect, regressing RER on real GDP per capita ($RGDPE_PC$):

$$\ln RER_{it} = \alpha + \beta \ln RGDPE_PC_{it} + f_t + \varepsilon_{it} \quad (22)$$

where i and t are country and time indexes, respectively, f_t accounts for time fixed effects, and ε_{it} is the error term. I obtain an estimate of $\hat{\beta} = -0.14$, with a t-statistic of 15.1. The sign of the coefficient is in line with the Balassa-Samuelson prediction; a 10% increase in $RGDPE_PC$ is associated with a 1.4% real appreciation. Finally, I define the undervaluation index ($UNDERVERAL$) as the ratio of actual to BS-adjusted real exchange rates: $UNDERVERAL_{it} = RER_{it} / \widehat{RER}_{it}$. Defined in index form, $UNDERVERAL$ is comparable across countries and over time; when it exceeds unity, the domestic currency is undervalued in real terms (i.e., domestic goods are cheap in *international* dollar terms). The log of this variable ($\ln UNDERVERAL$) has a zero mean and a standard deviation of 0.42.

In the case of China, I used the coefficients derived from the 5-year averaged sample to calculate \widehat{RER}_{it} for individual years.

NOTES

- In terms of the BPCG idea, a country with high income elasticity of demand for exports (η) and low income elasticity of demand for imports (π) should grow faster than ROW given a *positive* rate of world growth but also grow slower during periods of *negative* world growth. Do we see this pattern in the data?

²⁶And indeed with the Kaldorian cumulative causation model in which increased competitiveness via relative price changes plays a major role.

- In the canonical BPCG model, if $\eta_X + \eta_M - 1 = 0$, but $\hat{P}_X - \hat{P}_M - \hat{E} \neq 0$, \hat{Y}_{BPCG3} reduces to

$$\hat{Y}_{BPCG3} = \frac{(1 - \eta_M)(\hat{P}_X - \hat{P}_M - \hat{E}) + \hat{X}}{\pi_M} \quad (23)$$

- Do countries that specialize in manufactures have higher π_X and lower π_M on average?
- Consider using the end of the MFA as a natural experiment
- So then why do empirical studies of the BPCG hypothesis find that world growth is robustly correlated with domestic growth? May be partially capturing the effects coming from domestic investment. The expression for \hat{Y} in a general equilibrium framework shows why there could be a common trend between \hat{Y}^* and \hat{K} . Notice in the particular the expression $(\eta_X + \varepsilon_X)\varepsilon_M + (1 - \eta_X)\varepsilon_X$ that both the denominators for the coefficients of \hat{Y}^* and \hat{K} share in the reduced form solution for \hat{Y} (see eq. 20) of the file BPCG_Contrasting_Elasticities_More.tex).

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