Borrowing constraints and the trade balance-output comovement

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Abstract

The countercyclical trade balance ratio is one of the key stylized facts for open economies. The magnitude differs from country to country. Specifically, the trade balance ratio is more negatively correlated with output in emerging economies than in developed economies, suggesting that the trade balance is more sensitive to output changes in the former group. This paper explores whether this difference is caused by international borrowing constraints imposed on emerging economies.

By modeling the borrowing constraints as conditional on macroeconomic performance, the paper shows that when a positive shock takes place in emerging economies, *GDP* increases and the borrowing constraint becomes less binding, which results in less incentive to accumulate foreign assets. When a negative shock is present, in contrast, *GDP* decreases, and the representative household has to increase the trade balance to avoid the possibly binding borrowing constraints.

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1 Introduction

The trade balance is one of the most important research topics in international economics, including international trade, international finance and international macroeconomics. As the net of exports and imports, the trade balance reflects the terms of trade for one country within a period. The trade balance has a direct effect on the exchange rate and the level of the national debt. As world economies become more and more integrated, the trade balance also has a substantial effect on almost all macroeconomic variables, including economic growth, the level of output, economic fluctuations and unemployment ratio. For this reason, it draws wide public attention and the research on it has never waned.

While extensively discussed in various papers including Mendoza (1991), Backus et al. (1992), Correia et al. (1995), Blankenau et al. (2001), and Letendre (2004), there are, however, still some properties of the trade balance that have yet to be investigated. Most of these existing studies focused on the countercyclical behaviour regarding the trade balance.[1] Further examination of the trade balance across countries reveals not only that it is countercyclical for almost all open economies, but also it varies largely from country to country. In particular, the trade balance is more negatively correlated with GDP in emerging countries than in developed countries. As shown in Table 1, Aguiar and Gopinath (2007) document that the average of this correlation coefficient is -0.51 for developing countries, and -0.17 for developed countries, indicating that the comovement between trade balance and GDP is stronger in the former group.[2]

Moreover the difference in trade balance-GDP comovement has been expanding in recent years for some countries. Table 1 covers the period of $1980 - 2003$. Using the newly released Canadian and Mexican data till year 2009, the correlation coefficient becomes

[1]Producing a countercyclical trade balance is challenging in small open economy literature because this is in contradiction with predictions of standard preference.

[2]This table is excerpted from Aguiar and Gopinath (2007). $tb1_t$ is the trade balance ratio over GDP, i.e. $tb1_t = \frac{tb_t}{y_t}$.

Table 1: $corr(tb1_t, y_t)$ across countries

Emerging countries		Developed countries	
Country	$corr(tb1_t, y_t)$	Country	$corr(tb1_t, y_t)$
Argentina	-0.70	*Australia*	-0.43
Brazil	0.01	*Austria*	0.10
Ecuador	-0.79	*Belgium*	-0.04
Israel	0.12	*Canada*	-0.20
Korea	-0.70	*Denmark*	-0.08
Malaysia	0.01	*Finland*	-0.45
Mexico	-0.79	*Netherlands*	-0.19
Peru	0.12	*NewZealand*	-0.26
Philippines	-0.70	*Norway*	0.11
SlovakRepublic	0.01	*Portugal*	-0.11
SouthAfrica	-0.79	*Spain*	-0.60
Thailand	0.12	*Sweden*	0.01
Turkey	0.12	*Switzerland*	-0.17
$average = -0.51$		$average = -0.17$	

0.0043 and -0.75, respectively. The small correlation in Canada implies an almost zero comovement between trade balance and output.

Figure 1: Trade balance ratio and GDP

1(a): Canada

1(b): Mexico

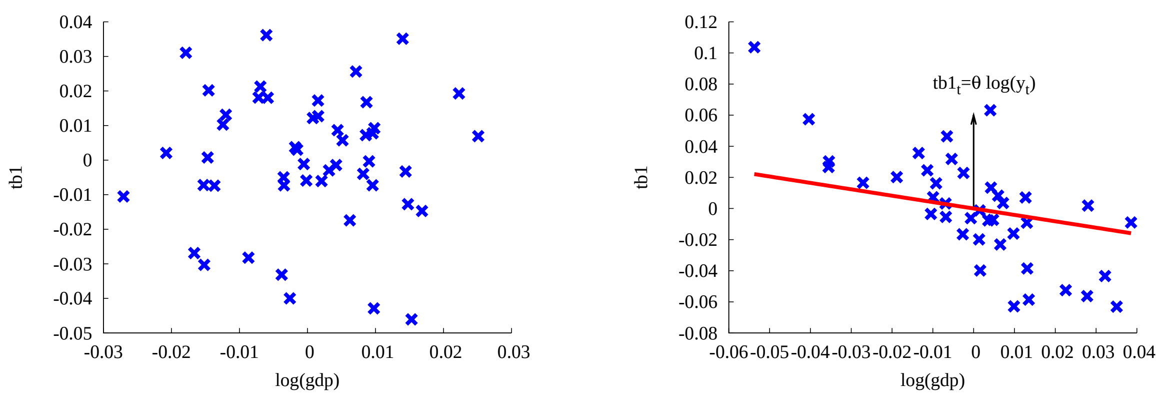


Figure 1 plots the trade balance ratio and HP filtered real GDP(in logs) for Canada and Mexico. As Figure 1 suggests, it is more difficult to tell the relationship between trade balance ratio and output for Canada. The fact that trade balance is more responsive to output changes in emerging economies can be further confirmed by performing the following regression:

$$tb1_t = \theta log(y_t) + \nu_t \tag{1}$$

where y_t is output per capita.[3] The estimated value of θ is 0.0026 (0.0884) for Canada, and -0.4115 (0.0614) for Mexico. The values in parenthesis are standard deviations of the estimated parameters. These results indicate that the trade balance ratio is almost independent of the output changes in Canada, and is significantly countercyclical for Mexico.

The larger correlation coefficient (in absolute value) indicates that the trade balance in some countries, especially in some emerging countries, is more responsive to GDP changes. Together with the fact that the trade balance is countercyclical, which suggests that the trade balance decreases more in the booms, and increases more in recessions for emerging countries, one possible explanation for this difference in magnitude across countries is that some countries face international borrowing constraint. Insofar that these borrowing constraints depends on GDP, one country may have to increase its trade balance during recessions to avoid the possibly a binding constraint, and may not accumulate foreign assets during booms when the borrowing constraint becomes less binding.

Since their introduction by Eaton and Gersovitz (1981), borrowing constraints have frequently been used in open economy macroeconomic models, and international borrowing constraits covers a wide range of topics including currency crisis as in Aghiona et al. (2001), foreign debt crisis as in Caballero and Krishnamurthy (2001), economic growth as in Gregorio (1996), "sudden stops" as in Mendoza (2001), and abnormally high consumption volatility in emerging economies as in Resende (2006).[4] Arellano and Men-

[3] All variables have been detrended by applying the HP filter, and thus there is no need to add a regressor of a constant term.

[4] Eaton and Gersovitz (1981) outline the theory of borrowing ceilings to answer the question of why countries choose not to default even when there is no forcible debt repaying mechanism. According to Eaton and Gersovitz (1981), borrowers refrain from defaulting when the disutility of exclusion from outside capital markets in the future exceeds a certain limit. Gregorio (1996) investigates the relationship between borrowing constraints and economic growth. Gregorio (1996) argues that borrowing constraints increases

doza (2002) survey the literature on borrowing constraints in small open economy models and illustrate the effects of the borrowing constraint. Their central findings are that the borrowing constraint introduces large distortion to relative prices including wages, the real interest rate, and the terms of trade, which in turn causes abrupt changes in trade balance, even when the borrowing constraint is only "occasionally" binding.[5]

While the effects of borrowing constraint on open economy macroeconomic model have been widely discussed, their effects on the correlation of the trade balance with GDP has yet to be investigated. This paper is concerned with answering the following question: to what extent can borrowing constraints explain the larger correlation coefficient in emerging economies?

As the first paper to investigate the relationship between borrowing constraints and the trade balance correlation with output, this paper is focused on this primary question of whether borrowing constraints make a difference in the trade balance ratio-GDP comovement. From this point of view, the model is set as standard as possible, and the borrowing constraint is modeled as generally as possible. This paper adopts the standard small open economy real business framework as presented by Schmitt-Grohe and Uribe (2003). The borrowing constraint is modeled as a ceiling limit: the existing debt can not exceed a certain fraction of the output. This simple setting reflects the lender's needs for default risk management. In particular, considering that there hardly exists forcible repaying mechanism on sovereign debt, the lender is more concerned of the borrower's ability to pay, rather than the will to pay. Debt limit reduces the likelihood of overborrowing and falling into the the foreign debt crisis trap, in which case borrowers often loses the ability to repay the debt.

With the assumption that it is chiefly emerging economies that face borrowing con-

saving, which increases growth; in the meantime, borrowing constraints reduces the time devoted to human capital accumulation, which decreases growth.

[5] Arellano and Mendoza (2002) divide the various models into two categories "ability-to-pay" and "willingness-to-pay". The former rules out the possibility of voluntary default and assumes that borrowers always repay whenever they have the ability. The latter permits the borrower to optimally default.

straints, the methodology of this paper is to study one typical emerging country and compare the predictions of the credit constrained and unconstrained models, respectively. In the small open economy literature, Mexico is frequently chosen as a representative emerging country. In this paper, Mexico is also chosen as the subject of analysis.

By including borrowing constraints in an otherwise the standard small open economy real business cycle model, the paper confirms the aforementioned conjecture, i.e., the debt ceiling makes the trade balance move more closely with output changes, and shows that borrowing constraints generate a more sensitive response of the trade balance to output. Whereas the correlation between the trade balance ratio and GDP is -0.22 for the model without constraints, it rises to -0.59 when a borrowing constraint is applied. Two factors contributed to the result. The first factor is that the trade balance is more volatile in the model with a borrowing constraint. When there is a negative productivity shock, for example, the standard model without financial market imperfections predicts that the trade balance will increase. In the model with a borrowing constraint, the representative household needs to reduce its foreign debt position to avoid the borrowing constraint bind. The second factor is that labor decreases less in the constrained model with negative productivity shock, and accordingly, output drops less. Less drop in labor and output serves the purpose to increase trade balance, which is also an optimal response to the borrowing constraint. Put together, the larger increase in the trade balance and the smaller decrease in output result in a larger correlation (in absolute value) between the trade balance ratio and output.

The structure of the paper is as follows. The next section, Section 2 presents the standard small open economy model as in Schmitt-Grohe and Uribe (2003); Section 3 calibrates the model to the Mexican economy and provides the simulation results. It also undertakes impulse response analysis to reveal the mechanism of why the borrowing constraint generates more comovement between the trade balance and the output; Section 4 provides the discussion, in which the role of interest rate is studied first, then the benchmark model is compared with existing literature on emerging economies. Section 5 concludes this paper, and gives directions for future research.

2 The Economic Environment

2.1 Preferences

In a small open economy, the infinitely lived representative agent derives utility from streams of consumption c_t, and disutility from working n_t. The agent's preferences are summarized by:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(c_t, n_t) \tag{2}$$

where β is the discount factor.

In the small open economy literature, the functional form for preferences receives particular attention because standard preferences fail to generate a counter-cyclical trade balance ratio. The counter-cyclical behavior is in contradiction with standard business cycle models. The usual intuition is that the individual should increase her asset holdings in booms so that she may consume more in the following periods as well, as implied by consumption smoothing.

To explain this countercyclical trade balance, researchers have come up with various explanations, of which two theories are widely accepted. The first explanation is that technological change, and accordingly the change in real income may contain two components, the long-term trend and a transitory fluctuation, as Aguiar and Gopinath (2007) argue. When changes in the long-term trend component dominates, consumption will increase enough to crowd out the trade balance, as the permanent income hypothesis suggests. The second explanation is that preferences may not be standard. In particular, when preferences are of GHH form, first proposed by Greenwood et al. (1988), the trade balance could be countercyclical. The reason is that GHH preferences have zero wealth effect, and consumption absorbs the effect of the wealth change. Adopting GHH preferences is a popular approach to generating a countercyclical trade balance ratio, as in Mendoza (1991), Correia et al. (1995), Schmitt-Grohe and Uribe (2003) among others.

For the purpose of concentrating on the trade balance in this paper, the GHH form is preferred. GHH preferences have the form

$$u(c_t, n_t) = \frac{[c_t - \mu \frac{n_t^{\omega}}{\omega}]^{1-\gamma}}{1-\gamma} \tag{3}$$

where μ in equation (3) is the weight in preferences on labor supply, ω is the elasticity of labor supply, and γ denotes risk aversion.

2.2 Technology and investment

This economy produces a single tradable goods according to

$$y_t = e^{z_t} k_t^{\alpha} n_t^{1-\alpha}, \tag{4}$$

where k_t is the capital stock, n_t is the labor supply, α is capital share in output and z_t is the productivity shock.

The productivity shock z_t evolves according to,

$$z_t = \rho z_{t-1} + \epsilon_t, \tag{5}$$

where the disturbance ϵ_t is distributed normally with variance σ_{ϵ}^2.

The law of motion for capital is

$$k_{t+1} = (1-\delta)k_t + x_t, \tag{6}$$

where δ is the capital depreciation rate, and x_t is investment. It is also assumed that a cost occurs to capital adjustment: the more rapid is adjustment, the greater this cost. The capital adjustment cost is modeled as $\frac{\phi}{2}(k_{t+1} - k_t)^2$, where ϕ is the the capital adjustment cost parameter.

2.3 Linkage to international markets

In this small open economy, the representative consumer can export goods to accumulate foreign asset holdings, or import goods to finance domestic spending. Let tb_t denotes the trade balance in period t, and d_t stand for the foreign debt level, then

$$d_{t+1} = (1 + r_t)d_t - tb_t. \tag{7}$$

where r_t is the world real interest rate.

It is further assumed that whenever borrowing or lending, this consumer faces a country-specific interest rate r_t

$$r_t = r^* + \psi(e^{(d_t - \bar{d})} - 1), \tag{8}$$

where ψ is a constant, and $\bar{d}$ is the long-run foreign debt level. It is worthy noting that the parameter ψ usually serves two purposes. On the one hand, it affects the borrowing cost: the more the country borrows, the higher interest rate the country has to pay. On the other hand, it serves to introduce stationarity in the model, as discussed in Schmitt-Grohe and Uribe (2003).[6]

Finally, it is assumed that debtors face borrowing constraints. The borrowing constraint depends on the performance of its GDP. When GDP increases, lenders take this as an indicator that borrowers have more resources ; accordingly, they are less likely to default. Specifically, it is assumed that its debt can not exceed ξ% of GDP, i.e.,

$$d_t \leq \xi\% y_t \tag{9}$$

This borrowing constraint looks similar to Mendoza (2001) and Uribe (2006) but is different. Mendoza (2001)'s model stipulates that some fraction of output must be used as collateral before contracting any new borrowing. Uribe (2006) sets the upper limit as a

[6] Schmitt-Grohe and Uribe (2003) introduce five settings to induce stationarity and illustrates that all settings deliver identical dynamics at business-cycle frequencies. In this paper, the debt elastic interest rate setting is preferred to compare with the "country premium cycle" model as discussed later.

constant. Here this borrowing constraint is not collateral, since there hardly exist forcible repaying mechanisms in international financial markets.[7] The motivation for this requirement is that it helps lenders to manage default risk by limiting the debt to a certain range. Moreover, setting an upper borrowing limit reduces the likelihood of going into the debt crisis trap, which often lead to debt default.

Accordingly, the resource constraint for the representative household is,

$$c_t + tb_t + x_t = y_t - \frac{\phi}{2}(k_{t+1} - k_t)^2. \tag{10}$$

Finally, neither the home country nor the foreign country can play a Ponzi-game, which implies:

$$lim_{T\to\infty}(1 + r_t)^{-T} d_{t+T} = 0. \tag{11}$$

3 Parameter Values & Simulation

3.1 Calibration

As Table 1 shows, the trade balance ratio varies greatly even for countries in a similar development stage. For example, in emerging countries, this coefficient varies from -0.79 (Ecuador, Mexico and South Africa) to 0.12 (Thailand, Turkey, Israel and Peru); in developed economies, it ranges from -0.60 (Spain) to 0.11 (Norway). The methodology of this paper is to study one emerging economy and check whether borrowing constraints delivers a stronger trade balance-output comovement.

Mexico is chosen as the subject economy for three reasons. The first is data convenience. Mexico is one of the a few emerging countries that has a consistent data set. For this reason, it has been frequently studied as in Colea and Kehoe (1996), Durdua et al. (2009) and Gelos (2003) among others. Secondly, Mexico has the largest negative comove-

[7] Uribe (2006) argues that it is costly for creditors to monitor the individual projects and instead, creditors make their lending decision on a few macroeconomic indicators.

ment between the trade balance and output, as Table 1 shows, and serves the purpose of this paper well. Thirdly, Mexico has experienced borrowing constraint, for example, during the period of year $1994-1995$.

Apart from the borrowing constraint, the model in this paper is the same model as Schmitt-Grohe and Uribe (2003). Schmitt-Grohe and Uribe (2003) calibrate their model to Canada economy. Here the parameters are re-calibrated except for those that are impossible to set owning to unavailability of data. For example, there is no labor income report in the national accounts of Mexico, and therefore, the parameter α is set to be 0.32, the same value in Canada.

The discount factor β is set as 0.93, implying an average annual real interest rate of 8 percent, which is consistent with the Mexican economy from 1970 to 2009. The capital depreciation rate δ is calibrated to be 0.08 to match Mexican average investment-output ratio(12.7 percent) over the sample period.

The risk aversion parameter γ takes the value of 2, as is commonly used number in real business cycle literature. As suggested by Garcia-Cicco et al. (2010), ω is set as 1.6, implying a labor supply elasticity of $\frac{1}{\omega-1}=1.7$ in Mexico. The preference parameter μ is assigned a value of 2 to ensure that the household allocates around 30 percent of its time to market work in steady state.

The steady state value of foreign debt is set as 0.12 to match with the average trade balance-output ratio(1.26 percent). The degree of capital adjustment cost ϕ is set to match the volatility of investment. For the debt elastic interest rate parameter, ψ, it is worthy noting that this parameter also represents the international borrowing cost. To focus on the borrowing constraint and to eliminate the noise introduced by borrowing cost, the debt elastic interest rate parameter is set to the smallest possible value that induces stationarity in the model.

The $AR(1)$ parameter of productivity shock process, ρ and the standard deviation of its shock, σ_ϵ are estimated from the Solow residual in the data. Since capital stock data is not available for Mexico, the Solow residual is computed without capital stock. As shown by Gomme and Rupert (2007), omitting capital stock will not change the time series property of Solow residual. Finally, the borrowing constraint parameter ξ is set to be 37 so that the probability of the debt constraint binding is 8 percent, as set in Benigno et al. (2010). The parameter values are summarized in Table 2.

Table 2: Parameter Values

Parameter	Value	Parameter	Value
γ	2	ω	1.6
α	0.32	ϕ	0.017
δ	0.08	ρ	0.93
σ_ϵ	0.0262	$\bar{z}$	0
r^*	0.08	ψ	0.00004
ξ	37	μ	2

3.2 Model solution and simulation

The model can be solved by a variety of dynamic programming methods. As argued in Arellano and Mendoza (2002), however, value function iteration is preferred to policy function iteration which involves linear approximation or continuous differentiable iterations because of the non-linearity property implied by occasionally binding constraint. In this paper, the model is also solved with value function iteration.

Let z_l, z_m, and z_h denote the "low", "middle", and "high" state of the total factor productivity. The three-state Markov chain $z = [z_l, z_m, z_h]$, and the associated transition probability matrix π, are specified as: $z = [-0.0477, 0, 0.0477]$, and

$$\pi = \begin{bmatrix} 0.6642 & 0.3016 & 0.0342 \\ 0.1508 & 0.6985 & 0.1508 \\ 0.0342 & 0.3016 & 0.6642 \end{bmatrix}$$

where

$$\pi_{i,j} = prob(z_t = z_j | z_{t-1} = z_i) \tag{12}$$

is the transition probability from state i to j.[8]

Let s denote the state vector, it consists of one exogenous state variable, the technology shock z, and two endogenous state variables, the capital stock k and the level of foreign debt d. The control vectors include the labor input n, next period's capital stock k', next period's foreign debt d', and finally consumption c. According, the dynamic programming problem is the following:

$$V(z, k, d) = max\{u(c, n) + \beta E[V(z', k', d')]\} \tag{13}$$

subject to the international interest rate equation (8), the borrowing constraint equation (9) and budget constraint equation (10).

For the purpose of comparison, the model without a borrowing constraint, which is obtained by setting ξ to an arbitrarily large number, is also solved with value function iteration. The model with $\xi \to +\infty$ is referred to the "unconstrained model", in contrast to the "constrained model" with $\xi = 37$. Table 3 displays the simulation results together with the second moments of the data.

The question of whether adding a borrowing constraint explains the countercyclicality of the trade balance ratio in some countries can be answered by comparing $corr(tb1_t, y_t)$ in the constrained and unconstrained models. Absent with the borrowing constraint, the correlation is -0.22. With a borrowing limit conditional on GDP, this correlation coefficient increase in absolute value, to -0.59. Since $corr(tb1_t, y_t) = -0.73$ in the data, the borrowing constraint brings the model much closer to the data.

Unfortunately, the borrowing constraint causes the model to match with other moments not well, especially for the trade balance volatility, and its serial correlation. The

[8]Here, The process z_t is approximated by a three-state Markov chain using the method of Rouwenhorst (1995). Galindev and Lkhagvasuren (2010) show that for highly persistent autoregressive processes, the method of Rouwenhorst (1995) outperforms other commonly-used discretization methods.

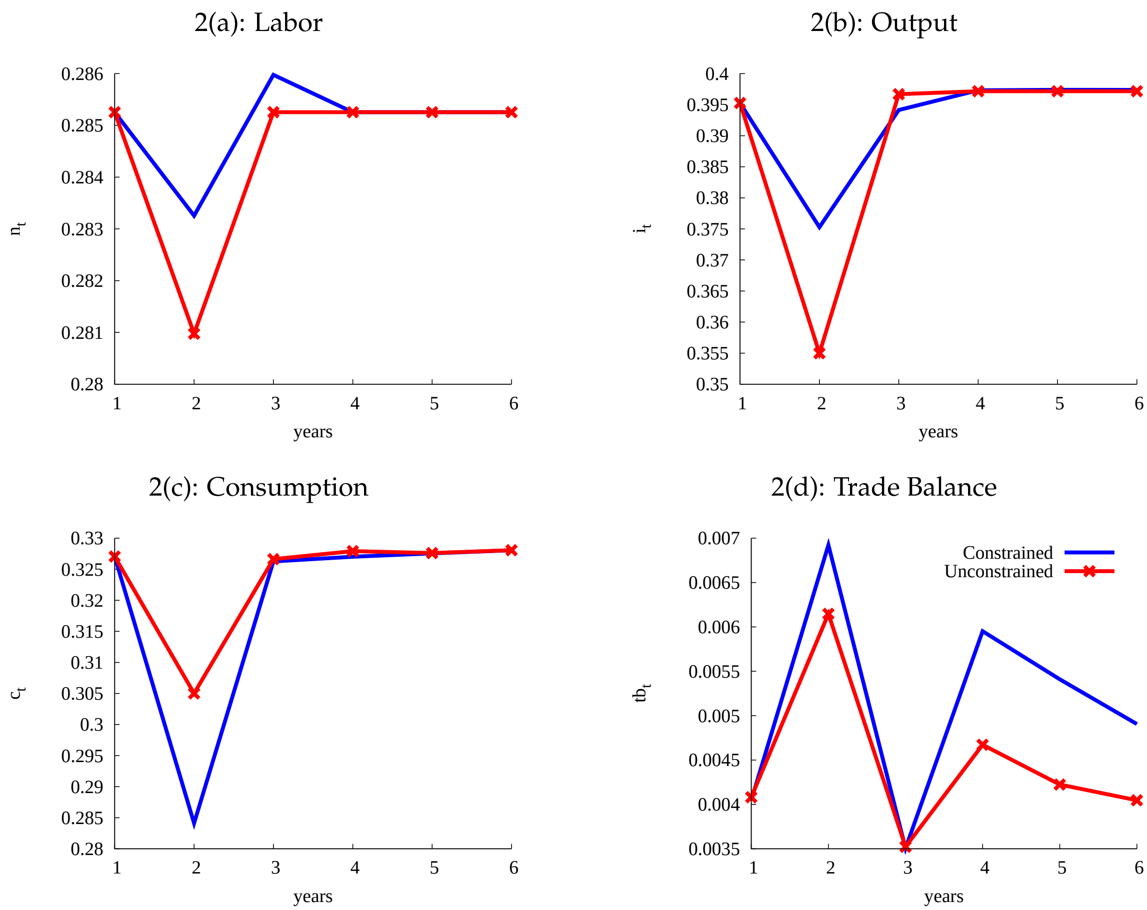
volatilities for trade balance in becomes lower in the constrained model. This is because some levels of the foreign debt are unavailable with the borrowing constraint. The lower serial correlation could be corrected by introducing a country premium, which can be obtained by increasing the debt elastic real interest rate parameter, ψ, as demonstrated by Garcia-Cicco et al. (2010). The country premium model, however, is not preferred here because it fails to capture the excess volatility in consumption, as detailed in the next section.

As summarized by Arellano and Mendoza (2002), the small open economy real business cycle framework with occasionally binding borrowing constraints is endowed with a self-adjustment mechanism that can mitigate the negative effects of financial frictions. The mechanism here is that debtors will respond to changes in GDP by adjusting the foreign debt level to decrease the possibility of the constraint binding. When the economy is in an upturn, the borrowing constraint becomes less binding, and the representative household will decrease the trade balance more and in turn, to increase consumption more; when the economy is in the downtown, the borrowing constraint becomes tighter, and the household has to save more by increasing the trade balance to avoid the borrowing limit.

Performing impulse responses helps to illustrate the effect of the borrowing constraint. Suppose that the economy is in steady state, and the technology moves from the "middle" to the "low" state in the next period, which means that z moves from 0 to -0.0477. The average changes of the variables of interest from the 1000 simulated paths are plotted. Figure 2 displays the movement of the these economic variables in the unconstrained and constrained models, respectively.

As Figure 2 shows, when the productivity falls to the "low" state, the labor supply decreases less in the constrained model than that in the unconstrained model. Accordingly, the output drop is larger in the unconstrained model. These less decrease in labor and output are optimal responses with the borrowing constraint: to avoid the tighter con-

Figure 2: Impulse Responses



straint in "low" state. Not surprisingly, the trade balance in the model with the borrowing constraint increases more, which serves to decrease the level of debt to avoid the binding constraint. As a result, there is a larger trade balance adjustment along with a smaller output change in the model with the borrowing constraint, leading to a larger correlation between the trade balance ratio and output.

Table 3: Observed and simulated moments

Variable	Data	Model with $\xi \to +\infty$	Model with $\xi = 37$	Model with interest rate shock	Model with unit-root trend	Model with country premium
volatility of GDP						
$std(y_t)$	3.60	3.36	3.13	3.45	3.27	3.40
volatilities relative to GDP						
$std(c_t)$	1.21	0.97	1.10	1.20	2.10	0.80
$std(x_t)$	3.28	3.68	3.28	3.68	3.11	3.43
$std(n_t)$	0.40	0.38	0.62	0.32	0.12	0.35
$std(tb1_t)$	0.56	0.30	0.26	0.65	0.23	0.29
Serial correlations						
$corr(c_t, c_{t-1})$	0.60	0.46	0.47	0.45	0.49	0.51
$corr(x_t, x_{t-1})$	0.41	0.38	0.55	0.32	0.51	0.43
$corr(h_t, h_{t-1})$	0.38	0.19	0.25	0.23	0.27	0.20
$corr(tb1_t, tb1_{t-1})$	0.55	0.25	0.21	0.34	0.33	0.46
$corr(y_t, y_{t-1})$	0.57	0.43	0.60	0.47	0.58	0.62
correlations with GDP						
$corr(c_t, y_t)$	0.93	0.97	0.88	0.98	0.87	0.95
$corr(x_t, y_t)$	0.93	0.88	0.87	0.87	0.89	0.84
$corr(h_t, y_t)$	0.03	0.98	0.99	0.98	1.00	0.99
$corr(tb1_t, y_t)$	-0.73	-0.22	-0.59	-0.24	-0.98	-0.17

Notes:

1. $tb1_t$ is the trade balance ratio over GDP, i.e. $tb1_t = \frac{tb_t}{y_t}$.
2. In the data, labor input is only available from year 1991.
3. Each model is simulated with 1000 replications with 39 periods each. All variables except $tb1_t$ are first logged, then applied with HP filter with the smoothing parameter $\lambda = 100$.

4 Further Discussion

4.1 Interest rate shock

In the small open economy literature, the role of interest rate shock is frequently discussed. So far, however, there is still no definite answer to the question whether introducing randomness into the exogenous interest rate is beneficial. For example, Mendoza (1991) compares various simulation experiment and shows that interest rate shock is of little importance; Correia et al. (1995) reach the same result by showing that the change of consumption, labor and output is quantitatively small. Blankenau et al. (2001), on the other hand, argue that the shock of interest rate is quantitatively large using variance decomposition; Nason and Rogers (2006) find that interest rate shock is essential to explain the present-value model of current account.

Introducing randomness in the interest rate is a contribution to this debate. Moreover, the role of interest rate shock is of particular interest because it has direct effect on the dynamics of foreign debt, and in turn, on the trade balance evolvement. As in Garcia-Cicco et al. (2010), the interest rate shock is modeled as

$$r_t = r^* + \psi(exp^{(d_t-\bar{d})} - 1) + exp^{(\eta_t - 1)} - 1, \tag{14}$$

where η_t is the exogenous interest rate shock following an $AR(1)$ process

$$ln(\eta_t) = \rho_\eta ln(\eta_{t-1}) + \nu_t, \qquad \nu_t \sim i.i.d. \quad N(0, \sigma_\nu^2) \tag{15}$$

Using the data of real interest rate, ρ_η and σ_ν are estimated to be 0.87 and 0.033, respectively. Accordingly, the discretinized process is approximated as $\eta_t = [1.0131, 1.1469]$, and the associated transition probability matrix π is

$$\pi = \begin{bmatrix} 0.9350 & 0.0650 \\ 0.0650 & 0.9350 \end{bmatrix}$$

where

$$\pi_{i,j} = prob(z_t = z_j | z_{t-1} = z_i) \tag{16}$$

is the transition probability from state i to j.

The model with both borrowing constraint and interest rate shock is simulated and its results are reported in Table 3. The comparison of simulations results in Table 3 suggests that the interest rate shock increases the volatility of the trade balance. Other than this, there is no notable difference from the benchmark model. Mendoza (1991) attributes this neutrality to the relative small share of the trade balance. When the trade balance is small, the effect of international shock is limited. In this paper, the trade balance ratio is 1.26 percent, smaller than the 2 percent in Mendoza (1991), therefore it is not surprising to get the limited effect of interest rate shock.

4.2 The "trend cycle", "country premium cycle", or the "borrowing cycle" ?

The success of the borrowing constraint in this paper strongly suggests that for emerging economies, the business cycle is the borrowing constraint. This section will compare the "borrowing cycle" model with the mainstream of existing literature on emerging economies: the "trend cycle" model and the "country premium cycle" model.

One common motivation for these two models is that some macroeconomics variables, especially for consumption, are more volatile in emerging countries. More volatile consumption violates the the theory of consumption smoothing and stands in sharp contrast with developed economies. It is also in contradiction with the predictions of standard real business cycle model and thus makes it a challenging task to match with the data for research on emerging economies.

The "trend cycle" model attributes the excess volatility in consumption to the permanent component of productivity shocks. Also known as "the cycle is the trend", Aguiar and Gopinath (2007) argue that the productivity shock is more trend-growth related rather than transitory fluctuations around a stable trend in emerging countries, as it is for most developed economies. When there is a shock on an economy, the representative agent in developed countries will not adjust consumption much because the agent knows that the shock is not permanent, with the expectation that output will return to the long-run trend. In contrast, in developing counties, the agent will adjust consumption accordingly because the shock implies a permanent change in output.

The "country premium cycle" model, as proposed by Garcia-Cicco et al. (2010), argue that the real interest rate is not fixed and is dependent on the foreign debt level: when the debt level is above the long-run trend, the country has to pay a premium in the interest rate. It is the change in the "country premium" that drives the business cycles in emerging economies. Garcia-Cicco et al. (2010) show that the permanent movements in productivity explains little excess volatility in consumption using the historical data for emerging economies. Instead, the authors finds that the the country premium model matches with the data better.

By emphasizing different factors that drive the business cycle in emerging economies, these two hypothesis divide the small open economy models into two distinct categories. Each hypothesis, however, has its own limitations. For "trend cycle" hypothesis, as criticized by Garcia-Cicco et al. (2010), it is problematic to use short sample data to identify the permanent component of productivity shocks because the productivity shock in the pre-war period is significantly different from data afterwards.

More importantly, the "trend cycle" hypothesis results in a too strong trade balance ratio-output comovement. This can be seen by setting the $AR(1)$ coefficient $\rho = 1$ in the productivity shock process $z_t = \rho * z_{t-1} + \epsilon_t$. By setting $\rho = 1$, the productivity shock becomes non-stationary, and any innovation ϵ_t has permanent effect on z_t and output y_t. As implied by permanent income hypothesis, the movement in consumption is larger than that of output. Accordingly, trade balance is crowded out and becomes strong countercyclical. As shown in Table 3, the trade balance ratio-output comovement, $corr(tb1_t, y_t)$ becomes -0.98, and the relative volatility of consumption is 2.1. In short, matching the excess volatility in consumption in "trend cycle" model is at the cost of overshooting the comovement between the trade balance ratio and output.

For the "country premium" hypothesis, it is worthy noting that in Garcia-Cicco et al. (2010), the country premium alone can not generate the excess volatility in consumption. It is the preference shock together with stationary productivity shock that explains most excess volatility. The predictions of the "country premium" model can be obtained by enlarging the debt elastic real interest rate parameter, ψ, to 2.8, as adopted by Garcia-Cicco et al. (2010). The simulation exercise shows that the "country premium" alone fails to produce the high consumption-output volatility ratio in the data. The borrowing constraint generates a relative volatility 1.10, while the country premium model generates the relative volatility as 0.80. The reason for consumption to be more volatile in the model with borrowing constraint is that relatively radical changes in the trade balance results in larger adjustments in consumption as well. As plotted in Figure 2, when the economy transits from the "median" to the "low" state, for instance, the trade balance experiences a larger increase to avoid the binding constraint, and this larger increase causes a larger decrease in consumption as well, compared with the unconstrained model and the country premium model. This result is in line with the idea that borrowing constraints imposed on emerging countries limits their ability to smooth consumption, as discussed in Resende (2006).

In summary, in matching with the trade balance ratio-output comovement and excess volatility in consumption, two typical phenomenon in emerging economies, the model with explicit borrowing constraint outperforms both the "trend cycle" and the "country premium" hypothesis. This suggests that the current research on emerging economies might be problematic, and the "borrowing cycle" should not be overlooked in studying emerging economies.

In addition, the "borrowing cycle" hypothesis in this paper goes beyond the emerging economies and sheds light on the business cycles in the developed counterparts. Although not documented yet, some developed economies start displaying procyclical trade balance ratio in the recent years, as shown in the first section of this paper. For Canada, although $corr(tb1_t, y_t) = 0.0043$ for the period of 1961-2009, this correlation coefficient is 0.38 after Canada joined the North American Free Trade Agreement in 1994.[9]. This reversal of the trade balance ratio calls for new developments in small open economy models because almost all existing literature is based on the fact that the trade balance is countercyclical.

The "borrowing cycle" can explain this new change. One country's borrowing is another country's lending. Without loss of generality, Mexico's borrowing, for instance, could be the lending of Canada. When there is a global negative productivity shock, the output will decrease in both countries.[10] Mexico's trade balance will increase, and accordingly, its foreign borrowing will decrease, as indicated by the previous discussion. This decrease in Mexico's borrowing is the decrease in Canada's lending, which in turn, leads to the decrease in the trade balance of Canada. The negative change in output and the trade balance in Canada results in the positive trade balance ratio-output comovement. Without the borrowing constraint, the changes in Canada's trade balance might not be enough to become procyclical.

5 Conclusion

The trade balance is subject to various factors and there is no wonder that its correlation with output changes from country to country. There is, however, a noticeable gap between the developing and developed countries: the trade balance ratio in emerging countries is more responsive to output changes. The author of this paper argues that this

[9] $corr(tb1_t, y_t) = -0.34$ for 1961 to 1993.

[10] As shown in Backus et al. (1992), the transmission of productivity shocks among countries is positive.

is not a random phenomenon, and the driving factor behind it is the imperfections in international financial markets.

The author conjectures that the borrowing constraint, mainly for emerging countries, can cause the trade balance and output move more closely. The borrowing constraint here is simply modeled as an upper limit, which is a fraction of the output. With the borrowing constraint conditional on aggregate economy activity, the representative household has to save more by accumulating more foreign asset(or decreasing foreign debt) in "low" states to avoid the possibly of a binding constraint. This prudence in "low" states is compensated in "high" states when the borrowing constraint becomes less binding and the trade balance can move to consumption. By including this borrowing constraint into an otherwise standard small open economy real business cycle model, the paper finds that the borrowing constraint explains around 70 percent of the trade balance correlation difference.

In addition, the model with borrowing constraint outperforms the existing models, in particular, the "trend cycle" model and the "country premium" model in terms of matching with the excess volatility in consumption, the other stylized fact of emerging economies. The borrowing constraint model generates realistic trade balance ratio-output comovement, compared with "trend cycle" model. In comparison with the "country premium" model, it easily generates the excess volatility in consumption without using preference shocks. Successfully capturing the typical characteristics of emerging economies, this paper strongly suggests that the borrowing constraint may be an important factor in studying emerging economies.

Moreover, the model with the borrowing constraint may initiate new developments in small open economy models. In particular, it sheds light on most recent change in the business cycles of the developed economies. Some countries start displaying procyclical trade balance ratio. This new phenomenon in some developed economies can be explained by the larger adjustments in foreign asset positions, which is caused by the larger adjustment in the foreign debt positions, when the debt ceiling is imposed on the borrowing countries.

As the first paper to investigate the difference in the correlation between the trade balance and output across countries, this paper focused on the question of whether borrowing constraint can make a difference, and thus ignored some other aspects. For example, this paper does not take the "willingness-to-pay" into consideration, i.e., the voluntary default case. Also, the paper assumes that the borrowing constraint is one-sided: it only sets a maximum for foreign debt, not a minimum. This is of particular interest considering global trade imbalances, which corresponds to the phenomenon of persistent surplus for some countries. Adding these features and analyzing their quantitative effects on the trade balance correlation will be interesting for further research.

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