Identifying the exchange-rate balance sheet effect over firms †

CÉSAR CARRERA
Banco Central de Reserva del Perú

This version: May 2014

Abstract:

I use firm-level data on investment and evaluate the balance sheet effect of changes in the exchange rate. The fact that a depreciation not only generates an expansion (for a small open economy that exports raw materials) but also has the potential of recession (in a dollarized economy in which most firms' liabilities are in foreign currency) brings up the question on what the final effect of a depreciation over either investment or production is. Following Bleakley and Cowan (2008), I evaluate if this channel is operating. I consider a time period in which inflation is stable and there are still swins on the exchange rate.

JEL Classification: E22, F41, G31

Key words: Balance sheet effect, exchange rate, investment.

† I would like to thank Nelson Ramirez and Fabrizio Orrego for valuable comments and suggestions. Natalia Guerrero provided excellent research assitantce. The points of view expressed throughout this document are the authors' own and are not necessarily shared by the institutions with which he is currently affiliated.
CÉSAR CARRERA is a Senior Economist in the Research Department, Banco Central de Reserva del Perú, Jiron Miroquesada 441, Lima, Peru.Email: cesar.carrera@bcrp.gob.pe

1. INTRODUCTION

One part of the Third generation currency-crisis literature highlight the fact that, if there is a large foreign-currency debt then an expansionary monetary policy and depreciation of the currency are not necessarily optimal policy answers in response to an adverse foreign shock.[1] Therefore, if a balance sheet channel is operating, a weaker local currency increases the value of debt service. Even more, those effects may wreck the balance sheets of both domestic banks and firms. If that is the case, a high degree of dollarization of assets and liabilities from the part of firms and banks may play a critical role for the monetary authority at the time of deciding, for example, intervention in the FOREX market or even an exchange rate regime.

On theoretical grounds, Krugman (1999), Aghion et al. (2001, 2004) and Cespedes et al. (2004) were among the first to utilize the open economy designed by Bernanke at al. (1999) i.e. in order to invest a firm should finance first the investment process. Given the assumption that most borrowing comes from abroad in foreign currency,[2] there is a balance sheet effect when there are changes in the exchange rate that directly affects firms' liabilities. So that currency depreciations may be contractionary because revenues and liabilities are denominated in different currencies.

On empirics, the usual way of evaluating the existence of a balance sheet channel is through its effects over capital accumulation. Firms tend to invest less if there are scenarios of financial distress regarding the increase of the adquired debt in foreign currency because of a large devaluation. In turn, those effects over investment translate into a lower level of production. Here the literature focuses on the components of the firms' balance sheet. The original version of Bleakley and Cowan (2008) motivated more empirical studies in this field. In 2003, six independent research teams evaluated the presence of balance sheet effects in Latin American countries by estimating how firm's investment is affected by real exchange rate fluctuations in

[1] See Chang and Velazco (2000).
[2] See Hale and Arteta (2009) for evidence of the link between balance-sheet effects and credit markets.

the presence of liability dollarization. They find that there is a balance sheet channel for the cases of Mexico and Argentina, no clear evidence for Colombia and Peru, and no evidence for Brazil and Chile.[3]

In the case of Peru, two periods can be observed. In between 1994 and 2001, this economy was in the transition from high to moderate inflation, with a clear tendency to a depreciation of the exchange rate, and a negative tendency in the terms of trade. Since 2002, the central bank of Peru has adopted an inflation targeting regime. Not only the Peruvian economy had a revaluation of its currency and a clear increase in the capital accumulation but also Peru experienced a long period of good terms of trade (see Figure 1).

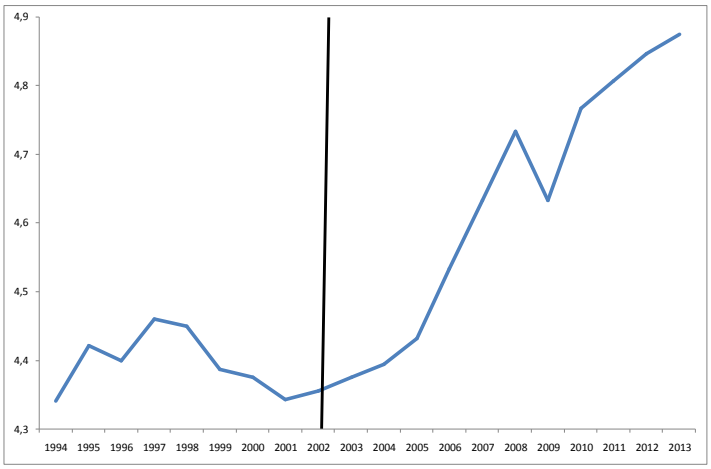
In other words, the strong negative correlation between exchange rate and investment between 2002 and 2013 may lead to the conclusion that a balance sheet channel is operating and over-powers the competitiveness channel. It is necessary to control for the terms of trade as well in order to account for great incentives to invest and produce for firms that exports (given the higher external demand) which in time translate to more investment in firms that are not involved in external trade (spillover effects).

This argument may be different in terms of disaggregated firm data. Some sectors may be more benefited from a revaluation of the local currency and take more debt in foreign currency. When a revaluation occurs, the debt decreases and firms may have a wealth effect and more incentives to take more debt. Especially during 2008-2012, it was observed an increase in international bonds emission from the part of local firms. This type of borrowing may be associated with large investment processes. In fact this is a question I intend to analyze.

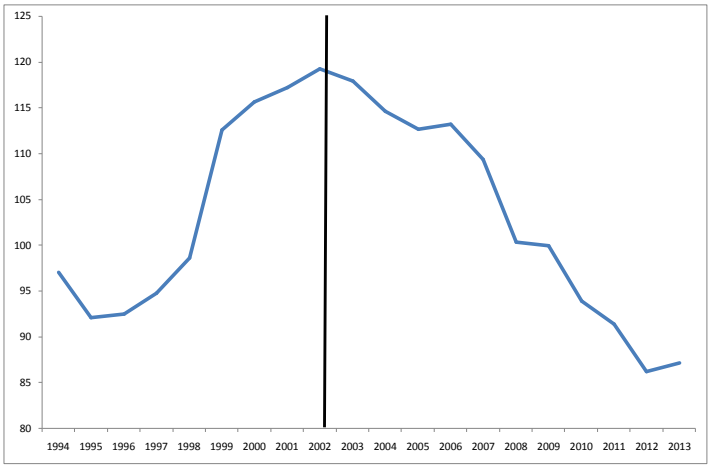
[3] See Galindo et al. (2003) for a review.

FIGURE 1 – AGGREGATE VARIABLES

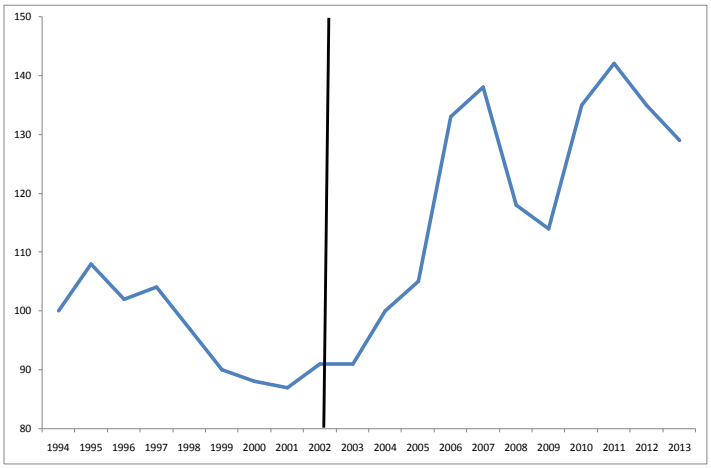
A: INVESTMENT



B: REAL EXCHANGE RATE



C: TERMS OF TRADE



Note. Investment is measured in real terms and logs, the real exchange rate and the terms of trade are indexes (1994=100). The real exchange rate is the bilateral exchange rate between Peru and the U.S. taking into account consumer price indexes for Peru and the U.S.

In terms of studies for the Peruvian economy using firm-level data, Carranza et al. (2003) analyzes the impact of the exchange rate changes over capital accumulation using financial information. The authors find that investment decisions are negatively affected by real exchange rate depreciation however this result is not robust to different specifications.

I fine tune Carranza et al. (2003) study, extend the sample of firms and frame time, and follow on Bleakley and Cowan (2008). I work an unbalanced panel that ranges from 1994 to 2013. In this way, I am able to analyze for a time period in which the Peruvian economy is more stable (2002 – 2013). During this time, the central bank of Peru commits to an inflation targeting regime and low inflation was observed since. Also during this time, it was observed changes in the exchange rate. Similar to Carranza et al., I mainly use non-financial listed firm's balance sheet information. In contrast to Carranza et al., I consider net exports that each firm made during the period under analysis and control for terms of trade.

The rest of this paper is structured as follows: section 2 contains a review of the literature. In section 3, I present the data used in section 4. Section 5 concludes.

2. LITERATURE REVIEW

In terms of modeling most of the literature focuses on balance sheet effects and exchange rate policy regimes. Krugman (1999) is one of the pioneering work in the field. Afterward, most work follows the formulation of Bernanke et al. (1999) such as Aghion et al. (2002) and Cespedes et al. (2004).

In Krugman (1999) the transfer problem is born from comparing the foreign real interest rate with the return achieved by converting foreign goods into domestic, then converting the next-period return back into foreign goods. This mechanism is key for his argument that a decline in capital inflows can adversely affect the balance sheet of domestic entrepreneurs, reducing their

ability to borrow and hence further reducing capital inflows because the volume of capital inflows affects the terms of trade and hence the valuation of foreign-currency-denominated debt.

Aghion et al. (2002) model is based on nominal prices stickyness. Here, a currency depreciation leads to an increase in the foreign currency debt repayment obligations of firms, and thus to a fall in their profits. This reduces firms' borrowing capacity and therefore investment and output in a credit-constrained economy, which in turn reduces the demand for the domestic currency and leads to a depreciation.

In Cespedes et al. (2004), the price of capital in terms of home goods is an increasing function of the real exchange rate. With incomplete depreciation, a real depreciation would raise the value of capital, thereby increasing networth. The keys of their mechanism are entrepreneurs who finance investment by borrowing abroad and borrowing is subject to frictions (either informational or enforcement problems). In this setup, the risk premium is an increasing function of the value of investment relative to networth. So, a real devaluation (an increase in real exchange rate) has a negative impact on networth and increases the next period's risk premium. These authors follow on Calvo (1999, 2001) who argue that if an entrepreneur's assets and liabilities are denominated in units of different goods, changes in their relative prices affect creditworthiness.

In terms of empirics, the presence of balance sheet effects is evaluated by estimating how the investment made by individual firms is affected by real exchange rate fluctuations in the presence of liabilities in U.S. dollars. In 2003, six independent research teams collected and analyzed balance sheet data for 8500 firms in Argentina, Brazil, Chile, Colombia, Mexico, and Peru. All these studies are inspired in the original version of Bleakley and Cowan (2008) and analyze the significance of an interaction term between real exchange rate fluctuations and the ratio of foreign currency debt to total debt. If the coefficient of the interaction term is negative, a depreciation have a negative balance sheet effect and leads firms with more debt in U.S. dollars

to reduce investment more compared with firms with less U.S. dollar debt. Galindo et al. (2003) present a review of those papers and report that there is a balance sheet channel for the cases of Mexico and Argentina, no clear evidence for Colombia and Peru, and no evidence for Brazil and Chile. For the case of Peru, Carranza et al. (2003) analyze the impact of the exchange rate changes over capital accumulation using financial information from 163 non-financial listed firms. For firms holding U.S. dollar-denominated debt, investment decisions are negatively affected by real exchange rate depreciation, however this result is not robust to different specifications.

Bleakley and Cowan (2008) find that for Argentina, Brazil, Chile, Colombia and Mexico there is no clear evidence of a balance sheet effect either in long term investment (capital expenditure) or short term investment (inventory investment). If any effect, this should be positive i.e. a devaluation of the exchange rate is correlated with an increase in investment. Bleakley and Cowan (2008) point out that those significant balance sheet effect reported in previous studies is the result of omitted variables that downward bias the parameter under analysis.

Some other work that use the interactive term between exchange rate and debt liabilities are Malone (2009) who includes balance sheet effects on the determinants of emerging market spreads.

On the other hand, Bigio (2010) studies the behavior a central bank that has model uncertainty. In a standard new-Keynesian small-open economy model, the aggregate demand equation describes how the output gap depends on a group of variables that includes the expected nominal depreciation. The standard model have the parameter associated to the expected nominal depreciation to be positive (nominal devaluations expand output) while the balance sheet model implies that parameter to work the opposite way (nominal devaluation has a negative effect on output). This parameter has an unknown value to both policy makers and

agents within the model and may come from either the standard or the balance sheet model. Bigio suggest that this approach is consistent with the hypothesis that by believing in the balance-sheet model, countries intervened substantially in their exchange rate markets and by doing this, they lost the ability to learn about the balance-sheet effect.

3. DATA CHARACTERISTICS

This study relies on the financial information collected from individual balance sheets. Here I describe the sample and variables under study. Our main data consist of firm-level accounting information for Peruvian non-financial firms organized as a panel data set. The time period under investigation ranges from 1994 to 2013, with yearly observations. Following Bleakley and Cowan (2008), the variables under study are in logs.

I approach investment as the change in the gross fixed capital (real terms). I take into account total liabilities, liabilities denominated in dollars, and short term liabilities (liabilities with maturity less than 1 year). Other financial variables such as sales, total assets, and EBITDA are also considered.

Regarding external variables, I take exports for each individual firm, terms of trade, a real exchange rate index, and the average lending rate in dollars (TAMEX). The real exchange rate is the bilateral exchange rate between the U.S. and Peru, adjusted by the consumer price index of each country.

For the estimation of the model I use the GMM in differences which is an estimator proposed by Arellano and Bond (1991) for dynamic panel data. The generalized method of moments (GMM) estimator is typically used to correct for bias caused by endogenous explanatory variables and considers the lagged dependent variable as a valid instrument. Arellano and Bond'

estimator is designed for situations in which a linear functional relationship is estimated, the one left-hand-side variable has dynamic and depends on its own past realizations.[4]

4. ESTIMATIONS AND EMPIRICS

4.1 Model especification

Let k_{it} be the log difference of gross fixed capital (real terms) for each firm *i*. This is a standard approach for fixed investment in each firm. The specification for firm *i* investment process is:

$$\mathrm{k}_{it} = \theta_1 \Delta er_t + \theta_2^{'} \mathrm{Z}_{it} + \varepsilon_{it} \qquad (1)$$

where Δer_t is the variation of real exchange rate in year t; and Z_{it} is a set of firm-specific variables such as leverage or cash flows, of macroeconomic variables, and of lagged investment.

The parameter θ_1 captures the effect on investment due to unexpected changes in the real exchange rate, which in time is affected by either real debt service burden or real incomes from exports. As Malone (2009) points out, a rise in real debt service burden, for a firm with a positive amount of dollar denominated debt, could occur for example due to a real depreciation, because this makes the value of dollar denominated debt service higher in domestic currency terms. The opposite occurs for firms that export and then have revenues in dollars. Moreover, Bleakley and Cowan (2008) argue that higher indebtedness leads to an increase in the cost of external finance and to a reduction in investment.[5] If so, the final effect of exchange rate changes over investment is subject to the level foreign currency liabilities and/or the total indebtedness level that each individual firm has, as well as a measure of competitiveness in external markets:

$$\theta_1 = \gamma d^*_{it-1} + \phi d_{it-1} + \lambda x_t \qquad (2)$$

[4] Arellano-Bond estimation begins with the transformation of all regressors, usually by differencing, and uses the generalized method of moments (GMM).
[5] Bleakley and Cowan (2008) also argue that omitting the interaction between total debt and the real exchange rate results in a sizeable downward bias in the estimated coefficient of the balance sheet effect.

where d_{it}^{*} and d_{it} are foreign currency liabilities and total liabilities of firm *i* over total assets in period t; and x_t is a measure of competitiveness in terms of exports in period t.

Replacing (2) in (1):

$$k_{it} = \gamma(d_{it-1}^{*}\,\Delta er_t) + \phi(d_{it-1}\Delta er_t) + \lambda(x_t\,\Delta er_t) + \theta_2^{'}\mathrm{Z}_{it} + \varepsilon_{it} \qquad (3)$$

The strategy is to test directly for the balance sheet effect of the exchange rate by estimating (3) and check on the sign and statistically significance of γ.

4.2 Baseline regression

I first estimate the relationship between investment and real exchange rate in order to capture only the principal first-order effects and the interaction (U.S. dollar debt times change in the exchange rate):

$$k_{it} = \beta_1 k_{it-1} + \beta_2(d_{it-1}^{*}\Delta er_t) + \varepsilon_{it} \qquad (4)$$

Equation 1 in Table 1 estimates (4) and shows the negative coefficient of the interactive term. According to this result, there is no clear evidence of a balance sheet channel operating in the Peruvian economy.[6]

Then, I consider that some firms have large levels of debt and that may reinforce any balance sheet effect in the investment process, as suggested in Bleakley and Cowan (2008). The new specification considers the interaction term between total debt and exchange rate changes:

$$k_{it} = \beta_1 k_{it-1} + \beta_2(d_{it-1}^{*}\Delta er_t) + \beta_3(d_{it-1}\Delta er_t) + \varepsilon_{it} \qquad (5)$$

Equation 2 in Table 1 estimates (5) and, as expected, the negative coefficient that captures the balance sheet effect becomes stronger and statistically significant.

Finally, I consider the case of any gain in competitiveness for the part of firm that export as well as any spillover to the other firms. The new baseline specification is:

[6] Micro-level indepent variables are lagged one year, so "current year" means contemporaneous with the macro variable.

$$k_{it} = \beta_1 k_{it-1} + \beta_2 (d^*_{it-1} \Delta er_t) + \beta_3 (d_{it-1} \Delta er_t) + \beta_4 (x_t \Delta er_t) + \varepsilon_{it} \quad (6)$$

The baseline regression that represents the dynamic panel is based on (6). Here x_t is represented for the terms of trade given the fact that the Peruvian economy (and some other exporting countries) was favored for higher commodity prices, especially in the mining sector. It is generally accepted that this good moment in exporting firms spillovers to the other firms in the economy and then consider it as an aggregate variable that affects all firms in the sample. As a matter of fact, Equation 3 in Table 1 suggests that, if any, changes in the exchange rate has a positive impact over investment. This result is not statistically significant and may suggest that, after controlling for the gains in competitiveness at the aggregate level, firms in Peru tend to be more productive and that is independent of changes in the exchange rate.

As suggested by Bleakley and Cowan (2008), I also consider the case of timing. In panel B of Table 1, the dependent variable is from the following period and the lagged dependent variable is therefore from the current period. It captures the fact of any feedback between exchange rate movements and investment between periods. Results are similar to those found in Panel A of Table 1, and the negative coefficient for the interaction term between exchange rate and dollar debt becomes no significant when the terms of trade effects are taking into account.

In line with Bleakley and Cowan (2008) I use the lead of the dependent variable as well, to take into account a bigger spam of time in terms of effects from the variables of control.

Previous results are also robust to a different set of controls (See Table 2, Panels A and B).

All these regressions have valid instruments, according to the Sargan test.[7]

[7] The Sargan test is a test of the validity of instrumental variables. It is a test of the overidentifying restrictions. The hypothesis being tested with the Sargan test is that the instrumental variables are uncorrelated to some set of residuals, and therefore they are acceptable, healthy, instruments.

TABLE 1 – EFFECT OF DOLLAR DEBT AND DEPRECIATIONS

Independent variables	(1)		(2)		(3)	
	Panel A: Dependent variable from the current year					
Lagged dependent variable	-0,127	***	-0,122	***	-0,120	***
	[0.005722]		[0.007161]		[0.011000]	
Interactions						
Dollar debt x (Δ log real exchange rate)	-0,033		-1,582	***	0,665	
	[0.040263]		[0.446343]		[0.790561]	
Total debt x (Δ log real exchange rate)			1,338	***	-6,912	***
			[0.401952]		[1.055944]	
Terms of trade x (Δ log real exchange rate)					15,712	***
					[1.617983]	
Controls						
Dollar debt	-0,026	***	-0,079	***	0,016	
	[0.010100]		[0.016391]		[0.030670]	
Total debt	-0,041		0,012		-0,183	***
	[0.038238]		[0.050019]		[0.049618]	
Terms of trade	0,012		-0,012		0,375	***
	[0.053822]		[0.051663]		[0.071595]	
Sargan test	0,845		0,852		0,739	
	Panel B: Dependent variable from the following year					
Lagged dependent variable	0,012		-0,006		0,012	
	[0.023244]		[0.024405]		[0.041111]	
Interactions						
Dollar debt x (Δ log real exchange rate)	-0,124	***	-2,940	***	-1,660	
	[0.044908]		[0.458358]		[1.068996]	
Total debt x (Δ log real exchange rate)			2,593	***	-6,890	***
			[0.426604]		[1.535248]	
Terms of trade x (Δ log real exchange rate)					20,858	***
					[2.414542]	
Controls						
Dollar debt	0,060	***	-0,010		0,097	
	[0.017847]		[0.022745]		[0.037734]	
Total debt	-0,008		0,012		-0,082	
	[0.038734]		[0.031772]		[0.073283]	
Terms of trade	-0,049		0,071		0,433	***
	[0.073689]		[0.079056]		[0.078404]	
Sargan test	0,583		0,527		0,835	

TABLE 2 – EFFECT OF DOLLAR DEBT AND DEPRECIATIONS

Independent variables	(4)		(5)		(6)	
	Panel A: Dependent variable from the current year					
Lagged dependent variable	0,116	***	0,045	***	-0,125	***
	[0.036664]		[0.018087]		[0.013236]	
Interactions						
Dollar debt x (Δ log real exchange rate)	-0,900		2,670	***	0,458	
	[0.947147]		[0.558951]		[0.802822]	
Total debt x (Δ log real exchange rate)	-8,061	***	-11,051	***	-6,433	***
	[1.020843]		[0.914699]		[1.054441]	
Terms of trade x (Δ log real exchange rate)	22,005	***	21,443	***	15,040	***
	[1.940626]		[1.432306]		[1.763250]	
Log Export x (Δ log real exchange rate)	0,037					
	[1.755542]					
Export ratio x (Δ log real exchange rate)			0,000			
			[5.89E-06]			
Not exports/imports x (Δ log real exchange rate)					3,378	
					[3.254215]	
Controls						
Dollar debt	0,079	***	0,144	***	0,011	
	[0.019753]		[0.017309]		[0.031512]	
Total debt	-0,111	***	-0,187	***	-0,171	***
	[0.040049]		[0.058532]		[0.051996]	
Terms of trade	0,364	***	0,549	***	0,366	***
	[0.108596]		[0.099134]		[0.078083]	
Sargan test	0,826		0,835		0,736	
	Panel B: Dependent variable from the following year					
Lagged dependent variable	-0,118	***	-0,115	***	-0,021	
	[0.042593]		[0.037797]		[0.061295]	
Interactions						
Dollar debt x (Δ log real exchange rate)	-0,911		1,343		-2,149	
	[1.364901]		[0.778786]		[1.474310]	
Total debt x (Δ log real exchange rate)	-8,216	***	-7,449	***	-5,779	***
	[2.110178]		[1.698049]		[1.568846]	
Terms of trade x (Δ log real exchange rate)	22,386	***	15,183	***	19,216	***
	[2.787741]		[2.930873]		[2.958263]	
Log Export x (Δ log real exchange rate)	0,311					
	[1.388053]					
Export ratio x (Δ log real exchange rate)			0,000			
			[4.51E-06]			
Not exports/imports x (Δ log real exchange rate)					5,036	
					[11.96275]	
Controls						
Dollar debt	0,054	*	0,095	***	0,072	**
	[0.032816]		[0.029253]		[0.037268]	
Total debt	-0,054		-0,112	*	-0,053	
	[0.074257]		[0.060296]		[0.072368]	
Terms of trade	0,256	***	0,357	***	0,405	***
	[0.101381]		[0.116010]		[0.100819]	
Sargan test	0,493		0,620			

5. CONCLUSIONS

My results suggest that there is not balance sheet effect from changes in exchange rate to investment in the Peruvian economy. They key for this conclusion is to control for terms of trade. In this period of time it is more important terms of trade rather than exchange rate in order to understand the investment process.

REFERENCES

Aghion, P., Bacchetta, P., Banerjee, A., 2004. A balance-sheet approach to currency crises. Journal of Economic Theory.

Aghion, P., Bacchetta, P., Banerjee, A., 2001. Currency crises and monetary policy in an economy with credit constraints.

Aysun, U., Hepp, R., 2013. Identifying the balance sheet and the lending channels of monetary transmission: A loan-level analysis. Journal of Banking & Finance 37, 2812 - 2822.

Benavente, J. M., Johnson, C.A., Morandé, F.G., 2003. Debt composition and balance sheet effects of exchange rate depreciations: A firm-level analysis for Chile. Emerging Markets Review 4, 397 - 416.

Bleakley, H., Cowan, K., 2008. Corporate dollar debt and depreciations: much ado about nothing? The Review of Economics and Statistics 90 (4), 612 – 626.

Bonomo, M., Martins, Betina., Pinto, R., 2003. Debt composition and exchange rate balance sheet effect in Brazil: A firm level analysis. Emerging Markets Review 4, 368 - 396.

Carranza, L., Galdon-Sanchez, J. E., Gomez-Biscarri, J., 2011. The relationship between investment and large exchange rate depreciations in dollarized economies. Journal of International Money and Finance 30, 1265 - 1279.

Chang, R., Velasco, A., 2000. Financial fragility and the exchange rate regime. Journal of Economic Theory 92, pp. 1 - 34.

Cespedes, L. F., Chang, R., Velasco, A., 2004. Balance Sheets and Exchange rate policy. American Economic Review, 94, 64 - 103.

Galindo, A., Pania, Ugo., Schiantarelli, Fabio., 2003. Debt composition and balance sheet effects of currency depreciation: A summary of the micro evidence. Emerging Markets Review 4, 330 - 339.

Krugman, P., 1999. Balance sheets, the transfer problem, and financial crises. International Tax and Public Finance, 6, 459 - 472.

Malone, S., 2009. Balance sheet effects, external volatility, and emerging market spreads. Journal of Applied Economics, vol XII, No. 2, 273 – 299.

Pratap, S., Lobato, I., Somuano, A., 2003. Debt composition and balance sheet effects of exchange rate volatility in Mexico: A firm level analysis. Emerging Markets Review 4, 450 - 471.