Banco Central de Chile
Documentos de Trabajo

Central Bank of Chile
Working Papers

N° 200

Febrero 2003

EXPLORING THE IMPLICATIONS OF OFFICIAL DOLLARIZATION ON MACROECONOMIC VOLATILITY

Roberto Duncan

BANCO CENTRAL DE CHILE

CENTRAL BANK OF CHILE

La serie Documentos de Trabajo es una publicación del Banco Central de Chile que divulga los trabajos de investigación económica realizados por profesionales de esta institución o encargados por ella a terceros. El objetivo de la serie es aportar al debate de tópicos relevantes y presentar nuevos enfoques en el análisis de los mismos. La difusión de los Documentos de Trabajo sólo intenta facilitar el intercambio de ideas y dar a conocer investigaciones, con carácter preliminar, para su discusión y comentarios.

La publicación de los Documentos de Trabajo no está sujeta a la aprobación previa de los miembros del Consejo del Banco Central de Chile. Tanto el contenido de los Documentos de Trabajo, como también los análisis y conclusiones que de ellos se deriven, son de exclusiva responsabilidad de su o sus autores y no reflejan necesariamente la opinión del Banco Central de Chile o de sus Consejeros.

The Working Papers series of the Central Bank of Chile disseminates economic research conducted by Central Bank staff or third parties under the sponsorship of the Bank. The purpose of the series is to contribute to the discussion of relevant issues and develop new analytical or empirical approaches in their analyses. The only aim of the Working Papers is to disseminate preliminary research for its discussion and comments.

Publication of Working Papers is not subject to previous approval by the members of the Board of the Central Bank. The views and conclusions presented in the papers are exclusively those of the author(s) and do not necessarily reflect the position of the Central Bank of Chile or of the Board members.

Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
Huérfanos 1175, primer piso.
Teléfono: (56-2) 6702475, Fax: (56-2) 6702231

Documento de Trabajo
N° 200

Working Paper
N° 200

EXPLORING THE IMPLICATIONS OF OFFICIAL DOLLARIZATION ON MACROECONOMIC VOLATILITY

Roberto Duncan
Economista
Gerencia de Investigación Económica
Banco Central de Chile

Resumen

Con pocas excepciones, las ventajas de una dolarización oficial o total han sido analizadas en un marco dinámico de equilibrio general, especialmente para economías parcialmente dolarizadas que se suponen son buenas candidatas para seguir esta clase de esquemas. Además de revisar los argumentos a favor y en contra de la dolarización, este trabajo explora sus implicaciones en la volatilidad de las principales variables macroeconómicas de una economía pequeña y abierta que enfrenta shocks de términos de intercambio. Modelos dinámicos de equilibrio general son usados como laboratorios para estudiar este tema y contrastar dos contextos: una economía parcialmente dolarizada con tipo de cambio flexible (calibrado para la economía peruana) y una economía totalmente dolarizada. Ejercicios de simulación son llevados acabo para analizar en ambos casos la volatilidad de variables claves como el producto, consumo, inversión, tasa de inflación, y déficit fiscal. Se concluye que una dolarización total implica: (1) mayor volatilidad real, especialmente en el producto y la inversión; (2) menor volatilidad de la inflación; (3) mayor volatilidad del déficit fiscal; (4) mayor respuesta del producto ante un shock de términos de intercambio. Por ende, en este contexto es difícil afirmar que la dolarización reduce el riesgo país. Finalmente, el artículo señala el rol de las rigideces de precios y el grado de ciclicidad de la política monetaria en estos resultados.

Abstract

With a few exceptions, the advantages of dollarization have not been discussed in a dynamic general equilibrium framework, especially for partially dollarized economies that are supposed to be good candidates to follow this kind of regime. After reviewing the arguments for and against dollarization, this paper explores its implications on the volatility of the main macroeconomic variables of an emerging small open economy that faces terms-of-trade shocks. Dynamic equilibrium models are used as laboratories to study these issues and contrast two environments: a partially dollarized economy with flexible exchange rate (calibrated for the Peruvian economy) and a fully dollarized economy. Simulation exercises are performed to analyze in both cases the volatility of key variables such as output, consumption, investment, inflation rate, and fiscal deficit. The conclusions are that full dollarization implies (1) higher real volatility, especially on output and investment; (2) lower inflation volatility; (3) higher fiscal deficit volatility; (4) higher output response to terms-of-trade shocks. Consequently, in this context it is difficult to affirm that dollarization reduces country risk. Finally, the paper points up the role of price stickiness and countercyclical monetary policy in these findings.

I thank Rómulo Chumacero, Klaus Schmidt-Hebbel, Felipe Morandé, Claudia Arguedas, Federico Sturzenegger, and the participants at the Economics Meeting of Chile, the VII Meeting of the Research Network of Central Banks of the Americas, and the Fourth Annual Global Development Conference for helpful comments and suggestions. Remaining errors are entirely of my own. The views expressed herein are those of the author and do not necessarily represent those of the Central Bank of Chile.
E-mail: rduncan@bcentral.cl.

1. Introduction

The adoption of official or full dollarization[1] is an issue that has been widely discussed in last years, especially after the Asian crisis, its effects on Latin American countries, and the advent of the euro. This has happened in both, partially dollarized economies[2] (e.g. Peru, Argentina, Bolivia and Uruguay) and non-dollarized developing economies (such as Ecuador, El Salvador, Nicaragua and Guatemala[3]) which show a low degree of substitution between domestic and dollar-denominated assets.

According to many authors, official dollarization has implications on the main macroeconomic variables (inflation rate, interest rates, level of economic activity, investment, degree of financial integration, and so on) and on fiscal and monetary management. Therefore the adoption of an official dollarization by a developing economy requires a deep analysis.

Thus, before taking this measure perhaps it is advisable to know:

- What are the benefits of abandoning domestic money and adopting the dollar or other "hard currency"?
- If the net benefits are significantly positive, What are the prerequisites that the economy should present, before its dollarization, to maximize benefits?[4] That is, What is the adequate foreign reserves level? What should be the features or conditions of the financial system?, Is it necessary to reform the government finances?, Is it necessary to have total flexibility in labor market?, Should the country be part of a currency union?; Is a partially dollarized economy a good candidate for an official dollarization scheme?; and so forth;

[1] Full or official dollarization is seen as one country's official adoption of the currency of another one for all commercial and financial transactions. The terms "full dollarization", "official dollarization" and simply "dollarization" are used as synonyms along this work.
[2] Partially dollarized economies are those that face currency and/or asset substitution between domestic and foreign money.
[3] See, for example, Edwards (2001a), p. 249.
[4] See, for instance, Eichengreen (2000, 2001), Gruben *et al*. (2001), and Guidotti and Powell (2002) on this issue.

- If preconditions were given, How to implement an official-dollarization scheme? That is, To what exchange rate level should the economy be dollarized? Will senioriage be shared with US?; and so on.[5]

As it can be seen, there are many questions that policy makers and researchers might formulate about this subject. From my point of view, it is still necessary to deepen the discussion on the first question from a theoretical perspective. This work seeks to assess the implications of an official dollarization program on the volatility of the main macroeconomic variables of an emerging market economy. I use simple dynamic general equilibrium models as laboratories to study these issues. Two models are formulated and simulated for a small open economy that faces external (via terms of trade) and domestic (via technological and fiscal and monetary policy) shocks. The first model represents a partially dollarized economy with floating exchange rate that is calibrated for the Peruvian economy during the nineties. The second represents a fully dollarized economy. Simulation exercises are performed to compare the behavior of key variables (such as output, inflation rate, consumption, investment and fiscal deficit) in both environments.

The structure of this study is organized as follows. Section 2 provides a discussion of the arguments for and against full dollarization advanced in the literature. Section 3 formulates the dynamic stochastic general equilibrium models. Section 4 describes their parameterization, solution and main findings. Next steps for future research and concluding remarks are provided at the end of the paper.

2. Costs and Benefits of Dollarization

Tables 1 and 2 show the pros and cons found in the economic literature on official or full dollarization. A summary of it follows.

[5] See Gruben *et al*. (2001) on this point.

2.1. Price Stabilization and Low Inflation

There seems to be a consensus in the literature on that a fully dollarized economy might achieve United States inflation rate (or a similar one) and that this economy could succeed on stabilization programs (a recent example seems to be Ecuador). Empirical findings that strengthen this viewpoint are showed by Edwards and Magendzo (2001) and Edwards (2001a,b). They detected that inflation rates have been significantly lower in dollarized nations than in non-dollarized ones.

On stabilization and credibility, Goldfajn and Olivares (2000) raise the point that credibility gains due to full dollarization cause less volatility in the domestic inflation rate. Through the calibration of a dynamic general equilibrium model for Mexico, Mendoza (2000) concludes that the welfare gain by removing the lack of credibility on stabilization would be from 6% to 10% of steady-state consumption level.

However, as Berg and Borenztein (2000) remark, the stability owing to dollarization is itself relative, as the US dollar fluctuates in value against other widely traded currencies.

2.2. Loss of Seigniorage vs. Fiscal Discipline

Savastano (1999) and Mendoza (2002) consider that the main disadvantage of full dollarization is the loss of seigniorage. As Berg and Borensztein (2000) point, the acquisition of the initial stock of domestic money could add an indirect cost for a country that do not have enough foreign reserves to buy up its domestic currency.[6] Calvo (1999a,b) opposes to this idea arguing that recently, partially dollarized economies already suffer loss of seigniorage. He argues that a full-dollarization scheme could include a pact with United States to share this revenue.

[6] This indirect cost will be lower if central bank depreciates the domestic currency before dollarizating the economy.

Table 1. Benefits of an Official Dollarization

Authors	Benefits	Observations
	Inflation and stabilization	
Savastano (1999) *	Promotes price stabilization. Inflation rate would be equal or less than US inflation.	Berg and Borensztein (2000): stability promised by dollarization is itself relative, given that the US dollar fluctuates in value against other widely-traded currencies.
Goldfajn and Olivares (2000)*	Credibility gains cause less variability in domestic inflation rate. Helps to achieve the inflation rate convergence to US inflation rate.	
Mendoza (2000)	Welfare gains by removing lack of credibility of stabilization (6.4-9.7% of level of consumption)	Based on DGEM calibration estimates.
Edwards and Magendzo (2001)	Inflation has been significantly lower in dollarized nations than in non-dollarized ones.**	See also Edwards (2001a,b).
Dornbusch (2000)	The gains are inversely proportional to the national money's quality, past, current, and prospective.	
	Fiscal policy	
Savastano (1999) *	Generate fiscal discipline.	Goldfajn and Olivares (2000): The absence of seigniorage does not necessarily imply fiscal discipline.
Chang (2000)*	May enhance the credibility of fiscal policy if the government does not choose sound policies.	Edwards (2001a,b): Dollarized countries have had similar fiscal records than non-dollarized countries.**
		Sims (2002): It does not automatically generate pressures for greater fiscal responsibility, and indeed may create incentives in the opposite direction.
	Interest rates, devaluation and default risk	
Calvo (1999a,b)	Lower level and volatility of domestic interest rates.	Savastano (1999): Interest rates would tend to decrease, but they do not converge totally to international interest rates due to country risk, which would not necessarily decrease.
Hinds (1999)	Pensions funds and other savings would be protected against devaluation and inflation.	
Schuler (1999)	Less inflation improves the safety of property rights, and thus, this allows less credit risk.	
Berg and Borensztein (2000)	Eliminates the sudden risk of sharp devaluations, and thus reduces risk premium of international borrowing.	Goldfajn and Olivares (2000): It is not clear whether reduction in domestic interest rates is the consequence of full dollarization or the competitive international banking system (in the case of Panama). Elimination of currency risk does not preclude default risk or the high volatility of sovereign spreads.**
Chang (2000)	May lower country's cost of credit.	
Panizza *et al*.(2000)	Virtually eliminates exchange rate risk.	
Dornbusch (2000)	Implies a dramatic decline in interest rates with all attendant benefits.	
Mendoza (2002)	Devaluation risk would be greatly reduced. It can never be fully eliminated because a sovereign nation might always try to reverse the dollarization.	Pereyra and Quispe (2002): Spreads actually reflect the perception of country's general features and they will be higher as higher are the macroeconomic, institutional and political soundness.
Powell and Sturzenegger (2000)	Elimination of currency risk will have significant impact on country risk spreads in Latin American emerging countries.	Carrera *et al*. (2002): Default risk would reduce if economy's real volatility reduces.

* The author compiles this advantage (sometimes from other authors), but he or she does not necessarily support it.
** Based on an empirical work.
*** DGEM denotes dynamic general equilibrium model.

Table 1. Benefits of an Official Dollarization (continued)

Authors	Benefits	Observations
	Financial integration and banking system	
Calvo (1999a,b) Schuler (1999)	Lower probability of external crisis and contagion. Contributes to accelerate the consolidation of the banking system and solves its losses because banks at the present do not present currency matching and they are exposed to currency instability.	Berg and Borensztein (2000): it does not eliminate the risk of external crises, since investors may flee due to problems of weakness in fiscal position or the soundness of the financial system.
Calvo and Reinhart (1999)	It ameliorates (eliminates) the "sudden stop problem".	Although, it does not reduce the impact of external real shocks.
Hausmann (1999)	Would expand the menu of financial options open to emerging-market governments and firms, and (therefore) would increase financial stability.	Goldfajn y Olivares (2000): It is not a warranty of instantaneous access to international markets.**
Berg and Borensztein (2000)	Facilitates international integration.	Sims (2002): It has ambiguous implications for the stability of the financial system, because it reduces range of assets available in trading risk and it leaves the government less able to intervene supportively in financial crises.
Goldfajn and Olivares (2000)	Increases financial markets efficiency creating long-run instruments and allocating resources in better way than other exchange regimes. May reduce the impact of external confidence shocks.	
Panizza *et al*.(2000)	Might reduce financial fragility by reducing volatility of key relative prices in the economy, and contributes to the development of banking system.	
Mendoza (2000)	Welfare gain from weakening of financial frictions and improved access to global capital markets.	Based on an empirical analysis for Central American countries.
Mendoza (2002)	Enhanced credibility and reduced informational frictions could result in better access to international capital markets in terms of reduced liquidity coefficients and margin requirements.	Mean: 4.6% of consumption. Even if policy credibility remained weak. Financial assets and liabilities would be matched in terms of currency denomination.
	Trade and current account position	
Panizza *et al*.(2000), Lizano (2000)	Lower transaction costs related to trading goods and assets denominated in different currencies. Reduces uncertainty and risk (exchange rate volatility) in trade and investment; and costs related to the need to deal with multiple currencies.	Based on Optimal Currency Area literature, Mundell (1961) and McKinnon (1963). Edwards (2001a,b): Dollarized countries have not been spared from major current account reversals.**
Morandé and Schmidt-Hebbel (2000)	Less market segmentation and higher market integration. Higher international trade due to less currency risk.	Klein (2002): The effect of dollarization on trade with US is not statistically different from the effect of a fixed dollar exchange rate on trade with US.
	Investment and growth	
Savastano (1999)*	Larger amounts of investment and growth rates.	Edwards (2001a,b): Panama's case suggests that external shocks result in greater costs in terms of lower investment and growth than non-dollarized countries.**
Berg and Borensztein (2000)	Higher level of confidence among international investors, more investment and growth. No possibility of sudden capital outflows motivated by fears of devaluation.	
Lizano (2000)	Improves the possibility to attract foreign investors.	
Mendoza (2002)	Sharp decline in information costs: foreign investors would no longer need to pay for information on the dollarized economy's monetary policy. This can increase demand elasticity for emerging markets equity of foreign traders which limits the size of asset price declines.	

* The author compiles this advantage (sometimes from other authors), but he or she does not necessarily support it.
** Based on an empirical work.

Similarly, for Alesina and Barro (2001) this loss is not a social waste, but redistribution between the countries. Therefore, the United States could return the seigniorage to the dollarized country.

In Dornbusch's (2000) view, there is an important offset to the loss of seigniorage from the reduction in public debt service costs that result from reduced interest rates, and this factor is surely far more significant that the 1% or so of GDP in seigniorage loss.

On the other hand, Savastano (1999) compiles the idea that one of the benefits of official dollarization is that it generates fiscal discipline owing to the elimination of the possibility of monetary issuance to finance fiscal deficit. Similarly, Chang (2000) claims that it has been argued that the loss of seigniorage may be beneficial if it forces an otherwise irresponsible government to choose sound policies, enhancing the credibility of the government policy.

In contrast, Goldfajn and Olivares (2000) perform an empirical analysis based on VAR estimates for Panama concluding that the absence of seignoriage does not necessarily imply fiscal discipline. Edwards (2001) also finds that dollarized countries have had similar fiscal records than non-dollarized countries.

2.3. Devaluation Risk, Default Risk and Interest Rates

Calvo (1999a,b) has defended the idea that full dollarization implies a lower level and volatility of domestic interest rates. Besides, Schuler (1999) states that the lower inflation provoked by full dollarization should improve the safety of property rights and, consequently, reduce the credit risk for an economy. On the contrary, Savastano's (1999) view is that interest rates would tend to decrease but they would not converge totally to international interest rates due to the country risk which would not necessarily decline. For Goldfajn and Olivares (2000), it is not clear whether the reduction in domestic interest rates is the consequence of full dollarization or the competitive international banking system in the case of Panama.

As another argument for dollarizing, Berg and Borensztein (2000) claim that it eliminates the sudden risk of sharp devaluations, thus dollarization reduces the risk premium of international borrowing. Chang (2000) and Powell and Sturzenegger (2000) also consider that dollarizing an economy may lower the country's credit cost[7]. Similarly, Mendoza (2002) thinks that devaluation risk would be greatly reduced but it can never be fully eliminated because a sovereign nation might always try to reverse the dollarization. In that sense, Goldfajn and Olivares (2000) regard that the elimination of currency risk does not preclude default risk or the high volatility of sovereign spreads.

2.4. Financial Integration and Banking System

It has been argued that dollarization facilitates financial integration and a better performance of the domestic banking system. According to Calvo (1999a,b), dollarization could lower the probability of external crisis and contagion. Analogously, Schuler (1999) considers that it would contribute to accelerate the consolidation of the banking system and solve its losses because banks –in a partially dollarized economy– do not necessarily present currency matching and are exposed to currency instability. The mechanism exposed by Hausmann (2000) is that dollarization would expand the menu of financial options open to emerging-market governments and firms, and therefore it would increase financial stability. For Panizza *et al* (2001), dollarization might reduce financial fragility by reducing the volatility of key relative prices in the economy, and contribute to the development of the banking system.[8] Mendoza (2000) calibrates a dynamic equilibrium model for Mexico and concludes that there could exist a welfare gain (4.6% of steady-state consumption level) by improving the access to global capital markets, even if policy credibility remained weak. Mendoza (2002) concludes that the enhanced credibility and reduced informational frictions could result in better access to international capital markets in terms of reduced liquidity coefficients and margin requirements.

[7] Powell and Sturzenegger (2000) consider that dollarization implies lower country risk especially for highly dollarized economies such as Argentina, Brazil, and Mexico.
[8] This conclusion is based on an empirical analysis for Central American countries.

Table 2. Costs of an Official Dollarization

Authors	Costs	Observations
	Monetary and exchange rate policy	
Rojas-Suárez (1999)	Loss of nominal exchange rate as an instrument to ameliorate terms-of-trade shocks.	Calvo (1999a,b): The loss of monetary policy is not significant in comparison to its current limited power: emerging economies depend on US monetary policy through the changes of the Treasury Bond rate.
Berg and Borensztein (2000)*, Mendoza (2002)	Loss of monetary policy. This is replaced by the US Fed monetary policy. The central bank could not affect money supply of the economy because that results from balance of payments.	Besides, "hyper-activity" by central banks is (in part) the responsible of our crisis. Calvo (1999a,b): Instead of nominal exchange rate, prices and wages would adjust to terms-of-trade shocks. Domestic currency depreciation is contractive in emerging economies. Competitivity gains might be achieved through fiscal policy.
Schmitt-Grohé and Uribe (2001a)	The least successful of monetary policies (in the particular case of Mexico). Agents would prefer to give up 0.1-0.3% of consumption to have a policy other than dollarization.	Based on the calibration of a model for Mexican economy.
Cooley and Quadrini (1999)	It is not welfare improving because of the lack of long-term monetary policy.	
	Lender of last resort	
Berg and Borensztein (2000)	Loss of lender of last resort (LLR) and hence the central bank's response to financial system emergencies. But, it should not impede the ability of authorities to provide short-term liquidity to the system or assistance to individual banks in distress.	Calvo (1999a,b): It can be outweigh by a deeper banking integration (between domestic and foreign banks, e.g. Panama) and through the use of contingent external credit lines (e.g. Argentina) in the case of a crisis. Dornbusch (2000): The assumption is that central bank, not the Treasury or the world capital market, is the appropriate lender.
Gale and Vives (2002)	Whereas the LLR may impose too little financial discipline, dollarization may impose too much.	Gavin (1999): The central bank could provide liquidity support to local banks if it keeps excess dollar reserves.
	Fiscal policy	
Savastano (1999), Mendoza (2002)	Loss of seigniorage.	Calvo (1999a,b): At the present partially dollarized economies suffer loss of seigniorage. A full-dollarization scheme should include a pact with US to share seigniorage.
Berg and Borensztein (2000)	For a country that does not have enough foreign reserves to buy up its domestic currency, the acquisition of initial stock could add indirect costs.	Dornbusch (2000): There is an important offset to the loss of seigniorage from the reduction in public debt service costs that result from reduced interest rates. Alesina and Barro (2001): It is not a social waste, but redistribution between the countries.
	Investment and growth	
Goldfajn and Olivares (2000)	The absence of monetary and exchange rate policy might induce larger output volatility (providing fiscal policy is not very countercyclical) in comparison to a flexible exchange rate regime.	Carrera *et al*. (2002): Real volatility reduction depends on the degree of synchronization between the cycles of the leader and associated country and the effect and relative importance of the trade and financial transmission channels from the leader to the associated country.
Edwards (2001), Edwards and Magendzo (2001)	Dollarized countries have grown at a significantly lower rate than non-dollarized countries.**	It is due, at least in part, to these countries' difficulties in accommodating external disturbances. There has not been statistical difference in macroeconomic volatility between dollarized and non-dollarized economies.
Drew *et al*. (2001)	Volatility in output and inflation would be greater under a common currency policy environment.	Based on an empirical analysis for New Zealand.

* The author compiles this advantage (sometimes from other authors), but he or she does not necessarily support it.

** Based on an empirical work.

On the other hand, Goldfajn and Olivares (2000) think that full dollarization is not a warranty of instantaneous access to international markets. Berg and Borensztein (2000) consider that it does not eliminate the risk of external crises, since investors may flee due to problems of weakness in fiscal position or the soundness of the financial system. For Sims (2002), dollarization has ambiguous implications for the stability of the financial system, because it reduces range of assets available in trading risk and it leaves the government less able to intervene supportively in financial crises.

From my viewpoint, mainly in the case of partially dollarized economies, an official dollarization scheme could initially cause important losses for the banking system since they receive revenues for currency exchange transactions. For instance, in the 1999-2000 period these net earnings are around 2.11 times the net profits of Peruvian banking system.[9] This cost for the private banks can be seen as the counterpart of the benefits for private firms and consumers. In this sense, Rojas-Suárez (1999) suggests that one precondition to dollarization is a sound domestic system.

2.5. Dollarization, Trade and Current Account Position

Based on the optimal currency area literature (Mundell, 1961, and McKinnon, 1963), several authors, such as Lizano (2000), consider that a benefit for dollarizing a Latin American economy is the lower transaction cost related to trading goods in different currencies. Similarly, Panniza *et al*. (2000) remark that a common currency would reduce uncertainty and risk (exchange rate volatility) in trade and investment aside from the cost related to the need to deal with multiple currencies.

Nevertheless, there are some objections to the possible benefits of dollarization on trade and current account positions. For instance, Edwards (2001a,b) found that dollarized countries have not been spared from major current account reversals. Also, Klein (2002) found that the effect of dollarization is not (statistically) different from the effect of a fixed exchange rate on trade with the US.

[9] Source: Superintendency of Banking and Insurance of Peru.

2.6. Investment and Growth

Among the benefits of dollarization, Savastano (1999) cites that dollarization is supposed to promote investment and growth. Berg and Borensztein (2000) think that it might generate a higher level of confidence among international investors and more investment and growth since there is no possibility of sudden capital outflows motivated by fear of devaluation. Besides, Mendoza (2002) contends that it produces a sharp decline in information costs because foreign investors would no longer need to pay for information on the dollarized economy's monetary policy. This effect can also increase the demand elasticity for emerging markets equity by foreign traders.

Nevertheless, there are many objections to these viewpoints. According to Edwards (2001), Panama's case suggests that external shocks result in greater costs in terms of lower investment and growth than non-dollarized countries. For Goldfajn and Olivares (2000), the absence of monetary and exchange rate policy might induce larger output volatility in comparison to a flexible exchange rate regime.[10] Through a theoretical model, Carrera *et al*. (2002) remark that real volatility reductions depend on the degree of synchronization between the cycles of the leader and associated country and the effect and relative importance of the trade and financial transmission channels from the former to the latter.

Edwards (2001) and, Edwards and Magendzo (2001) conclude that dollarized countries have grown at a significantly lower rate than non-dollarized countries. This is due, at least in part, to these countries' difficulties in accommodating external disturbances. However, the authors also find that there has not been statistical difference in macroeconomic volatility between dollarized and non-dollarized economies. Finally, Drew *et al*. (2001) find that volatility in output and inflation would be greater under a common currency environment in the case of New Zealand.

[10] Provided that fiscal policy is not very countercyclical.

2.7. Elimination of Monetary or Exchange Rate Policy: a Loss or a Gain?

Berg and Borensztein (2000) emphasize that a dollarized economy would relinquish any possibility of having autonomous monetary and exchange rate policies and that these would be replaced by the US monetary policy. Besides, the central bank would not affect the money supply as it results from the balance of payments. Rojas-Suárez (1999) contends that a cost of dollarization is the loss of the nominal exchange rate as an instrument to ameliorate terms-of-trade shocks. Alesina and Barro (2001) think that if we assume that the domestic monetary policy can commit to a useful countercyclical policy, then the loss of an independent policy will represent a true cost. They conclude that this cost will be higher the less correlated is the business cycle of the client country with that of the anchor.

Calibrating a dynamic general equilibrium model for Mexico, Schmitt-Grohé and Uribe (2001a) conclude that dollarization is the least successful of monetary policies. Agents would prefer to give up from 0.1% to 0.3% of consumption to have a policy other than dollarization. A similar finding is the one by Cooley and Quadrini (1999).

Calvo (1999) has some opposite observations to these points of view. He remarks that the loss of monetary policy is not significant in comparison to its current limited power since emerging economies already depend on US monetary policy through the changes of the Treasury Bond rate. Latin-American economies are subject to contagion effects from developed economies. He finishes stating three ideas. First, instead of the nominal exchange rate, prices and wages would adjust to terms-of-trade shocks. Second, domestic currency depreciation is contractive in emerging economies. Finally, competitivity gains might be achieved through fiscal policy.

It must be mentioned that a dollarization regime does not necessarily imply the full elimination of the monetary policy even though there would be a drastic reduction of the capacity of the monetary authority to perform its policy. The reasons are the following: (1) the central bank would still have the possibility to issue low-denomination currencies;[11] (2)

[11] For example, the central banks of Panama and Ecuador still issue low-denomination Balboas and Sucres, respectively.

it could still control the legal reserve requirement rate; and, (3) it could apply temporary capital controls to have certain degree of influence on (foreign) inflows.

2.8. Does Dollarization Imply a Loss of the Lender of Last Resort?

Gale and Vives (2002) explain that whereas the function of lender of last resort (LLR) may impose too little financial discipline, dollarization may impose too much. By constraining the central bank's role as LLR, it may be impossible to extend assistance to a distressed bank even in situations where this would be efficient ex ante. On the other hand, Berg and Borensztein (2000) allude to the fact that full dollarization may impair the country's lender-of-last-resort (LLR) function and hence the central bank's response to financial system emergencies. However, the authors continue, dollarization should not greatly impede the ability of the authorities to provide short-term liquidity to the system or assistance to individual banks in distress. Such facilities are available if the central bank saves funds in advance or secures lines of credit with international banks. Calvo (1999) has also raised this last point. He contends that the loss of LLR can be outweighed by deeper banking integration –between domestic and foreign banks, for example Panama– and the use of contingent external credit lines (e.g. Argentina). Similarly, Dornbusch (2000) has pointed out that the argument of the loss of LLR is intriguing because it is based on the assumption that the central bank, not the Treasury or the world capital market, is the appropriate lender. Finally, Gavin (1999) considers that the central bank could provide liquidity support to local banks if it keeps excess dollar reserves for this purpose.

2.9. Other costs

According to Bogetic (2000), there is also a cost of converting prices, computer programs, cash registers, and vending machines from domestic currency to the foreign currency chosen. This is a one-time cost that can vary considerably from country to country. Bogetic (2000) also adds that there may be associated legal and financial costs of revising contracts or refinancing. In addition, Cohen (2000) mentions that dollarization implies the loss of a vital symbol of national identity.

In summary, some conclusions of this review are the following. First, there is not a general consensus on the benefits and costs of full dollarization, except on a lower inflation rate. Second, there is a lack of studies for emerging market economies that face currency and/or asset substitution and that are supposed to be good candidates for a full dollarization scheme. Third, there are virtually no studies that formally evaluate the implications of full dollarization on macroeconomic volatility, especially through a dynamic general equilibrium framework.

3. A Simple Theoretical Framework

In this section I describe the main characteristics of the proposed models. First, I consider a model capable of representing a small open economy that shows currency substitution and asset substitution (between foreign- and domestic-currency-denominated assets). Second, I present a fully dollarized economy model in which the dollar is the only legal tender for commercial and financial transactions. In both cases I obtain first order conditions and steady-state solutions to analyze comparatively their implications. As an application, the first model is calibrated for specific sample moments of the Peruvian economy and the same parameter values will be used to solve the second model.

3.1. A Model of a Partially Dollarized Economy with Flexible Exchange Rate

The economy has the following features:

- household's utility is a function of consumption, leisure, and a liquidity service function which depends on real money holdings denominated in both currencies;
- an interest rate rule followed by the monetary authority;
- flexible exchange rate;
- demand for domestic and foreign money, and demand for assets denominated in domestic and foreign currency (asset substitution) in the domestic banking system;
- constant distortionary taxes and convex costs of price adjustment (price rigidities);
- open economy (presence of terms of trade);

- the presence of technological (or domestic supply), fiscal-policy, monetary-policy, foreign-interest rate, and terms-of-trade shocks.

Households

The economy is populated by an infinitely-lived representative agent that optimizes an utility function which depends positively on real private consumption c_t, real domestic money balances m_t, real foreign money balances m^*_t, and leisure l_t:

$$E_t \left\{ \sum_{t=0}^{\infty} b^t u\left[c_t, l_t, \Phi\left(m_t, m_t^*\right)\right] \right\}, \tag{1}$$

where $0<\beta<1$ is the subjective discount factor, E{.} the expectation operator and Φ is a liquidity service function:[12]

$$\Phi\left(m_t, m_t^*\right) = A_m m_t^f m_t^{*1-f}; \qquad A_m > 0, \quad 0 < f < 1,$$

where ϕ represents the share of domestic money on the total amount of money. In certain extent, the degree of currency substitution is captured by this parameter. With a progressively lower value of ϕ currency substitution increases.

The representative household's constraint is:

$$\begin{aligned} c_t + i_t + b_t + b_t^* + m_t + m_t^* \le (1-t)\left(w_t L_t + r_t K_t\right) + (1-t) q_t y_2 + T_t + \frac{m_{t-1}}{1+p_t} + \frac{\left(1+e_t\right) m_{t-1}^*}{1+p_t} + \\ + \frac{\left(1+R_t\right) b_{t-1}}{1+p_t} + \frac{\left(1+R_t^*\right)\left(1+e_t\right) b_{t-1}^*}{1+p_t} - \Psi\left(p_t\right) + D_t, \end{aligned} \tag{2}$$

where i_t denotes real investment in period t, b_t is the real stock of assets in domestic currency, b^*_t is the real stock of assets in foreign currency, t is the (constant) income tax,

[12] As in McNelis and Asilis (1992) and Bufman and Leiderman (1992).

w_t denotes real wage, L_t represents the level of employment, r_t represents real cost of capital, K_t is stock of physical capital, q_t is the relative price of exportable goods to importable goods or terms of trade, T_t denotes real lump-sum transfers, π_t is the inflation rate, $\Psi(\pi_t)$ is cost of price adjustment,[13] e_t is the nominal depreciation rate, R_t represents the domestic (net) interest rate, R^*_t is the foreign (net) interest rate[14], and D_t are firm profits.

Besides, it is supposed that the household is endowed each period with one unit of time, which it divides between leisure ($1-L_t$) and work (L_t). The function $\Psi(\pi_t)$ measures the cost of altering prices and thus represents the degree of price rigidity. It is supposed to be strictly convex in the inflation rate and it is zero in steady-state equilibrium. Particularly, I will assume that $\Psi(\pi_t)= (\rho_i/2)(\pi_t-\pi_{ss})^2$. I also assume that there are two goods produced in the economy. The first good (y_1, or importable good) is produced domestically and can be imported, but the second one (y_2, or exportable good) is not consumed domestically and it is supposed to be constant.

I assume that the utility function depends on the logs of consumption, the monies, and employment:

$$u\left(c_t, m_t, m_t^*, l_t\right) = \log c_t + \Phi\left(m_t, m_t^*\right) + h \log\left(1 - L_t\right). \tag{3}$$

With regard to capital accumulation, K_t presents the following law of motion:

$$K_{t+1} = (1-d)K_t + i_t, \tag{4}$$

where δ is the rate of capital depreciation.

The law of motion of the exogenous terms of trade is:

[13] As in Schmitt-Grohé and Uribe (2001a).

[14] In this theoretical framework, I call the foreign interest rate to the interest rate that US-dollar deposits yield in the domestic banking system, which can be different from the international interest rate.

$$q_t = (1-r_q)\,q_0 + r_q\,q_{t-1} + e_{qt} \;\; ; \;\; e_{qt} \sim N\,(0, s_q^2) \;\; ; \;\; q_0 > 0 \;\; ; \;\; 0 < r_q < 1. \tag{5}$$

I suppose an autorregresive interest rate rule like this:

$$R_{t+1} = (1-q_1)R_0 + q_1 R_t + q_2 (y_t - y_{ss}) + e_{Rt+1}; \;\; e_{Rt} \sim N\,(0, s_R^2); \;\; R_0, \;\; 0 < q < 1. \tag{6}$$

where y_t is current total output, y_{ss} denotes total output in steady state and R_0 corresponds to the long-run (or steady-state) domestic interest rate.

To finalize the description of the economy, I assume an exogenous foreign interest rate:

$$R^*_{t+1} = (1-r_R)R^*_0 + r_R R^*_t + e_{R^*t}; \;\; e_{R^*t} \sim N\,(0, s^2_{R^*}); \;\; R^*_0 > 0, \; 0 < r_R < 1. \tag{7}$$

where, R^*_0 corresponds to the long-run (or steady-state) foreign interest rate.

In a decentralized equilibrium, the agent maximizes (1) subject to (2)-(7).[15] Accordingly, the first-order conditions are:

$$\frac{1}{c_t} - l_t = 0 \tag{8}$$

$$\frac{f}{m_t} - l_t + b\,E_t\left(\frac{l_{t+1}}{1+p_{t+1}}\right) = 0 \tag{9}$$

$$\frac{1-f}{m^*_t} - l_t + b\,E_t\left(\frac{l_{t+1}(1+e_{t+1})}{1+p_{t+1}}\right) = 0 \tag{10}$$

$$-\frac{h}{(1-L_t)} + l_t(1-t)w_t = 0 \tag{11}$$

[15] For simplicity, it is assumed the logarithm of the liquidity services function.

$$-l_t + b(1+R_{t+1})E_t\left(\frac{l_{t+1}}{1+p_{t+1}}\right)=0 \tag{12}$$

$$-l_t + b(1+R^*_{t+1})E_t\left(\frac{l_{t+1}(1+e_{t+1})}{1+p_{t+1}}\right)=0 \tag{13}$$

$$-l_t + bE_t\, l_{t+1}[(1-t)r_{t+1}+(1-d)]=0\,. \tag{14}$$

Notice that since the bonds are risk-free assets, R_{t+1} and R^*_{t+1} are known in period t, thus they are placed out of the expectation operator.

Firms

The representative firm maximizes its profits given by equation (15),

$$D_t = y_t - w_t L_t - r_t K_t \tag{15}$$

subject to a returns-to-scale technology:

$$y_{1t} = F(K_t, L_t, z_t) = A_0 K_t^a L_t^{1-a} e^{zt} \quad ; \qquad A_0 > 0, \quad 0<a<1, \tag{16}$$

where z_t is a technological shock that follows an autorregresive process:

$$z_t = r_z z_{t-1} + e_{zt}, \qquad e_{zt} \sim N(0, s_z^2) \; ; \; 0<r_z<1, \tag{17}$$

and ε_{zt} is a zero-mean shock with variance σ^2_z.

Thus, the firm maximizes (15) subject to (16)-(17), obtaining the following first-order conditions:

$$aA_0\left(\frac{L_t}{K_t}\right)^{1-a} e^{zt} - r_t = 0 \tag{18}$$

$$(1-a)A_0\left(\frac{K_t}{L_t}\right)^{a} e^{zt} - w_t = 0 \tag{19}$$

Public Sector

The government budget constraint is:

$$g_t + T_t = t\left(w_t L_t + r_t K_t + q_t y_2\right) + m_t - \frac{m_{t-1}}{1+p_t} + m_t^* - \frac{(1+e_t)m_{t-1}^*}{1+p_t} + b_t - \frac{(1+R_t)b_{t-1}}{1+p_t} + b_t^* - \frac{(1+R_t^*)(1+e_t)b_{t-1}^*}{1+p_t} \tag{20}$$

where g_t is the exogenous government expenditure. It is assumed that the government finances its deficit (government expenditures net of tax revenues) through seigniorage, bonds denominated in domestic and foreign currency, and US-dollar from the central bank (international reserves)[16]. The model also considers a stationary law of motion for the fiscal policy:

$$g_t = (1-r_g)g_0 + r_g g_{t-1} + e_{gt} \;\; ; \;\; e_{gt} \sim N\left(0, s_g^2\right) \;\; ; \;\; g_0 > 0 \;\; ; \;\; 0 < r_g < 1, \tag{21}$$

and ε_{gt} is a zero-mean shock with variance σ^2_g.

3.2. A Model of a Fully Dollarized Economy

I suppose a fully dollarized economy with the following characteristics:

- household's utility function depends on consumption, real money holdings denominated in dollars, and leisure;

[16] The assumption is that the central bank has enough international reserves to satisfy demand for US-dollar money if it is necessary.

- fully dollarized economy, that is, fixed exchange rate equal to one and no domestic money as legal tender;
- loss of monetary policy;
- demand for bonds denominated in foreign currency;
- the remaining assumptions as before.

Households

In this framework the infinitely-lived agent optimizes an utility function which depends on real private consumption c_t, leisure l_t, and real foreign money balances m^*_t:

$$E_t \left\{ \sum_{t=0}^{\infty} b^t u\left(c_t, l_t, m_t^*\right) \right\}, \tag{1'}$$

The (new) representative household's constraint is:

$$c_t + i_t + b_t^* + m_t^* \leq (1-t)\left(w_t L_t + r_t K_t\right) + (1-t) q_t y_2 + T_t + \frac{m_{t-1}^*}{1+p_t} + \frac{\left(1+R_t^*\right) b_{t-1}^*}{1+p_t} - \Psi\left(p_t\right) + D_t, \tag{2'}$$

where each variable denotes the same as before.

The utility function now is represented by equation (3'):

$$u\left(c_t, m_t, m_t^*, l_t\right) = \log c_t + g \log m_t^* - h \log\left(1 - L_t\right). \tag{3'}$$

In a decentralized equilibrium, the agent of this officially dollarized economy maximizes (1') subject to (2'), (3'), (4)-(7). The first-order conditions are, as before, (8), (11), (12), (14) and:

$$\frac{g}{m_t^*} - l_t + b\, E_t\left(\frac{l_{t+1}}{1+p_{t+1}}\right) = 0 \qquad (10')$$

$$-l_t + b\left(1+R_{t+1}^*\right)E_t\left(\frac{l_{t+1}}{1+p_{t+1}}\right) = 0 \qquad (13')$$

The problem of the firms is like in the partially dollarized economy.

Public Sector

The government budget constraint is now:

$$g_t + T_t = t\left(w_t L_t + r_t K_t + q_t y_2\right) + b_t^* - \frac{\left(1+R_t^*\right)b_{t-1}^*}{1+p_t} + m_t^* - \frac{m_{t-1}^*}{1+p_t} \qquad (20')$$

4. Calibration and Results

This section describes the solution of the models and the main results obtained in terms of the series volatilities.

4.1. Parameterization and method of solution

I assume three criteria to assign values to each parameter of the models. The first criterion is to use some of the standard parameter values given in previous literature for the Peruvian economy. There are just a few works that attempt to calibrate dynamic equilibrium models for Peruvian data. Table 3 summarizes the (quarterly) parameter values and their corresponding criterion of choice.

Table 3. Parameterization of the Models [/a]

Parameter	Symbol	Value	Criteria of Choice
Subjective discount factor	β	0.976	Calibration of steady-state real interest rate around 10% (annual)
Utility sensitivity to domestic money (partially dollarized economy)	ϕ	0.42	Implies a degree of currency substitution (1-ϕ): 0.58 (share of US$ demand deposits on total amount of demand deposits in Peruvian banking system). [/b]
Utility sensitivity to dollar money (fully dollarized economy)	γ	0.42	The same as in the partially dollarized model.
Utility sensitivity to leisure	η	1	Calibration of steady-state labor: 0.35. This value implies a labor day of 8.2 hours.
Capital share	α	0.44	Bernanke and Gurkaynak (2001)
Technological constant	A_0	1.35	Calibration of steady-state share of consumption on GDP around 70%
Technological-AR1 coefficient	ρ_z	0.8	Quiroz et.al (1992)
Technological volatility	σ_z	0.06	Quiroz et.al (1992)
Depreciation rate	δ	0.0375	Calibration of steady-state share of investment on GDP around 15%
Cost of price adjustment parameter	ρ_i	2	Calibration of output volatility
Steady-state exportable sector	Y_2	3	Calibration of steady-state share of exportable sector on GDP around 10%
Terms-of-trade-AR1 coefficient	ρ_q	0.88	AR(1) estimate (data: 1992.1-2000.4)
Terms-of-trade volatility	σ_q	0.0964	AR(1) estimate (data: 1992.1-2000.4)
Income tax	τ	0.25	Income taxes (approximately)
Steady-state government expenditure	g_0	0.3	Calibration of steady-state share of government expenditures on GDP: 12%
Government-AR1 coefficient	ρ_g	0.73	AR(1) estimate (data: 1992.1-2000.4)
Government expend. volatility	σ_g	0.12	AR(1) estimate (data: 1992.1-2000.4)
Foreign interest rate (constant)	R^*_0	$1.1^{(1/4)}$-1	AR(1) estimate (data: 1992.1-2000.4)
AR1 coefficient	ρ_R	0.93	AR(1) estimate (data: 1992.1-2000.4)
Foreign interest rate volatility	σ_{R^*}	0.0061	AR(1) estimate (data: 1992.1-2000.4)
Domestic interest rate (constant)	R_0	$1.13^{(1/4)}$-1	Calibration of steady-state annual inflation rate between 2% and 3%
AR1 coefficient	θ_1	0.9	AR(1) estimate (data: 1992.1-2000.4)
Output deviation coefficient	θ_2	0.1	AR(1) estimate (data: 1992.1-2000.4)
Domestic interest rate volatility	σ_r	0.0126	Calibration of inflation rate volatility.

a. AR(1) denotes first-order autoregression process. All the parameter values are used in both models with the exceptions mentioned in this table. The covariances of the shocks are supposed to be zero. Data from the Peruvian economy are from Central Bank of Peru (BCRP) and the National Bureau of Statistics (INEI).

b. This proxy is more adequate due to its close association to the theoretical causes of currency substitution than other bank deposit ratios such as saving or term deposit ratios that tend to capture asset substitution. A discussion on this issue can be found in Duncan (2000, 2001).

The second criterion is to find the parameter value necessary to match some steady-state values for Peruvian economy (such as the steady-state consumption as a percentage of GDP, the steady-state inflation rate, and so on). The last criterion is to adjust the parameter

values to allow the model match the volatilities of real output and inflation.[17] The main metrics of comparison were an output coefficient of variation around 0.12 (Holdrick-Prescott filtered data), and a standard deviation of (quarterly) inflation rate around 8%.

The solution of the model is achieved using a perturbation method (second-order approximation) developed by Schmitt-Grohé and Uribe (2001). This method consists of a second order approximation to the policy functions of the dynamic equilibrium model. Once the models were solved, series of 5000 observations were generated in each case to perform a comparative analysis. To perform an appropriate comparison I calibrate both models to achieve the same steady-state values of the variables that are common to both models.

4.2. Main results

In this section, I use the simulated variables from the partially dollarized economy with flexible exchange rate and the fully dollarized economy to compare the performance of the official dollarization scheme in terms of macroeconomic volatility.

Real Volatility

Table 4 reports statistics of output, consumption and investment series from both models. As it can be seen, the fully dollarized economy generates higher real volatility expressed in higher standard deviations or coefficients of variation of output and investment series.[18] Particularly, the standard deviation of output increases around 7% (of the one from the partially dollarized economy). This finding is associated with the absence of the (countercyclical) monetary policy that can be endogenously used in the partially dollarized regime to ameliorate real shocks. The lack of this instrument in the fully dollarized economy could be causing the higher real volatility, especially in investment and output.

[17] For the last two criteria, quarterly Peruvian data for the 1991-2000 period was used. See table 3 for the sources.

[18] Along this work it will be assumed that higher volatility is expressed in higher standard deviations and/or higher coefficients of variation.

Table 4. Statistics of the (simulated) series from the models

Statistic	Simulated series from the partially dollarized economy with flexible exchange rate			Simulated series from The fully dollarized economy		
	Output	Consumption	Investment	Output	Consumption	Investment
Std. Dev.	0.677925	0.528259	0.329215	0.747617	0.458574	0.381866
Coeff. of Var.[a]	0.121466	0.292824	0.073391	0.133672	0.256714	0.084843

a. The coefficient of variation results dividing the standard deviation by the mean of each series.

When a test for equality of variances between output series is performed, the null of equality is rejected (see table 5) verifying that full dollarization implies higher real volatility according to the models.

Table 5. Tests for equality of variances between series (output, consumption, and investment)[a]

Test	Output	Consumption	Investment
F-test	1.216172 (0.0000)	1.327015 (0.0000)	1.345439 (0.0000)
Siegel-Tukey	4.930604 (0.0000)	6.765251 (0.0000)	8.928274 (0.0000)
Bartlett	43.00641 (0.0000)	89.72795 (0.0000)	98.65396 (0.0000)
Levene	36.97608 (0.0000)	70.75220 (0.0000)	101.3011 (0.0000)
Brown-Forsythe	36.57087 (0.0000)	66.69732 (0.0000)	99.72317 (0.0000)

a. The null hypothesis is the equality of the variances of the variables in each model. For an explanation of the main features of the tests, see Eviews 4.0 User´s Guide (2000). P-values are in parentheses.

The exception is consumption. This variable shows −without any doubt− a statiscally significant lower standard deviation in the case of full dollarization, even at 1% of significance (see table 5). This fact is basically owing to the absence of domestic interest rate in the fully dollarized economy. In other words, the lower interest rate volatility in the fully dollarized economy causes less volatility in consumption.

Inflation rate

In a fully dollarized economy, the inflation rate is not only lower in average but also presents lower volatility (see table 6).

Table 6. Volatility of the (simulated) inflation series from the models

Statistic	Simulated (gross) inflation rate from the partially dollarized economy with flexible exchange rate	Simulated (gross) inflation rate from the fully dollarized economy
Std. Dev.	0.085541	0.018258
Coeff. of Var.[a]	0.084549	0.018111

a. The coefficient of variation results dividing the standard deviation by the mean.

Tests for equality of variances confirm this fact. Table 7 shows unquestionably that the volatility of the inflation rate in the flexible exchange rate regime is (statiscally) different from the one of the full dollarization regime. This is due to a lower volatile monetary policy imported from the US Federal Reserve System.

Table 7. Tests for equality of variances between inflation series[a]

Method	Value	Probability
F-test	21.95044	0.0000
Siegel-Tukey	59.99717	0.0000
Bartlett	8059.480	0.0000
Levene	4633.670	0.0000
Brown-Forsythe	4631.125	0.0000

a. The null hypothesis is the equality of the variances.

Fiscal deficit volatility

Even though it is quite difficult to measure fiscal discipline in this case, I will try to approximate it through the volatility (standard deviation) of the public deficit.[19] The estimation of this statistic for both models indicates that a partially dollarized economy with flexible exchange rate causes a slightly lower volatility on fiscal position than a fully dollarized economy (see table 8).

[19] Public deficit in this case is defined as the excess of government expenditures over income tax revenues (all the variables expressed in real terms).

Table 8. Volatility of the (simulated) fiscal deficit series from the models

Statistic	Simulated fiscal deficit from the partially dollarized economy with flexible exchange rate	Simulated fiscal deficit from The fully dollarized economy
Std. Dev.	0.180276	0.196888
Coeff. of Var.[/a]	-0.165721	-0.180506

a. The coefficient of variation results dividing the standard deviation by the mean.

This fact is verified through the calculation of tests for equality of variances. The null of equality between fiscal deficit variances from each model is not rejected at conventional levels of significance (see table 9). That is, "fiscal discipline" is higher in a flexible exchange rate regime than a fully dollarized economy. This result can be explained by the fact that output is more volatile and so are income tax revenues.

Table 9. Tests for equality of variances between fiscal deficit series[/a]

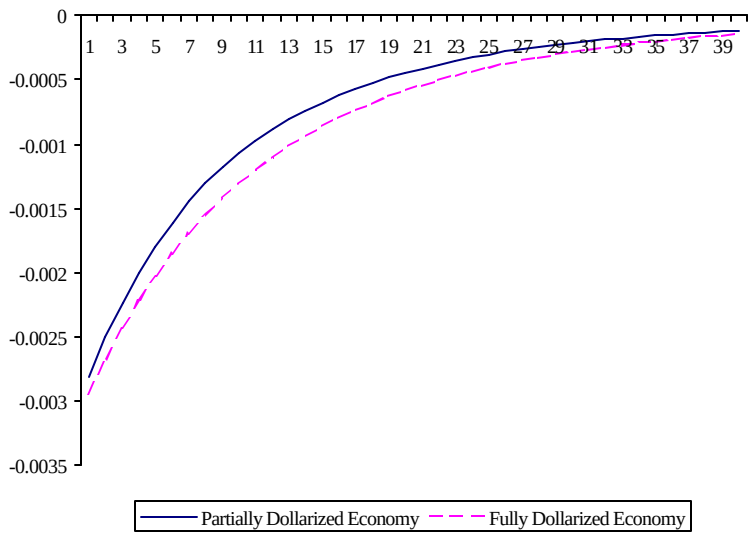
Method	Value	Probability
F-test	1.192793	0.0000
Siegel-Tukey	4.516643	0.0000
Bartlett	34.90914	0.0000
Levene	30.60821	0.0000
Brown-Forsythe	30.24550	0.0000

a. The null hypothesis is the equality of the variances.

Reaction to external shocks

Figure 1 shows the impulse-response function of a negative terms-of-trade shock on output in both models. It can be seen that the output response is higher for the full dollarization model than the partial dollarization model. That is, the lack of domestic monetary policy and nominal exchange rate in a fully dollarized economy implies that terms-of-trade shocks cause higher output reactions when comparing to the output response from a partially dollarized economy with flexible exchange rate. This finding is against Calvos' (1999a,b) argument that instead of nominal exchange rate, prices and wages would adjust to terms-of-trade shocks in a fully dollarized economy.

Figure 1. Responses of Output in Both Economies to a Terms-of-Trade Shock



Sensitivity analysis and future research

The results presented are not very sensitive to changes in parameter values such as the ones related to the consumer's preferences and firm's technology.[20] Further analysis can be done considering other utility function specifications.

However results are sensitive to the nature of monetary policy. The countercyclical monetary policy –expressed in an interest rule that depends positively on output deviation from steady state– has a key role. A less countercyclical monetary policy produces less difference on output and inflation volatility between both regimes[21]. Table 10 illustrates this idea.

[20] This would not be necessarily the same if welfare analysis had to be performed because of the elimination of domestic money in consumer's utility. In this case, it does not seem easy to model this structural change to perform that kind of analysis.
[21] Alesina and Barro (2001) also contend this idea.

Table 10. Sensitivity of Output and Inflation Volatility to Countercyclical Monetary Policy[/a]

	Output Volatility	Inflation Volatility
q_2	Full/Partial	Full/Partial
0.15	1.15121216	0.15921627
0.10	1.10280193	0.21344151
0.05	1.05249779	0.33669810
0.01	1.01058987	0.60124485

a. The values in each column are the ratios that results from dividing the standard deviation of output (inflation) from the full dollarization regime by the standard deviation of output (inflation) from the flexible exchange rate regime, respectively. Assumption and results of the baseline model are shadowed.

Therefore, in an economy with price rigidities (and flexible exchange rate), full dollarization implies higher real volatility due to the loss of a countercyclical monetary policy[22]. On the other hand, in an economy with price flexibility, full dollarization does not generate higher real volatility. Even in this case, the absence of monetary policy shocks could imply lower standard deviation of real output since a source of volatility is eliminated in the economy.

On the other hand, it could be interesting to include costs for transacting in foreign money in the partially dollarized economy, which had to disappear (or drastically diminish) through the complete dollarization of the economy. Also, an endogenous component of country risk could be included in the foreign interest rate law of motion that could depend on fiscal deficit or other crucial variables.

Finally, one of the assumptions of the models presented before is that the government (or the central bank) has enough international reserves (in foreign currency and assets) to satisfy the domestic demand for foreign money. Even though this supposition could be at the present feasible in Peruvian economy this should not be necessarily the rule for the future or for other partially dollarized economies. Further research on this topic

[22] I also performed a sensitivity analysis considering different degrees of price stickiness (ρ_i) and procyclical/anticyclical fiscal policy. As long as the degree of price stickiness reduces the difference between output volatility from the flexible exchange rate regime and the one from the fully dollarized regime is lower. In the extreme case when ρ_i is zero, the ratio of the variances becomes unity. This result indicates the crucial role of price stickiness. The main conclusions remained unchanged in the case of procyclical/anticyclical fiscal policy.

should be done considering the absence of this assumption to analyze its implications on macroeconomic volatility.

5. Conclusions

Some conclusions of the literature review are the following: (i) there is not a general consensus on the benefits and cost of full dollarization, except on a lower inflation rate (level and volatility); (ii) there is a lack of studies for emerging market economies that face currency and/or asset substitution and that are supposed to be good candidates for a full dollarization scheme; (iii) there are virtually no studies that formally evaluate the implications of full dollarization on macroeconomic volatility, especially through a dynamic general equilibrium framework.

The results of the simulation exercises suggest first, that a full dollarization scheme generates (significantly) higher real volatility, specially on investment and output in contrast to a partially dollarized economy with flexible exchange rate regime. This finding is associated to the fact that full dollarization lacks of domestic monetary policy, an instrument that can be endogenously used to ameliorate real shocks in an economy with price rigidities. This conclusion is valid for an economy with price stickiness and with a central bank that follows a countercyclical monetary policy. In an economy with flexible prices, the volatility might be the same or even lower since the absence of monetary policy shocks could imply lower standard deviation of the real output.

Second, full dollarization causes lower inflation volatility. This is due to the absence of a volatile monetary policy that is present in the flexible exchange rate regime and that is replaced by a less volatile monetary policy imported from the US Federal Reserve system. However, this latter benefit –if desired– can be reached through a less persistent and/or less volatile domestic monetary policy behavior. In other words, the obvious conclusion is that dollarization is not advisable for an economy that is able to have a monetary policy with low volatility.

Third, in spite of the absence of seigniorage, an official dollarization regime tends to cause a more volatile fiscal deficit than the economy with flexible exchange rate. This is closely related to the first conclusion abovementioned and might be seen by economic agents as a symptom of less fiscal discipline.

Fourth, negative terms-of-trade shocks cause more significant effects on real output in a fully dollarized economy than in an economy with flexible exchange rate. This finding is consistent with the first conclusion but is against Calvos' (1999a,b) argument that instead of nominal exchange rate, prices and wages would adjust to terms-of-trade shocks in a fully dollarized economy.

Finally, if full dollarization causes more real and fiscal volatility it is very difficult to imagine that dollarization reduces country risk. Thus, even though full dollarization (virtually) eliminates devaluation risk it does not necessarily eliminate default risk since real volatility could be higher and fiscal discipline might be difficult to improve.

References

Alesina, A., and R. Barro. 2001. " Dollarization." AEA Papers and Proceedings 91 (2).

Berg, A., and E. Borensztein. 2000. "Full Dollarization: The Pros and Cons." IMF Policy Discussion Paper. Washington DC.

_____, and, P. Mauro. 2002. "An Evaluation of Monetary Regime Options for Latin America." Central Bank of Chile: Working Paper 178, August.

Bernanke, B. S., and R. S. Gürkaynak. 2001. "Is growth exogenous? Taking Mankiw, Romer, and Weil seriously." Forthcoming, NBER Macroeconomics Annual, 2001.

Bloch, C., and J. Chiriaeva. 2002. "On Dollarization and Credibility." University of Aarhus. Unpublished paper, June

Bogetic, Z. 2000. "Official Dollarization: Current Experiences and Issues." *Cato Journal*, 20 (2): 179-213.

Bufman. G., and L. Leiderman. 1992. "Simulating an Optimizing Model of Currency Substitution." *Revista de Análisis Económico* 7 (1): 109-24.

Calvo, G. 1999a. *On Dollarization*. University of Maryland. Unpublished paper, April 20.

_____. 1999b. *Testimony on Full Dollarization*. Presented Before a Joint Hearing of the Subcommittees on Economic Policy and International Trade and Finance. Washington, DC, April 22.

_____, and C. Reinhart. 1999. "When Capital Inflows Come to a Sudden Stop: Consequences and Policy Options." Unpublished paper. University of Maryland, June.

Carrera, J., M. Féliz, D. Panigo, and M. Saavedra. 2002. "How does Dollarization Affect Real Volatility? A General Methodology for Latin America." Unpublished paper. April.

Chang, R. 2000. "Dollarization: A Scorecard." Federal Reserve Bank of Atlanta. Economic Review, Third Quarter.

_____, and A. Velasco. 2002. "Dollarization: Analytical Issues." NBER Working Paper 8838, March.

Cohen, B. 2000. “Political Dimensions of Dollarization.” Working Paper, Federal Reserve Bank of Dallas, March..

Cooley, T., and V. Quadrini. "The Costs of Losing Monetary Independence: The Case of Mexico." *Journal of Money, Credit, and Banking*, 33(2): 370-97.

Dornbusch, R. 2000. "Fewer Monies, Better Monies." Unpublished paper. December.

Drew, A., V. Hall, J. McDermott, and R. St. Clair. 2001. "Would Adopting the Australian Dollar Provide Superior Monetary Policy in New Zealand?". Reserve Bank of New Zealand Discussion Paper 03, August.

Du Bois, F., and E. Morón. 1999. "Los Riesgos y Oportunidades de Dolarizar la Economía Peruana". Unpublished paper, October.

Duncan, R. 2000. “Los Procesos de Sustitución Monetaria y de Sustitución de Activos en la Economía Peruana: 1993-1999.” PUC del Perú, Undergraduate Dissertation.

_____. 2001. “Histéresis, Sustitución Monetaria y Sustitución de Activos: Perú, 1993-1999.” Central Bank of Peru: *Moneda* XIII (123), September-October.

Edwards, S. 2001a. "Dollarization Myths and Realities" *Journal of Policy Modeling* 23: 249-65.

_____.2001b. "Dollarization and Economic Performance: An Empirical Investigation." NBER Working Paper 8274, May.

_____, and I. Magendzo. 2001. "Dollarization, Inflation and Growth." NBER Working Paper 8671, December.

Eichengreen. B. 2000. "When to Dollarize?" University of California, Berkeley. Unpublished paper, February.

_____. 2001. "What Problems Can Dollarization Solve?" University of California, Berkeley. Unpublished paper, January.

Gale, D., and X. Vives. 2002. "Dollarization, Bailouts, and the Stability of the Banking System." *Quarterly Journal of Economics* CXVII (2): 467-502.

Gavin, M. 1999. "Hearing on Official Dollarization in Latin America". Prepared Testimony in *Hearing on Official Dollarization in Latin America*. U.S. Senate, Washington, DC.

Goldfajn, I., and G. Olivares. 2000. "Is Adopting Full Dollarization the Solution? Looking at the Evidence." Pontificia Universidade Católica do Rio de Janeiro.

Gruben, W., M. Wynne, C. Zarazaga. 2001. "Dollarization and Monetary Unions: Implementation Guidelines." Federal Reserve Bank of Dallas, Working Paper 0201.

Guidotti, P., and A. Powell. 2002. "The Dollarization Debate in Argentina and Latin America." In *International Financial Markets: The Challenge of Globalization*, Auernheimer, L.(ed.), The University of Chicago Press.

Hausmann, R. 1999. "Should There Be Five Currencies or One Hundred and Five?." CIAO Foreign Policy. Fall 1999.

Hinds, M. 1999. Hearing on Official Dollarization in Emerging-Market Countries. Prepared Testimony. (www.senate.gov/~banking/99_07hrg/071599/hinds.htm). Washington, DC.

Hochreiter, E., K. Schmidt-Hebbel, and G. Winckler. 2002. "Monetary Unions: European Lessons, Latin American Prospects". Central Bank of Chile Working Paper 167. July.

Klein, M. 2002. "Dollarization and Trade." NBER Working Paper 8879, April.

Lizano, E. 2000. "Dolarización es Inevitable para las Economías más Pequeñas de la Región." www.eldiario.cl. December.

McKinnon, R. 1963. "Optimum Currency Areas". *American Economic Review* 53, 717-24.

McNelis, P., and C. Asilis. 1992. "A Dynamic Simulation Analysis of Currency Substitution in an Optimizing Framework with Transactions Costs." *Revista de Análisis Económico* 7 (1): 139-52.

Mendoza, E. 2000. "The Benefits of Dollarization when Stabilization Policy Lacks Credibility and Financial Markets are Imperfect". Forthcoming, *Journal of Money, Credit, and Banking*. August.

_____. 2002. "Why Should Emerging Economies Give Up National Currencies: A Case for 'Institutions Substitutions'". NBER Working Paper 8950, May.

Morandé, F., and K. Schmidt-Hebbel. 2000. "Esquemas Monetarios Alternativos: Una Evaluación Favorable al Peso Chileno." Revista de Economía Chilena 3(1), April.

Mundell, R. 1961. "A Theory of Optimum Currency Areas". *American Economic Review* 51, 509-17.

Panizza, U., E. Stein, and E. Talvi. 2000. "Measuring Costs and Benefits of Dollarization: An Application to Central American and Caribbean Countries." Washington, DC: Inter-American Development Bank. Unpublished paper, September.

Pesaran, H., and Y. Shin. 1998. "Generalized Impulse Response Analysis in Linear Multivariate Models." Economic Letters, 58: 17-29.

Pereyra, C, and Z. Quispe. 2002."Es conveniente una dolarización total en una economía parcialmente dolarizada." Banco Central de Reserva del Perú: *Revista de Estudios Económicos* 7, June.

Powell, A., and F. Sturzenegger. 2000. "Dollarization: The Link between Devaluation and Default Risk." Business School, Universidad Torcuato Di Tella, October.

Quiroz, J., F. Bernasconi, R. Chumacero, and C. Revoredo. 1991. "Modelos y Realidad: enseñando economía en los noventa." *Revista de Análisis Económico* 6 (2): 79-103.

Rojas-Suárez, L. 1999. *Dollarization in Latin America?*. Prepared Testimony. Prepared Testimony presented in *Hearing on Official Dollarization in Latin America*. U.S. Senate Banking Committee. Washington, DC. (www.senate.gov/~banking/99_07hrg/071599/rojas.htm).

Savastano, M. 1999. Presentation prepared for the conference "Dolarizar la Economía Peruana: Riesgos y Oportunidades". Lima, 1999.

Schmitt-Grohé, S., and M. Uribe. 2001a. "Stabilization Policy and the Costs of Dollarization." *Journal of Money, Credit, and Banking*, 33(2): 482-509.

_____. 2001b. "Solving Dynamic General Equilibrium Models Using a Second Order Approximation to the Policy Function." *Discussion Paper* 2963. Centre for Economic Policy Research, London.

Schuler, K. 1999. Presentation prepared for the conference "Dolarizar la Economía Peruana: Riesgos y Oportunidades". Lima, 1999.

Sims, C. 2002. "Fiscal Consequences for Mexico of Adopting the Dollar." Princeton University. Unpublished paper, May.

Appendix A

Steady-State Equilibrium of the Models

In steady state, the laws of motion (5), (6), (7), (17), and (21) imply the steady-state value of terms of trade, interest rate denominated in domestic currency, interest rate denominated in foreign currency, technological shock, and government expenditures, correspondingly:

$$q_{ss} = q_0 \tag{21}$$

$$R_{ss} = R_0 \tag{22}$$

$$R^*_{ss} = R^*_0 \tag{23}$$

$$z_{ss} = 0 \tag{24}$$

$$g_{ss} = g_0 \tag{25}$$

Substitution of condition (22) in (12) generates the steady-state inflation rate:

$$p_{ss} = b\left(1+R_{ss}\right)-1 \quad , \tag{26}$$

Using condition (13) and expressions (23) and (26), the steady-state rate of depreciation would be:

$$e_{ss} = \frac{1+p_{ss}}{b\left(1+R^*_{ss}\right)}-1 \quad , \tag{27}$$

Equations (2), (4), (8), (11), (14), (19), and (20) yields:

$$L_{ss} = \frac{w_1 w_3 + g_0 - q_0 y_2}{w_3\left(A_1 + w_1\right) - d w_2} \tag{28}$$

where:

$$w_0 = \left(\frac{aA_0 b(1-t)}{1-b(1-d)} \right); \quad w_1 = \left(\frac{(1-a)A_0(1-t)}{h} \right); \quad w_2 = w_0^{\frac{1}{1-a}}; \quad w_3 = w_0^{\frac{a}{1-a}}$$

Using the expression (28), equations (8), (11), (19) and rearranging, one obtains an expression for the steady-state consumption that depends on the steady-state employment:

$$c_{ss} = w_1 w_3 (1 - L_{ss}), \tag{29}$$

Similarly, the steady-state stock of capital can be found with the same equations:

$$K_{ss} = w_2 L_{ss}, \tag{30}$$

With equation (28) and (30) one can get the steady-state total production. Finally, equations (9), (10), (22), (23) and (29) generate the steady-state money balances in both currencies:

$$m_{ss} = f\ c_{ss} \left(\frac{1+R_{ss}}{R_{ss}} \right) \tag{31}$$

$$m^*_{ss} = (1-f) c_{ss} \left(\frac{1+R^*_{ss}}{R^*_{ss}} \right) \tag{32}$$

The steady-state values of the variables in the fully dollarized model are the same as the ones in the partially dollarized model. The only difference is that in the former there do not exist expressions like (22), (27), and (31).

Documentos de Trabajo
Banco Central de Chile

Working Papers
Central Bank of Chile

NÚMEROS ANTERIORES

PAST ISSUES

La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: http://www.bcentral.cl/Estudios/DTBC/doctrab.htm. Existe la posibilidad de solicitar una copia impresa con un costo de $500 si es dentro de Chile y US$12 si es para fuera de Chile. Las solicitudes se pueden hacer por fax: (56-2) 6702231 o a través de correo electrónico: bcch@bcentral.cl.

Working Papers in PDF format can be downloaded free of charge from: http://www.bcentral.cl/Estudios/DTBC/doctrab.htm. Printed versions can be ordered individually for US$12 per copy (for orders inside Chile the charge is Ch$500.) Orders can be placed by fax: (56-2) 6702231 or e-mail: bcch@bcentral.cl.

DTBC-199 Enero 2003
Errores de Proyección en Perspectiva
E. Albagli, G. Contreras, P. García, I. Magendzo y R. Valdés

DTBC-198 Enero 2003
Dinero e Inflación en el Marco de Metas de Inflación
Pablo García S. y Rodrigo Valdés P.

DTBC-197 Enero 2003
Efectos de la Nominalización de la Política Monetaria en Chile
R. Fuentes, A. Jara, K. Schmidt-Hebbel, M. Tapia y E. Arraño

DTBC-196 Enero 2003
The Role of Foreign Direct Investment and Natural Resources in Economic Development
José De Gregorio

DTBC-195 Enero 2003
Trade Intensity and Business Cycle Synchronization: Are Developing Countries any Different?
César Calderón, Alberto Chong y Ernesto Stein

DTBC-194 Diciembre 2002
Fiscal and Monetary Policy Coordination in EMU
Jürgen von Hagen y Susanne Mundschenk

DTBC-193 Diciembre 2002
Reflections on the Optimal Currency Area (OCA) Criteria in the Light of EMU
M.J. Artis

DTBC-192 Diciembre 2002
Growth, Integration, and Macroeconomic Policy Design: Some Lessons for Latin America
David Begg

DTBC-191 Noviembre 2002
Curva de Beveridge, Vacantes y Desempleo: Chile 1986-2002.II
Dolly Belani, Pablo García y Ernesto Pastén

DTBC-190 Noviembre 2002
How Well does a Monetary Dynamic Equilibrium Model Account for Chilean Data?
Roberto Duncan

DTBC-189 Octubre 2002
EMU and Accession Countries: Fuzzy Cluster Analysis of Membership
Dmitri Boreiko

DTBC-188
Monetary Integration in the Southern Cone: Mercosur is not Like the EU? Octubre 2002
Ansgar Belke y Daniel Gros

DTBC-187 Octubre 2002
Infrastructure Compression and Public Sector Solvency in Latin America
César Calderón, William Easterly y Luis Servén

DTBC-186 Octubre 2002
The Ouput Cost of Latin America's Infrastructure Gap
César Calderón y Luis Servén

DTBC-185 Octubre 2002
How did Latin America's Infrastructure Fare in the Era of Macroeconomic Crises?
César Calderón, William Easterly y Luis Servén

DTBC-184 Octubre 2002
The Direction of Causality between Financial Development and Economic Growth
César Calderón y Lin Liu