The welfare cost of real volatility: a comparative analysis*

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ABSTRACT:

This article provides a quantitative assessment of the welfare costs associated with real volatility by calibrating three different models for Latin America and the developed countries based on data from 1960 to 2006, previous to the international crisis. In an influential set of lectures Lucas (1987) argues that the cost of the business cycle in the US economy was negligible in the post-war era, consequently there would be little to gain from more aggressive stabilization policies. Based on two alternatives models, non-negligible welfare losses associated with real fluctuations can be found of more than two-order magnitude higher than those estimated by Lucas. The first alternative model allows for a stochastic trend in the consumption process, as is suggested by the rational expectation permanent income theory. The second alternative specification is a general equilibrium analysis with an uninsurable idiosyncratic human capital risk based on the Krebs model. In addition, the paper explores the cyclical behavior of fiscal policies finding evidence that they were mainly procyclical in Latin America from 1980 to 2006, but acyclical or countercyclical in most developed countries.

KEY WORDS: Welfare cost of macro fluctuations; Cost of business cycle; Fiscal policy.
JEL classification: E32, E62, O40

1. INTRODUCTION

Policy makers in developing countries have historically paid attention to nominal volatility in prices and exchange rates. Although some nominal stability has been achieved in Latin America and other emerging economies, high volatility in real variables such as

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per capita GDP and consumption is still an issue to be addressed. This article focuses on the welfare costs associated with real fluctuations not only in Latin American countries but also in the developed world by using macro data for the period 1960-2006[1]. From the seminal work of Lucas (1987) up to present, several studies analyze the welfare effect of real fluctuation for the US economy. Although Latin America registers the highest real volatility in the world, there is not relevant literature available that estimates the welfare consequences of macro fluctuations not only in this region but also in other developed countries. For the aim of this study, the terms business cycle, real volatility or fluctuations are compatible. Technically speaking the "real volatility" is a more general terminology for "business cycle" because it allows for cycles caused not only by technological shocks but also by terms of trade, capital fluctuations or even political crisis[2].

In an influential monograph, Lucas (1987) argues that the business cycles generate negligible welfare costs suggesting that further countercyclical policies would be unnecessary[3]. In this paper, two alternative models are considered estimating larger (non-negligible) welfare losses associated with the macro fluctuations in both Latin American countries and developed economies. In section.2, I characterize the macroeconomic fluctuations in these economies since 1960. In the following section, the welfare costs associated with real volatility are studied through three different models, taking the Lucas specification as a baseline model. A second specification allows for a stochastic trend in the consumption process while the third is a general equilibrium analysis that incorporates uninsurable idiosyncratic human capital risk. In these alternative models, larger welfare losses were estimated suggesting that countercyclical macro policies might be a way of smoothing economic fluctuations. However, this has not been the common public policy's response in most Latin American countries during the last thirty years (section 4).

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[1] Latin American economies includes: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela, RB. The developed countries sample includes: Australia, Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom and United States.

[2] The economic cycles in the third model with idiosyncratic risk are due to technological changes, in the other two models (3.1 and 3.2) the economic volatility might be caused not by technological changes but also by terms of trade shocks (see ECLAC, 2008)

[3] See also Lucas (2003).

2. REAL VOLATILITY: A COMPARATIVE EVIDENCE

After a period of high instability in the eighties, the stabilization of nominal variables (exchanges rates, money supply and inflation) became the major target for Latin American policy makers in the heyday of the Washington Consensus Reforms[4]. The typical blueprint for developing countries included: trade openness, financial liberalization, fixed exchange rates (neutral monetary policy) and the privatization of public companies. Although Latin American countries restored the economic growth with low inflation in the context of rigid nominal exchange rates, several problems arose. These economies faced a lack of competitiveness, growing unemployment and poverty, increasing fiscal deficit and external debt, undermining the inter-temporal sustainability of the exchange rate regimes in key regional economies. In this period the most important economies experienced deep crisis and national currencies devaluations (Mexico-1994/5, Brazil-1999 and Argentina-2001) with a high cost in terms of poverty and capital destruction. During the nineties other developing countries also faced similar crisis; Thailand (1997) experienced a large devaluation with a domino effect on Malaysia, Indonesia, Taiwan, Hong Kong and South Korea.

After 2002, a new phase of economic expansion began in Latin America which has been characterized by a favourable international environment, more competitive real exchange rates and better regional terms of trades. Accordingly for the first time in the region's history, the economic growth was accompanied by a surplus in the balance of payments current account for five consecutive years, improving the quality of growth. The recent international crisis, however, marks the end of this expansion-phase. Although the region seems to be in a better economic condition to face the crisis (i.e. better debt indicators, current account and primary balance surpluses), it will not break away from the collapse of the global economic activities in the context of tighter international liquidity and decreasing Latin American export commodity prices.

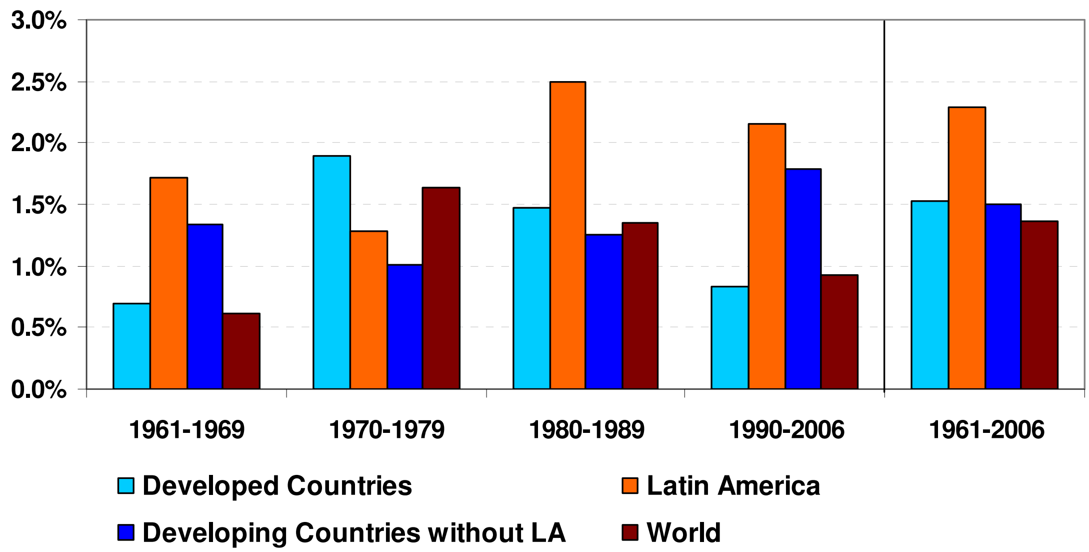
2. 1. Output and consumption volatility

Although some progress has been made in reducing Latin American output volatility in the last fifteen years, the region still accounts for the highest real volatility in

[4] For the Washington Consensus blueprint see Williamson (1989)

the world. As can be seen in Figure.1, the per capita GDP growth in Latin America has been highly volatile during the period 1961-2006, even more than in other developing regions.

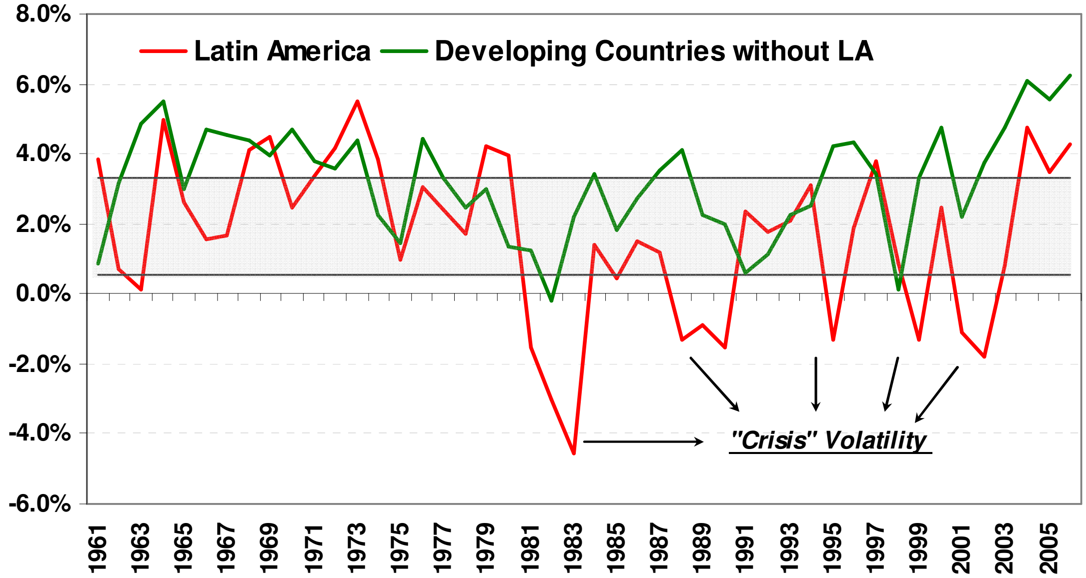
Figure.1
COMPARATIVE VOLATILITY ON PER CAPITA GDP GROWTH BY REGION



Source: Author's calculations on the basis of ECLAC and WDI databases

Additionally, Latin American region has faced several economic crises in the last three decades which have increased its overall volatility. In fact, they can be identified through the Hnatkovska and Loayza (2005) definition of "normal" volatility, i.e. one standard deviation of the world average per capita GDP (the shaded zone in Figure.2). Consequently, if the GDP per capita growth rate lies below this threshold, it will be considered as "crisis" volatility. Following this definition, Latin America as a whole registers five periods of "crisis volatility": the debt crisis (1981-82), the high inflation period (1988-90), the "tequila" crisis (Mexico, 1995), the Brazilian devaluation (1999) and the Argentinean crisis (2001-2002). Although other developing regions like the Asian economies in 1997 have experienced severe devaluations, the GDP per capita in the developing world as a whole has not recorded levels of "crisis volatility" as severe as those in Latin America.

Figure.2
NORMAL AND CRISIS VOLATILITY: LATIN AMERICA AND OTHER DEVELOPING COUNTRIES, 1960-2006 [a]
(GDP per capita growth rates)



Source: Author's calculations on the basis of ECLAC and WDI databases
a. Based on the Hnatkovska and Loayza (2005) definition of "normal" volatility.

Table.1 compares the real volatility in Latin American countries and developed economies between 1961 and 2006. In line with the previous analysis, per capita GDP growth rates in most Latin American economies have not only been highly volatile but also relatively lower than those registered in the developed world. In addition, the per capita private consumption in most Latin American countries is more volatile than the GDP. This disproportional volatility in real consumption, normally referred to as "excess volatility", might have negative affects on the optimal consumption path and welfare (see Section.3) generating highly volatile poverty rates, particularly when per capita income is close to poverty lines.

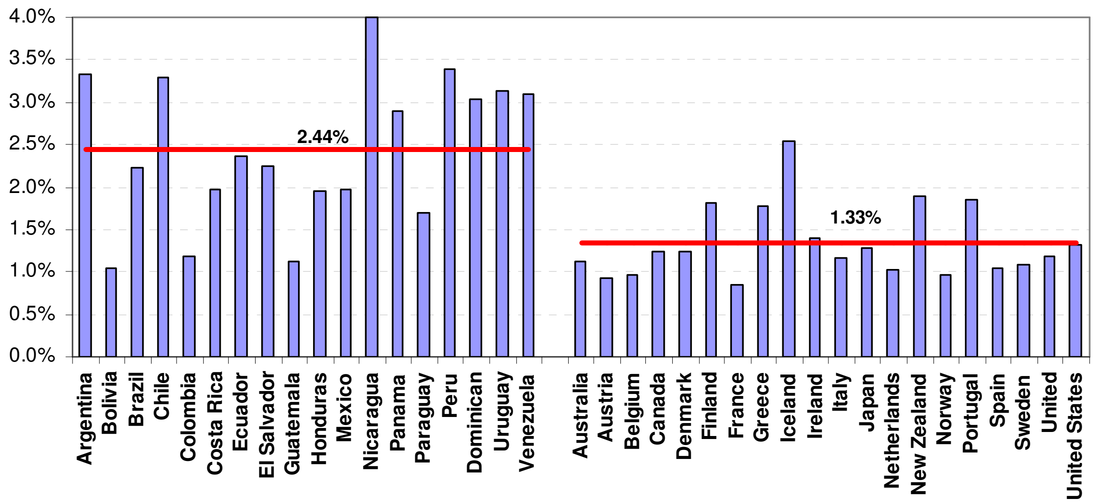
Table.1:
Volatility of GDP and Private Consumption: 1961-2006
(Per capita growth rates based on series in dollars at 2000 prices)

	GDP per capita growth rate		Private Consumption per capita growth rate		
	Average	Stdev	Average	Stdev	Excess Volatility
	(1)	(2)	(3)	(4)	(5)=(4) / (2)
Latin America	**1.5**	**4.1**	**1.5**	**5.2**	**1.3**
Argentina	1.1	5.3	1.5	6.5	1.2
Bolivia	1.0	2.8	0.8	3.0	1.0
Brazil	2.2	3.9	2.1	5.2	1.4
Chile	2.3	5.2	2.0	7.0	1.3
Colombia	2.0	2.0	1.7	2.5	1.3
Costa Rica	2.1	3.2	1.7	4.8	1.5
Ecuador	1.9	4.3	1.8	2.9	0.7
El Salvador	0.7	4.0	1.1	5.9	1.5
Guatemala	1.4	2.4	1.3	2.0	0.8
Honduras	1.2	3.0	1.2	3.5	1.2
Mexico	2.1	3.2	1.9	3.5	1.1
Nicaragua	-0.1	6.9	-0.1	10.8	1.6
Panama	2.5	4.4	2.7	7.1	1.6
Paraguay	1.7	3.4	1.1	4.7	1.4
Peru	0.9	5.1	0.8	5.6	1.1
Dominican Republic	2.7	5.0	2.9	6.6	1.3
Uruguay	1.4	4.6	1.2	6.5	1.4
Venezuela	0.4	5.2	1.4	5.6	1.1
Developed Countries	**2.5**	**2.3**	**2.4**	**2.3**	**1.0**
Australia	2.1	1.8	2.1	1.3	0.7
Austria	2.7	1.8	2.5	2.0	1.1
Belgium	2.5	1.8	2.3	1.7	0.9
Canada	2.2	2.0	1.5	2.1	1.0
Denmark	2.3	2.0	2.0	2.7	1.3
Finland	2.8	2.8	2.8	2.9	1.0
France	2.5	1.7	2.5	1.5	0.9
Germany	2.3	1.7	1.5	1.6	1.0
Greece	2.9	3.9	3.3	2.6	0.7
Ireland	3.9	2.6	2.8	2.9	1.1
Italy	2.6	2.3	2.9	2.4	1.0
Japan	3.8	3.4	3.5	2.9	0.8
Netherlands	2.2	1.9	2.2	2.5	1.3
New Zealand	1.3	2.8	1.3	2.6	0.9
Norway	2.9	1.6	2.6	2.2	1.4
Portugal	3.4	3.6	3.2	4.8	1.3
Spain	3.2	2.6	3.1	2.7	1.0
Sweden	2.2	1.9	1.6	2.0	1.1
Switzerland	1.4	2.2	1.5	1.6	0.7
United Kingdom	1.3	1.8	2.3	2.0	1.1
United States	3.0	1.9	2.4	1.6	0.8
WORLD	**1.9**	**1.4**	**1.9**	**1.1**	**0.8**

Source: Author's calculations on the basis of ECLAC and WDI databases

Beyond the total volatility in per capita GDP growth rates, it is useful to identify and compare the business cycle volatility. In order to isolate the cycle, the Hodrick-Prescott filter is applied over the GDP time series in logs for the period 1960-2006 with a lambda value of 6.25. As a result, the economic cycles in most Latin American economies have been more volatile than those in developed countries (see Figure.3). In effect, the simple average of the business cycle volatility in Latin America is 2.44% while for developed countries is only 1.33%.

Figure.3
BUSINESS CYCLE VOLATILITY: 1960-2006



Source: Author's calculations on the basis of ECLAC and WDI databases

2.2. What is Behind the High Volatility in Latin America?

This section explores the common factors that make Latin American economies highly volatile and crisis-prone. Recent literature has basically identified three reasons in order to explain the persistency of high volatility in Latin America and other emerging economies:

(i) First of all, developing countries and in particular Latin America usually face bigger ***external shocks*** than do developed economies. In the last four decades the Latin American region has suffered important external shocks, nominal and real, as a result of fluctuations in both international capital flows and terms of trades. The openness of the capital account in Latin American economies explains the increasing importance of capital flows in the region. In fact, during the last twenty five years the international financial market has become the main source of external volatility for Latin American economies[5]. On the

[5] There are several works which argue the importance of capital flow fluctuations in Latin America, just to mention: Calvo et al (2003), Kaminsky (2005), Ffrench-Davis and Ocampo (2001 and 2005).

contrary, until the middle of seventies, terms of trades were the main source of the Latin American external instability in the context of closer and undiversified economies. However, terms of trades fluctuations are still an important source of exogenous shocks for emerging economies including Latin America due to an export structure highly concentrated in primary products and manufactures based on natural resources.

(ii) Secondly (and associated with the previous factor), ***production patterns*** in developing countries are highly concentrated in more volatile industries which are intensive in nonflexible technologies and unskilled workers, whereas the industrial structure in developed countries is based on flexible technologies and skilled workers. Two recent papers provide further evidence on the relationship between technological patterns and real volatility. Kraay and Ventura (2007) argue that cross-country differences in real volatility can be explained by different industrial specialization patterns between developed and developing countries. Alternatively, Koren and Tenreyro (2006) show that poor countries are specialized in fewer and more volatile sectors and their macro fluctuations are highly correlated with shocks originating in these sectors. In general, the previous finding supports the idea that technologies which are more flexible and resilient to shock are chosen as the economic development increases.

(iii) Finally, ***institutional instabilities and inconsistent macroeconomic policies*** have also played an important role in increasing the real volatility in Latin American countries. Macroeconomic policies in the region have been characterized by abrupt changes in rules with deep socio-economic consequences. In general, Latin American countries (and most developing regions) have weaker `shock absorbers´ or `filtering mechanisms´. Market mechanisms and countercyclical macro policies are both needed in order to mitigate the economic consequences of external and domestic shocks[6]. Market's shock absorbers are mainly associated with structural characteristics such as: the depth of the financial market, the openness of trade, export diversification,

[6] See Fanelli (2008)

institutional development and political-economy features. On the other hand, countercyclical policies play an important role when these market filters are insufficient in absorbing shocks and restoring the equilibrium. Macroeconomic policies might be used as a stabilization mechanism in the absence of an adequate automatic market stabilizer.

Latin American countries, however, have historically had inefficient market filters as a result of shallow financial systems, insufficient export diversification and endogenous rigidities associated with the political economy. Together with these weaknesses in filtering mechanisms, the region on average has shown a tendency towards procyclical fiscal policies which amplify the volatility instead of counteracting it. In section.4, the cyclical behavior of fiscal policies is analyzed at country level in Latin American and industrialized economies.

Clearly, high volatility entails serious socio-economic consequences. A number of studies have found that volatility has a negative effect on economic growth. In particular, the pioneering work of Ramey and Ramey (1995) finds evidence of a negative relationship between high volatility and the long run growth[7]. One possible explanation behind this result is that the high volatility might seriously damage the capital accumulation, total factor productivity and financial system, undermining the basis for future economic growth.

Since this work focuses on the welfare effect of real fluctuations, what really matters is the consumption volatility instead of the pure GDP fluctuations, because in a perfect market households could diversify portfolios and risk shielding its consumption from income volatility. Indeed, households (even firms or governments) can avoid "non-permanent" income volatility through the precautionary savings and insurance mechanisms. However, as will be analyzed in section.3.3, incomplete markets provide a limited protection in the context of permanent shocks.

[7] For further analysis on the relationship between volatility and growth see Easterly, Islam and Stiglitz (2000); Wolf (2005) and Acemoglu el al (2004)

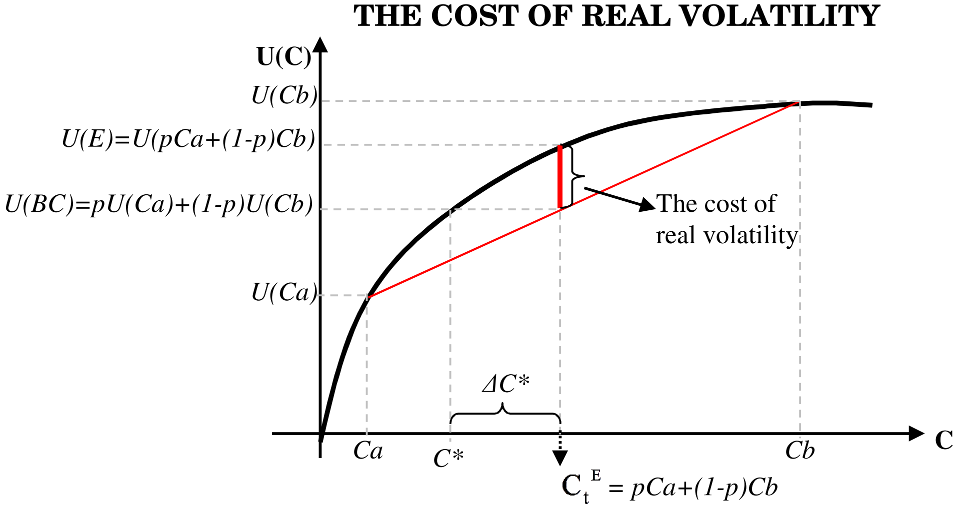
3. THE WELFARE COSTS OF REAL VOLATILITY WITH DIFFERENT APROACHES

In the previous section, there is evidence that private consumption is more volatile than GDP in most Latin American economies, but this does not seem to be the case for the majority of developed countries. This empirical finding is relevant to measure the welfare cost of consumption volatility. Intuitively one could think that real volatility has a negative effect on consumer welfare, but an appropriate framework is needed to estimate it. The 'welfare' is a subjective idea which depends not only on individual priorities but also on the pleasure or happiness that consumption produces. Arbitraries and formal difficulties emerge in ranking priorities and measuring happiness. For this reason, the utility function approach seems to be a natural way to measure satisfaction and rank different consumption plans by assuming rationality and complete properties.

3.1. The Baseline Model: the Lucas's approach

In an influential work Lucas (1987) studies the cost of business cycles in the context of a representative agent model that has a concave utility function (risk-averse). In Figure.4 a simple static utility function is used to illustrate the cost of the economic fluctuations in the Lucas framework.

Figure.4
THE COST OF REAL VOLATILITY



This representative agent faces uncertainty regarding his future consumption which will depend on the economic cycle. Thus, the individual might consume at point *Ca* (negative phase of a cycle) with probability p or at point Cb (positive phase of a cycle) with probability (1-p).

Thus, the expected utility is given by:

$$U(BC) = pU(C_a) + (1-p)U(C_b) \tag{1}$$

which is on the line between points $[Ca, U(A)]$ and $[Cb, U(B)]$. However if there was not uncertainty the agent would consume exactly $C_t^E = E(C_t)$ .In this case, the utility would be U(E) which is larger than U(BC) given the risk aversion. The difference could be defined as the utility cost or the welfare cost of the uncertainty caused by real volatility. Lucas seeks the cost of consumption volatility for the representative agent by asking what percentage increase in annual consumption (ΔC*) has the same positive effect as the total elimination of consumption volatility. Formally:

$$U\left[(1+\Delta)C_t^*(g', \sigma_\varepsilon^2{}')\right] = U\left[C_t^E(g^*, \sigma_\varepsilon^2{}^*)\right] \;;\; \text{where } g' = g^* \text{ and } \sigma_\varepsilon^2{}' > \sigma_\varepsilon^2{}^* = 0 \tag{2}$$

By following the Lucas model, the one-period preferences are defined by a constant relative risk aversion utility function:

$$U(\{C_t\}) = E_0\left[\sum_{t=1}^{\infty} \beta^t \frac{C_t^{1-\gamma} - 1}{1-\gamma}\right] \quad 0 < \beta < 1, \gamma \geq 0 \tag{3}$$

As usual β is the rate at which utility is discounted and γ is equal to the coefficient of relative risk-aversion, so the higher γ the more reluctant is the consumer to face a volatile consumption path. A consumption function is defined with a trend and cycle components:

$$C_t = (1+g)^t C_0 e^{\varepsilon_t - 1/2\sigma_\varepsilon^2} \tag{4}$$

Where g is the consumption rate of growth and ε_t is an independent and identically distributed normal random variable with mean 0 and variance σ_ε^2. In the Lucas framework the consumption level in the economy without real fluctuations (i.e. $\varepsilon_t = \sigma_\varepsilon^2 = 0$) is equal to the expected value of C_t, in other words the trend component.

By direct calculation:

$$E_0\left[C_t^{1-\gamma}\right] = (1+g)^{t(1-\gamma)} C_0^{1-\gamma} e^{-\sigma_\varepsilon^2(1-\gamma)/2} E_0\left[e^{\varepsilon_t(1-\gamma)}\right] \tag{5}$$

But using the fact that $e^{\varepsilon_t(1\text{-}\gamma)}$ is log-normally distributed with mean $e^{(1\text{-}\gamma)^2\sigma_\varepsilon^2/2}$, equation (5) is read :

$$E_0\left[C_t^{1-\gamma}\right] = (1+g)^{t(1-\gamma)} C_0^{1-\gamma} e^{-\sigma_\varepsilon^2\gamma(1-\gamma)/2} \qquad \text{if } \gamma \neq 1$$
$$\text{and} \qquad E_0\left[\ln C_t\right] = t\ln(1+g) + \ln C_0 - \frac{1}{2}\sigma_\varepsilon^2 \qquad \text{if } \gamma = 1 \tag{6}$$

Thus, the expected life-time utility is equal to:

$$U_t\left(\{C_t\}\right) = \begin{cases} \left(\dfrac{1}{1\text{-}\gamma}\right)\left(\dfrac{C_0^{(1\text{-}\gamma)} e^{\text{-}1/2\sigma_\varepsilon^2\gamma(1\text{-}\gamma)}}{1\text{-}\beta(1+g)^{(1\text{-}\gamma)}} \text{-} \dfrac{1}{1\text{-}\beta}\right) & \text{if } \gamma \neq 1 \\ \left(\dfrac{1}{1\text{-}\beta}\right)\left(\ln C_0 - \dfrac{1}{2}\sigma_\varepsilon^2 + \dfrac{\beta\ln(1+g)}{1\text{-}\beta}\right) & \text{if } \gamma = 1 \end{cases} \tag{7}$$

Coming back to the initial question in (2), one can estimate the percentage increase across all dates in annual consumption as a result of eliminating the consumption uncertainty. By equation (7),

$$U\left[(1+\Delta)C_t^*\right] = U\left[C_t^E\right] \begin{cases} (1+\Delta)^{(1\text{-}\gamma)} e^{\text{-}1/2\sigma_\varepsilon^2\gamma(1\text{-}\gamma)} = 1 & (\gamma \neq 1) \\ \ln(1+\Delta) = \dfrac{1}{2}\sigma_\varepsilon^2 & (\gamma = 1) \end{cases} \tag{8}$$

Thus the equivalent variation as a function of the consumption variance is:

$$\Delta(\sigma_\varepsilon^2, \gamma) = e^{1/2\sigma_\varepsilon^2\gamma} \text{-}1 \qquad ,\forall\ \gamma \tag{9}$$

The first-order Taylor approximation of (9) in the neighborhood $\sigma^* = 0$ yields:

$$\Delta(\sigma_\varepsilon^2, \gamma) \cong \frac{1}{2}\gamma\sigma_\varepsilon^2 \qquad ,\forall\gamma \tag{10}$$

This is the Lucas approximation to the cost of consumption volatility for an individual representative agent that depends on the degree of risk aversion and the variance from trend consumption. Therefore, real volatility is more costly the more volatile consumption becomes and the more averse the individual is. However, by using US data for consumer volatility after the WWII (σ_ε^2) and assuming γ=1, Lucas shows that the cost of consumption fluctuation is less than one-hundredth of one percent! Therefore, Americans would be willing to give up less than 0.01% of their consumption, uniform across all dates, in order to get macro stability. In light of these results Lucas concludes that more aggressive countercyclical policies than those applied in the post-WWII period are not needed because they would bring few benefits in terms of welfare. Before going on with the analysis it is essential to clarify the scope of this finding.

First of all, Lucas does not say that countercyclical policies are unnecessary at all or irrelevant from the welfare point of view. On the contrary what he points out is that *further* countercyclical policies than those *already applied* in the US since 1945 would have a negligible welfare gain for consumers. Of course, real consumption volatility (σ_ε^2) would have been larger if stabilization policies had not been applied at all in USA during the post war era. Indeed, monetary and fiscal policies have played an important role in stabilizing the US economy in the last decades, but Lucas' question is whether additional countercyclical policies would be useful. Although his answer is negative, it remains the question of what happens in Latin American countries and other developed economies.

Table.2 summarizes the welfare cost of consumption instability using Lucas' framework (equation 10) not only for the United States but also for Latin American countries and other developed economies. The first column shows the standard deviation (σ_ε) of the cyclical component (calculated through the Hodrick-Prescott filter, λ=6.25) of the private consumption per capita for the period 1960-2006. Notice that the estimate for the US economy is equivalent to the Lucas calculation, i.e. the welfare cost is less than one-hundredth percent of per capita consumption for a value of risk aversion lower than 1.5. Although the cost of real fluctuations in Latin American countries is lower than 0.5% of its per capita consumption (except for γ=20), it is on average almost six times higher than the average cost in developed countries and ten-time higher than the US.

Table.2
WELFARE EFFECT OF CONSUMPTION VOLATILITY BASED ON THE LUCAS FRAMEWORK FOR DIFFERENT VALUES OF RISK AVERSION (γ) [a]
(In % of the Household per capita consumption)

	STDEV of the cyclical component	γ=1.0	γ=1.5	γ=2	γ=5	γ=10	γ=20
Latin America	**3.2**	**0.06**	**0.09**	**0.12**	**0.29**	**0.59**	**1.18**
Argentina	**4.3**	0.094	0.142	0.189	0.472	0.945	1.889
Bolivia	**1.7**	0.015	0.022	0.030	0.074	0.148	0.296
Brazil	**2.8**	0.040	0.061	0.081	0.202	0.404	0.808
Chile	**4.8**	0.114	0.170	0.227	0.568	1.136	2.272
Colombia	**1.4**	0.010	0.015	0.020	0.050	0.100	0.200
Costa Rica	**3.1**	0.047	0.071	0.095	0.237	0.474	0.947
Ecuador	**1.5**	0.011	0.017	0.022	0.055	0.110	0.220
El Salvador	**3.5**	0.061	0.092	0.123	0.307	0.613	1.227
Guatemala	**1.0**	0.005	0.007	0.010	0.025	0.049	0.099
Honduras	**2.1**	0.022	0.033	0.044	0.110	0.219	0.439
Mexico	**2.3**	0.026	0.039	0.052	0.130	0.260	0.519
Nicaragua	**5.8**	0.171	0.256	0.341	0.853	1.707	3.413
Panama	**4.4**	0.097	0.145	0.194	0.484	0.969	1.937
Paraguay	**2.5**	0.031	0.046	0.061	0.154	0.307	0.615
Peru	**3.8**	0.073	0.110	0.146	0.366	0.731	1.462
Dominican Republic	**4.2**	0.087	0.131	0.174	0.435	0.870	1.740
Uruguay	**4.5**	0.101	0.151	0.202	0.505	1.009	2.018
Venezuela	**3.3**	0.053	0.079	0.106	0.264	0.528	1.057
Developed Countries	**1.3**	**0.01**	**0.02**	**0.02**	**0.05**	**0.10**	**0.20**
United States	**1.1**	0.006	0.009	0.011	0.028	0.057	0.114
Australia	**0.8**	0.003	0.005	0.007	0.016	0.033	0.065
Austria	**1.0**	0.005	0.008	0.010	0.025	0.051	0.101
Belgium	**0.9**	0.004	0.006	0.008	0.019	0.038	0.076
Denmark	**1.7**	0.014	0.022	0.029	0.072	0.144	0.289
Finland	**1.8**	0.016	0.024	0.032	0.080	0.161	0.322
France	**0.6**	0.002	0.003	0.004	0.010	0.020	0.041
Greece	**1.4**	0.010	0.015	0.020	0.050	0.099	0.198
Ireland	**1.9**	0.018	0.028	0.037	0.092	0.184	0.368
Italy	**1.2**	0.007	0.011	0.015	0.037	0.074	0.148
Japan	**1.0**	0.005	0.008	0.011	0.027	0.053	0.107
Netherlands	**1.3**	0.009	0.014	0.018	0.045	0.091	0.182
New Zealand	**1.7**	0.015	0.022	0.029	0.074	0.147	0.295
Norway	**1.4**	0.010	0.016	0.021	0.052	0.103	0.207
Portugal	**2.6**	0.034	0.051	0.068	0.170	0.340	0.679
Spain	**1.1**	0.007	0.010	0.013	0.033	0.066	0.132
Sweden	**1.2**	0.007	0.010	0.013	0.034	0.067	0.135
United Kingdom	**1.4**	0.009	0.014	0.018	0.046	0.092	0.185

Source: Author's calculations based on ECLAC and WDI databases.

a. Values for σ_ε is the standard deviation of the cyclical component of the private consumption per capita (applying a Hodrick-Prescott filter with λ=6.25) for the period 1960-2006. The cost of real fluctuations, $\Delta(\sigma_\varepsilon^2, \gamma)$, are calculated by equation (10).

It is straightforward to show that these findings are due to the higher consumption volatility in Latin America as was pointed out in section 2. In effect, standard deviations of the cyclical component of per capita consumption in Latin American economies are on average more than two times higher than those in developed countries. In terms of relative magnitudes, one may think that more aggressive countercyclical policies should be implemented in Latin American economies to reduce the cost of real volatility. Nevertheless, according to the Lucas model, on average Latin American consumers would be willing to give up a negligible fraction of their annual consumption across all dates in order to live in a world without real fluctuations. Despite the relative difference with respect to developed countries, the welfare cost of macroeconomic volatility in Latin America is still less than 1%. These outcomes lead us to study alternative specifications to work out the welfare losses.

On the other hand, one might also use Lucas' framework to compute the benefit (cost) of an increase (decrease) in the average consumption growth (g) by calculating the following equivalent variation:

$$U\left[(1+\Delta)C_t^*(g',\sigma_\varepsilon^2{}')\right] = U\left[C_t^E(g^*,\sigma_\varepsilon^2{}^*)\right] \;;\; \text{where } g' < g^* \text{ and } \sigma_\varepsilon^2{}' = \sigma_\varepsilon^2{}^* \quad (11)$$

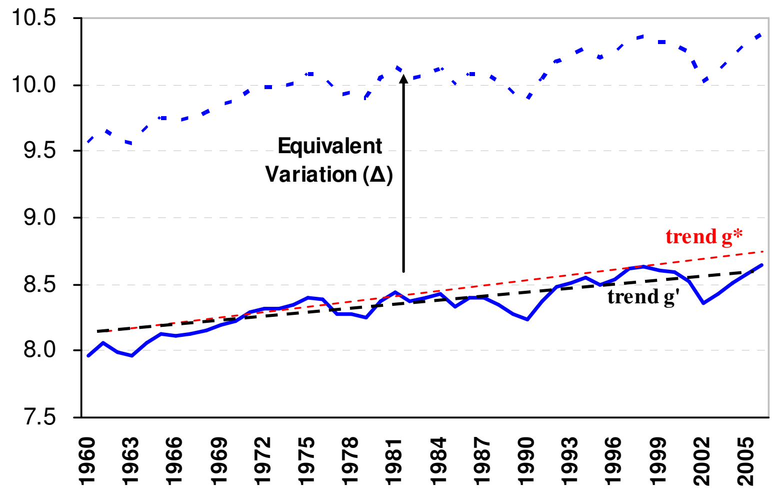
By using the expression (7) is straightforward to calculate this benefit (or cost) which reads,

$$\Delta(\beta,\gamma,g',g^*) = \begin{cases} \left[\dfrac{1-\beta(1+g')^{(1-\gamma)}}{1-\beta(1+g^*)^{(1-\gamma)}}\right]^{\frac{1}{(1-\gamma)}} -1 & (\gamma \neq 1) \\ e^{\left(\frac{\beta}{1-\beta}\right)\ln\left(\frac{1+g^*}{1+g'}\right)} -1 & (\gamma = 1) \end{cases} \quad (12)$$

Table.3 reports results for an increase in one percentage point of the trend consumption growth rates. The discount factor (β) might be set between 0.95 and 0.97 for yearly data[8]. Notice that the benefits rise as the discount factor increases but fall off as the risk aversion (γ) gets higher; this is because the γ parameter affects the effective discount factor applied to future consumption. In all countries analyzed, this extra percent point of trend growth is equivalent to a significant increase in more than 20% of consumption per capita across all dates. Moreover for β=0.97 this magnitude might reach 37%. To illustrate this point, Figure.5 represents the equivalent variation as a result of an extra percent point in the consumption trend of Argentina under the Lucas framework. In effect, per capita consumption should shift up more than 20% across the board, from the solid to dashed blue line, in order to leave the consumer indifferent between the growth rates g' and g*.

[8] Lucas (1987, p.25) focuses on US and uses a value of β of 0.95 analyzing only the case γ=1

Figure.5
ARGENTINA'S PER CAPITA CONSUMPTION: EQUIVALENT VARIATION OF ONE-PERCENT INCREASE OF TREND CONSUMPTION
(Series in logs and β=0.95)



Source: Author's calculations.

In light of these results, Lucas suggests that the economic policy should focus on stimulating the trend growth instead of reducing the business cycle because larger welfare gains might be obtained in the first case. However, as can be seen in the following sections, welfare gains from eliminating real volatility are not always negligible, particularly allowing for a unit root in the consumption path or an idiosyncratic labor risk in the context of incomplete markets.

Table.3
BENEFIT OF ONE-PERCENTAGE INCREASE OF TREND CONSUMPTION GROWTH FOR DIFFERENT VALUES OF RISK AVERSION (γ) AND DISCOUNT FACTOR (β) [a]
(per year, as a percentage of per capita consumption)

		Discount Factor (β) =0.95					Discount Factor (β) =0.96					Discount Factor (β) =0.97				
	g'	γ=1.0	γ=1.5	γ=2	γ=5	γ=10	γ=1.0	γ=1.5	γ=2	γ=5	γ=10	γ=1.0	γ=1.5	γ=2	γ=5	γ=10
Latin America	**1.5**	**20.5**	**17.0**	**14.5**	**7.9**	**4.6**	**26.5**	**21.0**	**17.4**	**8.9**	**5.0**	**37.3**	**27.3**	**21.8**	**10.1**	**5.5**
Argentina	**1.4**	20.5	17.1	14.6	7.8	4.2	26.6	21.1	17.5	8.6	4.5	37.4	27.5	21.8	9.5	4.7
Bolivia	**0.7**	20.6	18.2	16.2	9.9	5.9	26.7	22.8	19.9	11.2	6.4	37.6	30.3	25.4	12.9	6.9
Brazil	**2.0**	20.4	16.0	13.1	6.2	3.1	26.4	19.5	15.4	6.7	3.3	37.1	24.9	18.7	7.3	3.4
Chile	**2.0**	20.4	16.0	13.2	6.3	3.2	26.4	19.6	15.6	6.8	3.4	37.1	25.1	18.9	7.4	3.5
Colombia	**1.7**	20.4	16.6	13.9	7.0	3.7	26.5	20.4	16.5	7.6	3.9	37.2	26.3	20.3	8.4	4.1
Costa Rica	**1.6**	20.5	16.7	14.1	7.2	3.8	26.5	20.6	16.8	7.9	4.0	37.3	26.7	20.7	8.7	4.3
Ecuador	**1.8**	20.4	16.3	13.5	6.6	3.4	26.4	20.0	16.0	7.2	3.6	37.2	25.7	19.5	7.9	3.8
El Salvador	**1.1**	20.6	17.5	15.2	8.4	4.7	26.6	21.7	18.3	9.4	5.0	37.5	28.5	23.0	10.5	5.4
Guatemala	**1.3**	20.5	17.2	14.8	8.0	4.4	26.6	21.3	17.8	8.8	4.6	37.4	27.8	22.2	9.8	4.9
Honduras	**1.2**	20.5	17.3	15.0	8.2	4.5	26.6	21.5	18.1	9.1	4.8	37.4	28.2	22.6	10.2	5.2
Mexico	**2.0**	20.4	16.1	13.3	6.3	3.2	26.4	19.7	15.7	6.9	3.4	37.1	25.2	19.0	7.5	3.6
Nicaragua	**-0.1**	20.8	20.1	19.4	16.4	13.7	27.0	25.7	24.7	20.2	16.6	38.0	35.6	33.6	26.4	21.4
Panama	**2.8**	20.2	14.9	11.8	5.1	2.4	26.2	18.0	13.7	5.4	2.5	36.8	22.6	16.2	5.8	2.6
Paraguay	**1.0**	20.6	17.7	15.4	8.8	5.0	26.7	22.0	18.7	9.8	5.3	37.5	29.0	23.6	11.1	5.7
Peru	**0.8**	20.6	18.1	16.1	9.6	5.7	26.7	22.6	19.6	10.9	6.1	37.6	30.1	25.0	12.5	6.7
Dominican Rep.	**2.8**	20.2	14.8	11.7	5.0	2.4	26.1	17.9	13.6	5.3	2.5	36.7	22.4	16.1	5.7	2.6
Uruguay	**1.1**	20.6	17.4	15.2	8.4	4.7	26.6	21.7	18.3	9.3	5.0	37.5	28.5	22.9	10.5	5.4
Venezuela	**1.3**	20.5	17.2	14.8	8.0	4.4	26.6	21.3	17.8	8.8	4.7	37.4	27.9	22.2	9.9	5.0
***Developed Countries **	**2.5**	**20.3**	**15.3**	**12.3**	**5.5**	**2.7**	**26.2**	**18.6**	**14.3**	**5.9**	**2.8**	**36.9**	**23.4**	**17.2**	**6.4**	**3.0**
United States	**2.4**	20.3	15.5	12.5	5.6	2.8	26.3	18.8	14.6	6.1	2.9	36.9	23.8	17.5	6.6	3.0
Australia	**2.1**	20.3	15.9	13.0	6.1	3.1	26.4	19.4	15.3	6.6	3.2	37.0	24.7	18.5	7.2	3.4
Austria	**2.5**	20.3	15.3	12.2	5.4	2.6	26.2	18.5	14.2	5.8	2.8	36.9	23.3	17.0	6.3	2.9
Belgium	**2.3**	20.3	15.6	12.6	5.7	2.8	26.3	18.9	14.8	6.2	3.0	37.0	24.0	17.7	6.7	3.1
Denmark	**1.9**	20.4	16.1	13.3	6.4	3.3	26.4	19.8	15.8	7.0	3.4	37.1	25.3	19.2	7.6	3.6
Finland	**2.8**	20.2	14.9	11.7	5.0	2.4	26.2	17.9	13.6	5.3	2.5	36.7	22.4	16.1	5.7	2.6
France	**2.5**	20.3	15.3	12.3	5.5	2.7	26.3	18.6	14.4	5.9	2.8	36.9	23.5	17.2	6.4	2.9
Greece	**3.4**	20.1	14.2	10.9	4.4	2.0	26.0	16.9	12.5	4.7	2.1	36.5	21.0	14.6	5.0	2.2
Ireland	**2.7**	20.2	14.9	11.8	5.1	2.4	26.2	18.0	13.7	5.4	2.5	36.8	22.6	16.3	5.8	2.6
Italy	**2.8**	20.2	14.8	11.7	5.0	2.4	26.1	17.9	13.5	5.3	2.5	36.7	22.4	16.0	5.7	2.6
Japan	**3.5**	20.1	14.0	10.7	4.3	2.0	26.0	16.8	12.3	4.6	2.0	36.5	20.7	14.4	4.8	2.1
Netherlands	**2.3**	20.3	15.6	12.6	5.8	2.9	26.3	19.0	14.8	6.2	3.0	37.0	24.1	17.8	6.7	3.1
New Zealand	**1.3**	20.5	17.1	14.6	7.8	4.2	26.6	21.1	17.5	8.6	4.5	37.4	27.5	21.8	9.5	4.8
Norway	**2.5**	20.3	15.2	12.2	5.4	2.6	26.2	18.5	14.2	5.8	2.7	36.9	23.3	16.9	6.2	2.8
Portugal	**3.2**	20.1	14.4	11.1	4.6	2.1	26.0	17.2	12.8	4.9	2.2	36.6	21.4	15.1	5.2	2.3
Spain	**3.1**	20.1	14.5	11.3	4.7	2.2	26.1	17.5	13.1	5.0	2.3	36.6	21.7	15.4	5.4	2.4
Sweden	**1.6**	20.4	16.6	14.0	7.0	3.7	26.5	20.4	16.6	7.7	3.9	37.2	26.4	20.4	8.5	4.1
United Kingdom	**2.4**	20.3	15.5	12.5	5.6	2.8	26.3	18.8	14.6	6.1	2.9	36.9	23.8	17.5	6.6	3.0

Source: Author's calculations based on ECLAC and WDI databases.a. The media (g') is the average variation of the logarithm per capita consumption - trend component. Estimates for $\Delta(\beta, \gamma, g', g^{*})$ are obtained by equation (12)

3.1.1. Alternative Estimates for the welfare cost of the US real volatility:

After Lucas' calculation for the welfare cost of the business cycle in the US economy, several authors have criticized his results by using different assumptions and specifications. Before setting and calibrating two alternative models, I briefly summarize the most important works on the welfare costs associated with macroeconomic fluctuations in United States. One problem that was pointed out by several authors is the function used in the Lucas framework. Some authors (Obstfeld, 1994; Dolmas, 1998 and Tallarini, 2000) assume Epstein-Zin preferences which better fit the data on asset prices by separating the elasticity of intertemporal substitution from the coefficient of relative risk aversion[9]. This alternative specification suggests that consumption volatility is not very costly unless fluctuations are highly persistent[10]. Under these assumptions the welfare cost in terms of consumption for the US economy would be between 0.01% and a maximum value of 12.6% (with consumption fluctuation serially correlated and much higher risk-aversion).

On the other hand, there are relevant studies that consider consumer heterogeneity within the population. Focusing on aggregate consumption, the real volatility that some people face might be underestimated. As can be seen in section 3.3, it is possible to estimate a stochastic income process for the typical household assuming incomplete markets which provide limited protection against the income risks. Based on the empirical evidence, Imrohoroglu (1989) argues that stabilization might affect earning risks by avoiding long periods of unemployment, given the fact that unemployment spells are short in "good times" but longer during a recession. As a result, Imrohoroglu estimates a cost of business cycle in the US economy of about 0.3% ignoring the interest rate risk.

Krusell and Smith (2002) follow the idea that stabilization reduce the period of unemployment but they also allow the interest rate to vary over the cycle and introduce an asymmetric wealth distribution (heterogeneity in discount rates). Under this framework, the cost of fluctuation would be 3.68% for those individuals who are unemployed but smaller and even negative for households with savings[11]. As a result, in

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[9] See Epstein and Zin (1991)
[10] See Obstfeld (1994) and Dolmas (1998)
[11] People with accumulated saving might be interested in stabilization measures because other households might reduce their precautionary saving with the elimination of real fluctuations.

the Krusell-Smith framework the business cycle might be beneficial on net depending on the fraction of the population who are unemployed and with borrowing constraints. Thus, in countries with better wealth distribution and extended access to financial markets, stabilization policies could make the majority of people worse off. Of course, this is not the case in Latin America which is characterized by an unequal wealth distribution and a less-developed financial system.

By looking at reports of US household earnings, Storesletten, Telmer and Yaron (2001a) found that income shocks are highly persistent, i.e. once a household's income falls its earnings will be low for a longer time than in Krusell and Smith's specification. Storesletten et al. incorporate idiosyncratic labor income risk and they estimate that the gain from eliminating aggregate fluctuations in the US economy is about 2.5% of life-time consumption as a whole while for those without any savings the gain would reach 7.4%. In section 3.3, an alternative specification is analyzed basically following the Krebs (2003a) model with a different calibration. In general, it is an extension of the Storesletten et al. (2001a) model that incorporates permanent idiosyncratic income shocks, so individuals are not able to offset the negative shock to their income by borrowing. The welfare cost of real volatility in the Krebs' calibration for the US economy is 7.45% of the life-time consumption.

Other observation to Lucas' calculation is that the average consumption level might change in response to stabilization. Instead of backing its trend, consumption might increase with stabilization. In order to explain this statement, let C_t be the actual consumption in an economy with volatility that deviates from the average consumption for the stabilized economy (C_t^s). Formally, $C_t = (1+\varepsilon_t)C_t^s$ with $E(\varepsilon_t) \leq 0$. In other words, the consumption path in a stable economy might exceed the expected level in the economy with macro-fluctuations, i.e. $E(C_t) \leq E(C_t^s)$. By using this assumption, De Long and Summers (1988) estimate a cost of real fluctuation between 1.6% and 1.9% of US household consumption. Finally, stabilization might affect the consumption growth rate instead of the levels. Indeed, Barlevy (2004) shows that the cost of the business cycle due to its effects

Therefore, the reduction in the aggregate supply of loans would increase interest rate improving the assets returns.

of growth in the US economy might be between 7.5% and 8% of life-time consumption. The elimination of business cycle might also be growth-enhancing if an economy with idiosyncratic labor risk is considered.

3.2. Second Model: the consumption process has a stochastic trend

Lucas (1987) assumes that consumption is generated by a trend-stationary process as in equation 4. Nevertheless, from a statistical perspective, the rational expectation permanent income theory suggests that the consumption process contains a unit root (Hall, 1978). Table.4 shows the results from different unit root tests (Augmented Dickey-Fuller, ADF and the Phillips-Parron, PP) with the null hypothesis that the per capita consumption path (in natural logarithms) has a stochastic trend. The null is not rejected (NR) at the 5% significant level in almost all countries studied. Even when the ADF test rejects the null for the US, Dominican Republic and Netherlands, the PP test does not[12].

As Obstfeld (1994) suggests, the martingale is the simplest specification that describes a process with a unit root, so the natural logarithms of real per capita private consumption (c_t) might follow:

$$c_t = c_{t-1} + g - \frac{1}{2}\sigma_\varepsilon^2 + \varepsilon_t = c_0 + \left(g - \frac{1}{2}\sigma_\varepsilon^2 \right) t + \varepsilon_t + \varepsilon_{t-1} + \varepsilon_{t-2} + \ldots. + \varepsilon_1 \qquad (13)$$

where g is the trend annual growth rate, c_0 is the equal to ln(C_0) and again ε_t is a normal i.i.d. random variables with mean 0 and variance σ_ε^2. The term $-\frac{1}{2}\sigma_\varepsilon^2$ is added to ensure that the increase in the variance of ε_t does not affect the mean. Although Lucas does not completely rule out the possibility of the unit root in the consumption process, he would prefer an intermediate case between (4) and (13) [13].

Under (13), the level of per capita consumption can be written as

$$C_t = C_0 e^{(g\text{-}1/2\sigma_\varepsilon^2)t} e^{\varepsilon_t + \varepsilon_{t-1} + .. + \varepsilon_1} \qquad (14)$$

---

[12] Reis (2003) conducts a variety of statistical tests to investigate whether the consumption in United States has a unit root (including the Elliot-Rothenberg-Stock and Ng-Perron test) , finding that null hypothesis is never rejected at 5% significance level.

[13] See Lucas (1987, pp. 22-23, footnote 1)

Recalling that $e^{(1-\gamma)\varepsilon_t}$ is log-normally distributed random variable with mean $e^{(1-\gamma)^2 \sigma_\varepsilon^2/2}$:

$$
\begin{aligned}
& E_0\left[C_t^{\,1-\gamma}\right]=C_0^{\,1-\gamma}e^{(1-\gamma)(g-1/2\sigma_\varepsilon^2)t}e^{1/2(1-\gamma)^2\sigma_\varepsilon^2 t} = C_0^{\,1-\gamma}e^{(1-\gamma)(g-1/2\sigma_\varepsilon^2)t} \quad (\gamma\neq 1) \\
\textit{and} \quad & E_0\left[\ln C_t\right]=\ln C_0+\left(g-\frac{1}{2}\sigma_\varepsilon^2\right)t \qquad (\gamma=1)
\end{aligned} \tag{15}
$$

Therefore if consumption follows a martingale process the isoelastic time-separable expected utility function defined in (3) reads:

$$
U_t=\begin{cases}\left(\dfrac{1}{1-\gamma}\right)\left(\dfrac{C_0^{\,(1-\gamma)}}{1-\beta e^{(1-\gamma)(g-1/2\sigma_\varepsilon^2)}}-\dfrac{1}{1-\beta}\right) & (\gamma\neq 1)\\[2ex] \left(\dfrac{1}{1-\beta}\right)\left(\ln C_0+\dfrac{\beta\left(g-1/2\sigma_\varepsilon^2\right)}{1-\beta}\right) & (\gamma=1)\end{cases} \tag{16}
$$

Table.4

STATISTICAL TESTS OF UNIT ROOT ON PER CAPITA CONSUMPTION [a]

	Augmented Dickey Fuller Test		Phillips-Perron Test	
	Test Statistics	Decision at 5% critical value (-3.513)	Test Statistics	Decision at 5% critical value (-3.511)
Latin America				
Argentina	-3.31	NR	-2.83	NR
Bolivia	-1.97	NR	-2.07	NR
Brazil	-1.06	NR	-1.18	NR
Chile	-1.83	NR	-1.24	NR
Colombia	-1.78	NR	-1.78	NR
Costa Rica	-2.30	NR	-2.77	NR
Ecuador	-1.66	NR	-1.64	NR
El Salvador	-1.92	NR	-1.56	NR
Guatemala	-2.72	NR	-1.95	NR
Honduras	-1.95	NR	-1.95	NR
Mexico	-2.38	NR	-1.79	NR
Nicaragua	-1.44	NR	-1.70	NR
Panama	-4.54	R	-4.52	R
Paraguay	-0.74	NR	-1.13	NR
Peru	-3.02	NR	-2.45	NR
Dominican Rep.	-3.59	R	-3.47	NR
Uruguay	-2.75	NR	-2.39	NR
Venezuela	-2.06	NR	-1.50	NR
Developed Countries				
United States	-3.66	R	-2.26	NR
Australia	-1.71	NR	-1.79	NR
Austria	-0.74	NR	-0.46	NR
Belgium	-0.48	NR	-0.72	NR
Denmark	-3.49	NR	-3.49	NR
Finland	-1.97	NR	-2.25	NR
France	-3.16	NR	-2.76	NR
Greece	-2.27	NR	-2.25	NR
Ireland	-1.97	NR	-1.42	NR
Italy	-2.24	NR	-1.48	NR
Japan	-2.89	NR	-2.67	NR
Netherlands	-3.83	R	-2.06	NR
New Zealand	-1.96	NR	-1.22	NR
Norway	-2.06	NR	-2.20	NR
Portugal	-3.18	NR	-1.79	NR
Spain	-2.68	NR	-3.39	NR
Sweden	-2.68	NR	-2.75	NR
United Kingdom	-2.97	NR	-2.22	NR

Source: Author's calculations based on ECLAC and WDI databases.

a. NR: Not-rejected and R: Rejected

As can be seen the expected life-time utility in (16) is slightly different from that defined in expression (7). Consequently, the equivalent variation in per capita consumption required to keep the consumer indifferent between an economy with and without real volatility, $U\left[(1+\Delta)C_t^*(g,\sigma_\varepsilon^2{}')\right]=U\left[C_t^E(g,0)\right]$, will also change,

$$\Delta_t\left(\beta,\gamma,g,\sigma_\varepsilon^2\right)=\begin{cases}\left(\dfrac{1-\beta e^{(1-\gamma)(g-\gamma\sigma_\varepsilon^2/2)}}{1-\beta e^{(1-\gamma)g}}\right)^{1/1-\gamma}-1 & (\gamma\neq 1)\\ e^{\frac{\beta}{1-\beta}(\sigma_\varepsilon^2/2)}-1 & (\gamma=1)\end{cases}\qquad(17)$$

Consequently, equation (17) is different than the equivalent variation found in the baseline model (equation 9). To calibrate this alternative model I regress the first-difference logarithm of per capita consumption (Δc_t) on a constant by ordinary least square (OLS) in order to obtain an estimate of the standard error ($\hat{\sigma}_\varepsilon$). After that, point estimates for g in specification (13) come from making the previous regression again but now on a constant and adding $\frac{1}{2}\hat{\sigma}_\varepsilon^2$ to Δc_t. The first two columns in Table.5 show the estimates of g and σ_ε [14]. As was mentioned before, the discount factors are typically set between 0.95 and 0.97 for yearly data and γ is set within the parameters recognizer's range (Mehra and Prescott, 1985), so γ Є {1, 1.5, 2, 5, and 10}.

Table.5 reports the welfare cost of consumption instability estimated by equation (17). In fact, allowing for a unit root in the consumption process, the average welfare loss associated with real volatility in developed countries (for γ=1 and β=0.95) is more than sixty times the average cost estimated with the baseline model, and for Latin American countries is more than forty times. Even more, for β=0.97 average welfare losses in industrialized countries and Latin America might be more than one hundred times and sixty times the baseline's calculation respectively. The standard deviations estimated under specification (13) are larger than those calculated after applying the Hodrick-Prescott filter in the Lucas specification.

[14] Countries where $\hat{g}$ are not statistically significant at the 10% level are not listed.

Table.5

MODEL 2: WELFARE EFFECT OF CONSUMPTION INESTABILITY FOR DIFFERENT VALUES OF RISK AVERSION (γ) AND DISCUONT FACTORS (β)[a]

(Per year, as a percentage of per capita consumption)

			Discount Factor (β) =0.95					Discount Factor (β) =0.96					Discount Factor (β) =0.97				
	$\hat{g}$	$\hat{\sigma}_{\varepsilon}$	γ=1.0	γ=1.5	γ=2	γ=5	γ=10	γ=1.0	γ=1.5	γ=2	γ=5	γ=10	γ=1.0	γ=1.5	γ=2	γ=5	γ=10
Latin America	**1.90**	**4.6**	**2.4**	**3.0**	**3.4**	**5.1**	**9.5**	**3.0**	**3.6**	**4.0**	**5.7**	**11.9**	**4.1**	**4.6**	**4.9**	**6.5**	**9.7**
Argentina	**1.68**	**6.5**	4.06	5.31	6.33	10.93	32.99	5.15	6.53	7.61	12.45	53.43	7.00	8.42	9.49	14.42	-
	(0.08)																
Bolivia	**0.83**	**3.0**	0.84	1.18	1.46	2.70	4.10	1.07	1.46	1.79	3.13	4.60	1.44	1.91	2.29	3.71	5.23
	(0.07)																
Brazil	**2.27**	**5.2**	2.62	3.24	3.68	5.11	6.82	3.32	3.93	4.34	5.62	7.30	4.50	4.96	5.26	6.21	7.84
	(0.01)																
Chile	**2.29**	**7.0**	4.77	5.95	6.83	10.45	22.90	6.07	7.24	8.09	11.62	27.08	8.26	9.21	9.87	13.07	33.98
	(0.03)																
Colombia	**1.75**	**2.5**	0.61	0.78	0.91	1.29	1.51	0.77	0.95	1.08	1.42	1.60	1.04	1.21	1.32	1.58	1.71
	(0.00)																
Costa Rica	**1.77**	**4.8**	2.18	2.80	3.28	4.98	7.06	2.76	3.43	3.92	5.55	7.66	3.74	4.39	4.83	6.25	8.36
	(0.02)																
Ecuador	**1.88**	**2.9**	0.80	1.01	1.16	1.61	1.89	1.01	1.23	1.38	1.78	2.00	1.36	1.56	1.68	1.97	2.13
	(0.00)																
Guatemala	**1.31**	**2.0**	0.36	0.48	0.58	0.90	1.11	0.46	0.59	0.70	1.01	1.19	0.62	0.77	0.87	1.14	1.29
	(0.00)																
Honduras	**1.26**	**3.5**	1.19	1.60	1.93	3.16	4.41	1.51	1.97	2.33	3.58	4.83	2.04	2.55	2.92	4.11	5.31
	(0.02)																
Mexico	**2.00**	**3.5**	1.19	1.49	1.71	2.36	2.82	1.50	1.81	2.02	2.60	2.99	2.03	2.30	2.46	2.87	3.18
	(0.00)																
Panama	**3.00**	**7.1**	4.94	5.80	6.39	8.50	13.37	6.28	6.98	7.45	9.26	14.46	8.55	8.72	8.89	10.14	15.74
	(0.01)																
Dominican Republic	**3.13**	**6.6**	4.21	4.88	5.33	6.76	9.19	5.35	5.86	6.18	7.31	9.76	7.27	7.29	7.34	7.95	10.40
	(0.00)																
Venezuela, RB	**1.53**	**5.6**	2.99	3.95	4.73	8.01	15.30	3.80	4.86	5.70	9.10	17.68	5.15	6.28	7.12	10.49	21.05
	(0.07)																
Developed countries	**2.6**	**2.5**	**0.6**	**0.7**	**0.8**	**1.0**	**1.1**	**0.8**	**0.9**	**0.9**	**1.1**	**1.1**	**1.0**	**1.1**	**1.1**	**1.2**	**1.2**
United States	**2.39**	**1.6**	0.23	0.28	0.31	0.38	0.40	0.29	0.33	0.36	0.42	0.42	0.39	0.42	0.43	0.45	0.44
	(0.00)																
Australia	**2.07**	**1.3**	0.17	0.21	0.23	0.31	0.33	0.21	0.25	0.28	0.34	0.35	0.28	0.32	0.33	0.37	0.37
	(0.00)																
Austria	**2.54**	**2.0**	0.36	0.43	0.48	0.59	0.61	0.46	0.52	0.56	0.63	0.64	0.62	0.65	0.67	0.69	0.67
	(0.00)																
Belgium	**2.31**	**1.7**	0.29	0.35	0.39	0.50	0.53	0.36	0.42	0.46	0.54	0.55	0.49	0.53	0.55	0.59	0.58
	(0.00)																
Denmark	**2.00**	**2.7**	0.70	0.88	1.00	1.35	1.54	0.88	1.06	1.18	1.48	1.63	1.19	1.34	1.44	1.64	1.73
	(0.00)																
Finland	**2.88**	**2.9**	0.80	0.93	1.01	1.19	1.25	1.01	1.12	1.17	1.28	1.30	1.36	1.38	1.39	1.39	1.36
	(0.00)																
France	**2.48**	**1.5**	0.23	0.27	0.30	0.37	0.38	0.28	0.33	0.35	0.40	0.40	0.38	0.41	0.42	0.43	0.42
	(0.00)																
Greece	**3.37**	**2.6**	0.67	0.75	0.80	0.88	0.87	0.84	0.89	0.91	0.94	0.90	1.14	1.09	1.07	1.00	0.94
	(0.00)																
Ireland	**2.81**	**2.9**	0.78	0.91	1.00	1.19	1.24	0.99	1.10	1.16	1.28	1.30	1.33	1.36	1.37	1.38	1.36
	(0.00)																
Italy	**2.88**	**2.4**	0.53	0.61	0.67	0.78	0.80	0.67	0.73	0.77	0.84	0.83	0.90	0.91	0.91	0.90	0.87
	(0.00)																
Japan	**3.52**	**2.9**	0.80	0.89	0.94	1.02	1.01	1.02	1.06	1.08	1.09	1.05	1.37	1.30	1.26	1.16	1.09
	(0.00)																
Netherlands	**2.25**	**2.5**	0.61	0.75	0.85	1.09	1.20	0.78	0.91	0.99	1.19	1.26	1.05	1.14	1.20	1.30	1.33
	(0.00)																
New Zealand	**1.34**	**2.6**	0.65	0.86	1.03	1.61	2.03	0.82	1.06	1.24	1.80	2.19	1.11	1.36	1.54	2.05	2.38
	(0.00)																
Norway	**2.58**	**2.2**	0.45	0.53	0.59	0.71	0.75	0.56	0.64	0.68	0.77	0.78	0.76	0.80	0.82	0.84	0.82
	(0.00)																
Portugal	**3.33**	**4.8**	2.24	2.54	2.72	3.15	3.46	2.84	3.03	3.14	3.38	3.61	3.85	3.74	3.68	3.63	3.77
	(0.00)																
Spain	**3.14**	**2.7**	0.69	0.79	0.85	0.96	0.97	0.87	0.94	0.98	1.03	1.01	1.18	1.16	1.15	1.10	1.05
	(0.00)																
Sweden	**1.67**	**2.0**	0.40	0.51	0.60	0.85	0.99	0.50	0.62	0.71	0.94	1.06	0.68	0.80	0.87	1.05	1.13
	(0.00)																
United Kingdom	**2.35**	**2.0**	0.37	0.45	0.51	0.64	0.68	0.47	0.55	0.59	0.69	0.71	0.64	0.69	0.71	0.76	0.75
	(0.00)																

Source: Author's calculation s based on ECLAC and WDI databases

a. First two columns provide parameter estimates for process (13) for the period 1960-2006, the p-values are shown in brackets below the estimate. The welfare cost estimates, $\Delta_t\left(\beta,\gamma,g,\sigma_{\varepsilon}^{2}\right)$, are based on equation (17).

While the welfare cost in US is under 0.5% of per capita consumption for any value of γ and β, the average losses in Latin America are between 2.4% and 11.9% of per capita consumption with countries like Argentina and Chile where the estimate of the welfare cost exceeds the 10% for intermediate values of γ and β (say 5 and 0.96 respectively). Like in the baseline specification, the Latin American region registers the highest welfare cost associated with the macroeconomic volatility. These larger welfare costs suggest that further countercyclical macro policies than those applied since 1960 are needed in most of Latin American countries. However, before drawing any conclusion an alternative model will be analyzed in the next section which incorporates idiosyncratic risk and incomplete markets.

3.3 Third Model: a general equilibrium framework with idiosyncratic risk

Next, an alternative specification is studied by incorporating an uninsurable idiosyncratic labor risk following Krebs (2003a)[15]. The labor risk is uninsurable because there is no asset in the financial market with payoffs tied to the idiosyncratic risk, which is why the financial markets are incomplete. In line with Krebs (2003a and 2003b), the idiosyncratic income shocks are taken as permanent. This is a strong assumption because it is difficult to state from the data whether income shocks are permanent or just highly persistent[16]. Recall that Lucas' framework is a representative agent model with complete markets where the business cycle *does not* affect the economic growth, whereas this model is a general equilibrium framework where the business cycle will actually affect economic growth.

3.3.1. The Economy

There are aggregate productivity shocks (S_t) that affect the returns of both physical and human capital investments. Thus, in this model the real volatility (or aggregate risk) coincides with the typical business cycle definition. In addition, there are human capital shocks (s_{it}) that only affect human capital accumulation. Both shocks are unpredictable so they have an i.i.d. distribution over time. There are i = 1,…,I ex-ante identical households,

---

[15] Recall that the Krebs (2003a) model is based on Storesletten et al (2001a) with permanent idiosyncratic human capital shocks.

[16] Imrohoglu (1989) and Krusell and Smith (2002) consider shock with some degree of persistence.

meaning that the idiosyncratic shocks are identically distributed across them. As usual, there is one non-perishable good that can be consumed or invested and only one firm that produces it. This firm produces Y_t unit of the all-proposed good employing physical (K_t) and human capital (H_t) with a standard neoclassical production function with constant-returns-to-scale[17]. Formally, $Y_t = A(S_t)F(K_t, H_t)$, where A_t is a total factor productivity function $A: S \rightarrow R_{++}$ that assigns a productivity level for each aggregate state $A_t = A(S_t)$. The gross physical and human capital returns are denoted by $\widehat{r}_{kt}$ and $\widehat{r}_{ht}$ respectively. Hence, the firm faces the following maximization problem:

$$\max_{K_t, H_t} \left\{ A_t F(K_t, H_t) - \widehat{r}_{kt} K_t - \widehat{r}_{ht} H_t \right\} \tag{18}$$

On the other hand, households have identical time-additive preference over the consumption plan $\left\{ c_{it} \right\}$. Consequently, each household i solves the following autarky maximization problem:

$$\max \sum_{t=0}^{\infty} E\left[\beta^t u\left(c_{it} \right) \right] \tag{19}$$

This intertermporal maximization problem is subjected to the sequential budget constraints:

$$\begin{aligned} & c_{it} + x_{hit} + x_{kit} = \widehat{r}_{kt} k_{it} + \widehat{r}_{ht} h_{it} \\ & k_{it+1} = k_{it}(1 - \delta_k) + x_{kit} \\ & h_{it+1} = h_{it}(1 - \delta_h + \eta_{it}) + x_{hit} \\ & (k_{i0} \text{ } and \text{ } h_{i0} \text{ are given}) \end{aligned} \tag{20}$$

where x_{kit} and x_{hit} are the investment levels in physical and human capital respectively of household i in t and k_{it} and h_{it} are the stock of physical and human capital owned by household i at the beginning of period t. For convenience the average depreciation rates of human and physical capital (δ_{ht} *and* δ_{kt} respectively) are constant and independent of the

[17] All standard neoclassical holds, in particular F is twice-continuously differentiable, strictly concave and $\lim_{K \to 0} F_K^{'} = \lim_{H \to 0} F_H^{'} = +\infty$ and $\lim_{K \to \infty} F_K^{'} = \lim_{H \to \infty} F_H^{'} = 0$

aggregate risk[18]. The term η_{it} is the household-specific shock that only affects the stock of human capital with the $E[\eta_{it}/S_t]=0$. The function $\eta : s\times S \rightarrow R$ assigns to each pair (s, S) a realization η_{it}. Notice that the idiosyncratic shock is taken as another source of human capital depreciation, and is related to specific-skill looses or skills no longer used in the event of a job loss. The ideas is that there is some part of the accumulated human capital that is either destroyed or made obsolete when an agent losses his job, in this case $\eta_{it}<0$. Of course, these losses are more severe in a context of an economic downturn, in other words the aggregate risk affects the variance of the idiosyncratic shock[19].

In order to reduce (3), two additional variables are defined: the total wealth ($w_{it}=k_{it}+h_{it}$) and the capital-to-labor ratio ($\tilde{k}_{it}=k_{it}/h_{it}$). Given this notation, the total wealth invested in physical capital is: $\theta_{it}=k_{it}/(k_{it}+h_{it})=\tilde{k}_{it}/(1+\tilde{k}_{it})$. Thus, restriction (20) can be reduced by adding up the equations which describe capital stocks and introducing the income constraint:

$$\begin{aligned} k_{it+1}+h_{it+1} &= w_{it+1}=k_{it}-k_{it}\delta_k+h_{it}-h_{it}\delta_h+h_{it}\eta_{it}+(x_{hit}+x_{kit}) \\ w_{it+1} &= k_{it}+h_{it}-k_{it}\delta_k-h_{it}\delta_h+h_{it}\eta_{it}+\hat{r}_{kt}k_{it}+\hat{r}_{ht}h_{it}-c_{it} \end{aligned} \tag{21}$$

Rearranging and taking into account the net- rate of returns defined as $r_{kt}=\hat{r}_{kt}-\delta_k$ and $r_{ht}=\hat{r}_{ht}-\delta_h$ the budget constraint reads,

$$\begin{aligned} w_{it+1} &= w_{it}\left[1+\frac{k_{it}}{k_{it}+h_{it}}r_{kt}+\frac{h_{it}}{k_{it}+h_{it}}\left(r_{ht}+\eta_{it}\right)\right]-c_{it} \\ & or \\ w_{it+1} &= w_{it}\left[1+\frac{\tilde{k}_{it}}{1+\tilde{k}_{it}}r_{kt}+\frac{1}{1+\tilde{k}_{it}}\left(r_{ht}+\eta_{it}\right)\right]-c_{it} \end{aligned} \tag{22}$$

[18] Krebs(2003a) assumes that the aggregate depreciation rate of physical and human capital are equal and depend on the aggregate shocks, $\delta_{kt}=\delta_{ht}=\delta(S_t)$

[19] The model focuses on the permanent wage loss instead of taking into account the missed wage during the unemployment period.

Equation (22) simply shows that the household optimization problem is a portfolio choice problem where the agent decides the consumption path and the fraction of his wealth invested in physical and human capital.

3.3.2. The Sequential Equilibrium

The recursive equilibrium can be found by solving a decision problem of a household who lives in autarky and faces the same problem every period with different sets of information. Focusing on the stationary recursive equilibria with a constant physical-to-human capital ratio, $\tilde{K}_t = \tilde{K} = K_t / H_t$, the equilibrium will be the sequences of prices and actions, $\{r_{kt}, r_{ht}\}$, $\{k_t, h_t\}$ and $\{c_{it}, w_{it+1}, \tilde{k}_{it+1}\}$, where:

i. $\{k_t, h_t\}$ solves the firm maximization problem (18)
ii. $\{c_{it}, w_{it+1}, \tilde{k}_{it+1}\}$ maximizes expected lifetime utility (19) s.t. the sequential budget constraint (22)
iii. And markets clear.

The FOCs associated with the firm's maximization problem (i) are:

$$\begin{aligned} r_{kt}(\tilde{K}, S_t) &= A(S_t)F_K^{'} - \delta_k \\ r_{ht}(\tilde{K}, S_t) &= A(S_t) - \tilde{K}F_K^{'} - \delta_h \end{aligned} \tag{23}$$

where $F_K^{'} = \partial F(\tilde{K},1)/\partial K = \partial f(\tilde{K})/\partial K$. The market clearing condition (iii) implies that the aggregate capital-labor ratio must equal to the firm's capital to labor ratio:

$$\frac{\sum_i^I \frac{\tilde{k}_{it}}{(1+\tilde{k}_{it})} w_{it}}{\sum_i^I \frac{1}{(1+\tilde{k}_{it})} w_{it}} = \frac{\sum_i^I k_{it}}{\sum_i^I h_{it}} = \frac{K_t}{H_t} = \tilde{K} \tag{24}$$

If the households' capital-labor ratios are symmetric, $\tilde{k}_{it} = \tilde{k}$, then (24) is satisfied if only if $\tilde{K} = \tilde{k}$. Consequently, let $r_k = r_k(\tilde{k}, S)$ and $r_h = r_h(\tilde{k}, S)$ be the investment return functions defined by (23), so the household's maximization problem in (ii) is given by:

$$\max_{\{c_{it}, w_{it+1}, \tilde{k}_{it+1}\}} \sum_{t=0}^{\infty} E\left[\beta^t u\left(c_{it}\right)\right]$$

$$s.t.$$

$$w_{it+1} = w_{it}\left[1 + \frac{\tilde{k}_{it}}{1+\tilde{k}_{it}} r_{kt} + \frac{1}{1+\tilde{k}_{it}}\left(r_{ht} + \eta_{it}\right)\right] - c_{it} \tag{25}$$

$$\text{with } w_{it} \geq 0 \text{ , } \tilde{k}_{it} \geq 0 \text{ and } w_{i0}, \ \tilde{k}_{i0} \text{ given}$$

Rewriting the problem into the Bellman equation:

$$V(w_{it}) = \max u(c_{it}) + \beta E_t\left[V(w_{it+1})\right] + \lambda_t\left[w_{it}\left[1 + \frac{\tilde{k}_{it}}{1+\tilde{k}_{it}} r_{kt} + \frac{1}{1+\tilde{k}_{it}}\left(r_{ht} + \eta_{it}\right)\right] - c_{it} - w_{it+1}\right] \tag{26}$$

The FOCs are:

$$\begin{aligned} w.r.t.\ c_{it} &: \frac{\delta u(c_{it})}{\delta c_{it}} = \lambda_t \\ w_{it+1} &: \beta E_t \frac{\delta V(w_{it+1})}{\delta w_{it+1}} = \lambda_t \\ \tilde{k}_{it+1} &: \lambda_{t+1}\left[r_{ht+1}\left(\tilde{k}_{t+1}, S_{t+1}\right) + \eta_{it+1}(s_{it+1}, S_{t+1}) - r_k\left(\tilde{k}_{t+1}, S_{t+1}\right)\right] = 0 \end{aligned} \tag{27}$$

Combining the first and second FOCs we get the first key condition,

$$\frac{\partial u(c_{it})}{\partial c_{it}} = \beta E_t \frac{\delta V(w_{it+1})}{\delta w_{it+1}} \tag{28}$$

By using the envelope theorem, the derivative on the RHS is equal to:

$$\frac{\partial V(w_{it})}{\partial w_{it}} = \lambda_t\left[1 + \frac{\tilde{k}_{it}}{1+\tilde{k}_{it}} r_{kt}(\tilde{k}_{it}, S_t) + \frac{1}{1+\tilde{k}_{it}}\left(r_{ht}(\tilde{k}_{it}, S_t) + \eta_{it}(s_{it}, S_t)\right)\right] \tag{29}$$

Shifting up one period and substituting it into (28) gives the first Euler Equation:

$$\frac{\partial u(c_{it})}{\partial c_{it}} = \beta E_t\left[\frac{\delta u(c_{it+1})}{\delta c_{it+1}}\left[1 + \frac{\tilde{k}_{it+1}}{1+\tilde{k}_{it+1}} r_{kt+1}(.) + \frac{1}{1+\tilde{k}_{it+1}}\left(r_{ht+1}(.) + \eta_{it+1}(.)\right)\right]\right] \tag{30}$$

which basically says that the marginal utility loss (utility cost) of investing (saving) one more unit of good must be equal to the expected utility gain of doing so. The second Euler Equation is obtained by substituting out λ in the third FOC:

$$E_t\left[\frac{\delta u(c_{it+1})}{\delta c_{it+1}}\left[r_{ht+1}\left(\tilde{k}_{t+1},S_{t+1}\right)+\eta_{it+1}(s_{it+1},S_{t+1})-r_k\left(\tilde{k}_{t+1},S_{t+1}\right)\right]\right]=0 \qquad (31)$$

Equation (31) states the equality of expected returns on the two investment opportunities (marginal utility weighted). As was assumed in previous models, preferences exhibit a constant degree of relative risk aversion, thus the one period utility function is $u(c_{it})=c_{it}^{1-\gamma}/(1-\gamma)$ if $\gamma\neq1$ and $u(c_{it})=\ln c_{it}$ if $\gamma=1$. Consequently, the Euler equations can be rewritten as:

$$\begin{aligned}
&c_{it}^{-\gamma}=\beta E_t\left[c_{it+1}^{-\gamma}\left[1+\frac{\tilde{k}}{1+\tilde{k}}r_k(\tilde{k},S_{t+1})+\frac{1}{1+\tilde{k}}\left(r_h(\tilde{k},S_{t+1})+\eta(s_{it+1},S_{t+1})\right)\right]\right]\\
&E_t\left[c_{it+1}^{-\gamma}\left[r_h\left(\tilde{k},S_{t+1}\right)+\eta(s_{it+1},S_{t+1})-r_k\left(\tilde{k},S_{t+1}\right)\right]\right]=0
\end{aligned} \qquad (32)$$

Notice that the time index on $\tilde{k}_{it}$ is dropped as it is time-independent. As is noted in Krebs (2003a, 2006) the solution to the autarky problem exits if the following condition holds,

$$\sup_{\tilde{k}}\beta E\left[\left(1+\frac{\tilde{k}_i}{1+\tilde{k}_i}r_k+\frac{1}{1+\tilde{k}_i}(r_h+\eta_i)\right)^{1-\gamma}\right]<1 \qquad (33)$$

Let $r_{it}(\tilde{k},s,S)=\frac{\tilde{k}_{it}}{1+\tilde{k}_{it}}r_{kt}+\frac{1}{1+\tilde{k}_{it}}\left(r_{ht}+\eta_{it}\right)$ be the total return on investments and a be the consumption-to-wealth ratio. Direct calculation shows that the plan $c_{it}=a(1+r_{it})w_{it}$ solves (32) together with the budget constraint. Therefore, expression (32) reads,

$$\begin{aligned}
&\left[a(1+r_t)w_{it}\right]^{-\gamma}=\frac{\beta}{\left[a(1-a)(1+r_{it})w_{it}\right]^{\gamma}}E_t\left[\left(1+r_{t+1}\right)^{1-\gamma}\right]\\
&E_t\left[\frac{r_h\left(\tilde{k},S\right)+\eta_{it+1}(s_i,S)-r_k\left(\tilde{k},S\right)}{\left[a(1+r_{t+1})w_{it+1}\right]^{\gamma}}\right]=0
\end{aligned} \qquad (34)$$

Rearranging and defining $w_{it+1}=(1-a)(1+r_{it})w_{it}$ we get,

$$\begin{aligned}
&a=1-\left[\beta E_t\left[\left(1+r_{t+1}\right)^{1-\gamma}\right]\right]^{1/\gamma}\quad(\gamma\neq1)\quad\text{or}\quad a=1-\beta\quad(\gamma=1)\\
&E_t\left[\frac{r_h\left(\tilde{k},S\right)+\eta_{it+1}(s_i,S)-r_k\left(\tilde{k},S\right)}{\left(1+r_{t+1}\right)^{\gamma}}\right]=0
\end{aligned} \qquad (35)$$

Notice that condition (33) ensures that $0 < a < 1$. Additionally, equation (35) not only determines the equilibrium values of a and $\tilde{k}$ but also that the transversality condition is satisfied, $\lim_{t\to\infty} \beta^t E_t\left[\left(c_{it}\right)^{-\gamma} w_{it+1}\right] \to 0$ so in this case the Euler equations are necessary and sufficient. In sum, the allocations of the simple recursive equilibrium are given by:

$$
\begin{aligned}
&\tilde{k}_{it} = \tilde{k} = cte. \\
&c_{it} = a\left[1 + r(\tilde{k}, s_{it}, S_t)\right] w_{it} \\
&w_{it+1} = (1-a)\left[1 + r(\tilde{k}, s_{it}, S_t)\right] w_{it} \\
&k_{it} = \frac{\tilde{k}}{1+\tilde{k}} w_{it} \qquad ; \qquad h_{it} = \frac{1}{1+\tilde{k}} w_{it}
\end{aligned}
\tag{36}
$$

and the aggregate asset returns:

$$
r_{kt} = r_k(\tilde{k}, S_t) \quad \text{and} \quad r_{ht} = r_h(\tilde{k}, S_t)
$$

Furthermore, the expected life time utility yields:

$$
E\sum_{t=0}^{\infty} \beta^t u(c_{it}) = \begin{cases} \dfrac{c_{i0}{}^{1-\gamma}}{(1-\gamma)\left(1-\beta E\left[\left(1+g(\tilde{k}, s_i, S)\right)^{1-\gamma}\right]\right)} & \text{if } \gamma \neq 1 \\[2ex] \dfrac{1}{1-\beta} \ln c_{i0} + \dfrac{\beta}{(1-\beta)^2} E\left[\log(1+g(\tilde{k}, s_i, S))\right] & \text{if } \gamma \neq 1 \end{cases}
\tag{37}
$$

where $g(\tilde{k}, s_i, S) = \frac{c_{it+1}}{c_{it}} = (1-a)\left[1 + r(\tilde{k}, s_{it}, S_t)\right]$ is the individual consumption growth.

3.3.3. Calibration

Consider the case with a Cobb-Douglas production function with constant returns-to-scale: so the intensive form is $f\left(\tilde{k}_t\right) = A_t \tilde{k}_t^{\alpha}$. Under logarithmic preferences (γ=1) equations (35) is:

$$
\begin{aligned}
&a = 1-\beta \\
&E_t\left[\frac{r_h\left(\tilde{k}, S\right) + \eta_{it+1}(s_i, S) - r_k\left(\tilde{k}, S\right)}{\left(1 + r_{t+1}\right)}\right] = 0
\end{aligned}
\tag{38}
$$

The aggregate per capita consumption growth rate in this economy is obtained by the individual consumption growth in expression (36) and the law of large numbers:

$$\mu(S)=\frac{C_{t+1}}{C_t}=E\left[\frac{c_{it+1}}{c_{it}}\middle|S_{t+1}\right]=(1-a)\left[1+E\left[r(\tilde{k},s_{it+1},S_{t+1})\right]\right] \tag{39}$$

as a result $\mu(S)$ is also an i.i.d. process[20]. Considering the value of a and the assumption of the Cobb –Douglas production function so the consumption growth rate reads,

$$\mu(S)=\beta\left[1+\frac{\tilde{k}}{1+\tilde{k}}A_t\alpha\tilde{k}^{\alpha-1}+\frac{1}{1+\tilde{k}_i}A_t(1-\alpha)\tilde{k}^{\alpha}-\tilde{\delta}\right] \tag{40}$$

where $\tilde{\delta}$ is the total depreciation rate of both physical and human capital.

Again the Latin American countries with the developed economies will be compared for the period 1960-2006. The quantitative analysis is based on annual data with parameter values which are extensively used in RBC models as well as Krebs' assumptions:

i. The capital-to-labor (α) is equal to 0.36 [21]. Furthermore, the common discount factor β equals 0.96 to ensure that all households have the same intertemporal preferences in both Latin American and developed countries[22].

ii. The total depreciation rate $\tilde{\delta}$ is set in 0.06. If a common choice for the depreciation rate of physical capital is $\delta_k = 0.05$ (see Colley and Prescott, 1995), thus the depreciation rate of human capital will be lower and equal to $\delta_h = 0.01$. Krebs (2003a, 2003b) and Jones, Manuelli and Stacchetti (1999) also assume the same total depreciation rate.

iii. Two state shocks in the aggregate economy are assumed: the low level (L) and a high level (H) of the cycle. Thus, S has two realizations {L,H} with equal probabilities $\pi(L)=\pi(H)=0.5$. In addition, the human capital shock (s_{it}) follows a standard normal distribution which is independent of the aggregate shock S.

---

[20] See Campbell and Cachrone (1999)

[21] Although this value is commonly used in the calibration of RBC models, it might not match the real income share in Latin American countries.

[22] This β value is suggested by Colley and Prescott (1995). It is possible to derivate β from the equation (40). However, this would stand different preferences in each country with unrealistic values for some countries.

iv. The household-loss of human capital is defined as $\eta(s_i, S) = \sigma_\eta(S)s_i$, therefore $\eta_{it} \sim N(0, \sigma_\eta^2(S_t))$.

v. On the other hand, the individual labor income is $y_{iht} = (r_h + \delta_h)h_{it}$. From eq. (36) $h_{it+1} = (1-\theta)w_{it+1} = \beta\left[1 + \theta r_k + (1-\theta)(r_h + \eta_{it})\right]h_{it}$ thus the labor income growth can be re-written as:

$$\begin{aligned}\log y_{it+1} - \log y_{it} &= \log[(r_h + \delta_h)h_{it+1}] - \log[(r_h + \delta_h)h_{it}] \\ &= \log h_{it+1} - \log h_{it} \\ &= \log \beta + \log[1 + \theta r_k + (1-\theta)(r_h + \eta_{it})] \qquad (41) \\ &\approx \underbrace{\log \beta + \theta r_k + (1-\theta)r_h}_{Z} + \underbrace{(1-\theta)\eta_{it}}_{\tilde{\eta}_{it}} \quad \text{,because } \log(1+r) \approx r\end{aligned}$$

As a result the $\log y_{iht}$ approximately follows a random walk with drift (Z) and an error term $\tilde{\eta}_{it} \sim N(0, \sigma_y^2(S_t))$ where the income variance will depend on aggregate risk (i.e. the business cycle):

$$\sigma_y^2(S_t) = (1-\theta)^2 \sigma_\eta^2(S_t) = \frac{\sigma_\eta^2(S_t)}{(1+\tilde{k})^2} \qquad (42)$$

vi. The expected value of the per capita consumption growth rate for each economy, $E[g(S_t)] = E[\mu(S_t)] = 0.5\mu(L) + 0.5\mu(H)$, matches the country consumption data for the period 1960-2006. In order to take into account the consumption volatility, the growth rates for the two possible states depend on the standard deviation of the per capita consumption growth rate in each country: $\mu(L) = \mu - \sigma_\mu$ and $\mu(H) = \mu + \sigma_\mu$.

vii. Perhaps the most difficult step in the calibration process is to find suitable approximation of the standard deviation defined in (42), because there is not enough empirical literature to model the income labor with an idiosyncratic risk component for Latin American countries. However, there are relevant studies for the US economy (Carroll and Samwick, 1997; Meghir and Pistaferri (2001) and Storesletten et al., 2001b) which estimate the standard deviation of the error term for a random walk specification of the labor income (σ_y). Krebs (2003a) assumes two possible scenarios for each state by taking into account the maximum and minimum values reported in these studies: i.e. $\sigma_y(H) = 0.12$ or

$\sigma_y(H)=0.08$ for the high-state and $\sigma_y(L)=0.24$ or $\sigma_y(L)=0.28$ for the low-state. In the calibration, the average for each state, i.e. the standard deviations of the labor income process in (42) are equal to: $\sigma[y_{iht+1}/y_{iht}|S_t=L]=0.26$ and $\sigma[y_{iht+1}/y_{iht}|S_t=H]=0.10$. Notice, as was mentioned above, that the real fluctuation (business cycle) affects the uncertainty (the volatility) of the idiosyncratic shock but it does NOT affect the expected value of the idiosyncratic shock volatility $E\left[\sigma_\eta^2(S_t)\right]=0.5\sigma_\eta^2(L)+0.5\sigma_\eta^2(H)>0$. This basically means that the elimination of the aggregate risk transforms the idiosyncratic human capital risk from the heteroscedastic to homoscedastic process, i.e. from $\eta_{it}\sim N(0,\sigma_\eta^2(S_t))$ to $\eta_{it}^*\sim N(0,E[\sigma_\eta^2(S_t)])$. Although the estimates of the labor income volatility based in US data might be generalized for all developed countries, it can underestimate the actual labor income volatility in Latin American countries because these economies have higher per capita income volatility (see section 2) and an extended informal labor market[23]. Therefore, it seems reasonable to think that all these socio-economic features translate into higher labor income volatility. If the US estimate of σ_y is taken as a minimal benchmark for developing countries, then the calibration results for Latin American economies should be taken as *a lower-bound estimates*.

Mainly, we are interested in calculating the equivalent (or adjusted) average growth rate $\hat{\mu}$ of the per capita consumption, which is defined as the certain growth rate for which expected life-time utility is equal to that associated with the uncertain growth rate $g(S)\sim N(\mu(S),\sigma_g(S))$ with $\sigma_g(S)=\beta\sigma_y(S)$ and keeping the initial consumption constant:

$$E\left[\sum_{t=0}^{\infty}\beta^t\log c_{it}\right]=\frac{1}{1-\beta}\log c_{i0}+\frac{\beta}{(1-\beta)^2}E\left[\log(1+g)\right]$$

$$=\frac{1}{1-\beta}\log c_{i0}+\frac{\beta}{(1-\beta)^2}\log(1+\hat{\mu}(S))=E\left[\sum_{t=0}^{\infty}\beta^t\log c^*_{it}\right] \tag{43}$$

where $c^*_{it}=c_{i0}(1+\hat{\mu}(S))^t$

---

[23] On average the informal economy in Latin America represents 42% of GNP but 18% in the high-income OECD countries (Schneider, 2002).

Working out for $\hat{\mu}(S)$ yields,

$$\hat{\mu}(S) = e^{E\left[\log(1+g(S))\right]} - 1 \tag{44}$$

The risk-adjusted consumption growth rate is independent of the initial consumption c_{i0} and is equal for all households and the aggregate economy. The expression $E[\log(1+g(S))]$ is calculated through the Gauss-Hermite quadrature rule for expectations of functions of a normal random variable with two nodes:

$$E\left[\log(1+g(S))\right] \approx \pi^{-1/2} \sum_{i=1}^{2} \omega_i \log\left[1 + (\sqrt{2}\sigma_g(S)x_i + \mu(S))\right] \tag{45}$$

where x_i are the quadrature-nodes with weights ω_i[24].

The per capita consumption growth rate (g) changes to a homoscedastic process, i.e. $g' \sim N(E[\mu(S)], E[\sigma_g(S)])$, when the aggregate risk is eliminated. Then, the change in the risk-adjusted growth rate can be estimated by

$$\Delta\hat{\mu} = \hat{\mu}' - E\left[\hat{\mu}(S)\right] = e^{E\left[\log(1+g')\right]} - 0.5\left[\hat{\mu}(L) + \hat{\mu}(H)\right] \tag{46}$$

This expression approximates the welfare change expressed in risk-adjusted growth rates. However, to make this calibration comparable with the baseline (3.1) and second model (3.2), the equivalent change in consumption levels that has the same positive effect of eliminating the business cycle needs to be estimated. By direct calculation we find:

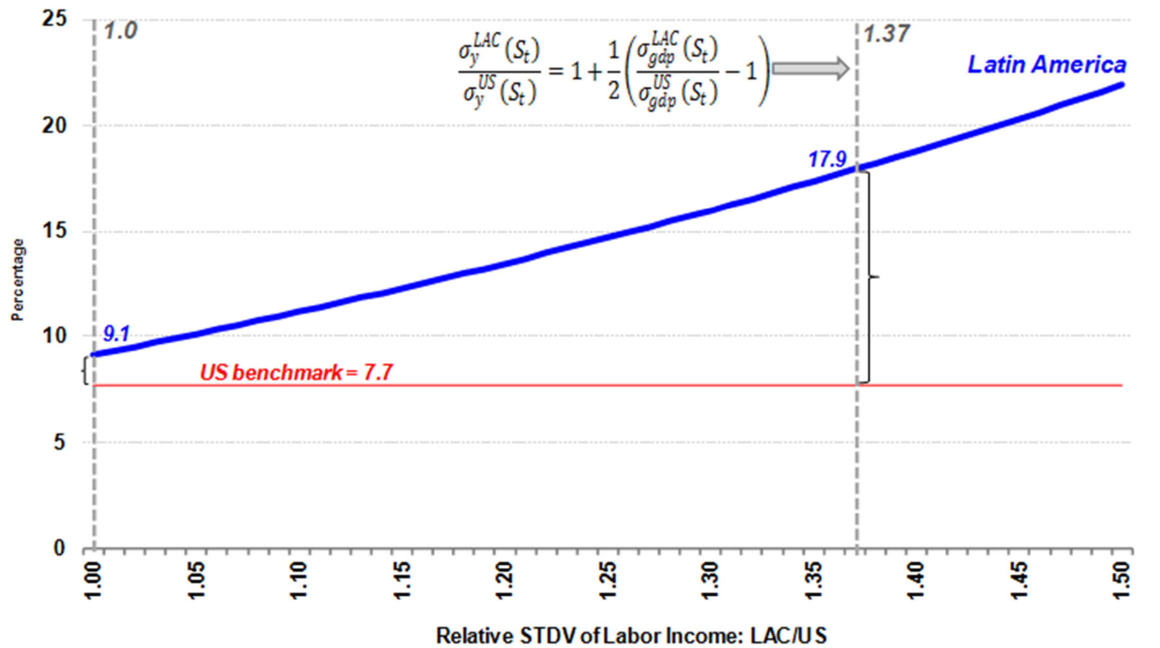
$$\begin{aligned}
&\log(c_{i0}(1+\Delta c)) + \frac{\beta}{1-\beta} E\left[\log(1+g(S))\right] = \log c_{i0} + \frac{\beta}{1-\beta} E\left[\log(1+g')\right] \\
&\Delta c = e^{\frac{\beta}{1-\beta}\left[E\left[\log(1+g')\right] - E\left[\log(1+g(S))\right]\right]} - 1 \\
&\Delta c \approx \frac{\beta}{1-\beta} \Delta\hat{\mu}
\end{aligned} \tag{47}$$

Even though there are not reliable calculation of how much greater is the labor income volatility in Latin American countries ($\sigma_y^{LAC}(S_t)$) with respect to the US/developed countries estimates ($\sigma_y^{DC}(S_t)$), we can simply make a sensitive exercise in order to capture

[24] For nodes values and weights see Judd (1998)

the equivalent variation in per capita consumption for different values of the LAC income volatility relative to the US benchmark (see Figure.6). As an extreme case, the cost of real fluctuation could represent more than 20% of per capita consumption in Latin America if its labor income volatility were 50% greater than in US.

Figure.6
THE RELATIVE WELFARE COST OF REAL VOLATILITY IN LATIN AMERICA: A SENSITIVE ANALYSIS



Source: Author's calculations.
BasicAssumptions:α=0.36;γ=1(log-utility);β=0.96;aggregatedepreciationrate=0.06

For comparison purposes, we pick a point from Figure.6 by assuming that the labor income volatility in Latin America might be as large as the half of difference in per capita GDP volatility between Latin American countries (σ_{gdp}^{LAC}) and the US (σ_{gdp}^{US}) in the period 1960-2006.

$$\frac{\sigma_y^{LAC}(S_t)}{\sigma_y^{US}(S_t)} = 1 + \frac{1}{2}\left(\frac{\sigma_{gdp}^{LAC}(S_t)}{\sigma_{gdp}^{US}(S_t)} - 1\right) \tag{48}$$

Although this is not an accurate measure of the actual $\sigma_y^{LAC}(S_t)$, it gives an idea of the model sensitivity in case of an economy that accounts for larger labor income volatility[25].

Table.6
MODEL 3: WELFARE EFFECT OF ELIMINATING THE BUSINESS CYCLE [a]
(In % of the per capita consumption)

		(E1) σ_y (L)=0.26 and σ_y (H)=0.10				(E1) σ_y (L)=0.26 and σ_y (H)=0.10		(E2) Assuming greater labour income risk σ_y (L)=0.36 and σ_y (H)=0.14	
Country	*E[u(S)]*	*Δû*	*Welfare Effects Δc*	*Country*	*E[u(S)]*	*Δû*	*Welfare Effects Δc*	*Δû*	*Welfare Effects Δc*
United States	2.4	0.32	**7.7**	*Argentina*	1.5	0.40	**9.6**	0.79	**18.8**
Australia	2.1	0.32	**7.7**	*Bolivia*	0.8	0.35	**8.4**	0.68	**16.4**
Austria	2.5	0.33	**7.9**	*Brazil*	2.1	0.38	**9.1**	0.74	**17.7**
Belgium	2.3	0.33	**7.8**	*Chile*	2.0	0.41	**9.7**	0.80	**19.1**
Denmark	2.0	0.34	**8.2**	*Colombia*	1.7	0.34	**8.1**	0.66	**15.9**
Finland	2.8	0.34	**8.2**	*Costa Rica*	1.7	0.37	**8.9**	0.73	**17.5**
France	2.5	0.32	**7.7**	*Dominican Republic*	2.9	0.39	**9.5**	0.77	**18.6**
Greece	3.3	0.33	**8.0**	*Ecuador*	1.8	0.34	**8.2**	0.67	**16.1**
Ireland	2.8	0.34	**8.2**	*El Salvador*	1.1	0.39	**9.5**	0.77	**18.5**
Italy	2.9	0.33	**8.0**	*Guatemala*	1.3	0.33	**8.0**	0.65	**15.6**
Japan	3.5	0.34	**8.1**	*Honduras*	1.2	0.36	**8.5**	0.70	**16.7**
Netherlands	2.2	0.34	**8.1**	*Mexico*	1.9	0.35	**8.5**	0.69	**16.6**
New Zealand	1.3	0.34	**8.2**	*Nicaragua*	(0.1)	0.49	**11.7**	0.96	**23.0**
Norway	2.6	0.33	**7.9**	*Panama*	2.7	0.40	**9.7**	0.79	**19.0**
Portugal	3.2	0.37	**8.8**	*Paraguay*	1.1	0.37	**9.0**	0.73	**17.6**
Spain	3.1	0.34	**8.1**	*Peru*	0.8	0.39	**9.4**	0.76	**18.3**
Sweden	1.6	0.33	**8.0**	*Uruguay*	1.2	0.40	**9.7**	0.79	**18.9**
United Kingdom	2.3	0.33	**7.9**	*Venezuela, RB*	1.4	0.34	**8.3**	0.76	**18.2**
Developed Countries	***2.5***	***0.33***	***8.0***	***Latin America***	***1.5***	***0.38***	***9.1***	***0.75***	***17.9***

Source: Author's calculations.
a. Basic Assumptions: α=0.36; γ=1 (log-utility); β=0.96; aggregate depreciation rate=0.06

Table.6 shows: the expected value of the per capita consumption growth rate ($E[\mu(S)]$), the change in the risk-adjusted growth rate ($\Delta\hat{\mu}$) as a result of eliminating the real fluctuations and its corresponding welfare effect in terms of equivalent changes in consumption level (Δc). As was mentioned above, the welfare cost is re-estimated (E2) by allowing for a higher labor income risk in Latin America (see eq.48).

The welfare costs associated with the business cycle are considerably higher than those estimated in the previous sections. The model analyzed in this section estimates an

[25] If we took the complete difference in the per capita GDP volatility, the welfare changes associated with the elimination of the idiosyncratic risk would be explosive.

average welfare cost of 8.0% of per capita consumption in developed economies, while the baseline model estimates only 0.01%. Identically, under the new specification the average welfare cost in Latin America is more than 9% of per capita consumption and just 0.06% with the baseline specification (see Table.2). Notice also, that larger welfare effects are estimated when greater labor income risks are considered for Latin America (estimate E2), on average it is equivalent to almost 18% of consumption across all dates.

Table.7
COMPARATIVE RESULTS ON THE WELFARE EFFECTS OF ELIMINATING THE REAL VOLATILITY [a]
(In % of the per capita consumption)

	Welfare Effects Δc				*Order of magnitud larger w.r.t. the baseline model*		
	Baseline Model (3.1)	*Model 2 (3.2)*	*Model 3 (3.3) -E1*	*Model 3 (3.3) - E2*	*Model 2*	*Model 3 E1*	*Model 3 E2*
Latin America	***0.06***	***3.0***	***9.1***	***17.9***	**1.7**	**2.2**	**2.5**
Argentina	0.09	5.1	9.6	18.8	1.7	2.0	2.3
Bolivia	0.01	1.1	8.4	16.4	1.9	2.8	3.0
Brazil	0.04	3.3	9.1	17.7	1.9	2.4	2.6
Chile	0.11	6.1	9.7	19.1	1.7	1.9	2.2
Colombia	0.01	0.8	8.1	15.9	1.9	2.9	3.2
Costa Rica	0.05	2.8	8.9	17.5	1.8	2.3	2.6
Dominican Republic	0.09	5.3	9.5	18.6	1.8	2.0	2.3
Ecuador	0.01	1.0	8.2	16.1	2.0	2.9	3.2
El Salvador	0.06	-	9.5	18.5	-	2.2	2.5
Guatemala	0.00	0.5	8.0	15.6	2.0	3.2	3.5
Honduras	0.02	1.5	8.5	16.7	1.8	2.6	2.9
Mexico	0.03	1.5	8.5	16.6	1.8	2.5	2.8
Nicaragua	0.17	-	11.7	23.0	-	1.8	2.1
Panama	0.10	6.3	9.7	19.0	1.8	2.0	2.3
Paraguay	0.03	-	9.0	17.6	-	2.5	2.8
Peru	0.07	-	9.4	18.3	-	2.1	2.4
Uruguay	0.10	-	9.7	18.9	-	2.0	2.3
Venezuela, RB	0.05	3.8	8.3	18.2	1.9	2.2	2.5
Developed Countries	***0.01***	***0.8***	***8.0***		**1.9**	**2.9**	
United States	0.01	0.3	7.7		1.7	3.1	
Australia	0.00	0.2	7.7		1.8	3.4	
Austria	0.01	0.5	7.9		2.0	3.2	
Belgium	0.00	0.4	7.8		2.0	3.3	
Denmark	0.01	0.9	8.2		1.8	2.8	
Finland	0.02	1.0	8.2		1.8	2.7	
France	0.00	0.3	7.7		2.1	3.6	
Greece	0.01	0.8	8.0		1.9	2.9	
Ireland	0.02	1.0	8.2		1.7	2.6	
Italy	0.01	0.7	8.0		2.0	3.0	
Japan	0.01	1.0	8.1		2.3	3.2	
Netherlands	0.01	0.8	8.1		1.9	2.9	
New Zealand	0.01	0.8	8.2		1.7	2.7	
Norway	0.01	0.6	7.9		1.7	2.9	
Portugal	0.03	2.8	8.8		1.9	2.4	
Spain	0.01	0.9	8.1		2.1	3.1	
Sweden	0.01	0.5	8.0		1.9	3.1	
United Kingdom	0.01	0.5	7.9		1.7	2.9	

Source: Author's calculations
a. Basic Assumptions: α=0.36; γ=1 (log-utility); β=0.96; aggregate depreciation rate=0.06

In order to summarize the different estimates of welfare cost associated with real fluctuations in Latin America and developed countries, Table.7 compares the equivalent variation in consumption level that has the same positive effects of eliminating the real volatility for the three models analyzed (based on the same parameter values). In other words, this is the benefit in terms of consumption of removing the real fluctuations. As can be seen, the Lucas specification shows the lowest results for the welfare cost by country, while the largest change in consumption can be obtained when idiosyncratic risk is considered. This is because the elimination of business cycle in the third model is growth-enhancing by increasing the adjusted consumption growth rate ($\hat{\mu}$).

In models 2 and 3 the average welfare cost of real volatility in developed countries might be almost two-order and three-order of magnitude higher respectively than the welfare estimated by the baseline framework. Identically, for Latin American economies the average welfare cost is also higher than that estimated with the baseline model, i.e. more than one and a half-order and two-order of magnitude higher with the second and the third model respectively. Consequently, it remains the question of whether countercyclical policies were effectively applied not only in Latin America but also in developed countries. This is the aim of the next section.

4. POLICY IMPLICATIONS: THE ROLE OF FISCAL POLICY

In previous sections comparative evidence of the real volatility in Latin American and developed countries and their welfare effects were analyzed. This section addresses the following question: to what extent were countercyclical macro-polices applied during the period 1960-2006? Policy makers have essentially two types of economic policies available: fiscal and monetary. However, several constraints might play a critical role to determine the viability and success of these policies, such as the exchange rate regime or the public sector's financial situation.

Basically, the cyclical behavior of the fiscal policy is computed for both Latin American countries and the most developed economies since 1960. The emphasis is placed on the fiscal side because the countercyclical power of the monetary policy is conditioned by the exchange rate regimes, the inflation targeting preferences and the depth of financial market. In fact, Latin American countries have had rigid (currency board or peg) or relatively rigid (crawling peg) exchange rate systems more than half of the time since 1960, this has reduced the degree of freedom of its monetary policy. Any exercise that measures the countercyclical power of monetary policy faces an additional problem because the instrument chosen as the target variable may vary over time and may depend on the existing exchange rate regime. Moreover, several economies in the region have experienced periods of high inflation (in some cases hyperinflation) and low growth as a result of a disproportional increase in money supply to finance growing fiscal deficits. In general, up to the nineties, monetary policy in Latin America was subjugated by fiscal needs with non-independent Central Banks that were not able to carry out its own targets.

On the other hand, the depth of the Latin American financial system, measured through domestic credit to the private sector over GDP, has been historically scarce (below to 50%) compared to the average level for High-Income OECD countries (almost 100%) with the only exception of Chile and Panama. Thus, the transmission and effectiveness of the monetary policy is restricted by the development of the financial system. Even in countries with deeper banking systems, the monetary policy may be ineffective in the context of a liquidity-trap, when the nominal interest rate is lowered close to zero and the liquidity created does not stimulate the economy[26].

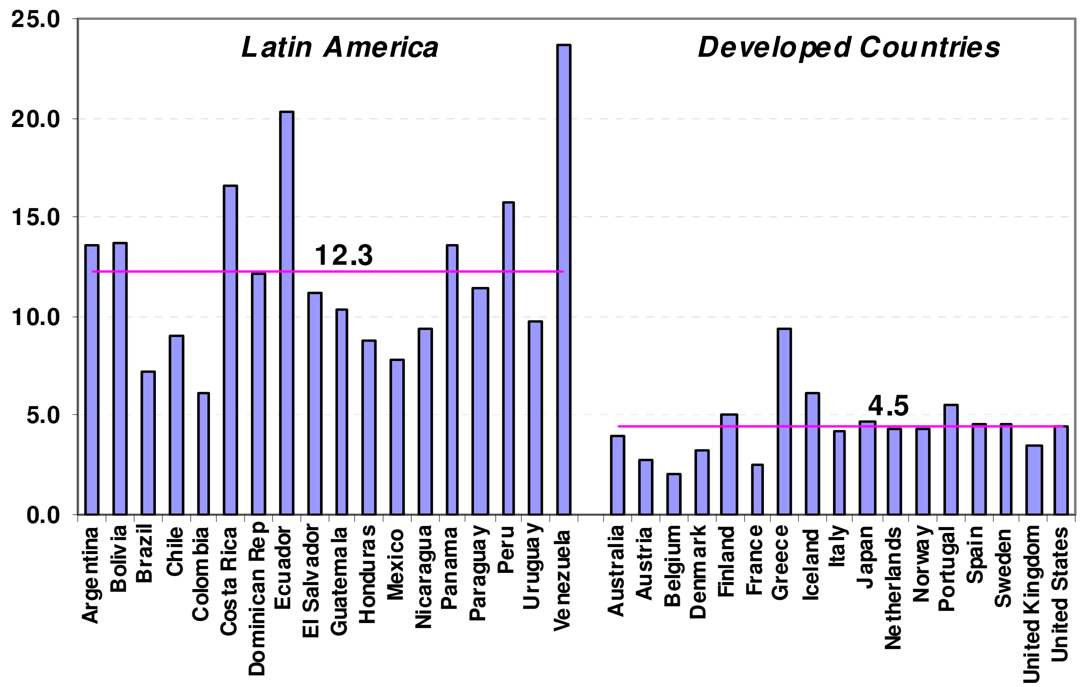
Of course, the quality and effectiveness of monetary policy in Latin American countries has recently improved in the context of more flexible exchange rate regimes. However, from the historical perspective the study of monetary policy's cyclicality in Latin America is not as useful as in the developed countries. In fact, most developed countries have made use of its monetary policies during the last decades, but they have benefitted from some relative advantages: more flexible exchange rate regimes, independent Central Banks, more stable money demand (no high-inflation history) and a deeper financial system. Indeed, Kaminsky, Reinhart and Végh (2004) show that monetary policies have tended to be procyclical in Middle-and-Low-Income countries and countercyclical in OECD countries since 1960[27].

[26] For a current discussion of the liquidity-trap see Krugman (1999 and 2008).

[27] However, they assume imperfect substitution between assets to overlook the shortcomings in identifying the proper instrument under fixed or predetermined exchange rates regimes and also they do not consider the financial depth.

On the other hand, the negative effects of real fluctuation on fiscal revenues is another factor that justifies the study of the fiscal policy. As was mentioned in the second section, Latin America has recorded a persistent high GDP and Consumer volatility which has had a direct impact on the regional fiscal tax-revenues[28]. In effect, the average volatility of Latin American fiscal tax-revenue (inflation-adjusted) is almost three times higher than the developed countries' tax-revenue fluctuation (see Figure.7).

Figure.7
VOLATILITY OF TAX-REVENUE 1980-2006 [a]
(Standard deviation of the inflation-adjusted growth rates)



Source: Author's calculations on the basis of ECLAC and OECD databases
a. Without Social Security. Country groups are calculated by simple averages.

As was suggested in section.2, in addition to the highly volatile government revenues, Latin American fiscal policy has been particularly procyclical after 1980. Thus, the volatility of real outcomes is amplified by the highly procyclical fiscal response. Next, this cyclical behaviour is characterized in Latin American economies vis a vis the developed countries' performance.

[28] Gavin el al (1996) review stylized facts about the volatility of the Latin American fiscal structure using OECD as a comparative reference.

4.1. Fiscal Policy Cyclicality: Latin America vs. Developed Countries

First, we need to identify the appropriate variables which better defines a particular fiscal policy, i.e. revenues, expenditures, primary balance. Several authors have analyzed the procyclicality of fiscal variables in Latin America. Gavin and Perotti (1997) select the fiscal balance to GDP as a key indicator that better explains the fiscal policy in a certain country. They found that this ratio has been procyclical for thirteen Latin American countries since 1968 (the fiscal balance to GDP decreases with economic expansion), while it has been countercyclical for OECD countries (it increases in good times). In line with this finding, Catao and Sutton (2002) also point out that the same indicator has shown a procyclical behaviour for eleven Latin American countries between 1970 and 2001. Moreover, a recent study conducted by Alesina and Tabellini (2005) confirms the former results.

Alternatively, Kaminsky, el al (2004) study the procyclicality of the government expenditure as a better indicator of fiscal policy. They simply estimate the correlation between the cyclical component of both the GDP and the government expenditures (filtered by the Hodrick-Prescott filter), and find that for non-OECD countries the general government expenditure increases when the cyclical GDP rises[29]. Bello and Jimenez (2009) analyze a sample of nine Latin American economies showing that the different components of the final government expenditure have been non-countercycal, i.e. they are either procyclical or acyclical.

In light of this empirical evidence, we measure and compare the cyclical behaviour of fiscal policy in Latin American and developed countries for two different periods: 1960-1979 and 1980-2006. The analysis is at country level instead of the common regional approach because the aggregation technique might hide country features. Consequently, the cyclicality behaviour of the fiscal policy is defined looking at the cyclical component of both the real government consumption (from the expenditure side) and the tax-rate (from the income side)[30]. Given the multiplicity of taxes and the lack of information for a complete

[29] Similar result is reached by Talvi and Végh (2005) with a sample of 56 countries (20 Latin American countries and 36 emerging economies).

[30] As is suggested by Kaminsky et al (2004), the fiscal balance is a result-variable that does not appropriately define a particular fiscal policy, it is just an outcome.

tax-rates series, "inflation-tax" is used, defined as $\pi/(1+\pi)$ being π the inflation rate , as a proxy of a country's average tax rate. Although there is not a consensus on taking inflation as another tax (see Woodford, 1990), a broad literature (from Phelps, 1973 on) interprets the inflation as an "optimal tax", in particular to calculate the cyclicality of the general tax-rates (see Kiminsky et al, 2004 and Talvi and Végh, 2005)[31].

Henceforth, by comparing the cyclical components of the selected fiscal variables with GDP both filtered by the Hodrick-Prescott filter (with λ=6.25), the cyclical behavior of government expenditure and tax-rates is defined according to the following criterion:

i. Countercyclical (CC): when real government expenditure is <u>negatively</u> correlated with GDP or the inflation-tax (as proxy for a tax-rates) is <u>positively</u> correlated. In other words, lower (higher) government expenditure and higher (lower) tax rates when GDP is over (below) its trend.
ii. Procyclical (PC): when real government expenditure is <u>positively</u> correlated with GDP or inflation-tax is <u>negatively</u> correlated.
iii. Acyclical (AC): when the correlation coefficient is not statistically significant at 10%.

Table.8 summarizes for each country the correlation between the cyclical components of GDP and cyclical components of both real government expenditure and inflation-tax. As can be seen, government expenditure was mainly acyclical in most of the Latin American economies (12 out of 17 countries) during the period 1960-1979, but it turned to procyclical after 1980 in most of the region (14 out of 17 countries). This means that government expenditure increases during expansion and fall in recessions in the post-1980 period. Only Chile, El Salvador and the Dominican Republic register an acyclical government expenditure policy. On the contrary, government expenditure in developed economies has been acyclical in 10 out of 16 countries and countercyclical in two (United Kingdom and France), only Australia, Portugal and Spain show procyclical government expenditures since 1980. In general, fiscal expenditure policy in developed countries has been acyclical or countercyclical in the last decades while it has been mainly procyclical in Latin America.

[31] The basic idea behind Phelps (1973) finding is that increasing fiscal revenue through money creation has no cost. So starting from a zero interest rate (the Friedman optimum), it is welfare improving replace any other distorting tax by increasing the inflation one (for further discussion see Woodford 1990, Chari and Kehoe, 1999 and Calvo and Végh, 1999).

Nevertheless, our results also reveal that government expenditure's procyclicality in Latin America has spread to most of the region since 1980.

Table.8
CYCLICAL ANALYSYS OF THE FISCAL POLICY: 1960-2006 [a]

LATIN AMERICA AND THE CARIBBEAN

	1960-1979		1980-2006	
	Real Government Expenditure	Inflation tax	Real Government Expenditure	Inflation tax
Argentina	0.35	-0.39 * PC	0.86 * PC	-0.59 * PC
	(0.135)	(0.092)	(0.000)	(0.001)
Bolivia	-0.14	-0.41 * PC	0.54 * PC	-0.16
	(0.548)	(0.076)	(0.004)	(0.432)
Brazil	0.49 * PC	-0.06	0.51 * PC	-0.17
	(0.028)	(0.795)	(0.006)	(0.409)
Chile	0.70 * PC	-0.39 * PC	0.26	-0.21
	(0.001)	(0.089)	(0.197)	(0.286)
Colombia	0.25	-0.11	0.50 * PC	0.38 * CC
	(0.285)	(0.655)	(0.008)	(0.054)
Costa Rica	0.31	-0.14	0.64 * PC	-0.62 * PC
	(0.183)	(0.569)	(0.000)	(0.000)
Ecuador	-0.20	0.29	0.38 * PC	-0.36 * PC
	(0.409)	(0.207)	(0.052)	(0.067)
El Salvador	0.49 * PC	0.02	0.22	0.20
	(0.028)	(0.944)	(0.271)	(0.316)
Guatemala	-0.20	0.14	0.61 * PC	-0.13
	(0.409)	(0.552)	(0.001)	(0.525)
Honduras	-0.40 * CC	-0.33	0.43 * PC	-0.19
	(0.077)	(0.159)	(0.024)	(0.352)
Mexico	0.48 * PC	0.06	0.67 * PC	-0.61 * PC
	(0.034)	(0.810)	(0.000)	(0.001)
Nicaragua	0.21	-0.72 * PC	0.53 * PC	0.39 * CC
	(0.382)	(0.000)	(0.005)	(0.047)
Panama	0.32	0.23	0.55 * PC	0.19
	(0.165)	(0.323)	(0.003)	(0.345)
Peru	0.00	-0.28	0.79 * PC	-0.51 * PC
	(0.991)	(0.230)	(0.000)	(0.006)
Dominican Rep.	0.19	0.62 * CC	0.12	-0.50 * PC
	(0.431)	(0.004)	(0.547)	(0.008)
Uruguay	0.38	-0.53 * PC	0.85 * PC	-0.46 * PC
	(0.102)	(0.015)	(0.000)	(0.016)
Venezuela	0.09	-0.02	0.71 * PC	-0.56 * PC
	(0.693)	(0.928)	(0.000)	(0.002)

DEVELOPED COUNTRIES

	1960-1979		1980-2006	
	Real Government Expenditure	Inflation tax	Real Government Expenditure	Inflation tax
Australia	-0.50 * CC	0.07	0.36 * PC	0.42 * CC
	(0.024)	(0.775)	(0.061)	(0.029)
Austria	0.06	0.07	0.25	0.09
	(0.806)	(0.783)	(0.215)	(0.638)
Belgium	0.11	0.19	0.01	0.20
	(0.648)	(0.419)	(0.942)	(0.310)
Denmark	0.47 * PC	-0.24	-0.03	-0.19
	(0.035)	(0.305)	(0.867)	(0.352)
Finland	-0.20	-0.10	0.36 * PC	0.66 * CC
	(0.391)	(0.675)	(0.068)	(0.000)
France	0.12	0.16	-0.36 * CC	0.37 * CC
	(0.611)	(0.504)	(0.068)	(0.060)
Greece	-0.44 * CC	-0.18	0.08	0.34 * CC
	(0.053)	(0.446)	(0.676)	(0.088)
Iceland	0.39 * PC	-0.34	0.28	-0.12
	(0.092)	(0.143)	(0.161)	(0.545)
Italy	-0.11	0.34	-0.04	0.57 * CC
	(0.638)	(0.138)	(0.830)	(0.002)
Netherlands	0.14	0.12	-0.08	0.29
	(0.552)	(0.620)	(0.702)	(0.141)
Norway	0.47 * PC	-0.41 * PC	-0.05	0.07
	(0.039)	(0.073)	(0.808)	(0.742)
Portugal	-0.05	0.05	0.73 * PC	-0.06
	(0.843)	(0.847)	(0.000)	(0.760)
Spain	0.44 * PC	0.06	0.50 * PC	0.18
	(0.050)	(0.787)	(0.008)	(0.362)
Sweden	0.35	0.09	-0.19	0.28
	(0.132)	(0.718)	(0.345)	(0.155)
United Kingdom	-0.13	-0.49 * PC	-0.36 * CC	0.30
	(0.584)	(0.028)	(0.069)	(0.129)
United States	-0.05	-0.04	-0.09	0.44 * CC
	(0.824)	(0.863)	(0.646)	(0.023)
Japan	0.17	-0.22	-0.04	0.58 * CC
	(0.476)	(0.351)	(0.829)	(0.002)

Source: Author's calculations on the basis of ECLAC and WDI databases
a. PC: Procyclical and CC: Countercyclical.
* Statistically significant at 10% level. P- Values in parentheses.

As expected, the inflation tax-rate has been procyclical in countries with a history of high-inflation like Argentina, Peru and Uruguay, but Costa Rica, Ecuador, Mexico, Dominican Rep. and Venezuela as well after 1980. Overall, inflation tax rates have been procyclical (it increases in recessions and falls during expansions) in almost half of Latin American countries in the post-1980 period while it was mainly acyclical in the pre-1980 period. In contrast, the inflation tax-rate in developed economies has been either acyclical (10 countries) or countercyclical (7 countries including the US and Japan) in the post-1980 period and was mainly acyclical before 1980

Therefore, empirical evidence suggests that most Latin American countries applied procyclical fiscal policies in the post-1980 period (with the only exception of Chile and El Salvador) while most developed economies have applied acyclical or coutercyclical fiscal policies.

5. SOME CONCLUSIONS

In this paper the real macroeconomic fluctuation was analyzed from a comparative perspective in both Latin America and most industrialized economies. This problem was characterized not only by empirical facts but also by estimating the welfare losses associated with real volatility. Next, the main findings of this study are summarized:

i. Latin America is the region that accounts for the highest volatility in the world. In fact, the real volatility problem in Latin American economies becomes evident not only through the highly volatile per capita GDP and consumption growth rates but also in the amplitude of its business cycle.

ii. The welfare costs associated with macroeconomic fluctuations were calculated by different models. Under the Lucas framework real volatility would not be important in terms of welfare not only in developed countries but also in Latin American economies. However, with the other two specifications analyzed, i.e. allowing for a stochastic trend in consumption (model 2) and incorporating human capital idiosyncratic risk (model 3), the welfare costs in both Latin American and developed economies are on average more than two-orders of magnitude larger than those estimated with the baseline model (see Table.7).

iii. In addition, the cyclical behavior of fiscal policy is explored in Section 4. There is evidence that from 1980 to 2006 the fiscal policy was mainly procyclical in Latin American economies but acyclical or countercyclical in developed economies. Consequently, the dynamic effects of the countercyclical macro policies, their effectiveness in reducing macroeconomic volatility and the associated welfare cost, might be a fruitful area for further research.

REFERENCES

[1] Acemoglu, D.; Johnson, S. and Robinson, J. (2004), "Institutions as the fundamental cause of long-run growth". NBER Working Paper, No. 10481.

[2] Alesina, A and Tabellini, G. (2005), "Why is fiscal policy often procyclical?". NBER Working paper 11600. Cambridge, MA.

[3] Auerbach, A. and D. Feenberg (2000), "The Significance of Federal Taxes as Automatic Stabilizers". Journal of Economic Perspectives, 14, p. 37-56.

[4] Barlevy, G. (2004), "The cost of business cycles under endogenous growth". American Economic Review, September.

[5] Bello, O. and Jiménez, J.P. (2009), "Política Fiscal y ciclo en América Latina". Serie Macroeconomía del Desarrollo. CEPAL. Naciones Unidas. Forthcoming

[6] Calvo, G.; Izquierdo, A. and Mejía, L. (2003), "On the Empirics of Sudden Stops". Processed, Inter-American Development Bank, Washington, DC, May

[7] Calvo, G. and Végh,C. (1999), "Inflation Stabilization and BOP Crises in Developing Countries".In John Taylor and Michael Woodford, eds., Handbook of Macroeconomics (Volume C; North Holland), pp. 1531-1614.

[8] Campbell, J. and Cochrane, J.(1999), "By force of habit: A consumption-based explanation of aggregate stock-market behaviour". Journal of Political Economy 107, 205–251

[9] Catao, L. and Sutton, B. (2002), "Sovereign defaults: the role of volatility". IMF Working Papers N° 149.Washington, DC.

[10] Carroll, C., Samwick, A. (1997),"The Nature of Precautionary Saving". Journal of Monetary Economics 40, 41–72.

[11] Chari, V. and Kehoe, P. (1999), "Optimal Fiscal and Monetary Policy," NBER Working Papers No. 6891.

[12] Cooley, T. and Prescott, E. (1995), "Economic growth and business cycles". In: Cooley, T. (Ed.), Frontiers in Business Cycle Research. Princeton Univ. Press, Princeton, NJ.

[13] De Long, B. and Summers, L. (1988), "How does macroeconomic policy affect output?". Brookings Papers on Economic Activity, Vol. 2, pp. 433–480.

[14] Dolmas, J. (1998), "Risk preferences and the welfare cost of business cycles". Review of Economic Dynamics, July, Vol. 1, No. 3, pp. 646–676.

[15] Easterly, W.; Islam, R. and Stiglitz, J. (2000), "Shaken and stirred: Explaining growth volatility", Annual World Bank Conference on Development Economics.

[16] ECLAC (2008), "Economic Survey of Latin America and the Caribbean , 2007-2008". Naciones Unidas. Santiago, Chile.

[17] Epstein, L. and Zin,S. (1991), "Substitution, risk aversion, and the temporal behavior of consumption and asset returns: An empirical analysis". Journal of Political Economy, April, Vol. 99, No. 2, pp. 263–286.

[18] Fanelli, J.M. (2008), "Macroeconomic Volatility, Institutions and Financial Architectures". The Developing World Experience, New York, Palgrave Macmillan.

[19] Ffrench-Davis, R. and Ocampo, J.A. (2001), "The globalization of financial volatility: Challenges for Emerging Economies", en R. Ffrench-Davis (ed.) Financial Crises in 'Successful' emerging economies, Brookings Institution, Washington, DC

[20] ____________ (ed.) (2005), Seeking Growth under Financial Volatility, Palgrave Macmillan, London

[21] Gavin, M. and Perotti, R. (1997), "Fiscal policy in Latin America". In NBER Macroeconomics Annual pp 11-66. Cambridge, MA.

[22] Hall, R.(1978), "Stochastic Implications of the Life Cycle-Permanent Income Hypothesis: Theory and Evidence" The Journal of Political Economy, Vol. 86, No. 6 (Dec.), pp. 971-987

[23] Hnatkovska, V., and Loayza, N. (2005), "Volatility and Growth." In J. Aizenmann and B. Pinto, eds.,Managing Economic Volatility and Crises. Cambridge, United Kingdom: Cambridge UniversityPress.

[24] Ilzetzki, E.; Reinhart, C. and Rogoff, K. (2008), "Exchange Rate Arrangements Entering the 21st Century: Which Anchor Will Hold?". Mimeo. Dataset available at: http://terpconnect.umd.edu/~creinhar/Papers.html

[25] Imrohoroglu, A. (1989), "Cost of business cycles with indivisibilities and liquidity constraints".Journal of Political Economy, December, Vol. 97, No. 6, pp. 1364–1383.

[26] Jiménez, J.P. and Tromben, V. (2006), "Política fiscal y bonanza: impacto del aumento de los precios de los productos no renovables en América Latina y el Caribe". Revista de la CEPAL Nº:90, 61-86.

[27] Jones, L. and Manuelli, R. (1990), "A convex model of equilibrium growth: Theory and policy implications". Journal of Political Economy 98, 1008–1038.

[28] Jones, L.; Manuelli, R. and Stacchetti, E. (1999), "Technology and policy shocks in models of endogenous growth". NBER Working paper No. 7063.

[29] Judd, K. (1998). Numerical methods in economics. Cambridge, MA: The MIT Press, 1998.

[30] Kaminsky, G. (2005), "International Capital Flows, Financial Stability and Growth". DESA Working Paper, No. 10.

[31] Kaminsky, G.; Reinhart, C. and Végh, C. (2004), "When it Rains, it Pours: Procyclical Capital Flows and Macro Policies". In Mark Gertler and Kenneth S. Rogoff (eds). NBER Macroeconomics Annual 2004. National Bureau of Economic Research, Cambridge, MA: 11-53.

[32] Koren, M. and Tenreyro, S. (2007), "Volatility And Development". The Quarterly Journal of Economics, February 2007, Vol. 122, No. 1: 243-287

[33] Kraay, A., and Ventura, J. (2007) "Comparative Advantage and the Cross-Section of Business Cycles". Journal of the European Economic Association 5(6).

[34] Krebs, T. (2003a), "Growth and welfare effects of business cycles in economies with idiosyncratic human capital risk". Review of Economic Dynamics, October, Vol. 6, No. 4, pp. 846–868.

[35] _________ (2003b), "Human capital risk and economic growth". The Quarterly Journal of Economics (118), May.

[36] _________ (2006), "Recursive Equilibrium in endogenous growth model with incomplete markets". Economic Theory (29) pp.505-523. Research Article

[37] Krugman, P (1998), "Japan's Trap". http://web.mit.edu/krugman/www/japtrap.html

[38] Krugman, P. (2008), "Optimal Fiscal Policy in a Liquidity Trap". http://www.princeton.edu/~pkrugman/optimalg.pdf

[39] Lucas, R. Jr. (1987), Models of Business Cycles. New York: Basil Blackwell.

[40] ________ (2003), "Macroeconomic priorities".American Economic Review, March, Vol. 93, No. 1, pp. 1–14.

[41] Meghir, C. and Pistaferri, L. (2001), "Income variance dynamics and heterogeneity". Working paper. Stanford University.

[42] Mehra, R and Prescott, E. (1985), "The Equity Premium: A Puzzle".Journal of Monetary Economics, Vol. 15 pp 145-161

[43] Obstfeld, M. (1994), "Evaluating risky consumption paths: The role of intertemporal substitutability". European Economic Review, August, Vol. 38, No. 7, pp. 1471–1486.

[44] Phelps, E.S. (1973), "Inflation in the theory of public finance". Swedish Journal of Economics 75:6'7 82.

[45] Reis, R. (2006), "The Time-series Properties of Aggregate Consumption: Implications for the Costs of Fluctuations" Princeton University, Department of Economics, Princeton, New Jersey.

[46] Rodrik, D. (1998), "Why do More Open Economies Have Bigger Government". Journal of Political Economy 106 (5)

[47] Schneider, F. (2002), “Size and measurement of the informal economy in 110 countries around the world”. Paper presented in the Workshop of Australian National Tax Centre, ANU, Canberra, Australia.

[48] Storesletten, K.; Telmer, C. and Yaron, A. (2001a), “The welfare cost of business cycles revisited: Finite lives and cyclical variation in idiosyncratic risk” European Economic Review, June, Vol. 45, No. 7, pp. 1311–1339.

[49] __________ (2001b), “Asset pricing with idiosyncratic risk and overlapping generations”. Working paper. Carnegie-Mellon University

[50] Tallarini, T. (2000), “Risk sensitive real business cycles” Journal of Monetary Economics, June, Vol. 45, No. 3, pp. 507–532

[51] Talvi, E. and Vegh, C. (2005), “Tax base variability and procyclical fiscal policy in developing countries”. Journal of Development Economics. Vol. 78, pp. 156-190

[52] Van den Noord, P. (2000), “The Size and Role of Automatic Fiscal Stabilizers in the 1990s and Beyond” OECD Working Paper # 230.

[53] Williamson, J. (1989), “What Washington Means by Policy Reform”. In Williamson, John (ed.): Latin American Readjustment: How Much has Happened, Washington: Institute for International Economics.

[54] Wolf, H. (2005), “Volatility: definitions and consequences”. Managing Volatility and Crises. A Practitioner Guide, J. Aizenman and B. Pinto (eds.), Cambridge, Cambridge University Press.

[55] Woodford, M. (1990), "The optimum quantity of money", in: B.E Frie&nan and EH. Hahn, eds., Handbook of Monetary Economics (North-Holland, Amsterdam) 1067-1152.