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The Cost of Volatile Investment in an Emerging Economy

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Abstract

I measure the welfare gains from eliminating fluctuations in investment in an emerging economy such as Argentina. The estimated welfare effects are an order of magnitude higher than those for the US and arise with moderate degrees of diminishing returns to investment.

I thank Reda Cherif for stimulating discussions. The views expressed herein are those of the author and should not be attributed to the International Monetary Fund, its Executive Board, or its management. All errors are my own.

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1. Introduction

This note calculates the welfare costs associated with volatile investment flows in an emerging economy. Compared to a developed economy, these costs could be higher in an emerging economy for at least two reasons. First, emerging economies face larger swings in real quantities such as consumption and output compared to developed countries.[1] A smoother investment path implying less volatilile consumption could bring about relatively bigger welfare gains. Second, emerging economies import most of their capital goods.[2] The dependence on foreign investment goods for building the domestic capital stock could be a significant source of macroeconomic uncertainty. In addition, many emerging economies face significant currency fluctuations over time, with non-negligible implications for the relative price of investment goods. In fact, this note suggests that there could be sizable gains from reducing the volatility in the flow of imported investment goods.[3]

To examine the cost of the volatility in investment, I use the framework proposed in Barlevy (2004). The key insight is that under endogenous growth and diminishing returns to investment the growth rate of the economy is a concave function of the level of investment. Smoothing out fluctuations in investment can then lead to substantial welfare gains by reallocating investment from periods of high investment to periods of low investment. Using US consumption growth data, Barlevy (2004) finds welfare effects that are substantially higher than the estimates obtained by Lucas (1987). However, an important caveat to these results is that welfare gains decrease significantly in calibrations with a lower degree of diminishing returns to investment.

I calculated the welfare costs of volatile investment for Argentina, a widely studied emerging market. Argentina has the additional advantage that the required data on consumption and labor are readily available. As it turns out, estimated welfare effects are an order of magnitude higher than those associated with stabilizing the investment share in the US and remain sizable even with moderate degrees of diminishing returns to investment.

Section 2. lays out the model. Section 3. describes the data and contains the welfare calculations. Section 4. concludes.

[1] Neumeyer and Perri (2005) document the relatively higher volatility of output and consumption in emerging economies.

[2] See Eaton and Kortum (2001) and De Bock (2010).

[3] Cole and Obstfeld (1991) argue that the gains from international risk sharing are likely to be small as fluctuations in the international terms of trade offset national output risks in simple general-equilibrium models with output uncertainty. Based on a Lucas (1987) style calculation, Pallage and Robe (2003) find that the welfare costs from eliminating volatility could average a multiple of the corresponding US estimate in emerging economies.

2. Endogenous growth with diminishing returns

This section summarizes the endogenous growth model with diminishing returns proposed in Barlevy (2004). The consumer's utility function is given by:

$$U(\{C_t\}) = \Sigma_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma} - 1}{1-\sigma}, \tag{1}$$

where $\beta < 1$ and σ is the coefficient of relative risk aversion. The consumption stream has a trend and cycle component:

$$C_t = \lambda_t (1 + \varepsilon_t) C_0, \tag{2}$$

where the parameter λ_t is the growth component, and ε_t is an independently and identically distributed (i.i.d.) random variable. Production is linear in capital :

$$Y_t = A_t K_t,$$

and A_t follows a Markov process. This stochastic AK specification is widely used in the growth literature. In the model the level of investment I is endogenously determined and a fraction δ of the capital stock K depreciates each period. The production function of a new unit of capital is:

$$\Phi(M^K, K_{t+1}) = \phi\left(\frac{M_t^K}{K_t}\right) K_t.$$

Concavity of $\phi(\cdot)$ implies diminishing returns to investment. A widely used functional form for this function is:

$$\phi\left(\frac{M^K}{K}\right) = \left(\frac{M^K}{K}\right)^{\psi},$$

where ψ governs the degree of diminishing returns. Lower values for ψ correspond to larger degrees of diminishing returns. The assumptions on function $\phi(\cdot)$ imply that the marginal return to investment is higher when there is less investment as each additional unit of investment contributes less to the stock. In that case, agents achieve more growth from the same resources if they could reallocate investment from periods of high to periods of low investment.

The evolution of the stock of the capital stock is given by:

$$K_{t+1} = \left[1 + \phi\left(\frac{M_t^K}{K_t}\right) - \delta\right] K_t. \tag{3}$$

Repeated substitution of (3) leads to:

$$K_{t+1} = \left[\prod_{s=o}^{t} \left(1 + \phi\left(\frac{M_s^K}{K_s}\right) - \delta\right)\right] K_0. \tag{4}$$

It is helpful to define $c_t = C_t/Y_t$ as the fraction of output the agent consumes and $m_t = M_t^K/Y_t = 1 - c_t$ as the fraction set aside for investment :

$$C_t = c_t A_t K_t.$$

Using equation (3), consumption can be rewritten in a form reminiscent of section III in Lucas (1987):

$$\begin{aligned} C_t &= c_t A_t \left[\prod\nolimits_{s=o}^{t-1} \left(1 + \phi\left(\frac{M_s^K}{K_s}\right) - \delta\right)\right] K_0 \\ &= c_t A_t \left[\prod\nolimits_{s=o}^{t-1} (1 + \phi(m_s A_s) - \delta)\right] K_0 \\ &= (1 + \frac{c_t A_t}{c_0 A_0} - 1) \left[\Pi_{s=0}^{t-1} \lambda_s\right] C_0 \\ &= (1 + \varepsilon_t) \left[\Pi_{s=0}^{t-1} \lambda_s\right] C_0, \end{aligned} \tag{5}$$

where m_s is the investment share of output M_s^K/Y_s and the growth rate of consumption is defined as $\lambda_s = 1 + \phi(m_s A_s) - \delta$.

3. An empirical illustration for Argentina

The upper panel of Figure 1 displays the ratios of total imports and exports of machinery and transport equipment to GDP for Argentina in the period 1965-2000.[4] The output share of imports moves around quite a bit; from a low of about one percent in 1974 or 1990 to a peak of five percent in 1998. These swings are consistent with the evidence on private investment presented in Dornbusch and de Pablo (1989). In fact Dornbusch and de Pablo (1989) show that overall private investment as a percentage of GDP experienced even more extraordinary gyrations from 1970 to 1986, from a low of about two percent to a high of fifteen percent. The export share of capital goods, on the other hand, is small and has been stable over this period. The lower panel of Figure 1 shows the cyclical behavior of capital good imports, investment as measured by Gross Fixed Capital Formation (GFCF), and GDP and illustrates the procyclicality and relatively high volatility of imported capital goods compared to national accounts variables.

3.1. Consumption growth gains

This subsection examines what happens when (i) the volatility of the investment share m is eliminated around its average $m*$ such that $m^* = E(m_t A_t)/A^*$ and (ii) the

[4] National accounts data are from IFS. The trade data is from the UN-NBER collected by Feenstra et al. (2005). In the SITC Rev. 2, these measures of traded capital goods correspond to category 7, machinery and transport equipment. This includes: power-generating machinery and equipment (71), machinery specialized for particular industries (72), metalworking machinery (73), general industrial machinery and equipment (74), office machines and automatic data processing (75), telecommunications (76), eletrical machinery, apparatus and appliance (77). Eaton and Kortum (2001) use input-output tables to show that these variables approximate trade in capital equipment.

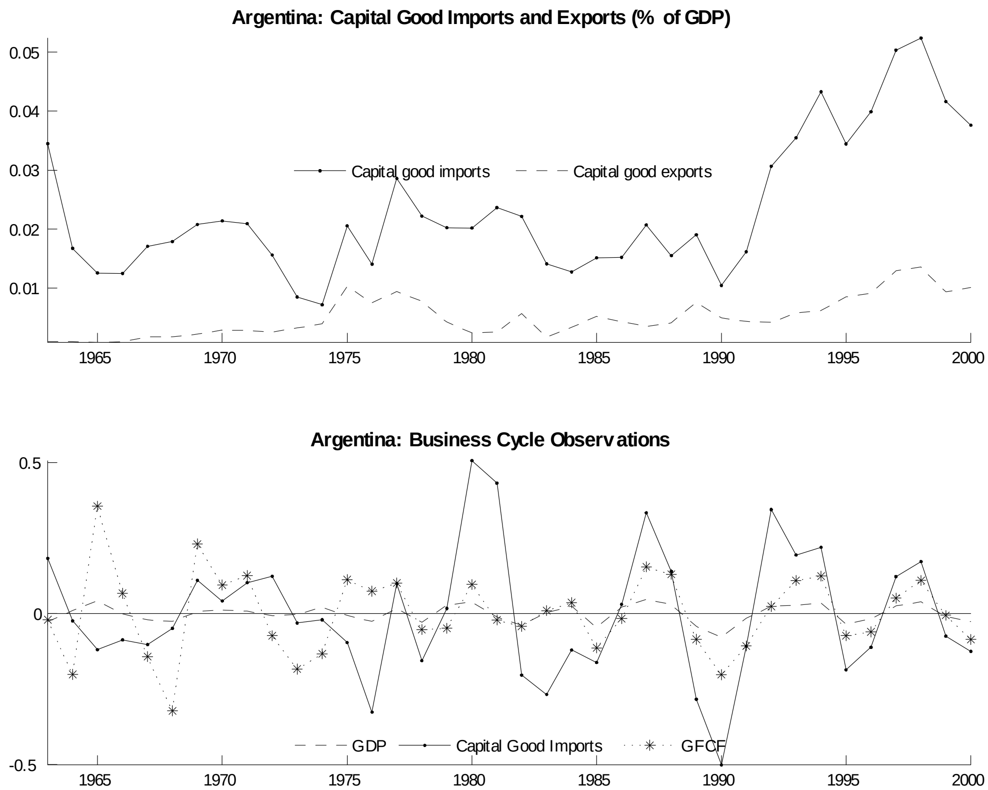

Figure 1: Trade and Business Cycle Data for Argentina, 1965-2000. Note:The business cycle component is extracted using the HP filter with a smoothing parameter of 6.25 suggested in Ravn and Uhlig (2002).

consumption path starts at the same level. As $\Phi(\cdot)$ is concave eliminating volatility in investment leads to more rapid growth even if the average amount of investment remains unchanged. This follows from an application of Jensen's inequality:

$$\begin{aligned} 1+\Phi(m^*A^*)-\delta &= 1+\Phi(E\left[m_tA_t\right])-\delta \\ &> 1+E(\Phi\left[m_tA_t\right])-\delta. \end{aligned} \tag{6}$$

Eliminating volatility in investment will lead to more rapid growth, even if the average amount of resources remains unchanged. If the agent chooses $m* \neq E(m_tA_t)/A^*$, the long-run growth rate changes further. The direction of change depends on whether the agent desires higher or lower investment in the absence of shocks.

The effect on the growth rate of consumption is examined under the assumption that A_t follows a two-state Markov process. With the distribution of trend per capita consumption growth, $\lambda_t = 1+\Phi(i_tA_t)-\delta$, in hand, it is possible to compute m_iA_i from:

$$m_iA_i = \left(\lambda_i - 1 + \delta\right)^{1/\psi}. \tag{7}$$

To estimate the Markov model, I assume the following process for consumption growth:

$$\Delta \ln(C_t) = \ln \lambda_t + \phi\Delta \ln(C_{t-1}) + \eta_t, \tag{8}$$

where η_t is measurement error. To recover the distribution of trend consumption growth, equation (8) is estimated by maximum likelihood in a two-regime Markov switching process using annual real per capita consumption growth from Argentina for the period 1965-2000. Over this time span average annual growth is about 0.48 percent. Table I reports the estimates for the two trend consumption growth parameters. The estimates indicate stark differences between the two regimes. Argentina has a growth rate of 7.13 percent per year in the high regime, and a negative growth rate of -2.43 percent in the low regime.

Table I: Maximum Likelihood Estimates for Consumption Growth Argentina.

	Coefficient	Standard Errors	
$ln(\lambda_0)$	-0.0243	0.0194	
ϕ_0	-0.4199	0.1560	
$ln(\lambda_1)$	0.0713	0.0333	
ϕ_1	0.2017	0.2885	
		Implied Invariant Distribution	$\sigma^2 = 0.06$
p_{00}	0.373	p_0= 0.64	$R^2 = 0.67$
p_{11}	0.647	p_1= 0.36	$\bar{R}^2 = 0.64$

Note: Data used is real Argentine consumption per capita 1965-2000. The markov chain is estimated using the EM algorithm described in chapter 22 of Hamilton (1994)

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The gains in consumption growth after stabilization is given as a function of ψ by:

$$\begin{aligned}\Delta^{GAIN}(\psi) &= 1-\delta+[p_0\cdot m_0A_0+(1-p_0)\cdot m_1A_1]^{\psi}-E(\lambda) \qquad (9)\\ &= 1-0.1+\left[p_0\cdot(\lambda_0-1+\delta)^{1/\psi}+(1-p_0)\cdot(\lambda_1-1+\delta)^{1/\psi}\right]^{\psi}-E(\lambda),\end{aligned}$$

where depreciation δ is fixed at 0.10. The gains in consumption growth implied by equation 9 can then be calculated for different values for the capital adjustment cost parameter ψ (Table II). Note that the average consumption growth before stabilization, $E(\lambda)$, is subtracted and there are no gains when $\psi = 1$ (the case of no diminishing returns). The parameter value $\psi = 0.12$ is the estimate implied by Abel (1980), $\psi = 0.24$ is from Christiano and Fisher (1998), and $\psi = 0.26$ corresponds to the average estimate of 11 OECD countries from Eberly (1997). For comparison, I present estimates for the stabilizing the US investment share calculated using the two-regime Markov process for consumption growth estimated in Barlevy (2004).

Table II: Gains in Consumption Growth after Stabilization.

Elasticity ψ	Source	Argentina	US
0.12	Abel (1980)	4.15	0.74
0.24	Christiano and Fisher (1998)	2.58	0.40
0.26	OECD average from Eberly (1997)	2.38	0.36
0.37	Private investment and UN-NBER trade flows data	1.53	0.22
0.71	UN-NBER trade flows data	0.40	0.00
0.95	GFCF from IFS National Accounts	0.05	0.00
1		0.00	0.00

Note: Figures are the percent per year gains in consumption growth after stabilization. For the US the table present consumption gains following investment stabilization as calculated in equation 12 of Barlevy (2004).

Table II shows large differences between the US and Argentina. For Abel's estimate of 0.12, stabilizing investment at its average value raises the growth rate by 0.74 percent in the US but by 4.15 percent in Argentina. Lucas (1987) calculates that that if $\sigma = 1$ the agent is willing to sacrifice 20 percent of consumption each year to increase the growth rate of consumption by 1 percentage point. Using this rule, the Argentine consumer would be willing to sacrifice a whopping 80 percent of annual consumption when $\psi = 0.12$. This is an order of magnitude larger than what Barlevy (2004) found for the US. Interestingly, estimates for higher values of ψ imply large growth effects for Argentina when there are only modest growth increases for the US. When $\psi = 0.24$ and $\psi = 0.26$, the increase in consumption growth for Argentina is still sizable, at 2.58 and 2.38 percent per year respectively.

3.2. Backing out the degree of diminishing returns from growth data

The previous subsection found substantial welfare gains for the range of estimates for the investment elasticity reported in the literature. Unfortunately a lot of uncertainty surrounds the estimates for this parameter. Barlevy (2004) also points out that estimates of sharply diminishing returns make it hard to reconcile the model with aggregate investment data. To address these issues I calculate the welfare gains in calibrations with a value for ψ consistent with other growth data, starting with the ratio A_1/A_0. This ratio corresponds to the ratio of aggregate productivities for the two regimes. Using a key result of Romer (1986), a variant of the AK function with labor and capital and increasing returns *external* to the firm, A_t can be rewritten as:

$$Y_t = A_t K_t = Z_t N_t^{\alpha} \cdot K_t. \tag{10}$$

Setting the regime values for N as $N_1 = (1+x)\overline{N}$ and $N_0 = (1-\frac{p_1}{p_0}x)\overline{N}$, the standard deviation σ_N of N is $x\overline{N}\sqrt{\frac{p_1}{p_0}}$. The regime ratio N_1/N_0 is then:

$$\frac{N_1}{N_0} = \frac{(1+x)}{(1-\frac{p_1}{p_0}x)} = \frac{1+\sigma_N\sqrt{\frac{p_0}{p_1}}}{1-\sigma_N\sqrt{\frac{p_1}{p_0}}}.$$

The standard deviation σ_N of logged annual civilian employment in Argentina is 7 percent.[5] I assume a similar standard deviation for Z_t. From equation (10), A_1/A_0 is given by:

$$\frac{A_1}{A_0} = \frac{Z_1 N_1^{\alpha}}{Z_0 N_0^{\alpha}} = \left(\frac{1+0.07\sqrt{\frac{0.64}{0.36}}}{1-0.07\sqrt{\frac{0.36}{0.64}}}\right)^{1+\alpha} = 1.15^{1.36} = 1.21. \tag{11}$$

3.2.1 Peak to trough investment ratio

Returning to equation (7), the investment-to-capital ratio in the regime with high consumption growth over the investment-to-capital ratio in the regime with low consumption growth is:

$$\frac{m_1}{m_0} \cdot \frac{A_1}{A_0} = \left(\frac{\lambda_1 - 1 + \delta}{\lambda_0 - 1 + \delta}\right)^{1/\psi}. \tag{12}$$

At its peak to trough $\frac{m_1}{m_0}$ is 7.28.[6] This is in line with the peak to trough ratio of 7.5 for the ratio of private investment in Dornbusch and de Pablo (1989). Combining a value of 7.28, the estimates for consumption growth and the ratio of productivities from equation (11), I calculate the value for ψ implied by equation (12):

$$\begin{aligned} 7.28 \cdot 1.21 &= \left(\frac{1.0713 - 1 + 0.1}{0.9760 - 1 + 0.1}\right)^{1/\psi} \\ &\Rightarrow \psi = 0.37. \end{aligned}$$

[5] The standard deviation is calculated from the number of employed people working at least 35h per week (semestrial data also used in Neumeyer and Perri (2005) and available from Encuesta Permanente de Hogares, Table A3.2, Informe Economico) for the period 1980-2001.

[6] m_1 is 5.24 percent and m_0 is 0.72 percent.

A value of 0.37 for ψ is higher than estimates found in the literature, and corresponds to a lower degree of diminishing returns. Table II shows there is a growth gain of 1.53 percent when $\psi = 0.37$. This suggests sizable welfare costs even for degrees of diminishing returns lower than generally estimated in the literature. The table also reproduces welfare gains where the ratio of gross fixed capital formation over GDP is used to calculate $\psi = 0.95$.[7]

3.2.2 Volatility of Imported-Capital-to-GDP ratio

I also calculate $\frac{m_1}{m_0}$ from the volatility of Imported-Capital-to-GDP ratio, $\sigma_m = 0.49$. I convert this as above into $\frac{m_1}{m_0} = \frac{1+0.49\sqrt{\frac{0.64}{0.36}}}{1-0.49\sqrt{\frac{0.36}{0.64}}} = 2.61$. In that case equation (12) implies:

$$\begin{aligned} 2.61 \cdot 1.21 &= \left(\frac{1.0713 - 1 + 0.1}{0.9760 - 1 + 0.1}\right)^{1/\psi} \qquad (13) \\ &\Rightarrow \psi = 0.70. \end{aligned}$$

Table II shows that for $\psi = 0.70$ stabilizing investment raises the growth rate of consumption by 40 basis points in the case of Argentina. This is still a sizable number compared to Lucas (1987). For this parametrization the increase in consumption growth for the US is close to zero.

4. Conclusion

This note shows that a similar calculation can lead to welfare gains that differ by an order of magnitude depending on the characteristics of the economy. Business cycles affect the rate of economic growth more negatively in an emerging economy such as Argentina compared to an advanced economy such as the US. The implied welfare costs are orders of magnitude higher than what Lucas (1987) calculated in his monograph and stem from relatively higher volatility in both consumption and investment. Looking forward, one extension could apply this type of calculation to microdata.

The policy implications of these results are less clear. It remains an open question to what extent stabilization policy can mitigate the costs of volatility. The calculations do suggest that the dependence on foreign capital goods and the effect of currency moves is a spillover channel worth exploring in business cycles models for emerging economies.

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[7]The maximum value for GFCF/GDP is 27 percent, the minimum 14 percent.

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