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TOLERABLE RECESSIONS AND LONG TERM GROWTH

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Tolerable recessions and long term growth

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Abstract:

This article sets out from the coexistence of two kinds of growth, a determinist one to the steady state and a random one, which, systematically, let some economies escape from that steady state. The last is related with the innovation business processes, which are only possible in presence of both inventions in portfolio and a economic recession with certain characteristics. It show empirical evidence about the innovation process and growth deceleration, and its relationship with the cycle volatility in twenty developed countries as well as in a worldwide sample. The main conclusions point out the existence of two kinds of cycles: one have positive effect upon economic growth and the other not. The economic policy must try to reduce the influence of the last one but not the influence of those whose presence is essential in order to keep an enough economic growth rate in the long term.

Keywords:

Economic growth, economic cycle, long term, Total factor productivity;

Introduction

Economic growth lets the individual promotion because the new economic spaces offer both new opportunities as social mobility. It is also necessary for the operation of democracy system. Most of public expenses have steady character and economic growth does increase the public income and lets manoeuvre capacity to the alternative politic too. It is essential for to reduce unemployment[1] and to keep a factors payment level higher than the replacement one. An economy without growth become a framework with strict social classes without possibility to get itself organised in a real democracy, with high rates of unemployment and subsistence wages. Growth is not an option to improve the standard of living but rather a necessity to keep it. Without growth, economic structures get stiff, damaging progressively the quality of life of individuals.

In spite of its importance and the worry that it has aroused between economists of all generations, the last causes of long term growth are not revealed to us as something obvious. The reasons of the differences in the standard of living between regions seem to depend on a little amount in historical growth rates; However they cause an unfair and unbearable difference which is probably cause of most important humanity problems.

Nowadays, it seems to exist a certain consensus between economists about identifying technological innovation processes as the makers of the long term growth

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[1] Caused by the replacement of labour with capital or by the growth in population. This is an interpretation in the opposite direction of the Okun law, formulated in 1962 which said that a descent in the output of a 3 per cent causes an increase in unemployment of 1 per cent.

process and the technological backwardness as the main cause of differences in growth rates. Literature shows numerous causes of technological backwardness: for example rights of property not well defined (Sala i Martin, 2002, 171), political instability, lack of business people, financial markets developed incorrectly, lack or excess of foreign investment, etc. (Blanchard, 200,245). All these works are showing a wide range of reasons that suggest that a elemental model would be mistaken, but they also suggest the lack of an explanatory reference model.

This article worries in two matters that, according to some authors (Delong, 2002, 150) are still a mystery on the whole: What have been the reasons of the deceleration of technological progress in the developed countries during the last twenty years? What are the causes of technological backwardness between developed countries and those who are developing now? For them, we expect to open a new line of debate and investigation proposing that the cycle, when is negative, bearable and general, is the main cause of innovation processes.

The literature about innovation, growth and cycles is wide. In a seminal work Schumpeter (1942) collects many of the main problems of those relationships and Solow (1957) suggests a measure of the technological growth rate opening a debate that is very far to be closed. . Now we try to go into it.

In summary, this article, in a classic model context, identifies two kinds of growth: a deterministic evolution to the stable state one and stochastic caused by the technological capacity growth another. This last one is gathered by the known as "Sollow's residue" that we suppose exogenous. Without despising the first kind of growth, our objective is to show, in a simple model, evidence about the technological innovation process, which remains as the only guarantee of long-term growth, is based on economic cycle, whenever this one has certain characteristics. The article has been structured in three parts; The first shows a simplified version of the growth model, the second gathers some evidences that support it, and the third concludes.

Model

The influence of cycles in economy is a controversial and recurrent issue. A literature revision[2] shows that economists disagree over the persistence of the fluctuation effects. Under a Real Business Cycles model (Kyndland y Prescott, 1982), it is argued that its effects are only temporary, around a structural growth path, alternatively other authors defend that a depression can have permanent effects in the level of capital or labour which forces to resume a process of lost growth (King, Plosser y Rebelo, 1988), and also due to the asymmetry of the cycles (Rodrik, 1991)[3].

The worrying fact is that it is not ever clear whether the effects of disturbances in growth are positive or negative. Recently, between who have studied the relationship between cycles and growth must be mentioned to Ramey y Ramey (1995), Martín y Rogers (2000) or Fatas (2000) who stand out the negative relationships between volatility (understood as the width of the cycles) and long-term growth. Other authors

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[2] For a more complete literature review, Fatas (2000) makes one we have not been able to improve, so we refer to it.

[3] In the sense that usually negative and positive cycles are not the same in most of countries, little depressions, briefer and deeper, take turns with growth periods, milder and more continuous.

have written in the opposite direction: Hall (1991), Caballero y Hammour (1994), De long (1990), etc. Their arguments establishes that the economic crisis lets that a research-development investment increases their relative profitability compared to ordinary production activity and it also makes the less efficient enterprises succumb, at least in economic Darwinism terms.

Here we show a model that argues that the cycles existence is a direct cause of technological innovation process when they have certain characteristics. The positive principle of this thesis consists on assuming that the inner risk of every innovation is a possibility of failure that damages innovation when the economy is obtaining reasonable profits and on the contrary, the same risk becomes a success probability, favoring the innovation, when the same economy comes into a loss cycle[4].

Economic theory lets everyone identify two kinds of growth. One is due to the better adjustment of markets, the dynamic adaptation between physical capital, human capital and labour etc. Solow-Swan model develops this kind of growth, it lead each economy to its steady state and it is determined by the initial conditions of economy, it is, therefore, a determinist growth. Nevertheless another type of economic growth takes place, what is unpredictable and random, this is somehow caused by the knowledge frontier movement. A double coincidence is necessary for this second kind of growth: Firstly it must be invented or discovered and secondly these innovations and discoveries must be added to the productive system, in other words, innovate. To invent we must do something like to protect the market of patents, to increase the investment in Investigation and development and, in general, to perfect the inventions markets. However, to innovate, one must have a stimulus to add the invention to the productive processes. A stimulus to compensate the effort and risk of change. The more the profit is reduced, the stronger this stimulus is[5].

Now, we suppose that the production function of a simple economy, with the basic restrictions of Solow-Swan model, has the following form:

$$Y_t = F(A_t, K_t, L_t, \varepsilon_t)$$

Where Y,A, K and L are, each one, production, knowledge, physical and human capital and labour potential. The sub-index t shows that it is a dynamic model. ε is a measure of disturbances, a random variable with unknown functional form. We suppose here it distributes itself with an average of 0 and an unknown standard deviation σ. In other words $\varepsilon \sim G(0,\sigma)$. The disturbances must perform three necessary conditions for leads a positive effect in economic growth: i) negative, ii) enough and tolerable, iii) general. Negatives mean that in the negative part of disturbance stimulus to innovation is stronger. The condition of enough and bearable means that the variability of disturbances must be in an suitable range; If it is too small, the stimulus will be small, if it is too big any effort to get over it will be unsuccessful. So, not all disturbances caused innovation, just if they are in certain interval. Formally, we can write $\varepsilon_t \in [(\omega - \dot{k}); -\dot{k}]$. Finally, cycles must be general because if disturbance only affects a sector or an

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[4] Each technological-economic innovation entails a probability of success and failure. In a growing economy, innovation can interrupt growth and damage investment. In a crisis economy, the same innovation can interrupt the crisis and help investment.

[5] Logically, reduction of profit can be caused by the recession. We don't fathom here the possible origins of cycle because it doesn't belong to the objectives of this article.

individual, while the other sectors or individuals obtain profits, it is possible that incentives to relocation are higher than incentives to innovation.
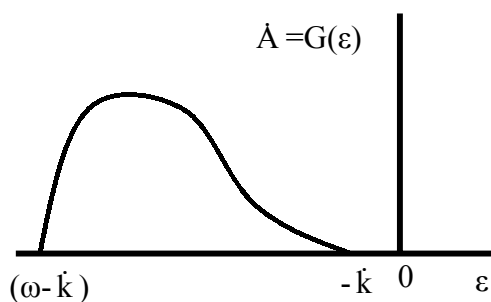
In this context, we suppose A can not decrease, is not constant and it distributes according to disturbances in the way:

$$A_t = A_{t-1} + \dot{A}_t$$

where,

$$\dot{A}_t = \begin{cases} 0 & \text{si } \varepsilon \geq -\dot{k} \\ G(\varepsilon) & \text{si } (\omega - \dot{k}) \leq \varepsilon < -\dot{k} \\ 0 & \text{si } \varepsilon \geq (\omega - \dot{k}) \end{cases}$$

In other words, technological knowledge depends on disturbance. If disturbance is negative but tolerable, A will increase in according to it. Graphically, an innovation function could be:

This functional form for A entails that most of knowledge just becomes into innovation when disturbances are negative and get a bearable intensity. In this environment, the essential equation of the simple model in absence of disturbances and in terms per capita is:
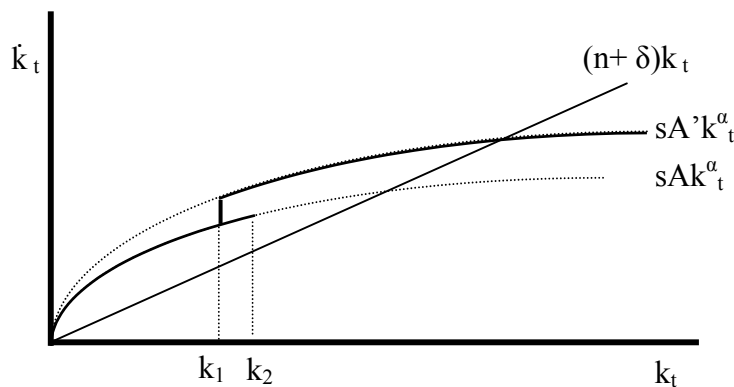
$$\dot{k}_t = sA\, f(k_{t-1}\,;\,\varepsilon_{t-1}) - (n + \delta)k_{t-1}$$

If ε is a tolerable disturbance, individuals will introduce innovations in productive processes and the new situation will be:

$$\dot{k}_{t+1} = sA'\, f(k_t\,;\,\varepsilon_t) - (n + \delta)k_t$$

where A'>A

Graphically,

$\dot{k}_t$

$(n+\delta)k_t$

$sA'k^{\alpha}_t$

sAk^{α}_t

k_1 k_2

k_t

The country's growth path was determined by $sAf(k_t)$. In k_1 individual saving rate is higher than the depreciation rate, so, in the next period the capital by worker should be k_2. If, now, we imagine that a disturbance from out of the model leads the worker stay in k_1, innovation will increase from A to A'. The new growth path will be $sA'f(k_t)$. Normally, going from a growth path to another one will take some time because producers must get adapted to the innovation. Graphically, and in time terms, the evolution could be:

k_t

t_1

t
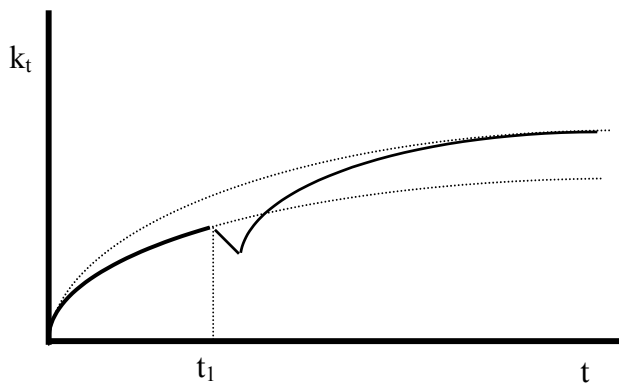
In t_1 a negative disturbance happens and then capital by worker is reduced. Innovation does not give immediate results, its progressive establishment, with the determinist model, stimulate that the capital by worker grow progressively. This process also explains why, although with symmetrical distribution above the growth path, crisis are shorter than times of growth (Romer, 2002, 161).

Empirical evidence

Evidence has been focused in looking for the relationship between economic disturbance and growth. This is a complex task, because two circumstances are added to

the fact that it is difficult to find trustworthy and similar information. These circumstances are: Firstly one must try to distinguish between the determinist and the random growth rate (we use, when possible, total productivity of factors). Secondly, the described process has an important random component, the kind of cause that generate disturbances can make very different results. In this last sense, the following picture shows, in a simple computer simulation, how the same performance model[6] can generate a very different growth path (in the end, economy 1 has almost three times more capital by worker than economy 2).
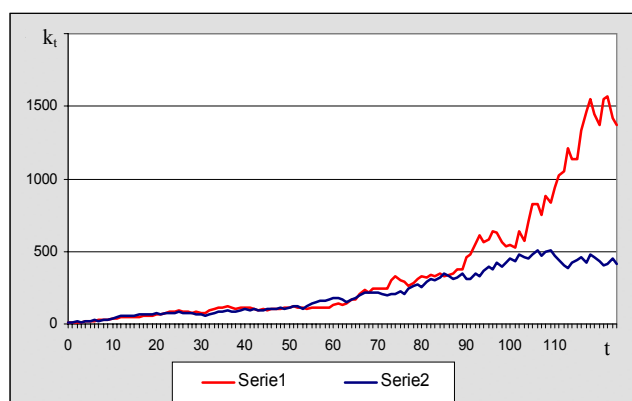
In spite of the difficulties mentioned above, some evidence that support tolerable cycles theory has been obtained. The main results are showed now. Results have been classified in two groups depending on the information base kind. First, results of developed economies are showed; second, results from the rest of the world are added. To looking for evidence the information of following sources has been used:

AMECO data base. (Annual Macro-economic database of the European Commission)[7]. Information from EU-25 and other countries from the OCDE(USA, Japan, Canada, Switzerland, Norway, Iceland, Mexico, Korea, Australia and New Zealand) from 1960 to 2004[8]. The used series have been real per capita GDP in 1995 prices, real GDP by worker in 1995 prices and total factors productivity. (TFP) (1995=100). At your disposition at http://europa.eu.int

 (ONU-Database) National Accounts Main Aggregate database. Data from more than 200 member countries, from 1970 to 2003.We extract Series of real GDP in USA dollars, in 1990 prices. Available at http://unstats.un.org.

First evidence: Production and innovation growth rate are intimately related. Innovation growth rate in developed countries is lower when the economy stabilizes, so, growth is related to innovation rate and this one is also related with a certain level of economic instability.

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[6] In reference to the same rate of saving, capital payment, depreciation, growth in population and even the same driving force behind random disturbances.

[7] Official data base from the general direction of financial and economics matters (ECOFIN) belonging to the EU.

[8] Provisional data of 2005 and forecast for 2006 have been rejected.

Illustration 1: GDP by worker Growth rate and Technological progress rate of twenty developed countries. 1961-2004.
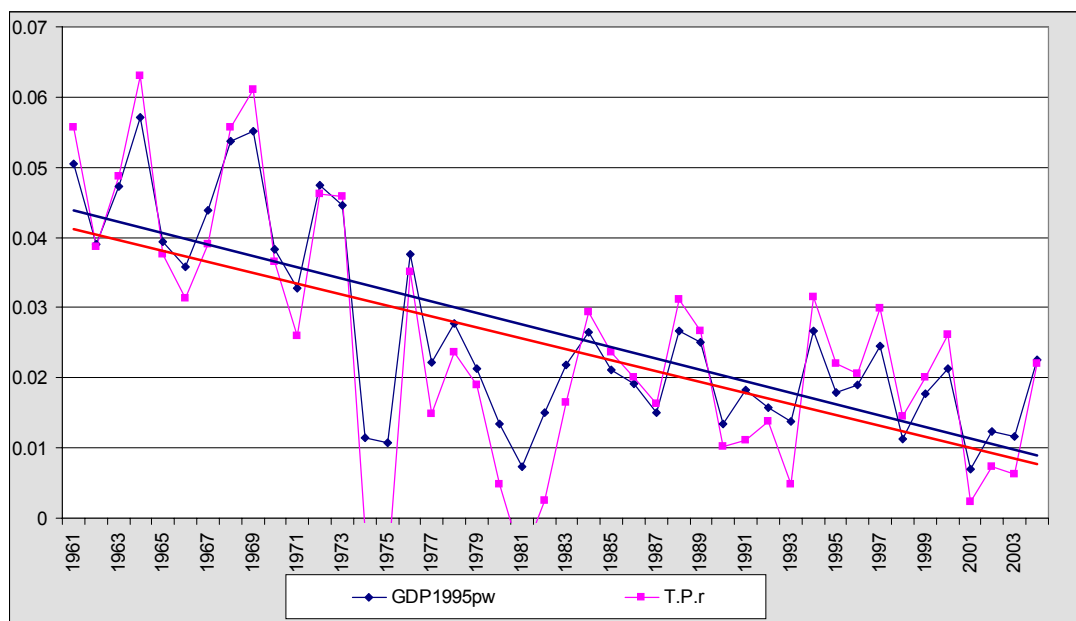
GDP1995pw: Average Real (1995 prices) GDP per worker in twenty developed countries; T.P.r: Average Technological Progress rate (Solow's residue) twenty developed countries. Source: AMECO

The illustration 1 compares the average of twenty countries[9] between the real GDP by worker and the technological progress rate, the last one approximate with Solow residue[10]. A tendency line has been added to both of them. The evolution of these rates lets us to make some observations: i) the growth rate of the richest economies is decreasing. ii) fluctuations are becoming lower, and iii) growth rate is very related to technological innovation.

As has been mentioned, the picture shows the average of twenty countries. With some exceptions, a similar reproduction can be obtained for each country. A reason of progressive descent in volatility are the strong measures of macroeconomic stability used by the governments of developed countries. However, the theory predicts that, when stability is too high, then economic growth must decrease. In other words, in developed countries there should be a positive relationship between the disturbances

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[9] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Holland, Norway, Portugal, Spain, Sweden, UK, USA.

[10] The residue may not be well measured. A reason can be that we supposed real wages are equal than de factor productivity. A proof is that there are moments in which the residue is negative. That would mean a loss of knowledge when the measured thing can be a descent in productivity (for example, slower work) without impact in payment. Anyway, the relationship is strong and be worthy to be studied.

Solow's residue measures economic growth not related to the increasing of primary factors(capital and labour). Ir is also called total productivity growth rate of factors. Let g_y real economy growth, g_l labour growth, g_k capital growth and capital payment (marginal productivity), then,

$$\text{Residue} = g_y - [\alpha g_l + (1-\alpha)g_k]$$

In other words, residue is total growth minus capital and labour growth weighed up with their payment. And the technological progress, g_A rate, is:

$$g_A = \text{residue}/(1-\alpha).$$

average and growth. Then now, we will measure whether the volatility average has something to do with the growth average of the 20 richest economies each year.

Picture 2: Relationship between average growth and average volatility in 20 developed countries. 1970-2004.
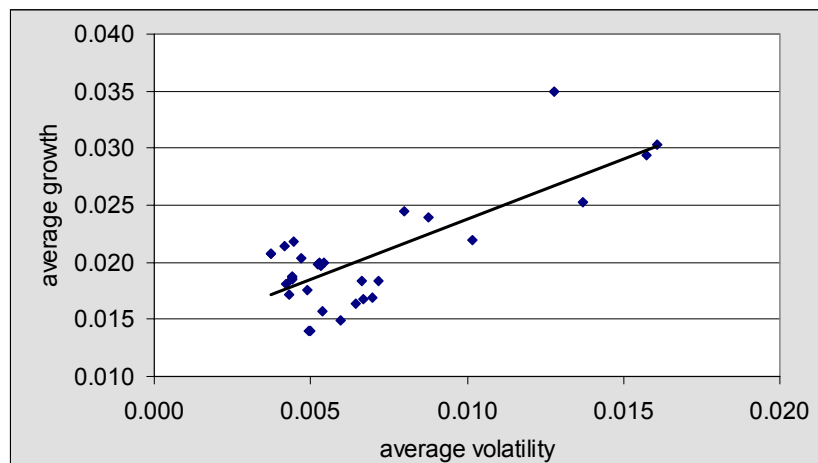
Each point of the picture represents a year. For each year and country volatility and growth rate of GDP by worker have been calculated. The floating form has been calculated during five years. After that, the average of the 20 countries each year has been calculated[11]. The central line is a ordinary least square adjustment. The positive relationship illustrates that the average growth rate during five years is related in a positive way with the average volatility of these same years.

The results of the regression adjustment have been the following:

$$average\_G = \beta o + \beta 1 \, volatility + \varepsilon$$

	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
$\hat{\beta}_1$	1.057	0.16	6.51	0.000	0.72	1.39
$\hat{\beta}_0$	0.013	0.00	10.73	0.000	0.01	0.016
Number of obs	31					
F(1, 29)	42.32					
Prob > F	0					
R-squared	0.5934					
Adj R-squared	0.5794					

These results show a significant positive correlation between the width of economic cycle and average growth. Doing the same analysis individually, instead of average, those countries which show better that correlation are: Spain, Austria, Belgium, France, Greece, Italy, Japan, Holland and Portugal[12].

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[11] For example, a point will represent year 2000. For that point, *x* axis is the average volatility of growth for the period 1998-2002 and *y* axis is the average growth of GDP by worker during the same period. That information to the average of the 20 countries.

[12] A regression model with transverse information (fixed effects) has estimated the following parameters of the model.

average_G$_i$ = β$_o$ + β$_1$ volatility$_i$ + ε

Second evidence: When is taken a sample from all the economies in the world, related to the volatility of oscillations, average growth rate takes the form of a bell. For the economies that suffer from excessive cycles (most of economies) the growth is smaller. The highest growth is obtained by economies with intermediate cycles, while those economies with too short cycles, growth trend is also descending.

Our thesis predicts that in countries with a lower volatility, measured as standard deviation, lower rates of growth will be obtained. Also in those ones with excessive volatility economic growth will be smaller. The result will always be that the relationship between growth average and volatility should have bell form

Illustration 3: Relationship between average growth and volatility. Sample of 108 countries. 1970-2003.
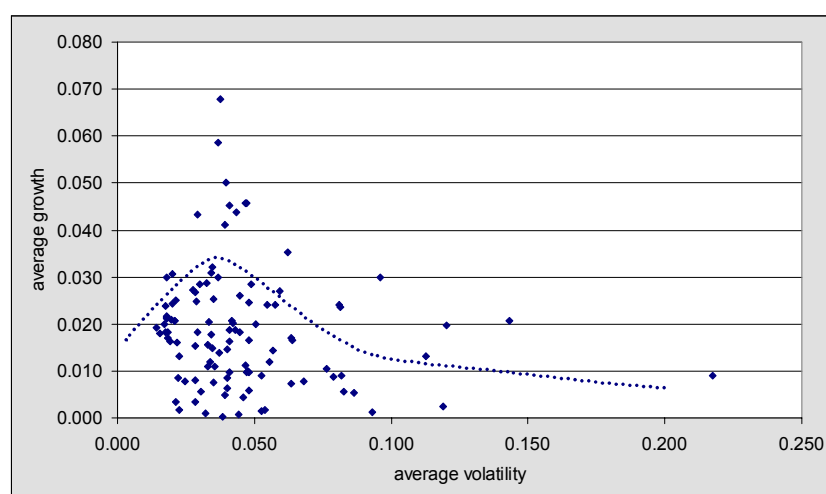
Source: UNO Main Aggregate Database

Illustration 3 shows the results. Each point represents, for each economy, the relationship between average growth and average volatility, from 1970 to 2003. The line draws is an envelopment line[13]. The sample of 108 countries[14] suggest that those with

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Fixed-effects (within) regression
Group variable (i): control
Number of obs =      620
Number of groups =    20
                                    F(1,599)      =     32.00
                                    Prob > F      =    0.0000
---------------------------------------------------------------------------
medium_G|   Coef.    Std. Err.    t    P>|t|   [95% Conf. Interval]
-------------+-------------------------------------------------------------
volatility |  .2976969  .0526219   5.66  0.000   .194351    .4010427
     _cons |  .0161939  .0008099  19.99  0.000   .0146032   .0177845
-------------+------------------------------------------------------- _ ----------
 sigma_u |  .0060087
 sigma_e |  .00899335
      rho |  .30862566   (fraction of variance due to u_i)
---------------------------------------------------------------------------
F test that all u_i=0:    F(19, 599) =   13.79        Prob > F = 0.0000
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[13] Drawn by hand, just to show the direction.

average volatility higher than 4% have lower growth rates, this rate also descends when the average volatility is lower.

It can also be observed that relationship is not simple, not direct. Without doubt, this is the most difficult correlation in the way of finding evidence. There are many countries under the tendency. The argument that we can argue could be that a certain intensity is not enough for the cycles to have a positive effect in growth. The cycles should be also general, they must affect the most of population. Besides we can't forget the influence, in some cases, of institutional conditions or measure problems, etc.

Illustration seems to show there are two kinds of growth, so we'll divide the list into two samples. In the first one we will include the richest 20 economies in 2003, and in the second one the rest of countries. To check structural change between both groups we have made Chow test[15] . The results have been the following:

	SCR	GL
all economies	0.015	92
20 richest	0.000	18
Rest of world	0.013	72
total	0.013	90
test	3.83	
F(inv)	3.10	
p-value	0.025	

The test gives a value of 3.83 against a threshold of 3.10. So we can state, assured at 95%, that there is structural change between the twenty richest countries and the rest of economies. In other words, the two samples show different behaviours. Graphically, it can be observed that, if we dissociate illustration 3, the relationship between volatility

[14] Growth rate per capita of GDP has been obtained from ONU Database. (in USA dollars of 1990). Some areas or countries have been excluded: those with a population under 2.000.000 people in 2003, those extinguished or with less than 20 years (recently created: past URSS, Balkan countries, etc), those with a negative average growth during 70 years, and, finally the Arabian Emirate, Equatorial Guinea and Senegal. The selected countries have been Albania, Algeria, Argentina, Armenia, Australia, Austria, Bangladesh, Belarus, Belgium, Benin, Bhutan, Bolivia, Brazil, Bulgaria, Burkina Faso, Cameroon, Canada, Caribbean, Chad, Chile, China, Colombia, Congo, Costa Rica, Cote d'Ivoire, Croatia, Cuba, Czech Republic, Democratic People's Rep. of Korea, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Eritrea, Ethiopia, Finland, France, Germany, Greece, Guatemala, Guinea, Honduras, Hong Kong SAR of China, Hungary, India, Indonesia, Iran (Islamic Republic of), Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Lao People's Democratic Republic, Latvia, Lebanon, Lithuania, Luxembourg, Malawi, Malaysia, Mali, Mauritania, Melanesia, Mexico, Mongolia, Morocco, Mozambique, Myanmar, Nepal, Netherlands, New Zealand, Nigeria, Norway, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Puerto Rico, Republic of Korea, Romania, Rwanda, Singapore, Slovakia, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Thailand, Tunisia, Turkey, Uganda, United Kingdom, United States, United Republic Of Tanzania, Uruguay, Vietnam, Yemen.

[15] This test allows to contrast hypotheses of structural changes between two samples, and it is defined as:

$$F = \frac{SCR_T - (SCR_1 + SCR_2)}{SCR_1 + SCR_2} \frac{m}{n} \qquad F \sim F_{n,m}$$

SCR is the total of square residues (T) or the total of each sample (1 and 2); m is the total of freedom degrees of the samples regression, n is the difference between the freedom degrees of complete regression and m. The Chow test follows a $F_{n,m}$ and the null hypothesis consists on absence of structural change.

and growth is positive in the more capitalized economies. In the poorest economies this correlation is negative and the behaviour is much more different inside the sample.

Illustration 4: Correlation between volatility and average growth depending on GDP per capita.

20 richest countries (GDP per capita) in 2003				Rest of countries			
Linear OLS estimated model:							
$$average\_g_i = \beta_o + \beta_1\,volatility_i + \varepsilon$$							
where ε are the residues and i represents each observation (country)							
	Coef.	**Std. Err.**	**t**	**P>|t|**	**Coef.**	**Std. Err.**	**t**	**P>|t|**

	Coef.	Std. Err.	t	P>|t|		Coef.	Std. Err.	t	P>|t|
β_1	1.19	0.24	4.89	0.000	β_1	-0.04	0.06	-0.74	0.463
β_o	-0.01	0.00	-0.29	0.772	β_o	0.02	0.00	6.58	0.000
Number of obs	20				Number of obs	74			
F(1, 17)	23.94				F(1, 17)	0.54			
Prob > F	0.0001				Prob > F	0.463			
R-squared	0.5847				R-squared	0.0074			
Adj R-squared	0.5603				Adj R-squared	-0.0062			

In the illustration above, each point represents a country. In x axis we represent average volatility of real GDP per capita during the period 1970-2004 and in y axis the average growth rate of real GDP per capita during the same period. The results allow to observe that the adjustment for the richest 20 economies is positive and has a relatively high determination coefficient, while for the rest of the countries have a low coefficient[16].

Conclusions and investigation agenda

When economic crisis have certain characteristics; general, enough and tolerable, they leads long-term growth. As they loose these characteristics the effect can be the opposite. The implications for positive economy of that statement are wide. In a iusnaturalist context, concretely utilitarianism, allows appreciating how going out of a crisis can be more relevant for long-term growth than the simple hedonist egoism. It can also explain some differences in the distribution of income between geographic areas, in the sense that if the cycles are more tolerable, the inequality should be smaller.

From a normative point of view, the main implications will be two:

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[16] That doesn't entail that no one doubts about the idea that a higher volatility can damage long-term growth.

i) Excessive cycle oscillations must be reduced in development countries (this is not new), and institutions and economic systems that cause general and bearable cyclical oscillations must be established; ii) In developed countries, stabilization policy must be limited to control undesirable disturbances, but must not stop all disturbances.

Tolerable cycles theory implies a full investigation programme that must deepen in many other aspects, like: which systems lets the best bearable cycles, the failure of growth models in communist countries, the role of real and monetary cycles and the role of credit institutions in economic development; the negative effects of monetary illusion phenomenon from inflation because reduces the cycle perception and innovation process in the long-term, etc.

Related to the more technical aspects, to progress for obtaining the form of the function of the relationship between crisis and innovation and improving the adjustment, will also be necessary; also to specify the optimum degree of volatility for each economy; Since random disturbances can be classified as both constants and proportional to economies, in a dynamic context, the influence of each one has important effects determining the steady state, and, which is more interesting, in the evolution from one steady state to another one; etc.

It is deeply intuitive that setbacks can be a great stimulus to effort and to excel ourselves. Also History shows many examples of human capacity to escape from his own steady state moved by dissent and disconformities with adversities that seems evident[17]. However, for no apparent reason, the importance of these processes has been systematically ignored in the theoretical models of economic growth. For the progress and the humanity's well-being, this is a defect that must be soon corrected.

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[17] If 13 million years ago a family of monkeys wouldn't have had to risk the African savannah, now we had been extinguished or would be hanging of a tree. Something more recent and in the developed countries, the convulsions caused by the oil crisis of 1973 leads, between other phenomena, to the introduction of innovations that saved energy or the tertiary economy represented, by example, by the computer development.

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