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**Time Series: Gross Domestic Product vs Exports, a Mexican Cointegration Analysis, 1990-2012**

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The objectives of Mexico's trade policy in recent years has been to deepen the opening of the economy, ensuring market access and create a favorable investment environment, all with the aim of achieving higher economic growth and therefore improve the living standards of society. Currently international trade to Mexico means one of the most important sources of income, as this stands as the tenth largest exporter in the world and first in Latin America. The variables to be studied to analyze the cointegration relationship, which is vital of commerce in Mexico, are the Gross Domestic Product (GDP) and Exports (X).

**Forecasting and Simulations, Macroeconomics, Production, Time Series Models.**

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**Introduction**

This paper documents the main stylized facts of the business cycle in Mexico in the past twenty years, from 1990 until 2012.

The purpose of this paper is to present a quantitative framework to evaluate a dynamic model for the Mexican case. In this sense, the approach of the modern theory of business cycles is to evaluate different assumptions about the sources and propagation mechanisms of economic fluctuations.

Therefore, before developing a simple economic model, the first step is to describe the characteristics of the business cycle, using a systematic method.

As it is known, the Gross Domestic Product or (GDP) is the total monetary value of the current production of goods and services of a country during a period (usually a quarter or a year)<sup>1</sup>.

About Exports, these are goods and services sold abroad economy is exports, to use our research manufacturing exports.

Is the shipment of goods or products of the country itself to another for use or consumption<sup>2</sup>.

The ratio of exports to GDP has increased over time, represent on average 16% of GDP during the period 1980-1998, exports came to represent from 30% to 36% proximity of GDP in the period 1999-2012.

This structural change, where foreign sales account for a larger share of production, higher exports means that tend to encourage further expansion of economic activity, so cyclical components of GDP and exports tend to be positively correlated.

So, the objective is determining through an econometric model using time series by a cointegration technique of Augmented Dickey-Fuller (ADF).

Our variables: GDP and Exports can help to analyze the relationship in short and long term between them for the Mexican case during the period from 1990 to 2012.

Based on the above, the work is divided into five parts. The first shows an introduction of the current situation in México in the period 1990 – 2012. The second part analyzes of behavior between the both variables.

The third part, there is an evaluation of time series in order to determine the commitment of stationarity. The fourth part, shows the consideration of Error Correction Model, and finally in the fifth part, a relationship evaluation with short and long term.

The results, thanks to having used the Error Correction Model, are given at the end of this research.

**Cointegration Variables**

As regards, the calculation of Gross Domestic Product (GDP) can be as cost factors or market prices.

<sup>1</sup> SACHS, Larrain. *Macroeconomía en la economía global*. México, Prentice Hall, 1994, p. 298.

<sup>2</sup> SACHS, Larrain. *Macroeconomía en la economía global*. México, Prentice Hall, 1994, p. 302.

Its relationship is obtained by subtracting the GDP valued at market prices, indirect taxes linked to production and then deducting operating subsidies.

GDP is undoubtedly the most important variable in macroeconomics to estimate the productive capacity of an economy.

There are other variables macro which consider the GDP differs in quantity flow of goods and services produced by nationals of a country, while GDP does not take into account the criterion of nationality.

By sector of economic activity, highlights the dynamism of the secondary sector because manufacturing continued to expand at a rapid pace and the building had a significant rebound.

Among the changes in the last five years highlights the downward adjustment around the growth of the Mexican economy, which rose from 5.15 per cent in 2006 to 3.3 percent by 2012.

The downward adjustment on the growth of the Mexican economy is recognition that the deterioration of the international economic activity, particularly the U.S., had impacted on the Mexican economy.

Which is felt mainly through less momentum of exports from Mexico and the expansion of domestic demand cannot offset the decline in external demand, Estey (1967). On the other hand, the Exports (X) is a variable which represents the total of goods, which amount may be expressed in terms of volume, weight or monetary value leaving the country permanently or temporarily by a motion customs and compliance with the provisions of the Customs Act and Regulations in force. It also includes major reassessment of agricultural and fishery products.



**Graph 1**

Shown in the chart above, the Mexican GDP (at current prices) during the period from 1990 to 2012 has a line up which will allow to observe and contrast with exports variable exports, the relationship existing between them in short and long term.

Information is presented for the economy as a whole and for each of the 20 economic sectors already mentioned in the section on GDP.

In the first half of 2011 gross domestic product (GDP) showed a real annual rate of 3.9%.



**Graph 2**

To rate the exports data are two ways: the destination country and the purchasing country, but for purposes of the Foreign Trade Statistics of Mexico is considered the "country of destination" for recording exports.

In the U.S., the pace of economic activity slowed in early 2011 compared to that observed in the last quarter of last year.

Thus, according to preliminary information, real GDP increased 1.8 percent to an annualized quarterly rate in the first quarter, down from 3.1 per cent the previous quarter.

This was reflected in a reduction in the growth prospects of the analyst consensus for this year.

The consumer spending grew at a slower pace than the previous quarter, due to rising price of gasoline, and secondly, it also suffered the effects of the slow recovery in household net wealth derived from the continuous drop in housing prices.

Current indicators of foreign trade show that merchandise exports remained buoyant, particularly those pertaining to the manufacturing sector.

This development has been widespread across different product categories and is derived from both higher sales to the United States, and the rest of the world.

The chart above shows the evolution that have manufacturing exports (at current prices) during the study period, ranging from 1990 to 2012, there was a line up and it shows that exports have grown steadily, this will allow us in our analysis to observe the impact on the dependent variable (GDP).

### **Statistical evaluation of the time series model**

Variables: Gross Domestic Product (millions of pesos at current prices, in quarters) Exports (thousands of pesos at current prices, in quarters).

- In Graph 1, it is observed that the gross domestic product (GDP) variable has intercept and trend.
- In Graph 2, it is observed that Exports (X) variable has intercept and trend.

The model is via Ordinary Least Squares (OLS) and current prices as natural treatment.

Thus the model to estimate first test was done using the unit root statistic Augmented Dickey-Fuller (ADF) to each variables, in order to see if they are stationary, if not make them stationary and then proceed to cointegrate them by an Error Correction Model (ECM).

Once it is identified the characteristics of the variables (trend and intercept), it is proceed to estimate the better model and perform time series into unit root tests using the Augmented Dickey-Fuller (ADF), finding stationary behavior and cointegrate them whit an Error Correction Model (VEC), i.e. the cointegration vector.

- In Graph 1, it is observed that GDP variable presents intercept and trend, but without stationary behavior.
- In Graph 2, it is observed that X variable presents intercept and trend, but without stationary behavior.

With trend and intercept (ADF) our variable gross domestic product shows the following characteristics:

Unit Root Test			
Augmented Dickey Fuller Test			
ADF Test Statistic	-2.563300	1% Critical Value*	-4.0613
		5% Critical Value	-3.4591
		10% Critical Value	-3.1554

**Table 1**

In the first unit root test shows that our variable has no stationarity, since the value (ADF) is greater than our critical value (ADF) at the 5% level, the test is:

$$\text{ADF Test Statistic } -2.563300 > 5\% \text{ Critical Value } -3.4591$$

Conclusion:  $\Delta \text{GDP} \sim I(1)$   
 $\text{GDP} \sim I(1)$

With intercept and trend in ADF and differenced in t-1, it is observed that GDP variable becomes stationary and it is much higher in significance level as it is presented in the following table:

Unit Root Test			
Augmented Dickey Fuller Test			
ADF Test Statistic	-19.97772	1% Critical Value*	-4.0625
		5% Critical Value	-3.4597
		10% Critical Value	-3.1557

**Table 2**

In the first unit root test shows that the variable presents stationarity, since the value ADF with a difference is less than our critical value at the 5% level, the test is:

$$\text{ADF Test Statistic } -19.97772 < 5\% \text{ Critical Value } -3.4597$$

Conclusion:  $\Delta \text{GDP} \sim I(0)$   
 $\text{GDP} \sim I(1)$

With trend and intercept with ADF in Exports, the variable has the following characteristics:

Unit Root Test			
Augmented Dickey Fuller Test			
ADF Test Statistic	-2.223119	1% Critical Value*	-4.0613
		5% Critical Value	-3.4591
		10% Critical Value	-3.1554

**Table 3**

In the first unit root test shows that the variable is non stationarity, since the value of ADF is greater than our critical value at the 5% level, the test is:

$$\text{ADF Test Statistic } -2.223119 > 5\% \text{ Critical Value } -3.4591$$

Conclusion:  $\Delta X \sim I(1)$        $X \sim I(1)$

With trend and intercept with ADF in a difference of Exports, it becomes stationary (before it was not).

Unit Root Test			
Augmented Dickey Fuller Test			
ADF Test Statistic	-9.592829	1% Critical Value*	-4.0625
		5% Critical Value	-3.4597
		10% Critical Value	-3.1557

**Table 4**

In the first unit root test shows that the Export variable presents stationarity, since the value ADF with a difference is less than our critical value at the 5% level, the test is:

$$\text{ADF Test Statistic } -9.592829 < 5\% \text{ Critical Value } -3.4597$$

Conclusion:  $\Delta X \sim I(0)$        $X \sim I(1)$

**Error Correction Model (ECM)**

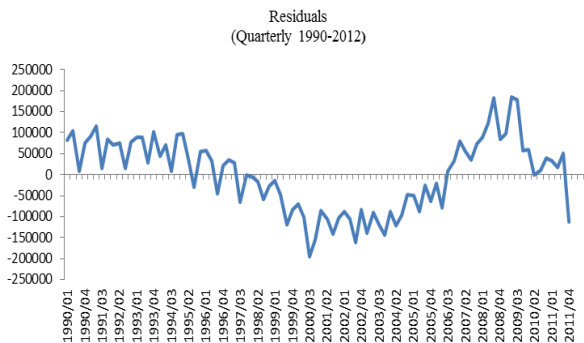
Once it is known that two variables used in the study are stationary, it is proceeded to cointegrate them performing the regression using OLS method obtaining in that way the residuals and apply then the Augmented Dickey-Fuller test to analyze the stationarity behavior, as follows:

Regression of GDP vs. X Method: Least Squares				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.17759	0.105932	105.5162	0
X	<b>0.230859</b>	<b>0.008655</b>	<b>26.67313</b>	<b>0</b>
R-squared	0.887704			
Adjusted R-squared	0.886457			
Durbin-Watson stat	0.593017			

It is observed that the Exports variable is significant to gross domestic product and meets in level (t).

The test of significance registered in 26.67313 (t-Statistic) and R<sup>2</sup> 0.887704 corroborate that GDP is function of Exports.

So, with this regression is obtained the residuals, which are used to validate the stationarity behavior and identify whether obtaining the test ADF by ECM, the function is cointegrable in long term.



**Graph 3**

After obtaining the residuals, it is notable that the graph most has average residual, so, it becomes stationary. Now it is applicable the Augmented Dickey-Fuller test to compare the data from the last as follows:

Unit Root Test Augmented Dickey Fuller Test			
ADF Test Statistic	-4.358157	1% Critical Value*	-4.0613
		5% Critical Value	-3.4591
		10% Critical Value	-3.1554

**Table 5**

ADF Test Statistic -4.348157 < 5% Critical Value Engle- Granger -3.4591

Conclusion:  $\Delta$   
RESREG ~ I (0)                      RESREG ~ I (1)

It is notable that the residuals are stationary because the ADF test is less than the critical value of Engle-Granger.

It means that both variables are cointegrated (GDP and X), so, now is possible to find a cointegrating vector.

**Cointegration Relationship with Short and Long Term**

This mechanism, originally proposed by Engle and Granger (1987), aims to link the short-term performance (STP) of the dependent and independent variables with the long term behavior (LP) thereof:

Behavior in Short Term:

$$\hat{U}_t = \alpha_0 + \alpha_1 PIB_t + \alpha_2 X_t \tag{1}$$

Behavior in Long Term:

$$PIB_t = \alpha_0 + \alpha_1 X_t + \varepsilon_t \tag{2}$$

The simplest mechanism is Error Correction Model:

$$\Delta PIB_t = \alpha_0 + \alpha_1 (PIB_{t-1} + \alpha_2 X_{t-1}) + \alpha_3 \Delta PIB_{t-1} + \alpha_4 \Delta X_{t-1} + \varepsilon_t \quad (3)$$

Since the variables are cointegrated, implies that there is a stable long-term equilibrium between them, however, in the short term there may be disequilibrium<sup>3</sup>.

The error term in  $\hat{U}_t$  cointegration regression is interpreted as the equilibrium error and this, precisely, is used to tie the short-term behavior of the variable  $\Delta LPIB_t$  in its long-term value.

Where:

$\Delta$  denotes the first difference of the variables GDP and X

$\hat{U}_t$  is the error correction mechanism. It is used to correct the imbalance in the short term.

$\alpha_1$  is the ratio which represents the error correction term, i.e. Equation cointegrated and ranked as the residual of the cointegrated vector, Soyatas (2001).

In addition, it also indicates that independent variable have a long-term relationship with the behavior of GDP at current prices.

For more detail about it, validate the following:

**Error Correction Model (ECM)**

Dependent Variable:  $\Delta GDP$   
Method: Vector Error Correction Estimates

Cointegrating Equation:

GDP <sub>t-1</sub>	1
X <sub>t-1</sub>	-2.010298
C	-484860.2

Error Correction:

	$\Delta$ (GDP)	$\Delta$ (X)
CointEq1	-0.137003	-0.070490
$\Delta GDP_{t-1}$	-0.438892	-0.026173
$\Delta X_{t-1}$	0.005571	-0.330461
C	39051.76	26293.35

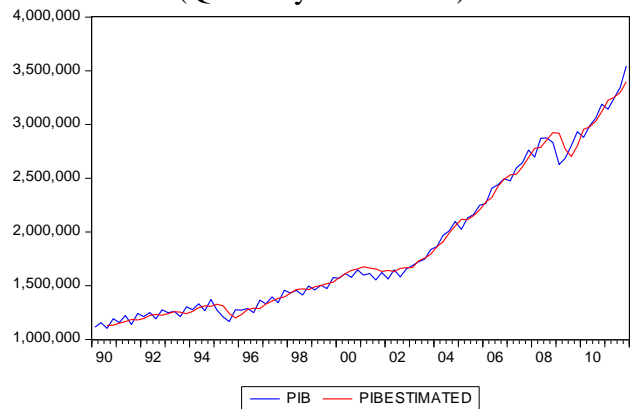
So, its representation in equation is:

$$\Delta(GDP) = -0.137002790115 * (-484860.167209 + GDP_{t-1} - 2.01029820975 * X_{t-1}) + 39051.7614363 - 0.438891861831 * \Delta GDP_{t-1} - 0.00557098872276 * \Delta X_{t-1} \quad (4)$$

In the vector error correction data, the both variables (GDP and Exports) show that in the long run tend to balance as it is observed, so, the model is accepted.

So, the estimation in graph is:

GDP (PIB) vs GDPe(PIBESTIMATED) (Quarterly 1990-2012)



**Graph 3**

The term  $\hat{U}_t = -0.137002790115$ , is the Error Correction Mechanism (ECM).

Note that it has the correct sign (negative), thus acting to reduce the imbalance in the next period t-1, then the MCE acts to restore gradually towards equilibrium variables in period t, or in the future.

In the present research, it is observed that the deviation of GDP from its level of long-run equilibrium, it is corrected by 13.70% (0.137002) quarterly approximately.

<sup>3</sup> SOYTAS, U., SARI, R. and ÖZDEMİR, O., (2001), "Energy consumption and GDP relation in Turkey: a cointegration and

vector error correction analysis". *Economies and Business in Transition*.

In this regression relationship covers short and long term, which helps us to determine that Exports variable used in the model to analyze the GDP behavior in terms of first difference.

As the result of the last regression (4), we obtain the predicted variable and differentiated  $\Delta GDP$ , which is converted in terms of "t" adding the  $GDP_{t-1}$  level.

The comparative estimation of GDP against the observed is shown in Graph 3 below.

### Conclusions

Gross Domestic Product is the thermometer of the situation in which the economy is in a country like Mexico, one of the main components exports are recorded as part of the foreign currency entering the country for sales of them, our analysis shows that exports in most years have grown steadily while contributing to the growth that our economy has been measured as GDP growth.

Also the cointegration testing shows that corroborates the above, our model is consistent in time series, we are one of the major exporting countries in the world.

The tenth in the latest data published by major international organizations such as the International Monetary Fund (IMF) and World Bank (WB), the main buyer is the United States to be our neighbor and be the world's largest economy.

In resume:

- The unit root test (ADF) to our variable GDP meets the test of stationarity significance level of 5% being less than the critical value.

- The unit root test (ADF) to our variable Exports meets the test of stationarity significance level of 5% being less than the critical value.
- Identified stationarity in the two variables cointegrated.
- Having identified our two variables to stationarity, it was proceeded to perform regression Ordinary Least Squares (OLS) for the residuals and see if it meets the unit root test with Augmented Dickey-Fuller technique.
- Was obtained Vector Error Correction (VEC) when it was identified the stationarity of the residuals of our regression where GDP is a function of Exports.
- We obtained values of our long-term (VEC) and see when they have to balance in the long term, there are no exogenous variables.
- Exports are a key part of the determination of gross domestic product and the contribution they have shown growth in Mexico.
- Finally, the model can be improved by econometric treatment.



## Appendix

Data Series of GDP & Exports. INEGI, Mexico 1Q1990 - 2Q2012											
Date	GDP	X <sub>MEX</sub>		GDP	X <sub>MEX</sub>		GDP	X <sub>MEX</sub>			
1990	I	1115169.614	144193.679	1998	I	1431861.73	410655.828	2006	I	9791537068	2668983
II	1156561.622	157368.085	II	1455594.109	432733.927	II	10406339800	3029586			
III	1102849.467	184715.91	III	1412881.987	433513.234	III	10541058677	2929139			
IV	1193416.591	200257.519	IV	1496902.413	468008.283	IV	10777428360	2983763			
1991	I	1157545.393	166819.146	1999	I	1460942.069	435352.683	2007	I	10700044059	2868612
II	1221763.62	193288.145	II	1504374.752	486117.464	II	11215537316	3126853			
III	1140121.717	204550.146	III	1473441.564	513137.832	III	11429853877	3254409			
IV	1241096.451	226077.515	IV	1575240.003	555845.894	IV	11937910254	3396671			
1992	I	1211845.485	216089.961	2000	I	1569113.332	543717.716	2008	I	11657164288	3252917
II	1249936.352	237007.83	II	1614377.336	593761.955	II	12407969034	3507980			
III	1191295.606	238759.778	III	1576816.693	629750.768	III	12421845275	3403312			
IV	1276024.881	253990.215	IV	1648696.936	650907.777	IV	12238045726	3502135			
1993	I	1248725.336	228315.261	2001	I	1597181.78	572222.396	2009	I	11354031147	3107295
II	1260351.974	235932.289	II	1614733.927	597069.5	II	11606266749	3056690			
III	1211579.717	242869.972	III	1553575.56	579301.263	III	12114821524	3284121			
IV	1304126.855	256318.687	IV	1623441.68	600604.315	IV	12673879570	3733954			
1994	I	1277838.033	275995.651	2002	I	1562542.253	550551.509	2010	I	12448647600	3636314
II	1331435.052	293977.777	II	1647338.742	618547.647	II	12907099067	3938007			
III	1267386.307	292773.661	III	1581810.389	611435.911	III	13224351818	4049278			
IV	1372142.329	305446.163	IV	1654975.305	607528.617	IV	13778750526	4229262			
1995	I	1272241.55	237477.972	2003	I	1835027	1835027	2011	I	13578774874	4158744
II	1209052.7	235754.615	II	7441940328	1809484	II	14019046267	4371654			
III	1165580.183	251715.726	III	7550988638	1906228	III	14455959851	4494841			
IV	1275557.485	267532.921	IV	7936719969	2112323	IV	15315502254	5147520			
1996	I	1273078.048	264401.877	2004	I	8053215236	2061739	2012	I	14917268563	4892703
II	1287401.277	289647.621	II	8500389210	2309565	II	15210598000	5319510			
III	1248665.098	316141.226	III	8683441919	2343272						
IV	1366292.008	349412.068	IV	9062246515	2410859						
1997	I	1331526.939	317850.785	2005	I	8752269958	2285045				
II	1395247.461	363829.641	II	9200944169	2544547						
III	1342047.951	390928.742	III	9341421953	2488494						
IV	1457278.334	424402.584	IV	9712313897	2711325						

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## **SLAM maps builder system for domestic mobile robots navigation**

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Mobile domestic robots require information to navigate through an assigned exploration area, this work provides a solution using the pattern recognition of icons distributed in a house to identify rooms and build an array used as a text topological map, allowing to realize explorations in a previously known way displaying the angle, direction and viability.

**Artificial vision, Robotic navigation, SLAM, RGB.**

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**Introduction**

Today diverse disciplines in the robotics field require navigation in environments, to find objects, and get references for decision making as guidebots, nursebots and contests as robo-home, were not enough just to have sensors to avoid obstacles or cameras for pattern recognition, it must have a system capable to create maps simultaneously navigates in a new environment as a house, allowing an automatic recognition of assigned rooms with icons.

**Artificial vision navigation**

Robotic navigation is a research area and a very used technology for artificial intelligence; in cognitive robotics the main goal is build a technique composed with the better vision algorithms or characteristics to get a performance evaluation in data obtaining navigation in a real environment.

The maps are used to represent a zone using a simple form plane or to analyze conditions in a represented area, also depending kind of map it will the number of details, representations to have, and information to contains.

Coordinates are those points inside a map can locate an object in a specific zone of the represented area, the description of the extension from one point to another.

An image is a cell composed of pixels, which are the smallest components of a digital image, each pixel is a space in the computer memory that stores a number which represents the definition of color and brightness of an image area, being able to define a unique single color simultaneously.

On the other hand, the number of pixels defines the information contained in an image.

To represent an RGB image an array of  $M \times N$  dimensions is formed with vector classes elements, where each vector is composed of 3 items which are the RGB channels, whose interval's values are included between 0 and 255 in a closed interval.

Vision systems are those able to capture images used for the machine vision process in a computer system, or visual information acquisition of items in an environment.

The basic parameters in the vision systems development are the view field, resolution, depth, focal length, contrast, modulation transfer function and distortion.

Map builder systems are intended to solve complex problems in navigation creating geographical models using specialized software and hardware to capture storage and manage the obtained data.

A guidance system for navigation builds routes with the initially provided elements as antennas and satellite maps, used as references to build routes and reaching a goal.

Topological navigation is an anthropomimetic technique to plan robot movements, travels, and find goals or objectives without a graphical map using instructions with descriptions, marks and environment conditions as doors, throws and crossroads. The landmarks are descriptions of perceptual interest in some objects as a room for the domestic roboticist, and this could be natural or artificial as the icons or draws.

The maps builder system for domestic mobile robots navigation, group the recognized labels distributed in a house representing a room each one.

One of the most common techniques used in robots navigation is the SLAM (Simultaneous Localization and Mapping), this allows a robot to know its own position and make “simultaneously” a model of the world building a map, calculate distances, routes and travel through an environment.

The system can be used as a tool for the roboticist in task planning, topological navigation, maze solving, SLAM applications, graphs, search, trajectory experiments or any, independently of the architecture and programming language used in the robot. The maps builder system creates a text file in real time and simplifies the programming work to read the text chain and link to conditions in the robot behaviors.

### The maps builder system

The system begins with the image acquisition captured by a camera with a resolution of 640 x 400 pixels; this image is sent to the corresponding module to build a route through the line detection using the Hough transform, obtaining the parameters for the robot navigation.

The same image is processed by the pattern recognition module. Using the previously learned labels, the system will search rooms' images stored, which match with the new acquired ones; the block brings the result of direction and founded labels name and simultaneously getting the movement and location of the label, at the same time build a stack array as map as shown in Figure 1.

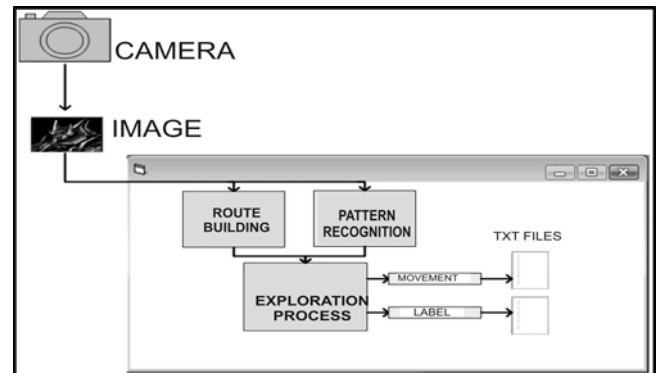


Figure 1

### Concatenation

Simulink have a video input device detection module and allows the use of custom outputs as one channel or three colors.

The data acquisition subsystem detects RGB colors and builds the group of spectra concatenation getting the labels detection as shown in Figure 2.

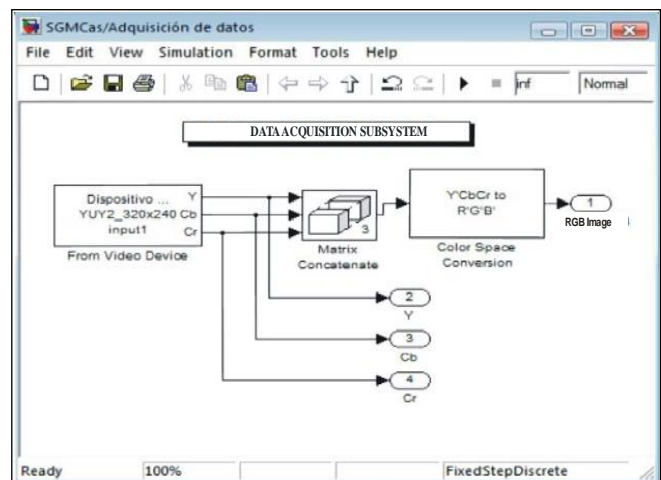


Figure 2

### Tracking

The tracking kernel is obtained through Hough transform; it takes a representation of the parameters and compares it with the geometrical figures acquired through the vision system building a statistical location and sampling points to determine their membership respect to a segment, indicating the existence of a doorway or an entrance to another room.

Using the Hough transform block to find lines in an image, it can map points in the Cartesian image to curves in parameters for the Hough's block, where Theta means the columns and Rho the rows, by the formula:  $Rho = (x \cos(\theta)) + (y \sin(\theta))$  [1].

This subsystem generates a binary image  $M \times N$ , where  $Pd$  and  $\theta d$  are vectors containing discrete values from the parametric space by  $P$ ,  $\theta$ ,  $P \in (0, \frac{(M^2+N^2)}{2})$  and  $\theta \in (0, 180)$ .

The algorithm segments an image and detects which lines forms an entrance as a room. The detection begins with the comparison of frame sequences with different intensity and the pixels location with more intensity to build two segments, the intersection of both, form one angle. The block returns parameters named as "detected line", "drew line", "valid line", "invalid line" and "rotation angle" as shown in Figure 3.

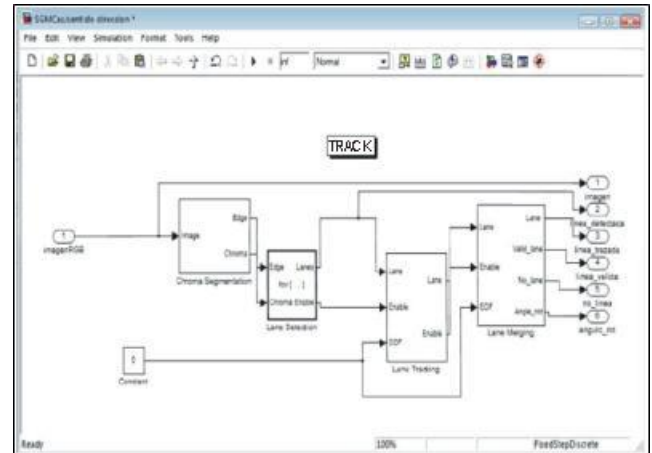


Figure 3

### Movement

Using two intersection lines the movement module uses the tracking subsystem obtained variables to draw arrows and indicate the direction where a room is detected.

"Rotation angle" variable inherited of the tracking subsystem draws the viability arrow and the chain containing the direction-angle.

If the system can't find any line, or finds 3 walls, it sends an error message with an "X" indicating there is no door or viability.

When is found, an arrow with his respective "rotation angle" will be displayed.

This is a combination in real time of the arrow's video module and the angle module, indicating which way the robot must take to travel and find a recognized pattern as a room.

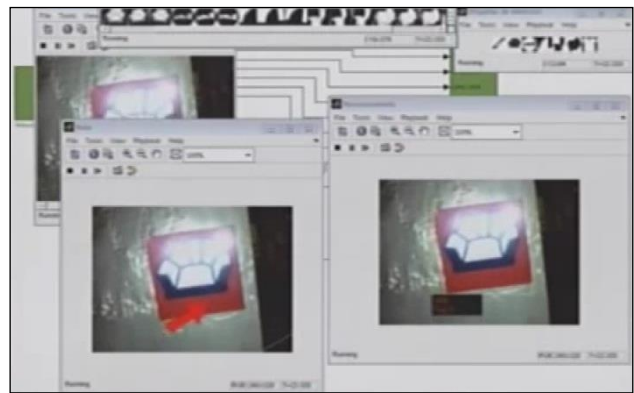
### *Labels detection*

Labels are images as icons and represent semantically a location in the house, using topology and are linked to a chain. The system's user can build or customize his own labels linked to a chain to will read from the text file when the label contains features to be considered as a pattern, and has been stored at least with three instances<sup>[2]</sup> with different angle. These images can be customized with any icon by the user to be used in robot navigation; the images must have a size of  $90 \times 90$  pixels, red background and one black and white icon.

The exercise was made with 7 images labeled "Entrance", "Dinner room", "Kitchen", "Closet", "Bathroom", "Living room" and "Laundry room". Video input is formed by three channels and uses the Cr (Channel red) bringing data of red color intensity. "Labels detection" subsystem uses the modules of "detection" and manages the red color making an interruption with a call to the "icons' analysis" module. The second one to activate is "Draw" and measures the label dimensions. "Recognition" is the next module and compares a pattern "room" formed by the image instances data base named "labels" with different angle if the camera has captured one label, identified it, processed it and recognized it by the comparison of the icons' knowledge base using the previously stored labels library, then the label will be semantically linked to the corresponding chain's name of the room and stored in the map text file.

### *Storing icons as labels*

Labels are patterns that identify a place in map. To create one label's library previously stored to identify rooms in navigation, must be created some artificial landmarks to act as image labels storing the described features; they can be packed in a .mat file and storing the images knowledge data base. Each label must be stored using 3 shots with the degrees:  $0$ ,  $45$  and  $-45$ , increasing the accurate probability considering the mechanical break system and the stability of the attached to the robot camera. The system displays the executed windows when it's running as shown in Figure 4.



**Figure 4**

The knowledge base icons of the .mat file are located at the top frame, below it, is the detection window displaying the intersection between two lines.

The graphic result window is located at the bottom left and displays an arrow with the angle or the "X" symbol if it corresponds. At the bottom right is displayed a window describing with a stack the name of the identified labels.

The created file allows to the robot to travel and to navigate indicating graphically the access viability and writes a text file with the corresponding rotating angle, variables and the associated label with the name of the identified room.

With this information the robot is able to know where it is, the sites where it has been, viability<sup>[3]</sup>, and if some landmarks are stored. The knowledge can be used to program path's commands indicating conditions as the order in which the nodes must be visited and stops in a place using tracking and searching techniques.

If the robot is located in front of a wall, the arrows and text file will indicate the viable exits in real time. If it is located in the middle of the wall, the rotate viability to left or right will be equiprobable<sup>[4]</sup>, and the roboticist is able to program the robot to select a rotate tendency in maze solving problems and searches experiments or choose the most tendency recorded angle in one sampling period<sup>[5]</sup>.

When the system is executed to build the map text file, it creates one .m or script function with .txt format. If a chain is detected the system writes on the text file, forming a stack.

### Exercises with a domestic mobile robot

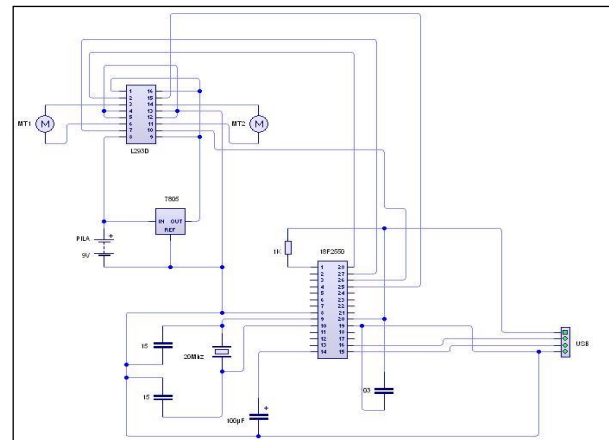
To verify the correct system operation, it was realized a manual navigation experiment with a small computer-controlled mobile robot, built with the USB "Human Interface Device" technology and allowing a real plug and play control system with a 18f2550 PIC microcontroller, a camera and a motor driver.

The robot was placed in a house scale model with labels attached to the doors as landmarks to find its position.

The electronics scheme of the "domestic" robot experiment is shown in figure 5.

Figure 5

The robot was controlled through the rooms in the scale model while the maps builder system recognized each label and creates a text file to be used as a map.

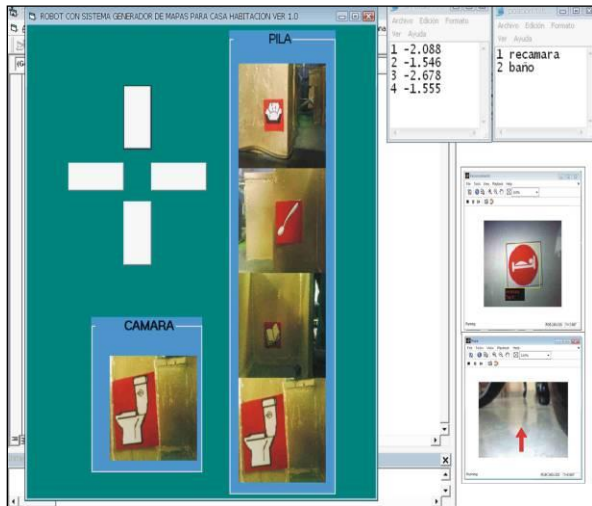


In another experiment it was programmed a .NET control interface to be used with an autonomous robot version allowing to search a room and stops when it is found.

The experiment finds the user must consider developing an anti-bounce camera system before to use the maps builder, because bouncing causes wrong data acquisition when brakes are applied.

After that, it was programmed a depth first search technique graphs navigation experiment using 8 nodes<sup>[6]</sup> with a damping system attached to the robot camera to get slow movements avoiding the bounce and noise problems.

The .NET GUI storing text stacks is shown in Figure 6.



**Figure 6**

Mobile robot system interface shows the camera and the stack array, simultaneously in “posicion.txt” the file stores all the recognized tags writing a text-map of the inside’s house scale model, “movimiento.txt” file contains the angles to get the robot motion, the tags Matlab recognition window shows the recognized labels as valid, and the path window where the red arrow image appears shows the navigation route, based on the obtained angle from the 2 lines intersection located in the Hough transform.

The robot experiment proved the system allows to starts in a dynamic root, travel and arrive to a goal in a graphs map, storing the visited nodes successfully.

Anyway the user must consider the system needs to communicate with some sensors to build a real “model of the world”, using RNA’s techniques to assign a weight to the maps builder system, as the brain do to vision and not exclude the touch sense, getting a whole biomimetics dynamics system if the motor outputs as A PWM signal or some analogical techniques as the DAC.

When the system is executed to build the map text file, it creates one .m or script function with .txt format. If a chain is detected the system writes on the text file, forming a stack.

### Conclusions and future work

Using the navigation acquisition parameters algorithm formed by the subsystems: data segmentation, Hough transform’s line detection and line drawn; it allowed programming the data acquisition area limits.

The SLAM maps builder system gets real time navigation and indicates the location of a robot, learning the appearing order of labels storing in a stack structure and brings the data to deduce how to travel to any place, the corresponding angle and the possible viabilities to find an entrance.

The average time of room’s icons recognition taken is of 3.5 seconds in a constantly illuminated environment using matte paper.

The system has an error rate when the used colors are over of 20%, and the recognition process must be performed when the robot is completely stopped. We suggest the use of buffers in robotics implementations, an anti-bounce system in the camera device or an adaptive fuzzy control system on implementations<sup>[7]</sup>.

Using an algorithm based on a 9 x 9 potential pixels matrix detection to be compared with an icon pattern matrix previous knew; it can be matched by the recognition and labeling subsystem.

The algorithm based on the recognized label’s name write a text file the chain acquisition data allows to program a map builder system of a previously travelled road with any external language capable to read the array.



The system was adapted to a robot prototype and brings the ability to navigate in the open spaces of a house scale model; it was controlled by the programming of a .NET application dedicated to the map text file reading and connected to a 18F2550 PIC microcontroller board using the USB HID technology, allowing to control and explore an area, get a location, searching dynamics, controlling user's GUI, labels identification, angles and direction with the text file's chain in a real time language reading.

This data array may used with A.I. cost searching techniques embedding devices as encoders or ultra sonic sensors to add weight by measurement in a neural network embedding to the algorithm.

Currently the CIUSC and ENSM automatic control research group is building a body for a robot-home competition prototype using the SLAM maps builder system with the A.I. group; they will incorporate the vision and sensors as weights in a neural network model to take navigation decisions in the robot.

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## Sensitivity of seasonality effects on mean and conditional volatility to error distributional assumptions: evidence from French stock market

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This paper examines seasonality effects on both the return and volatility of a GARCH family model for the French CAC-40 daily index returns. Four calendar effects — day-of-the-week, turn-of-the-month, month-of-the-year and holiday effect — are simultaneously examined. We examine the changes in inferences that might occur when the error terms of descriptive models modeling volatility are specified under different error distributions: normal, Student's-t, generalized error distribution and double exponential distribution. The usefulness of the in-sample significant estimated seasonality patterns for out-of-sample forecasts in return and volatility is also examined. We find that the few significant seasonality patterns in descriptive models, in the mean and conditional volatility equations, are sensitive to the underlying distributions of the error term. Additionally, the significant estimated effects are not useful in explanatory models and do not introduce predictive ability against the random walk model.

### Seasonality effects, conditional volatility, error distributions, stock market.

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## Introduction

The existence of seasonality effects has been documented over the last three decades in the financial markets. These studies challenged the assumptions of the dominant theory (Efficient Market hypothesis) and suggested alternative explanations for possible regularities in prices both due to the behaviour of investors and institutional arrangements. However, various empirical studies have reported a decline on seasonality over time. Rationally, as these anomalies are relatively easy to exploit, if they were regular, predictable and had any economic significance after accounting for transactions costs it would be expected that they have weakened over time. Although not contradicting an enlarged efficient market view, the eventual seasonality effects, albeit statistically but not economically significant, could be due, for instance, to the higher transactions costs over the potential gain, the *ex ante* uncertainty on whether seasonality effects will materialize and external arrangements to the market. Yet, also the robustness of these significant effects remains a controversial issue either in the stock, foreign exchange and forward markets. Connolly (1989, 1991), after adjusting t-values for sample size with a Bayesian approach shows that evidence of day-of-the-week effects reported in earlier studies disappears. Chang et al. (1993) report that Connolly's evidence holds for the U.S. and other international markets. Hsieh (1988) notes that evidence of the day-of-the-week effect may be illusory if not properly accounting for the non-normality and volatility clustering observed for spot foreign exchange rate distributions. As such this paper is concerned with the "weak form efficiency", i.e., whether asset prices reflect the past history of prices including seasonality effects.

The focus of the study is on the seasonal patterns in conditional mean and volatility equations subject to various error distributional assumptions.

The robustness of seasonality effects is often called into question because many previous studies have generally ignored the econometric issues and based their analysis mainly on the results of Ordinary Least Squares method (OLS) which do not account for the stylized facts of financial time series (i.e. non-normality and volatility clustering). The distribution of stock returns and hence the error term of regression models is also a key issue in examining the seasonality. If the true error distribution is considerably fatter-tailed than the normal, the distribution assumed in much of the previous papers, the null hypotheses of no seasonality effect is more likely to be rejected than the chosen significance level would indicate. Studies failing to take into account stylized facts of financial time series may report effects that do not exist. Fama (1965) suggest that the variance of returns might be infinite and best modeled by a stable paretian distribution. Blattberg and Gonedes (1974) and Jansen and de Vries (1991) argue that daily stock returns could be adequately modeled by a fat-tailed distribution such as the Student t-distribution. The time-varying volatility and volatility clustering are also stylized facts in daily stock returns. Much of the literature focuses on non-linear models of the GARCH (General Auto-Regressive Conditional Heteroscedasticity) family to explain the volatility (variance) of prices. Baker et al. (2008) report that using GARCH models to test for the day-of-the-week effect on both the mean and volatility are not suitable when it is assumed that the returns follow a normal distribution.

Though evidence exists for the main seasonality effects for the mean returns, only limited evidence exist for similar effects on conditional volatility. Berument and Kiyamaz (2001) test for the day-of-the-week effect on conditional volatility for the S&P 500 index assuming a GARCH specification with a normal distribution for stock returns. They show that volatility varies by the day of the week with the highest volatility observed on Fridays. Likewise, using a similar framework with a normal distribution, Kiyamaz and Berument (2003) test for the day-of-the-week effect on mean, volatility and transaction volume for the major global stock markets indexes and find that the effect is present in both return and volatility equations. Choudhry (2000) provides evidence of the day-of-the-week effect in emerging Asian countries using a GARCH model that assumes the error distribution follows a conditional Student-t density function. Baker et al. (2008) using a GARCH specification report that the day-of-the-week effect in both mean and volatility for the S&P/TSX composite price index from the Toronto Stock Exchange is sensitive to the error distributional assumptions.

The purpose of this paper is to simultaneously examine a range of seasonality effects in both the mean and conditional variance in the CAC-40 stock return index subject to various error distributional assumptions. The study makes a distinction between descriptive and explanatory study. The first part involves a descriptive study in which the interest is in determining the evidence about seasonal patterns in the mean and conditional variance. The second part involves an explanatory study where the intention is to predict future mean and return volatility.

The seasonality patterns could manifest itself in the estimation period but they should be considered important only if its inclusion in the model result in better forecasts. To account for autocorrelation, non-normality and volatility clustering, we use an AR(K)-EGARCH(p,q) model under normal as well as three additional error distributions that are fatter-tailed than the normal to accommodate the stylized facts in financial time series: Student-t, generalized error distribution (GED) and double exponential error distribution (DED). This allows us to test for the robustness of seasonality effects to error distributional assumptions in both the conditional mean and volatility. Our general null hypothesis is that the various seasonality effects are robust to error distributional assumptions in both returns and conditional volatility.

This study contributes to the literature in two ways. First, we consider at the same time various seasonality effects in both the mean and conditional volatility using several error distributional assumptions. Second, we consider the descriptive study separated from the predictive study using a non-overlapping sample for each analysis. If there are seasonality patterns in the mean and/or variance they should be considered important only if its inclusion in the explanatory model result in better forecasts. The framework analysis used in this study is similar to that used by Baker et al. (2008). However, these authors only provide a descriptive study, analyze only one seasonality effect and do not perform an explanatory study on the usefulness of the significant in-sample seasonal patterns for forecasting returns and volatility. The findings show that the few significant seasonality patterns in descriptive models, in the mean and conditional volatility equations, are sensitive to the underlying distributions of the error term.

Also, the significant estimated seasonality effects are not useful for forecasting purposes and do not add predictive ability against the random walk model.

The paper is structured as follows. Section 2 reviews the literature of seasonality effects in mean return and conditional volatility under alternative error distributional assumptions. In Section 3 we provide a description of the data series, we analyse their distributional features and statistical tests for the homogeneity of the means and variances are conducted. In Section 4 we start by estimating an OLS model with the various seasonality effects to examine the evidence of significant patterns. Then an AR(K)-EGARCH(1,1) model with the various seasonality effects in the mean equation is estimated under alternative error distributions and an analysis of sensitivity of inferences is carried out. In Section 5 an AR(K)-EGARCH (1,1) model with seasonality effects included in the mean and conditional volatility equations are estimated and an analysis of sensitivity of inferences to alternative error distributions is conducted on the two equations. In section 6 we analyse the usefulness of the significant estimated seasonality effects, in the return and conditional volatility equations of the above descriptive models, to forecast out-of-sample the return and volatility. Finally, section 6 presents a summary and conclusions.

## Literature Review

The most common seasonality effects in financial markets are the January effect (also termed turn-of-the-year or month-of-the-year effect).

The weekend and day-of-the-week effects<sup>4</sup>; the turn-of-the-month effect (or the monthly effect) and the holiday effect. The literature contains many studies on the above cited effects on the mean returns. A number of hypotheses have been put forward to explain the presence of such seasonality.

The *January effect* refers to the higher returns in January reported by many researchers in various markets (Gultekin and Gultekin 1983; Arsal and Coutts 1997; Mehdiian and Perry 2002; Al-Saad and Moosa 2005). Initially Rozeff and Kinney (1976) and Keim (1983, 1986) found this effect to be particularly large for returns on small stocks using returns from US stock portfolios. For the US market, the most popular explanation for higher January returns is the tax-loss selling hypothesis associated with the payment of tax bills each December (end of the (US) financial year): investors sell stocks with losses in December to qualify for a tax-loss and then invest the available funds in January. Several papers found empirical support for the tax-loss selling hypothesis (Dyl and Maberly 1992; Griffiths and White 1993; and Agrawal and Tandon 1994)<sup>5</sup>.

<sup>4</sup> There is a difference between the weekend and the day-of-the-week effects. In the former, stocks exhibit lower returns between Friday and Monday closing (Agrawal and Ikenberry, 1994; Wang et al., 1997). In the second, returns on some trading days of the week are higher than others (Chang et al., 1993; Kamara, 1997; Chang et al., 1998).

<sup>5</sup> Alternative explanations for the January effect exist. Odgen (1990) argues that the effect stems from seasonal cash received by investors. Miller (1990) suggest that year-end time pressures cause investors to postpone purchases until January, while sales in December are more likely for tax-loss reasons and because deciding to sell stock already owned takes less time than deciding what new stocks to buy. Lakonishok *et al.* (1991) report evidence consistent with the hypothesis that institutions often sell their losers in December to window-dress their end-of-year reports.

The January effect has also been found in other countries. In a study of the stock markets in 17 major industrialized countries over the period 1959-79, Gultekin and Gultekin (1983) found that significant differences in the month-to-month mean returns were present in 12 countries.

The *day-of-the-week effect*, initially studied in US markets (French 1980; Gibbons and Hess 1981), refers to the finding that Monday returns are, on average, negative and lower than for the rest of the week. A number of studies have focused on and reported evidence on the day-of-the-week effect (see, for example, among others, Jaffee and Westerfield 1985; Thaler 1987; Agrawal and Ikenberry 1994; Arsal and Coutts 1997; Keef and Roush 2005). An explanatory hypothesis is that more stocks go ex-dividend on Mondays, thereby lowering prices and returns. Some have suggested that stock returns could be lower on Mondays if firms typically wait until weekends to release bad news. Other work casts some doubt on the robustness of the weekend effect. Connolly (1989) argues that previous findings depend heavily on the assumption that returns are normally distributed with a constant variance. Using estimators that are robust with respect to violations of these assumptions, he finds much weaker evidence of a weekend effect, particularly after 1975. Chang et al. (1993), using procedures similar to Connolly, also report little evidence of an effect for a portfolio of larger companies' stocks for the period 1986 to 1990. Some recent studies have also shown a decline in the Monday effect in the US markets (Chen and Singal 2003; Marquering et al. 2006).

The *turn-of-the-month effect* (TOM), first reported by Ariel (1987) in US markets, is the concentration of positive stock returns in the last trading day and the first nine trading days of each month. Various explanations have been put forward: a *portfolio rebalancing*, a *month-end cash flow and company announcement hypotheses*. Ariel could not account for this effect by the turn-of-the-year effect, dividend patterns, or higher return volatility at the beginning of months. He suggests systematic purchasing by pension funds at the turns of months as a possible explanation. Ogden (1990) attributes the effect to the temporal pattern of cash received by investors, while Jacobs and Levy (1988) attribute it to investors' desires to postpone decisions until the beginnings of periods. Kunkel et al. (2003) carried out an extensive study of this effect in major global stock markets. They examine the evidence of the TOM pattern in 19 country stock market indices and found that the 4-day turn-of-the-month period accounts for 87% of the monthly return, on average, across countries, in the equity markets of 15 countries where this pattern exists.

The *holiday effects* allow the mean returns to be different on the day before a holiday and the day after. The *pre-holiday effect* is also associated with Ariel (1990). He reports that returns on days before such standard holidays as Christmas or Labour Day have been about 10 times the return on other days. Pettengill (1989) also reports evidence of high returns on pre-holidays. Lakonishok and Smidt (1988) report similar evidence over a much longer time period. Kim and Park (1994) also find higher pre-holiday mean returns for U.K. and Japanese as well as U.S. stocks, and that the effect in the first two was independent of the US markets.

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Seasonality in profit announcements and tax deadlines hypotheses are also suggested.

Vergin and McGinnis (1999) examined the pre-holiday effect and found that this effect has disappeared for large firms but persists for small firms, though on a scale unlikely to exceed transaction costs. Thus, the gathered evidence for holiday effects suggests that higher than normal returns occur before a holiday, because of increased activity, and lower returns after the holiday. However, in recent years, the evidence for these effects has diminished.

Although the focus of the above studies has been the seasonal pattern in average returns, many empirical studies have investigated the behavior of the stock price series in terms of volatility using variations of GARCH models (French et al. 1987; Baillie and DeGennaro 1990; Nelson 1991; Glosten et al. 1993). French et al. (1987) examine the relationship between prices and volatility and report that the unexpected returns are negatively related to unexpected changes in volatility. Nelson (1991) and Glosten et al. (1993) report that positive (negative) unanticipated returns result in reduction (increase) in conditional volatility. Baillie and DeGennaro (1990) do not report evidence of a relationship between the average returns on equity portfolios and the variance of these returns. Corhay and Rad (1994) and Theodossiou and Lee (1995) investigated the behaviour of stock market volatility and its relationship to expected returns for major European stock markets. They found no relationship between stock market volatility and expected returns. However, none of the above studies investigated seasonal patterns in stock market volatility. Although there is a wide range of studies examining the seasonality patterns in average returns a limited set of studies examine these effects in the conditional volatility.

Fama (1965) reported the earliest evidence that the mean and variance of return distributions vary by day of the week. Ho and Cheung (1994) found that stock return variances of several Asia-Pacific markets are heterogeneous across days of the week. Berument and Kiyamaz (2001) showed that volatility varies by day of the week in the S&P 500 index. Their study assumes a GARCH specification under a normal distribution in the errors. Kiyamaz and Berument (2003) examined the day of the week effect on the mean, conditional volatility and transaction volume in major global equity indices assuming a GARCH specification under a normal error distribution. They found evidence of variation in return distributions by day of the week. Choudhry (2000) uses a GARCH specification where the error term follows a conditional Student-t distribution and finds evidence of the day of the week effect in mean and conditional variance for seven Asian emerging equity markets. Baker et al. (2008) examine the day of the week effect in both the mean and volatility in the S&P/TSX composite price index from the Toronto Stock Exchange using a GARCH specification under various error distribution assumptions. They find that the effect is sensitive to the error distributional assumptions.

Some empirical studies show that the financial time series have fatter tails than the normal distribution and exhibit volatility clustering. However, almost all previous studies ignore these stylized facts and uses standard methods such as ANOVA to test for equality of means or F and t tests on OLS regression with dummy variables to test for significance of the seasonality effects. This casts doubt on the reliability of results given that normality is one of the basic assumptions of these tests.

In this paper we allow for time varying conditional volatility and we consider at the same time a range of seasonality effects in the return and conditional variance equations on the regression analysis. We examine the robustness/instability of seasonality effects in models specified under different error distributions and also consider descriptive separated from explanatory models.

### Data and Initial Statistical Tests

The data employed in this study are daily closing prices from the French stock market over the estimation period December, 3, 1990 to December, 30, 2009. The long-term market index was obtained from the Paris Stock Exchange - Euronext Paris. We use the CAC-40 index which is the main index and is based on 40 of the largest companies in terms of market capitalization. The constituent stocks of the index are the 40 most representative stocks in term of free-float adjusted capitalisation and turnover and the weighting scheme of the index is based on free-float adjusted market capitalisation. In the Euronext - Paris the index is available in terms of “net return” and “total return”, where the later incorporates a special “avoid fiscal” tax credit which takes into account the reinvestment of ordinary gross amount of dividends declared by companies in the index. For comparability with other studies our analysis is based on the “net return” index. The series of daily market returns are calculated as the continuously compounded returns where:

$$r_t = Ln(P_t / P_{t-1}).100$$

$r_t$  is the daily return in day  $t$  and  $P_t$  is the index level at the end of day  $t$ .

Table 1 reports sample statistics for the CAC-40 return series over the full period and two sub periods related to the *pre* and *introduction* (December, 3, 1990 to December, 28, 2001) and *post introduction* period of the euro (January, 3, 2002 to December, 31, 2009). Table 1 contains statistics testing the null hypotheses of independent and identically distributed normal variates. The descriptive statistics for the index return series are, among others, the mean, standard deviation, skewness, excess kurtosis, first three-order autocorrelation coefficients, and the Ljung-Box Q(10) for the standardized residuals and the squared standardized residuals.

There is strong evidence, in all periods, against the assumption that returns are normally distributed. The evidence indicates significantly fatter tails than does the stationary normal distribution for each period. The skewness coefficient rejects the symmetric distribution null hypothesis only in the first sub period. The Jarque-Bera statistic and the comparison of the empirical distribution (Lilliefors statistic) with the theoretical one also reject the null hypothesis of normality of daily returns. The independence assumption for the  $T$  observations in each period is tested by calculating the first three order autocorrelation coefficients. Using the usual approximation of  $1/\sqrt{T}$  as the standard error of the estimate, the statistics for the full period reject the second and third order zero correlation null hypothesis at the 5 and 1% level. Although not reported here, the autocorrelation function (ACF) from lag 1 to lag 40 in full period shows some small but significant autocorrelations at the 5% level. In the first ten lags the returns exhibit, mostly, negative autocorrelation. These significant coefficients are likely a result of the nonsynchronous trading effect.



The Ljung-Box  $Q(10)$  statistic for the cumulative effect of up to tenth-order autocorrelation in the standardized residuals exceeds the 1% critical value from a  $\chi^2_{10}$  distribution for all three periods. The Ljung-Box  $Q(10)$  statistic on the squared standardized residuals provides us with a test of intertemporal dependence in the variance. The statistics for all three periods reject the zero correlation null hypotheses. That is, the distribution of the next squared return depends not only on the current return but on several previous returns. These results clearly reject the independence assumption for the time series of daily stock returns. Finally, Augmented Dickey-Fuller and Phillips-Peron tests reject the null hypothesis of a unit root and we conclude that the CAC-40 returns series over the full period and sub periods is stationary and suitable for a regression-based analysis.

The ADF test reported is performed with an intercept and an optimal lag structure according to the Akaike Information Criteria.

At a first stage we use parametric and nonparametric tests to examine for the existence of differences in average returns and volatility within returns categories of seasonality effects. Since the statistics in Table 1 show a non-normal distribution, the Brown and Forsythe (1978) test is used to test for the equality of variances which is robust to departures from normality. Although we could have used the Levine test, the Brown-Forsythe test is more robust when groups are unequal in size and the normality and equal variances are not verified. This test estimates whether more than two groups are homoscedastic. The Brown and Forsythe test statistic is the F statistic resulting from a one-way analysis of variance on the absolute deviations from the median.

Statistics	Full period	First sub-period	Second sub-period
Observations	4822	2774	2048
Mean	0.0274	0.045263	0.0032
S. deviation	1.4166	1.2815	1.5814
Minimum	-9.471	-7.6781	-9.4714
Maximum	10.594	6.8080	10.594
Skewness	-0.0392	-0.1862***	0.0835
Kurtosis	7.8770***	5.2685***	8.8815***
JB test	4780***	610***	2954***
Empirical Distribution Test	0.0574***	0.0371***	0.0783***
$r_1$	-0.015	0.035*	-0.059***
$r_2$	-0.032**	-0.039**	-0.026
$r_3$	-0.062***	-0.036*	-0.086***
$Q(10)$ Standardized Residual	56,04***	23,86***	65,327***
$Q(10)$ Squared Standardized Residual	2453,6***	362,98***	1326,2***
ADF unit root test	-11.45***	-21.17***	-7.99***
P-P unit root test	-70.89***	-50.88***	-48.79***

Table 1

JB test: Jarque-Bera test for a normal distribution. Empirical Distribution Test is a goodness-of-fit test that compares the empirical distribution of daily returns with the normal theoretical distribution function. The value reported is the Lilliefors statistic.  $r_1, r_2, r_3$  are the first three autocorrelations coefficients. Asterisks indicate significance at the 10%\*, 5%\*\* and 1% \*\*\* levels.

Let  $x_t$  be the  $t$ th observation in the  $g$ th group and let  $m_g$  be the sample median for the  $g$ th group, and let Brown and Forsythe's test is to reject the null hypothesis of equal variances between groups if  $F_{\alpha, g-1, n-g}$  represents the quantile of order  $\alpha$  of distribution  $F$  and the level of significance of the test. To test for equality of mean returns across return categories of seasonality effects we use the Welch (1951)'s ANOVA modified F-test which accounts for the unequal variances, the standard ANOVA F-test and the nonparametric Kruskal-Wallis (KW) test. The test statistics for equality of means and variances are reported in Table 2.

Regarding tests for the homogeneity of the variance this statistic reveals significant differences across all seasonality effects.

Seasonality effect	Number of categories	Tests of equality of variances: F-statistic	Tests of equality of means		
			Welch F-statistic	ANOVA F-statistic	KW statistic
Day-of-the-week	5	2,8798**	0,3826	0,3890	0,6443
Month-of-the-year	12	4,7365***	0,9491	0,9692	9,8199
Turn-of-the-month	2	5,0989**	6,5179**	6,6609***	9,4670***
Holiday	3	4,2548**	10,0514***	5,9142***	14,1847***

**Table 2**

Asterisks indicate significance at the 10% \*, 5% \*\* and 1% \*\*\* levels. Sample period spans from Monday 3 December 1990 to Friday 30, December 2009. The test for equality of variances is the Brown-Forsythe (1974) test. The test statistics for the equality of means are the Welch (1951)'s modified ANOVA F-statistic, the ANOVA F-statistic and the Kruskal-Wallis statistic.

Regarding tests for the equality of means, we cannot reject the identical mean null hypothesis throughout days of the week and months of the year. For these two effects the results in the parametric and non-parametric statistics are consistent. For the TOM effect test results suggest that differences in means are significant at 5% in the Welch F-test and significant at the 1% level in the other two tests.

Regarding the holiday effect, results provided by parametric and non-parametric tests are consistent, suggesting that mean returns are significantly different at the 1% level across the three return categories. In sum, the Brown-Forsythe test rejects the homogeneity of volatility in all seasonality effects and the tests for the equality of means suggest differences in means returns in the TOM effect and across return categories of holiday effect.

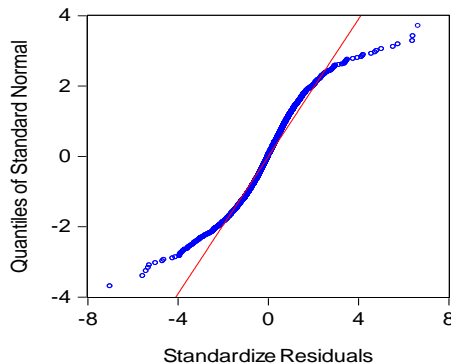
### Seasonality Patterns in Mean Return with Different Distributional Assumptions

We consider at the same time the various seasonality effects and we start by estimating the effects in the following return equation using the OLS method:

$$r_t = \alpha_0 + \sum_{i=1}^4 \alpha_i D_{it} + \sum_{j=1}^{11} \gamma_j M_{jt} + \beta D_{TOM} + \lambda PreH_t + \delta PostH_t + \sum_{m=1}^k \omega_m r_{t-m} + \varepsilon_t$$

Where  $r_t$  is the return on day  $t$ ,  $D_i$  is a dummy variable taking a value of one for day  $i$  and zero otherwise (where  $i = 1, 2, 3, 4$ ) and the reference category is Monday,  $M_j$  is a dummy variable taking a value of one for month  $j$  and zero otherwise ( $j = 1, 2, \dots, 11$ ), the reference category is January,  $D_{TOM}$  is a dummy variable for the TOM period taking a value of one for TOM trading days and zero otherwise,  $PreH_t$  and  $PostH_t$  are dummy variables taking a value of one for a trading day preceding (following) a public holiday, respectively, and zero otherwise,  $r_{t-m}$  is the lagged return of order  $m$  and  $\varepsilon_t$  is the random error term of the regression assumed to be independently normally distributed with a zero mean and constant variance. Each coefficient of the regression is interpreted as follows. The intercept term,  $\alpha_0$ , is the mean return on a Monday in January, not included in the TOM period and which is not immediately before or after a public holiday. We interpret each coefficient for the dummy variables as its relative excess return to the intercept term. Eq.(4) attempts to simultaneously take into account all the above suggested seasonality patterns and allows partial tests of interactions between effects.

We base the choice of the lag length ( $k$ ) on the lowest Akaike information criterion (AIC). To remove the linear dependence in the return series we estimate an autoregressive model  $AR(k)$  that minimizes the AIC. Then we estimate eq.(4) with this lag length and retest the resulting residuals from this equation for possible non-captured linear dependence. Lo and Mackinlay (1990) show that the non-synchronous trading causes linear dependence in the observed index returns but this effect is much less pronounced in price indices constituted by very liquid stocks. The Akaike's criterion suggests an autoregressive model of order 5 to estimate the returns series.



**Figure 1**

Eq.(4) assumes that residual terms are normally distributed with a constant variance. The estimated coefficients, the standard errors of the parameters and diagnostic statistics of eq.(4) are reported in Table 5. Table 5 only reports variables whose coefficients are significant. The standard errors of the OLS regression are corrected by the autocorrelation and heteroskedasticity consistent covariance estimator of Newey–West. As expected, due to the stylized facts of financial time series assumptions of normality and constancy of variance are rejected by the Jarque-Bera and the ARCH LM tests. The result from the ARCH LM test statistic indicates a time varying conditional heteroscedasticity in the CAC-40 daily index returns. The cumulative effect of autocorrelation coefficients of residuals up to twentieth–order is insignificant. However, Ljung-Box statistics for the cumulative effect up to thirtieth and fortieth-order autocorrelation in the residuals are significant indicating that the AR(5) model is not able to capture linear dependence at high lagged orders in the return series. Figure 1 shows the q-q plot of the standardized residuals of Eq.(4).

Fig. 1 also rejects the normality assumption and shows that the tails of the residuals of OLS regression are fatter than the normal distribution.

Since the null hypothesis of no ARCH effects in residuals of OLS regression is rejected, we examine the effect of assuming a time varying variance in seasonality patterns. We estimate Eq.(4) with a GARCH-type model with only the dummy variables in the conditional mean equation. We chose the best GARCH type model from the GARCH(p,q), TGARCH(p,q) and EGARCH(p,q) variations that best fit the daily index returns on the basis of Maximum Loglikelihood and AIC criteria, where  $p$  and  $q$  are the lag orders of the residuals and conditional variance in the variance equation. Empirical studies modeling the conditional volatility with GARCH type models generally assume a normal error distribution. As figure 1 shows the tails of the residuals of OLS regression are fatter than the normal distribution and it becomes appropriate to use a distribution with fatter tails. To capture fatter tails in the return series we use three distributions proposed by Nelson (1991) that better fit financial time series - Student - t, GED and DED<sup>6</sup> error distributions.

Thus, we analyze how the choice of error distribution affects seasonality patterns. Baillie and Bollerslev (1989) show that a GARCH (1,1) model provides a parsimonious fit for stock return series. Based on the selection criteria we chose an EGARCH (1,1) model after examining alternative models and combinations such as GARCH (1,1), GARCH (1,2), TGARCH (1,1), TGARCH (1,2) and EGARCH (1,2).

<sup>6</sup> The Student-t, GED and DED are heavy-tailed distributions with positive excess kurtosis relative to a normal distribution, which has excess kurtosis of 0. Excess kurtosis is  $6/(df - 4)$ , where  $df$  = degrees of freedom, for the Student-t distribution and

3 for DED. For the GED distribution, the value of the shape parameter determines the thickness of the tail. When this parameter has a value less than 2, the distribution is thick tailed. When the values are 1 and 2, the result is DED and Normal distribution, respectively.

Based on the leverage effects noted in Black (1976) and French et al. (1987), Nelson (1991) proposed the exponential GARCH (1,1) model

$$\ln \sigma_t^2 = \omega + \beta \ln \sigma_{t-1}^2 + \alpha \left\{ \frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \left( \frac{2}{\pi} \right)^{0.5} \right\} + \phi \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}}$$

In this formulation the conditional variance is an exponential function of the previous conditional variance and standardized unexpected return.

If  $\alpha > 0$ , then conditional volatility tends to increase (decrease) when the absolute value of the standardized unexpected return is larger(smaller). A positive  $\alpha$  represents the empirical observation that large (small) price changes tend to follow a large (small) price change.

This is volatility clustering. An asymmetric effect occurs when an unexpected decrease in price resulting from bad news increases volatility more than an unexpected increase in price of similar magnitude, following good news.

This phenomenon has been attributed to the "leverage effect": bad news lowers stock prices, increases financial leverage, and increases volatility. If  $\phi < 0$ , then conditional volatility tends to rise (fall) when the standardized unexpected return is negative (positive). Thus, this specification is expected to capture a large amount the skewness and leptokurtosis.

The estimated coefficients and standard errors of the parameters in the mean and conditional volatility equations of the EGARCH(1,1) model for the normal, Student's t, GED and DED error distributions are reported in Table 3. Several relevant observations emerge from the results in Table 3.

First, our evidence supports the existence of the TOM effect with TOM trading days having a significantly higher average daily return. For the EGARCH (1,1) model with a normal error distribution, the average return for the TOM trading days is 0.12% higher than that for non-TOM trading days and the average daily return on trading days in this period is not significantly different from zero.

The excess average return of TOM trading days is significant at the 1% level. The results also support the existence of the holiday effect. When compared to ordinary trading days (days that do not precede or follows a holiday), the excess average return in the pre-holidays is 0.29% higher while for the post-holidays the excess average return is 0.31% higher being these excess returns significant at the 1% level. The EGARCH with DED distribution also reports that the average return on August differs significantly from January at the 10% level and is about 0.10% less and the average return in January is not statistically different from zero.

Except for the DED distribution that reports a significant difference in average returns in August there is no reliable evidence to suggest the existence of the day-of-the-week or month-of-the-year effects.

	OLS		EGARCH(1,1) with normal error distribution		EGARCH(1,1) with Student's t error distribution		EGARCH(1,1) with generalised error distribution		EGARCH(1,1) with double exponential error distribution	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
<i>Mean equation</i>										
August	-	-	-	-	-	-	-	-	-	0,0573
TOM	0,1373*	0,0548	0,1164***	0,0449	0,0951***	0,0366	0,1032***	0,0371	0,0873***	0,0310
Pre-Holiday	0,3575**	0,1073	0,2965***	0,1127	0,3067***	0,1428	0,2941**	0,1382	0,2774**	0,0980
Post-Holiday	0,2851*	0,1357	0,3152***	0,1237	0,3161***	0,1027	0,3204***	0,1040	0,3213**	0,0888
<i>Variance Equation</i>										
Constant	-	-	0,0782***	0,0200	0,0877***	0,0094	0,0821***	0,0083	0,0807**	0,0128
$\alpha$	-	-	0,1077***	0,0251	0,1174***	0,0122	0,1113***	0,0110	0,1211**	0,0189
$\phi$	-	-	0,0720***	0,0111	0,0757***	0,0076	0,0723***	0,0071	0,0792**	0,0119
$\beta$	-	-	0,9846***	0,0026	0,9862***	0,0024	0,9855***	0,0024	0,9869**	0,0035
<i>Diagnostic statistics</i>										
R <sup>2</sup>	0,0164	-	0,0115	-	0,0119	-	0,0119	-	0,0114	-

**Table 3**

This table reports results of the EGARCH(1,1) for the normal, Student's t, GED and DED error distributions. The estimated model is the AR(5)-EGARCH(1,1) with the day-of-the-week, month-of-the-year, TOM and holidays effects only included in the mean equation. Table only reports dummy variables with significant coefficients. \*, \*\*, \*\*\* Statistically significant at the 10%, 5% and 1% level, respectively.

Thus, the reported significant effects of the TOM and holiday effects in the mean equation are not very sensitive to assumptions about the distribution of errors.

TOM and holiday effects are significant in all error distributions despite the magnitude of their coefficients vary and average daily return on pre-holiday being significant at 1% level under the normal but are significant at 5% level under the Student's t and GED distributions. In general, given results in Table 5, the examined seasonality effects do not depend on the assumptions of the error distributions. The significant effects shown under normal distribution tend to be robust under the other error distributions. However, there is the question of which of the four error distributions is more appropriate to capture the stylized facts of financial time series with seasonality effects included. To answer this question we examine which of the four EGARCH models best fits the data series. Although not shown, the q-q plots of standardized residuals of the four distributions show a better fit of distributions with fatter tails (Student's t and GED).

Since these plots do not help determine the best model, we make the decision based on the two model selection criteria: Maximum Log-Likelihood and AIC. Table 5 indicates that the two model selection criteria choose the model with a Student-t error distribution. The second best model is the GED distribution followed by the model with the normal distribution. The EGARCH model with the DED error distribution is the one with the worst fit to the data series. Thus, these results suggest that examining seasonality patterns, individually or jointly, assuming a normal error distribution may be inappropriate.

In this study, however, allowing for time varying conditional variance of the errors in the four distributions, all models detect the existence of the TOM and holiday effects that are consistent in terms of significance with those obtained in the preliminary analysis of equality of means in Table 2 and consistent in the signal, significance and magnitude with those obtained in OLS regression.

The results of diagnostic tests in Table 3 show that the EGARCH specification using the four error distributions reduces the intertemporal dependence in the standardized residuals and squared standardized residuals. The Ljung-Box statistics up to lag 40 do not reject the null hypothesis of zero autocorrelation coefficients. The ARCH LM test up to lag 20 is not significant, indicating that the four EGARCH models are successful in modeling the conditional volatility.

The Jarque-Bera test for normality rejects the null hypothesis that the standardized residuals are normally distributed, indicating that none of the four models are able to capture most of leptokurtosis present in the data series. For the four models the coefficient on the natural logarithm of the lagged conditional variance,  $\beta_1$ , is significantly positive and smaller than one. Cross-sectionally, magnitudes of this coefficient are similar and indicate a long memory (smoothing) in the conditional variance. The hypothesis that  $\beta_1 < 1$  is confirmed in all models at the 1% level, supporting the existence of volatility clustering. Finally, the hypothesis that  $\beta_2 > 0$  for a leverage effect is evidenced by all models in magnitude and statistical significance.

### Seasonality Patterns in Mean Return and Conditional Volatility with Different Distributional Assumptions

To test for the day-of-the-week, month-of-the-year, turn-of-the-month and holiday effects in volatility, we introduce the corresponding dummy variables into the mean and conditional variance equations of EGARCH(1,1) (6)

Where the dummy variables and parameters of the EGARCH conditional variance equation are defined as previously. Each coefficient of the dummy variables in the conditional variance equation is interpreted as follows. The intercept term,  $\omega$ , is the mean volatility on a Monday in January, not included in the TOM period and which is not immediately before or after a public holiday. Each coefficient for the dummy variables is interpreted as its relative excess volatility to the intercept term.

Table 4 reports results from the estimation of the EGARCH(1,1) model with dummy variables included in the mean and conditional variance equations for normal, Student's t, GED and DED error distributions. The results show that some effects of seasonality in conditional mean and variance are sensitive to the assumption of the distribution. Similar to the results reported in Table 3, our evidence supports the presence of the TOM effect. For the normal distribution the average daily return in the TOM trading days is about 0.11% higher than that in the non TOM-trading days whose average return is not significantly different from zero. This pattern is shown in the other error distributions with a similar magnitude in the coefficients. The results also support the existence of the holiday effect.

In the normal distribution the average daily return in the pre-holiday and post-holiday is higher by 0.25% and 0.31%, respectively, when compared to the average daily return in the other trading days where the average is not significantly different from zero. These significant effects are also shown in the other error distributions. The DED distribution reports that the intercept term is positive and significant at 5% level and the average daily return in August is lower by 0.13% compared to the average return in January. Except for the above significant terms reported by the DED error distribution there is no evidence of the day of the week and month of the year effects in the remaining error distributions. TOM and holidays effects in the mean equation are sensitive to the assumption about the underlying distribution. Specifically, assuming a normal distribution, the average return in the TOM trading days is significant at the 5% level, being however significant at the 1% level in fatter distributions as evidenced by the GED and DED. Additionally, the average return in pre-holiday days is significant at 5% under the normal and Student-t distributions but it is significant at 10% and 1% under the GED and DED distributions, respectively, with a considerable variation in the magnitude of the coefficients. Concerning the post-holiday trading day, the average return is significant at the 5% level under the normal but is significant at the 1% level under the Student-t, GED and DED distributions. Thus, in the mean equation there is instability in the significance level and in the coefficient estimate magnitudes.

For the conditional volatility equation, the significant estimated seasonality effects are also sensitive to the error distribution assumed in the model.

The presence of the day of the week effect with significant coefficients under all error distributions and the holiday effect (post-holiday) is evident only under the Student-t distribution.

Under the normal distribution the variance dummy variable for Tuesday and Friday is significant at the 5% level and the average volatility in these two days is 0.38 and 0.27 lower than the average volatility on Monday, after controlling for the persistence effect, volatility clustering and the asymmetry effect in the volatility equation. When we consider the Student-t distribution, the variance dummy variable for Tuesday and Friday remains significant but changes occur in the significance level and magnitude of the estimated coefficients. In this case Tuesday dummy variable is significant at the 1% level. Under this distribution the post-holiday variance dummy variable also reveals significant at the 10% level and the average volatility in this trading day is 0.15 higher than the average volatility on trading days not preceding or following public holidays. For the model with GED distribution the variance dummy variables for the Tuesday, Thursday and Friday are significant at the 1, 10 and 5% level and are, respectively, 0.35, 0.16 and 0.26 lower than average volatility for Monday. Concerning the model with the DED distribution only the variance dummy variable for Tuesday revealed significant at the 1% level and the volatility is 0.34 lower than the average volatility on Monday.

A striking result occurs in the DED distribution where the estimation process provides the more efficient parameter estimates (lowest standard errors) for the mean equation and, simultaneously, the less efficient estimates (highest standard errors) for the conditional variance equation among all error distributions.

In the preliminary analysis for variance homogeneity on the various seasonality effects it resulted that the Brown-Forsythe test statistic rejected the null hypothesis of homogeneity of variance across the return categories on all seasonality effects. However, when we allow for time varying conditional variance on the errors to detect the existence of differences in volatility across the various effects, differences only reveal significant on the day-of-the-week effect and only between a few days.

Table 4 also reports the results of the diagnostic statistics that examine whether all EGARCH models are correctly specified. As shown in Table 3, the EGARCH specification for the four error distributions cancels the intertemporal dependence in standardized residuals and squared standardized residuals. The Ljung-Box statistics up to lag 40 could not reject the zero autocorrelation coefficients null hypothesis in standardized residuals. The ARCH LM test statistic up to lag 20 could not reject the null hypothesis of serial independence in squared standardized residuals indicating that the four EGARCH models were successful in modeling the conditional volatility. The Jarque-Bera test for normality rejects the null hypothesis that the standardized residuals are normally distributed. Concerning the model that best fit the data series, results indicate that the model with a Student's-t error distribution outperforms others distributions based on the maximum log-likelihood and AIC model selection criteria.

In sum, the estimated and significant parameters of the seasonality effects in the mean and conditional variance equations are sensitive to the error distribution that is assumed in the EGARCH specification, either in magnitude, significance and significance level.

	EGARCH(1,1) with normal error distribution		EGARCH(1,1) with Student's t error distribution		EGARCH(1,1) with generalised error distribution		EGARCH(1,1) with double exponential error distribution	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
<i>Mean equation</i>								
Constant	-	-	-	-	-	-	0,1006**	0,0479
August	-	-	-	-	-	-	0,1295**	0,0595
TOM	0,1092**	0,0444	0,0946**	0,0369	0,1001***	0,0374	0,0910**	0,0311
Pre-Holiday	0,2539**	0,1217	0,2930**	0,1380	0,2712*	0,1431	0,2589**	0,0952
Post-Holiday	0,3190**	0,1238	0,3089**	0,1034	0,3182**	0,1046	0,3366**	0,0877
<i>Variance Equation</i>								
Constant	0,0913	0,0925	0,0497	0,0664	0,0754	0,0651	0,0697	0,1015
$\alpha$	0,1140**	0,0196	0,1164**	0,0124	0,1132**	0,0120	0,1222**	0,0203
$\phi$	0,0715**	0,0108	0,0741**	0,0079	0,0716**	0,0076	0,0786**	0,0126
$\beta$	0,9836**	0,0031	0,9862**	0,0024	0,9850**	0,0026	0,9867**	0,0036
Tuesday	-	0,1505	-	0,1106	-	0,1085	-	0,1677
Thursday	-	-	-	-	-0,1647*	0,0857	-	-
Friday	-	0,1314	-	0,1173	-	0,1175	-	-
Post-Holiday	-	-	0,1514*	0,0910	-	-	-	-
<i>Diagnostic statistics</i>								
$R^2$	0,0128	-	0,0123	-	0,0125	-	0,0116	-
$R_c^2$	0,0080	-	0,0076	-	0,0078	-	0,0069	-

Table 4

This table reports results of the EGARCH(1,1) for the normal, Student's -t, GED and DED error distributions. The estimated model is the AR(5)-EGARCH(1,1) with the day-of-the-week, month-of-the-year, TOM and holidays effects included in the mean and conditional variance equations. Table only reports dummy variables with significant coefficients. AIC – Akaike Information Criteria. \*, \*\*, \*\*\* Statistically significant at 10%, 5% and 1% level, respectively.



### Forecast Performances in Mean Return and Volatility

In order to test the importance of the seasonality effects the previously estimated EGARCH models were used for out-of-sample one-step-ahead forecasts for 2010 in returns and conditional volatility. This gives 258 forecasts. The measure of forecast accuracy used is the root mean square error (RMSE), which penalizes large errors in either direction. The results are reported in Table 5 for the estimated models with different error distributions.

The forecasts for returns and conditional volatility are firstly performed in models including only the seasonality effects in the mean equation and then performed in models including either seasonality effects in the mean and conditional volatility equations. As additional references in the forecast accuracy we also consider the autoregressive model AR(k=5) and the random walk model in forecasting returns, where denote the historical mean return. Andersen and Bollerslev (1998) argue that squared daily returns provide a very noise proxy for the ex post volatility and a much better proxy for the day's variance would be to compute the volatility for the day from intra-daily data. As we have no intra-day prices taken at hourly intervals, we use as the proxy for the actual volatility the variance of six intra-day returns calculated as (close-open prices), (close-maximum prices), (close-minimum prices), (maximum-minimum prices), (maximum-open prices), (minimum-open prices). In performing forecasts for returns and conditional volatility, all models, except the random walk model, include autoregressive terms of returns in the mean equation.

	Return		Volatility	
	RMSE	Rank	RMSE	Rank
Seasonality effects included in mean equation				
Random Walk	1,4668	1	-	-
AR (k=5)	1,4812	10	-	-
OLS	1,4841	11	-	-
EGARCH - Normal	1,4692	2	2,2706	1
EGARCH - Student-	1,4706	4	2,2783	3
EGARCH - GED	1,4697	3	2,2769	2
EGARCH - DED	1,4717	8	2,4192	7
Seasonality effects included in mean and conditional volatility equations				
EGARCH - Normal	1,4708	5	2,3004	4
EGARCH - Student-	1,4716	7	2,3036	6
EGARCH - GED	1,4709	6	2,3032	5
EGARCH - DED	1,4733	9	2,4434	8

**Table 5**

RMSE – Root Mean Square Error, Rank = 1 for smallest RMSE.

From table 5 it can be seen that the random walk model gives better forecasts for returns and the OLS model performs worst among all the estimated models. Within the set of EGARCH models for the various error distributions, those specifications that do not include seasonality effects in the conditional volatility equation gives better forecasts and, among these, the EGARCH with normal distribution provides the best forecasts followed by GED distribution. DED distribution provides the worst forecasts with and without seasonality effects included in conditional volatility equation. Concerning volatility forecasts, EGARCH models with seasonality effects not included in the conditional variance equation provides best forecasts with the normal performing best and the DED performing worst. Thus, albeit some seasonality effects are significant in the return and conditional volatility equations in the above descriptive models, these effects are not useful in explanatory models and do not introduce predictive ability against the random walk model.

### Summary and Conclusion

In this paper we investigate the day-of-the-week, month-of-the-year, TOM and holiday effects in return and conditional volatility. We examine the sensitivity in inference that might occur when using different distributional assumptions for the error terms in GARCH modelling. We examine daily time series data of the French CAC-40 index. The four different error distributions are the normal, Student's-t, generalized error distribution and double exponential distribution. We test whether inferences drawn from statistical test are robust to different error distributions. We also examine the usefulness of the significant estimated seasonalities in the return and volatility equations to forecast out-of-sample return and volatility.

We consistently find the presence of the turn-of-the-month and holiday effects in return equations for the French CAC-40 stock index using a EGARCH (1,1) model. We find evidence that the average return in the TOM period and in the pre- and post-holiday days are significantly higher than the average return in the other trading days. No significant coefficient of the day-of-the-week and month-of-the-year was found except the August dummy variable in the model with the DED distribution. We show that conditional volatility only varies with some days of the week but results are not consistent across different error distributions. In sum, we show that many of the expected seasonality effects are small and not significant, the significant dummy variables in return and conditional volatility are sensitive to the error distribution that is specified under the EGARCH descriptive model and the Student's-t distribution best describes stock index returns.

We examine if the significant dummy variables found in the return and conditionally volatility equations in descriptive models are useful for forecasting out-of-sample the return and volatility. Results show that the in-sample significant effects do not add forecast improvements against the random-walk model.

Our conclusion, based on this evidence, is that significant effects obtained from studies of seasonality patterns may be fragile. Although some significant effects could manifest in the in-sample period, the inference is instable to different error distributions and the estimated significant effects do not have forecast ability for out-of-sample forecast for returns and volatility. The above evidence adds to the literature that cast doubts on the economic significance of the seasonality effects.

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**Debt sustainability framework for low income countries: Case study of Nicaragua**

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The debt sustainability framework (DSF) developed by the International Monetary Fund and the World Bank (BM) in 2005, applied to Nicaragua lacks elements that impede measure the presence of an excessive accumulation of debt and does not reflect the need for funding needed to meet the Millennium Development Goals (MDGs). This research includes information on the DSF and analyses the economy to identify structural problems that should be considered to cover more risks in the country. In turn we propose to implement an alternative analysis of debt sustainability to increase the effectiveness of this tool and support for the MDGs.

**External Debt, Development, Sustainability, Financing, Low-Income Countries.**

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## Introduction

The study investigates the Debt Sustainability Framework (DSF) and exposes that the framework needs to incorporate additional indicators due to the high vulnerability of external shocks that can pose real dangers to the Nicaraguan debt sustainability.

Some empirical and theoretical literature respect of the DSF and the vulnerability that the frameworks has respect with exogenous shocks, discussion is present in authors like (Mwaba, 2005), (Hussain & Gunter, 2005) and (Ferrarini, 2008). The debate of the determination of the effects of overindebtedness in economic growth has been described in (Krugman, 1988), (Pattillo, Poirson, & A. Ricci, External Debt and Growth, 2002), (Bannister & Barrot, 2011) and (Reinhart, Reinhart, & Rogoff, 2012) has to be present in the determination of the debt threshold used in the current DSF.

Section 2 reviews the Nicaraguan economic context, describing a brief behavior of some key economic and social indicators. The following part, Section 3, analyzes the importance of 4 economic variables – foreign aid, foreign direct investment (FDI), exports and remittances – in the economic performance of Nicaragua. Its magnitude is considerable and poses threat to external shocks; they can play an important role in contributing to the debt problem.

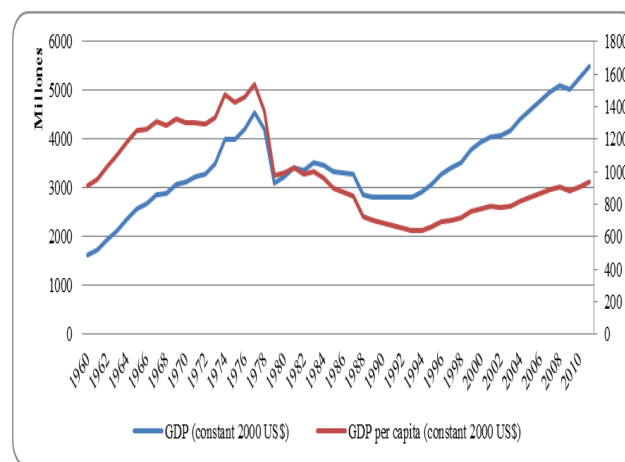
From there we proceed, section 4, to a discussion of the different approaches assessing the debt sustainability. Beyond the solvency question addressed by the debt sustainability diagnosis, there is a question of the implications of the overindebtedness and economic growth.

To illustrate the importance of this framework we analyze the relationship and its implications that should be taken account in the elaboration of an alternative debt sustainability framework.

In the light of the theoretical expositions, section 5, we present our proposal of an alternative debt sustainability framework for Nicaragua. Finally in section 6 we present our conclusions, considering the implications of the findings and the attendant policy design issues.

## Nicaraguan Context

The Republic of Nicaragua is the second nation with the lowest GDP per capita income in the American Continent. The economy has grown steadily from 1990 to 2011 (except 2009 due to the international crisis); the average annual growth rate of the GDP has been 3.24% and 1.49% the GDP per-capita.



**Graph 1**

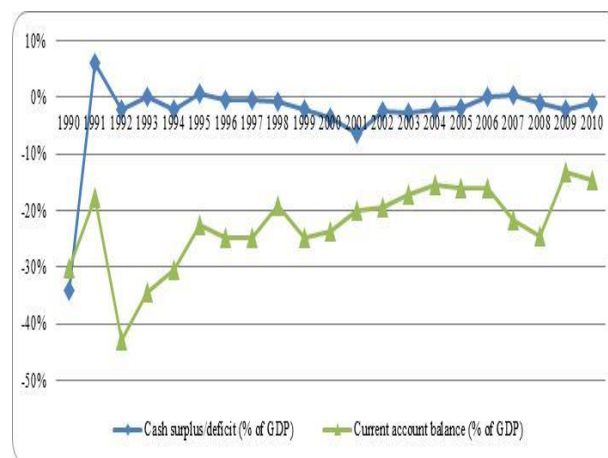
Socially, poverty is high, in 2009 42.5% of the population was poor and 14.2% of the inhabitants were living below the extreme poverty.

Notwithstanding this growth, the impact on poverty has been very low, considering that from 1993 to 2009 both poverty and extreme poverty declined slightly 7.8% and 5.2% respectively.

The evolution in terms of GDP and GDP per capita of Nicaragua has been low relative to developing economies. Comparing Nicaragua to neighboring countries like Costa Rica in terms of GDP per capita in constant 2000 terms, GDP per capita was \$ 914 in Nicaragua in 1960, representing 51% of GDP per capita of Costa Rica. By analyzing the data of 2011 the GDP per capita was \$ 936 in Nicaragua, representing 17% of GDP per capita of Costa Rica during the same period.

Nicaragua has a history of having difficulty honoring its external debt maturities because of lack of foreign exchange. The country has close economic dependence on the external sector, which largely explains the deficit in the current account for more than three decades, a situation that is related to the following variables was marked mainly by the evolution of four exogenous variables: foreign financing, exports, remittances and foreign direct investment (FDI).

The financing behavior is associated with deficits in the balance of payments and changes in the level of gross foreign assets; your employer rests on official development assistance, remittances, exports and foreign direct investment. Allowing the country to live and consume beyond what occurs in a dependent relationship. Graph.



Graph 2

### Debt History

Throughout the study of public debt, we find that this is the result of government spending financed with foreign capital (debt). Transactions in goods and services flows between a country and the rest of the world that are reflected in the balance of payments are the basis for contrasting aspects of the economy that are directly related to spending levels.

Nicaragua has used foreign borrowing to finance local projects to achieve its development goals. This reality and its current weaknesses present in the economic and social environment are capable of undermining the generation of resources to meet debt commitments.

These deficiencies are found in its vulnerability to exogenous shocks that may impair the ability to pay and to prevent the fulfillment of contractual obligations of the loan.

The current account deficit increased dramatically by external shocks during the decade of the 70s, both economic and noneconomic factors: increases in oil prices, the earthquake in 1972 and the popular uprising against the Somoza dictatorship.



This combined with a slowdown in economic growth and exports and protectionist measures in industrialized countries achieved the level of debt relative to the size of the economy, the ratio of debt to GDP increased from 24.2% to 96.8%.

In the decade of the 80s, the debt problem worsened by the large economic imbalances motivated primarily by the armed conflict, the trade embargo and other exogenous shocks. This led to increased accumulation of external debt and the country will not be able to pay the accumulated debt when he thought he had more creditworthy.

This triggered the loss of access to the financial market, exacerbating the negative initial turbulence, causing a collapse in demand for pushing government sector debt increased interest rates and widening fiscal deficit. The expansionary monetary and fiscal policies, an overvalued exchange rate and the deterioration in the terms of trade and the financing of the current account deficit with foreign loans generated increased the debt burden, the ratio DET / GDP reached 940%. See Appendix 1: debt burden measured by various indicators.

Macroeconomic distortions were so great that adjustment policies were implemented in 1988 and 1989, to reduce hyperinflation. With the change of government in 1991, goes to the international community in order to obtain resources.

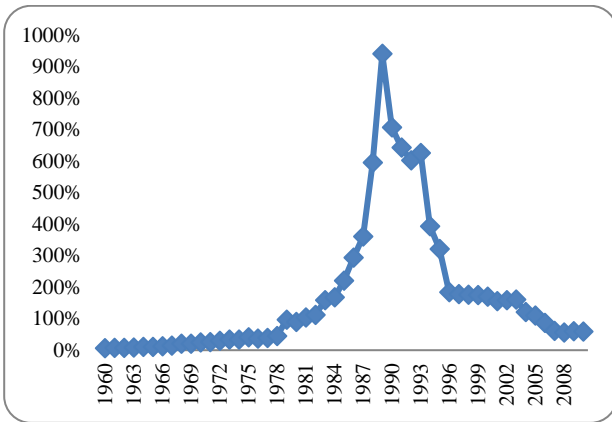
Developed countries brought a requirement to establish programs with the IMF and World Bank to access capital multilateral agencies, its implementation was supported concessional external resources and grant funding.

In the 90s, economic policy is subject to the execution of financial programs with the International Monetary Fund (IMF) and World Bank (WB) and implemented Structural Adjustment Programs (SAPs) to control external deficits and imbalances macroeconomic. From this time economic policy experienced a confrontation of policy objectives, the payment of debt service and rebuilding the country.

The lack of state resources to make a series of social cuts and budgetary pressures resulting from military demobilization, reconstruction means that in 1993 the poverty be at 50.3% and 19.4% in extreme poverty. The fight against poverty starts with the SAPs (1994-1997) with the aim of consolidating the gains achieved in areas of economic stability. The implementation of further reforms intended to eliminate macroeconomic distortions and achieve external viability (IMF, 1994).

Stabilization policies to correct macroeconomic imbalances generated growth, and that the end of the trade embargo and war formed the positive situation this time. Effect measures arising in generating economic growth, GDP grew at 3% per year and a reduction of poverty by 2.3%. However there was a failure, the country increase the number of poor people from 2.1 million to 2.3 million (WB, 2001).

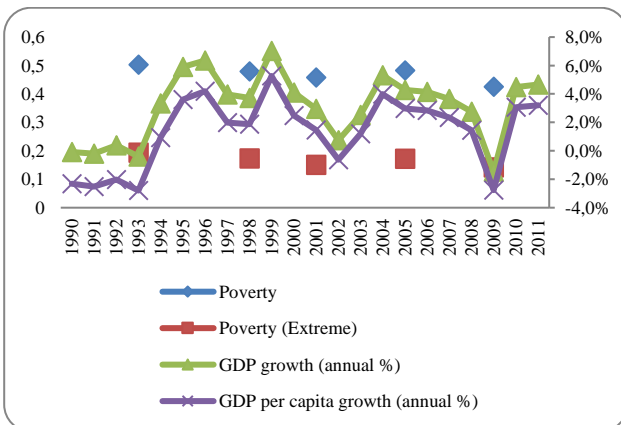
The implementation of adjustment programs were successful in achieving macroeconomic stability but poverty and inequality indicators deteriorated. In practice meant the destruction of the domestic market and the improvement in the external sector was at the expense of a deterioration of income distribution and low growth rate. Adjustment policies do not achieve the debt solution. See Graph



**Graph 3**

The levels of external debt continued to be high and the international financial institutions acknowledge that the debt burden had to be lowered to a sustainable quantity. To judge whether a country's level of debt is sustainable, the World Bank (WB) takes a present value of debt to export ratio of 150 per cent. This is the main criterion for relief under the Heavily Indebted Poor Countries Initiative (HIPC).

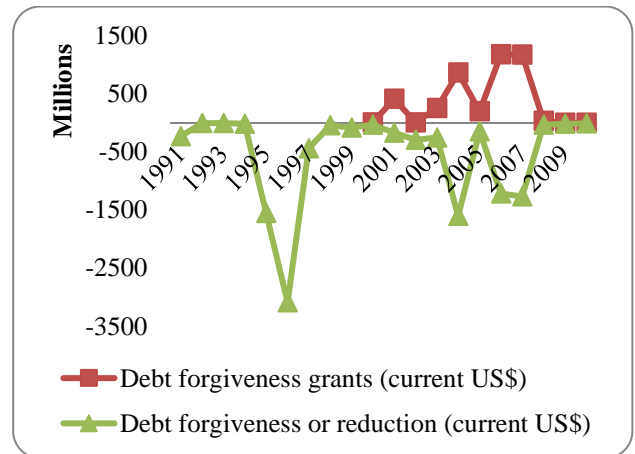
Given the inability to increase the ability to pay in 1999 was determined that Nicaragua needed debt relief under the HIPC debt to reach sustainability and continuous economic reform agenda within of IMF programs and increase spending on poverty reduction. Graph.



**Graph 4**

In 2005, the HIPC initiative and programs with the IMF and WB did not generate the expected positive impact on social indicators and creates another debt relief initiative Initiative Multilateral Debt Relief (MDRI), which aimed to reduce further debt levels and providing additional resources to achieve the Millennium Development Goals (MDGs) by 2015.

Nicaragua can be financed only in conditional terms (not less than 35% of concessionality). By the year 2010, under HIPC and MDRI has achieved total relief formalize 6.954 million dollars, equivalent to 87 percent of the planned total relief. As a result of debt relief and maintain a policy of debt on concessional terms, debt has decreased gradually. The debt forgiveness path excluding bilateral donors can be appreciated in the graph below.



**Graph 5**

The latest analysis of debt sustainability published by the IMF notes that Nicaragua has a moderate risk of debt problems and the presence of vulnerabilities to deteriorating terms of financing and risk degradation product of the quality assessment of policies and institutions, which sets a lower threshold of permitted indebtedness (IMF, 2011).

The implicit assumption of this analysis is that the country will maintain a quota on the realization of the prospect of growth in the baseline scenario posed in the quality and sustainability of economic policies and institutions. However, high levels of domestic debt and private debt (contingent) can cause a significant risk in the medium term as it is not covered by this analysis.

Under the DSF the international financial institutions prepare a Debt Sustainability Analysis (DSA), the 2011 report for Nicaragua establishes that it “maintains a moderate risk of external public debt distress, with vulnerability arising from worsening financing terms and a historical scenario that indicates a significant risks should growth and the envisaged external adjustment not materialize.” (IMF, IDA, 2011).

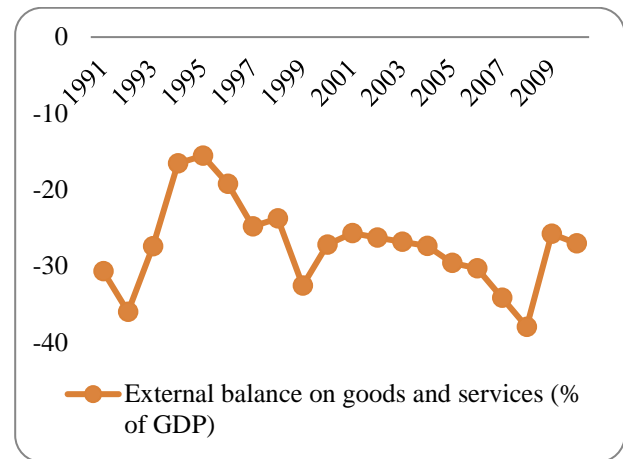
This is despite the lower debt threshold established since the reclassification as a medium performer in terms of policies and institutional quality.<sup>7</sup>

### Nicaraguan Economic Vulnerabilities

When a government spends more than it earns we call the excess of government expenditure over government revenues the government’s budget deficit. When a nation as a whole spends more on foreign goods and services than it earns by selling exports to foreigners we call the excess of expenditures over income the nation’s trade deficit. Since the nation earns income by selling exports and since it spends accumulated assets by purchasing imports, the trade deficit is equal to imports minus exports.

In recent years the government has typically spent more than it earns – the difference has been made up by accumulating debt.

The methodology used to determine the vulnerability to external shocks of the Nicaraguan economy coming from the large trade deficits. We analyze balance of payments, to determine the weight of the variables -external financing, exports, remittances and foreign direct investment - to the economy and its role to finance the external imbalances reflected in the historical current account deficit.



**Graph 6**

In an open economy, domestic savings can be supplemented by many kinds of external assistance. In this investigation we shall consider the various types of foreign assistance, including bilateral assistance from developed countries, multilateral assistance from international financial institutions, foreign direct investment, and remittances, which in recent years has come to dominate the financial flows to the country.

Nicaragua has a foreign exchange gap, which manifests itself in a chronic balance of payments deficit on the current account, while domestic resource lies idle. These deficits require financing not only interests of countries themselves, but the sake of the growth momentum of the whole economy.

<sup>7</sup> Threshold for the present value of external public debt to GDP ratio from 50 to 40 percent.

The debt problem is a foreign exchange problem. It represents the inability of debtors to earn enough foreign exchange through exports to service foreign debts, and the same time to sustain growth of output (which requires foreign exchange to pay for imports).

Countries are allowed to run deficits, sometimes for subnational periods of time, financed by capital inflows from abroad from a variety of sources such as – foreign aid, foreign direct investment (FDI), exports and remittances. A positive growth of capital inflows will allow a country to grow faster than would be the case if it was constrained to maintain balance of payments equilibrium on the current account. This flow of capital allows Nicaragua to import more than they export and to invest more than they save.

This paper discusses the role of the Nicaraguan economic vulnerabilities in contributing to the debt sustainability framework. We investigate the role these factors – foreign aid, foreign direct investment (FDI), exports and remittances – played a role in contributing to the solution of the debt problem.

## Vulnerability Factors

### *Exports*

From an overall perspective of the production structure Nicaraguan agriculture accounted in 2011 for 21% of total gross value added in GDP and use 30% of employment. The industry constituted 30% of gross value added and occupied 20% of employment. The sector heavier jurisdiction over services, 49% of total gross value added and employment to 50% of the workforce.

Nicaragua is primarily an exporter of raw materials, production structure has been characterized as export-oriented, this is a sector in turn strongly disassociated from the rest of the economy. In 2010 it exported a total of 1,851 million of goods of which food was 88% and 7% manufacturing.

While in commercial service concept was exported \$ 430 million, of which 72% were service travel. Exports of goods and services in 2010 amounted to 41% of GDP.

The export sector is concentrated in a few products of total exports, the top ten products account for 81%, implies susceptibility to international price changes and external sector demand.

In addition, 55.3% of total exports are concentrated in the United States (30.6%), Venezuela (13.4%) and El Salvador (11.1%).



**Graph 7**

In 2010, we may note that the 5 main exports: coffee, meat, gold, peanuts and shrimp accounted for 53% of total exports that year.

This implies that it is highly dependent on international price changes and external sector demand.

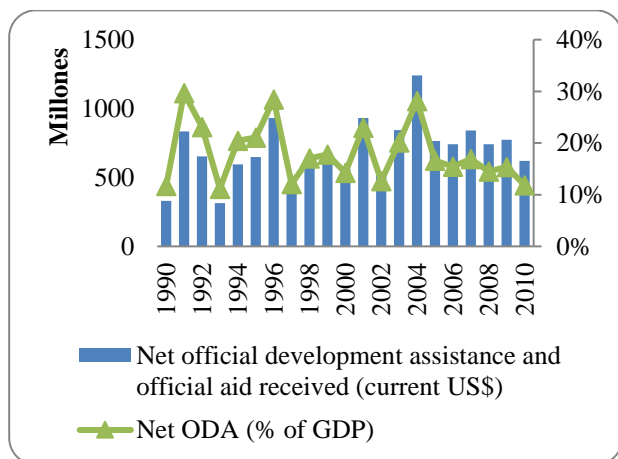
**Foreign Aid**

The foreign aid has played an important role in financing the trade deficit and the balance of payments.

With the flow of resources such as official development aid (ODA), debt forgiveness and concessional loans.

There has been a lot of volatility of the ODA and foreign aid, but through the period 1990 to 2010 Nicaragua has received an average of 897 million dollars a year and if we analyze its weight respect the GDP has been around 18%.

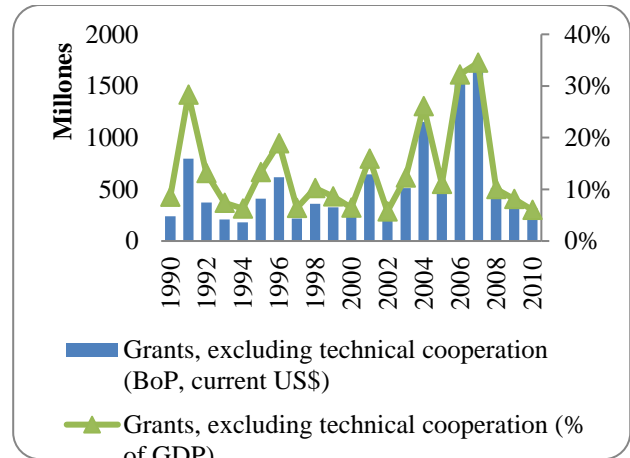
This flow of resources exclude the oil financing scheme that Nicaragua has with Venezuela that account as much as 7% of GDP that amounts of half of oil bill from Venezuela that accounts as a long term concessional loan.



**Graph 8**

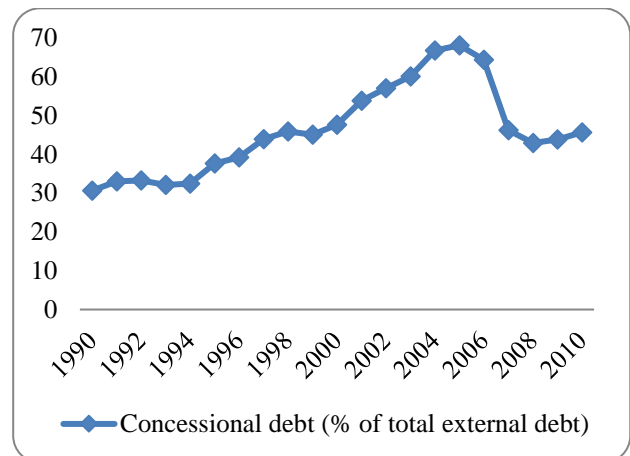
To illustrate the external dependence of external resources we show the quantity of grants received by Nicaragua.

These resources are used to promote economic development and finance social programs.



**Graph 9**

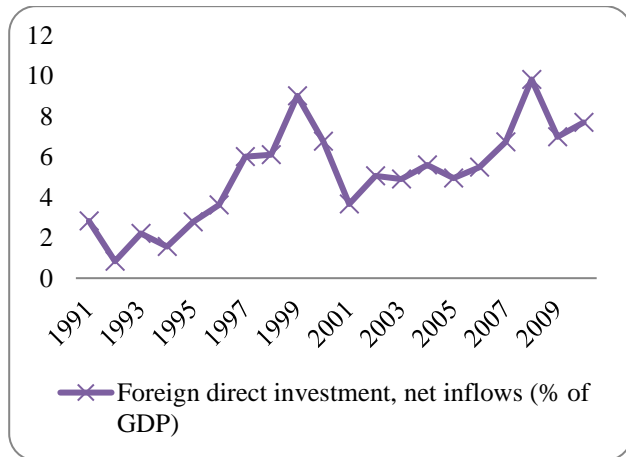
Since the entrance of Nicaragua in the HIPC initiative the external loans are under concessional terms (grant element) with at least 35%. Continued external financing on concessional terms allows for the reduction of market-based debt, the concessionality of the loans during 2000 to 2010 have an average of 57% of concessionality. A large quantity of external debt burden is concessional debt, 45% of the debt was concessional debt.



**Graph 10**

**Foreign Direct Investment**

In Nicaragua, much of the foreign direct investment has been allocated to the production system in the form of textile factories. We find that it represents 30% of total exports and 118 companies that generate 69,000 direct jobs (BCN, 2010, pág. 32). The weight of FDI has significant Nicaraguan economy, it has a positive impact on trade flows, investment and employment growth have been progressively impacted the country's economic opening.



**Graph 11**

**Remittances**

They account for 12.5% of GDP around 20% of households reported receiving remittances according to the National Census of 2005, which.

The current foreign exchange generated by placing much of the savings of migrants in their country of origin, generated financial revenues that serve to mitigate the problems of balance of payments of the host country and develop its economy.

In general terms, quantitative and qualitative changes occur with respect to the relationship between remittances and current account. In principle, we could say that some fluctuations remained relevant.

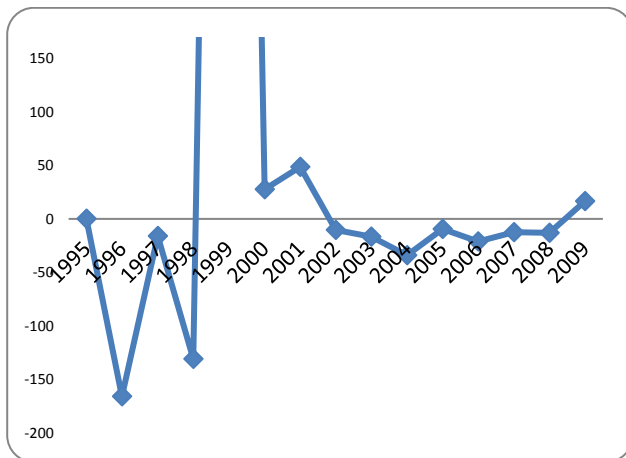
The remittances play a role as a balancing mechanism of the balance of payments, the steady increase since the nineties and continuity, have made it a substantial source of funding for the importance Nicaragua in amount to GDP.



**Graph 12**

**Vulnerabilities to External Shocks**

Nicaragua has 2 problems with the terms of trade, the first its volatility and the negative effects as seen in the graph below:

**Graph 13**

- Family remittances directly influence the exchange rate appreciation. The study of BCN Remittances and Real Exchange Rates in Central Bank of Nicaragua explore the effect of remittances on the real exchange rate in the period 1994.I-2007.IV. (Bello, 2010)
- The open condemn of anomalies by the International Community of electoral proceses of the Municipally elections of 2008 and presidential elections in 2011 have lowered the bilateral grants. Nicaragua currently receives grants from Venezuela and the Multilateral Institutions narrowing the number of donors.
- FDI has been channeled to energy projects with the principal investor as the Venezuelan government, exposing risk due to the political nature of the investments and the state of president Chaves health.
- The simulation of (CEPAL, 2010, págs. 37-38) estimating a 50% reduction in different variables such as remittances, FDI, terms of trade shocks and foreign aid from the rest of the world affect greatly social variables and macroeconomic variables that can put at risk the financial solvency of Nicaragua.

### Debt sustainability framework

Working out what level of debt is sustainable requires an assessment of how outstanding stocks of debt are likely to evolve over time, together with forecasts about the future interest rates, exchange rates and foreign exchange earnings. The IMF and WB has recently developed a standardized framework for assessing debt sustainability which takes account of a country's future growth rate, interest rate and exchange rate, and applies sensitivity analysis based on each country's history.

The present paper analyses the World Bank (WB)- International Monetary Fund (IMF) debt sustainability framework (DSF) for low income countries (LICs) which objective is of the framework is to "support low-income countries in their efforts to achieve the Millennium Development Goals (MDGs) without creating future debt problems, and to keep countries that have received debt relief under the HIPC Initiative on a sustainable track" (PNUD, 2007).

This section is based on a review of official writings of the DSF, which have set the standard both in formulation and implementation of theoretical concepts. Then we address the critical views on the current tool in a subsection called Alternative Framework.

The synthesis of DSF was derived from the following documents consulted: (IMF, 2012); (IMF, 2011); (IMF, IDA, 2010); (IMF, 2009c); (IMF, WB, 2009b); (IMF, 2009a); (IMF, IDA, 2008); (IMF, WB, 2007); (IMF, WB, 2006a); (IMF, WB, 2006b); (IMF, IDA, 2005); (IMF, IDA, 2004a); (IMF, IDA, 2004b); (IMF, 2003); (IMF, 2002).

**Background**

The advice of external sustainability is a work item of the IMF and World Bank advising countries in the implementation of economic policies, based in the context of monitoring programs that assess the ability of countries to pay when they issue debt.

If the need arises and financial adjustments, these in turn jeopardize the inherent stability and economic partner.

The IMF and World Bank developed the DSA which was operational since 2002.

To improve detection of potential crisis with a new driving external debt process seeks transparency through effective information. The objectives of this tool are (FMI, 2003): i) Identify the level of debt, maturity, payment structure, if the interest is fixed or floating, if indexed and who are holders ii) Identify vulnerabilities debt structure or identify future risks early enough to make policy changes before incurring payment problems, and iii) In case of problems, or imminent emergence, examine various alternatives stabilization policies.

The DSA is sectored in total external debt. For both cases is used to measure the same in terms of net present value, because they contain concessional loans in the portfolio.

Each component consists of: i) a baseline scenario, based on a series of assumptions that link macroeconomic policies that the government intends to implement, the main ones are: public debt, tax assumptions, macroeconomic, and closing new funding gap, among others parameters clearly itemized

ii) A series of sensitivity analyzes applied to the base scenario, providing a probabilistic assessment debt dynamics under various conditions over variables, macroeconomic and financial cost.

**IMF and WB framework**

The IMF and WB defines sustainability as “an entity’s liability position is sustainable if it satisfies the present value budget constraint without a major correction in the balance of income and expenditure given the costs of financing it faces in the market (IMF, 2002, pág. 5). This definition implies 3 things as exposed in (Wyplosz, 2007), that the definition includes i) liquidity constraints, the second, ii) an estimation of financing cost and iii) a vague definition of what is a “mayor correction” , because is a matter of judgment.

The international community implemented a number of initiatives for debt relief that permitted lowering the level of indebtedness of some LICs, recovering the susceptibility to new loans to finance their development needs.. The implementation of multilateral initiatives made possible - in a context of economic growth, a higher contribution of fiscal resources to the fight against poverty and social spending (FMI, BM, 2009).

Despite the success of lowering the debt burden they achieved, it does not guarantee that the phenomenon is not re-emerge with new loans on very favorable financial conditions.

The reason why the IMF and WB develops this tool for LICs is to prevent future debt crises by monitoring the debt burden of these countries and to help agent’s policymakers to develop strategies for sustainable debt in the medium and long term (FMI, 2006).



### Methodology of debt sustainability framework for Low Income Countries

The design of a guide for countries and donors in mobilizing funding for this DSF was created as part of the Millennium Development Goals (MDGs). The IMF and World Bank in awareness of the needs of development and at the same time to avoid excessive accumulation of debt in the future (FMI, 2011).

Key elements considered for drawing the new methodology were: i) Provide guidance regarding decisions of new debt in LICs, so that the financing needs of agree with your ability to pay current and future, taking into account the particularities of each country, ii) Provide guidelines for the granting of loans and grants by the creditors / donors, so that you can ensure that resources are allocated to LICs in terms consistent with both its process, as compared to their development goals, as well as the sustainability of long-term debt, iii) Assist detect potential crises early so that preventive action can be taken (CEMLA, 2009, pág. 5)

The DSF is a standardized analytical framework that allows comparison between countries, but is flexible to address characteristics of each circumstance that crosses a country. Based in these pillars: i) An analysis seen forward foreign debt and the dynamics of the sector and debt service under a baseline scenario, alternative scenarios.

And sensitivity analysis standardized ii) A scenario-based sustainability benchmark thresholds debt sustainability depends on the quality of the country's institutional policies and

iii) Recommendations on borrowing strategy to limit the risk of crisis paid.

The objective of the DSF for LICs is supported in their efforts to achieve their development goals without creating debt problems in the future.

The countries that have received debt relief under the initiatives: i) HIPC ii) MDRI need to stay on a sustainable path. Under this framework, an analysis of debt sustainability DSA is prepared jointly by the World Bank and IMF officials who collaborate in the design of the base situation macroeconomic alternative scenarios, risk assessment and preparation of written debt.

In this approach associated benchmark indicators of debt sustainability to the quality of policies and institutions of countries.

The argument is based on empirical studies relating to countries with strong policies and institutions have a greater chance of withstanding a higher debt load and is therefore less likely to experience debt problems, unlike countries with weak policies and institutions.

Thresholds have been set aside for countries referential policies and institutions with strong, medium and weak. The quality of policy implementation and institutional strength is measured Teves index IDA resource allocation (IRAI).

- Prior assessment of Country Policy and Institutional Assessment<sup>8</sup> (CPIA), whose scale is 1 to 6: (see Figure 1 Resource Allocation Index IDA).

<sup>8</sup> The CPIA is an index of 16 indicators grouped into four categories: (1) economic management; (2) structural policies; (3) policies for social inclusion and equity; and (4) public sector management and institutions. Countries are rated on their current

status in each of these performance criteria, with scores from 1 (lowest) to 6 (highest). The index is updated annually for all IDA-eligible countries, including blend countries.

In (IMF, 2012) describes that the DSF consists of “a set of indicative policy-dependent thresholds against which projections of external public debt over the next 20 years are compared in order to assess the risk of debt distress. Vulnerability to external and policy shocks is explored in alternative scenarios and standardized bound tests. The indicative threshold for each debt burden indicator depends on each country’s policy and institutional capacity, as measured by the World Bank’s Country Policy and Institutional Assessment (CPIA) index”. The specific thresholds are as follows:

A	PV of debt in percent of			Debt service in percent of	
	GDP	Exports	Revenue	Exports	Revenue
Weak policy (CPIA ≤ 3.25)	30	100	200	15	25
Medium policy (3.25 < CPIA < 3.75)	40	150	250	20	30
Strong policy (CPIA ≥ 3.75)	50	200	300	25	35

Based on the assessment, one of four possible risks of debt distress ratings is assigned:

- Low risk: All the debt burden indicators are well below the thresholds.
- Moderate risk: Debt burden indicators are below the thresholds in the baseline scenario.

But stress tests indicate that the thresholds could be breached if there are external shocks or abrupt changes in macroeconomic policies.

- High risk: One or more debt burden indicators breach the thresholds on a protracted basis under the baseline scenario.

- In debt distress: The country is already experiencing difficulties in servicing its debt, as evidenced, for example, by the existence of arrears.

### Discussion on the threshold of sustainability

The approach based on the "debt overhang"<sup>9</sup>, which is defined as the negative effect of a high debt burden has on economic growth. In this case, sustainability thresholds should be defined according to the level at which debt begins to have the negative (Krugman, 1988).

There is disagreement about the level of the threshold used by the IMF and World Bank because it omits negative effects on growth.

Debt financing can generate a positive impact on investment and growth if they produce enough returns to service the same. Otherwise, to high levels of debt, anticipating tax increases required to pay the debt would cut investors gains (Krugman, 1988), having a negative impact on investment and growth.

The volume of private investment may be restricted as a result of high interest rates and credit constraints, due to excessive government borrowing (crowding out). At high levels of debt (debt overhang), this harmful effect dominates, affecting physical capital accumulation, as well as all production factors that promote growth. Product of the growing difficulties of debt service generated expectations that part of the debt will be forgiven, therefore discourages investors to provide new financing and consequently reduces government borrowing, in a search for economic policies that strengthen ability to pay.

<sup>9</sup> It can also be defined as Debt overhang is defined as the situation where outstanding debt is so large that investment will

be inefficiently low without sizable debt or debt service reduction (Claessens & Diwan, 1989).

Various authors like (Pattillo, Poirson, & A. Ricci, 2002), (Clements, Bhattacharya, & Quoc Nguyen, 2003), (Kraay & Nehru, 2004) (Cordela & Levy Yeyati, 2006), (Imbs & Ranci re, 2005) and (M. Reinhart & Rogoff, 2010) conclude the presence of negative effects of debt over economic growth but differ the debt ratio threshold were it initiates.

Analyzing the case of Nicaragua we find that empirical studies such as (Bannister & Barrot, 2011) conclude that above the 28% debt to growth ratio the presence of debt overhang effects. The DSF does not take into account the debt overhang into consideration in the determination of debt sustainability thresholds.

This idea contradicts the determination of the debt threshold present in the DSF. Debt is sustainable, according to the creators of the it, when a borrower is able to continue servicing its debt without incurring large corrections to your income and expenses. Sustainability relates to the solvency and the liquidity. Sustainability also captures the notion that there are political boundaries, which define the will of a country, as opposed to their economic capacity to pay, which will be important in the context of sovereign independence.

The debt sustainability analysis (DSA) is to determine the patterns of debt that can be maintained without incurring problems with the payment of debt service or having to resort to exceptional financing (debt restructuring or build it). The DSA provides a link between the debt dynamics and macroeconomic policy and therefore have a look into the future using probabilistic estimates.

Proper design of a debt strategy must take into account country-specific circumstances. The ability of a country to absorb new elements, some of which are structural weaknesses in the economy in question.

Some of the elements that influence the propensity to save are private sector, the degree of financial market development, growth rate of productivity, the government's ability to raise taxes, expand tax base and cutting subsidies and exemptions. It is not possible to identify a universal indicator that determines levels of debt is safe or dangerous, it can be assigned to a group of countries with similar economic characteristics. There is a general acceptance that what the levels are those levels but are only indicative or ranges.

The debt intolerance hypothesis, developed by (Reinhart, Rogoff, & Savastano, 2003) states that countries with a default and inflation history are more vulnerable that a country that does not have. This paper gives an idea that a universal debt ratio threshold can be wrong. For example, many economists are surprised to learn that the DSF for emerging countries states that debt ratios above 150% GDP pose high risk of default. This threshold is contradicted by the empirical evidence: for example, in 1982 the Mexican crisis occurred with one ratio of DET / GDP of 47% and Argentina crisis occurred in 2001 with a ratio DET / GDP above 50

External debt-to-GNP range in first year of default or restructuring	Percent of total defaults or restructurings
Below to 40%	13
41% to 60%	40
61% to 80%	13
81% to 100%	20
Above 100%	13

**Table 2**

**Alternative debt sustainability framework for Nicaragua**

We identified economic vulnerabilities in section 2, the DSF variables used to establish the debt ratios give a limited perspective to analyze the case of Nicaragua. We propose the need to incorporate the potential nature of external shocks on Nicaragua in the sustainability analysis to assess its ability to generate the resources to pay their debts.

The DSF needs stronger designing scenarios that reflect a more credible economic policy and institutional framework of the country, its external environment and in this context, assessing the impact of additional debt to finance public spending. Second, it appeals to the strengthening of the preventive capabilities already contained within the framework of debt sustainability. And finally there is the need for a more thorough and prudent macroeconomic assumptions, particularly regarding economic growth and debt, and policies when the rate of borrowing exceeds a certain threshold (IMF, 2005).

From a sustainability perspective: remittances, FDI and foreign aid can affect the ability to pay (exports and GDP). All these variables increase the foreign exchange needed available in a country.

Despite needs to fund utility imports, exports also may be associated with large import requirements. Also alleviate resource constraints and the impact of changes in GDP growth generated domestically. Nicaragua experienced senior currency revenue flow.

The lack of adequate and comprehensive statistical series has prevented formal inclusion in sustainability analysis.

Only GDP, exports and goods and services tax revenues are used in the analysis of sustainability as proxies for the ability of payments.

All this leads to recommend the incorporation of family remittances, foreign direct investment and official development assistance in the analysis of key indicators of sustainability of public debt and public debt.

Proposal	External Debt / Family Remittances
	External Debt / FDI
	External Debt / Official Development Assistance

This would be a strategy to generate a tighter access to the Nicaraguan economy from reality in order to challenge the vulnerabilities.

**Conclusions**

Throughout this paper we have shown that there are deficiencies in the analytical framework of multilateral debt sustainability, DSF, in the case of Nicaragua by omitting key variables used to balance the current account balance.

This exposes a structural problem for in the debt management and debt sustainability in a long term perspective.

The DSF approaches debt sustainability to an investigation of the situation of financial solvency. There is a methodological problem in the analytical framework to analyze the risk multilateral debt of poor countries like Nicaragua: analysis based on annual data and focused on short-term responses to exogenous shocks are not well posed to investigate the impact the medium and long term in the context of the current economic crisis, and how it is affected by the structural characteristics of the economy.

In conducting an analysis of the external situation of the economy by assessing the current account deficit of the balance of payments remains fragile. The main cause of the deficit has been overspending in relation to income. The external imbalance has been financed by external funding; official external financing and private capital flows, which becomes an unsustainable in the medium to long term, vulnerable to exogenous shocks.

Our alternative approach of current DSF, suggest the need to incorporate additional indicators and measures Nicaraguans sustainability due its economic vulnerabilities. We argue the need to lower the debt ratio threshold currently applied in the framework in order to avoid the negative effects of levels of debt, debt overhang.

Vulnerabilities of the Nicaraguan economy found were: i) external financing, ii) export, iii) remittances, and iii) FDI.

It is difficult to assess the sustainability of external debt to shocks to the possibility of a significant drop in official development assistance, remittances and foreign direct investment that could threaten the financial solvency.

The phenomena that produce any of these conditions can cause fiscal imbalances that limit the ability of debt and should be considered in the DSA.

## Appendix

Year	Percentage				Millions of Dollars				
	External Debt/ Exports		External Debt Service/ Exports		External Public Debt	External Debt Service	Exports year	GDP	
1970	94	24	13	3	188	27	216		777
1971	101	26	15	4	213	34	225		827
1972	101	29	11	4	255	35	320		881
1973	123	34	12	4	368	44	349		1094
1974	135	33	11	3	503	49	452		1521
1975	154	40	12	4	644	56	456		159
1976	133	37	14	5	681	88	623		1948
1977	145	39	13	4	874	98	733		224
1978	136	45	13	5	961	103	770		2142
1979	219	97	10	4	1562	62	634		1613
1980	293	89	26	6	1851	130	492		208
1981	452	104	34	8	2337	192	557		2448
1982	607	111	45	7	3033	203	451		2726
1983	795	159	31	6	399	154	498		2511
1984	989	167	34	6	465	158	462		2778
1985	1271	220	41	6	5522	142	344		2509
1986	1791	293	40	5	6464	110	277		2204
1987	2614	361	39	5	8045	117	302		2231
1988	3082	595	41	7	8622	107	261		1449
1989	3217	940	20	6	9597	66	333		1021
1990	3269	707	14	4	10715	54	390		1517
1991	2883	643	177	39	10313	618	350		1605
1992	3081	602	56	10	10792	172	310		1793
1993	3217	626	53	11	10987	194	364		1756
1994	3083	393	52	8	11695	242	464		2976
1995 <sup>3</sup>	2136	321	53	10	10248	324	612		3191
1996	1063	184	36	7	6094	229	644		3320
1997	877	177	36	8	6001	287	797		3383
1998	830	176	28	6	6287	231	830		3573
1999	797	175	20	5	6549	169	839		3743
2000	762	169	19	5	666	185	954		3951
2001	698	159	16	4	6374	153	947		4016
2002	680	159	17	4	6362	158	907		4007
2003	694	160	10	2	6596	98	997		4135
2004 <sup>4</sup>	521	122	6	2	5391	76	1200		4418
2005	379	139	6.6	2	3347.5	92.6	1411.1		4872
2006	274.4	112	6.2	2	4526.7	102	1649.7		5230
2007	179.8	82.2	8	3	3384.6	151.1	1881.9		5662
2008	155.7	74.8	4.5	2	3511.5	101.3	2254.9		6372
2009	167.5	80.1	4.8	2	3660.9	104.6	2185.6		6214
2010	143.1	78.5	3.6	1	3876.4	96.8	2708.6		6552

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**The financing of the current account balance of the United States, 2000-2011**

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The objective of this study is to analyze the sources of funds for the balance of current account in the United States in the period 2000-2011. The theoretical framework is based on an economy open according to Samuelson. The result is that the sources of financing of the current account balance are: the balance of financial account, surplus savings countries such as China, Japan, United Kingdom and the oil exporting countries, which picked up through the bonds of the United States treasure. Also other sources of external financing are central banks and other official agencies foreign, as well as other capital flows such as: deposits, loans to the Government or the private business sector, or the purchase of shares, movable property or financial instruments with mortgage bonds.

**Balance of current account surplus of external savings, Treasury bonds.**

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## Introduction

The economy of the United States has three decades with deficit in the balance of current account.

In 2000 the deficit stood at -416, 339 millions of dollars, increasing gradually to reach in 2006 the figure of -800, 621 millions of dollars. In 2007 decreased to -710, 304 millions of dollars and then -376, 551 millions of dollars in 2009 and finally -473, 441 millions of dollars in 2011.

This behavior is due to an increase in investment and household consumption.

Hence the interest of this work in determine the sources the financing the deficit in the balance of current account in the period 2000-2011.

This is part of a theoretical framework based on an open economy as Samuelson in establishing that the deficit in the current account balance is due to an excess of investment over savings or failure of the latter.

According to analysis of the percentage of savings and investment with respect to GDP of the United States the percentage of investment is always greater than the savings.

After establishing the theoretical framework analyzes the different sources of financing of the current account balance. Finally, conclusions are presented.

One is that one of the sources of financing of the United States is the external savings surplus countries like China, Japan, United Kingdom, oil exporting countries and other countries, which is obtained by placing bonds of the United States in these countries.

## Theoretical Framework

In an open economy like the U.S. current account balance is defined as the difference between exports and imports.

The current account balance has more items (net income, transfers abroad) but with less weight in the total accounting, being the most significant trade balance.

According to Samuelson (2006) if we start from the accounting identity:

$$Y = C + I + G + XN \quad (1)$$

Where:

Y = national income

C = Consumption

I = Investment

G = Government Spending

NX = Net Exports

Passing consumption and government spending right side of the equation (1), the following equation results:

$$Y - C - G = I + XN \quad (2)$$

$$\text{Where } Y - C - G = S \quad (3)$$

Substituting for S (save) the term  $Y - C - G$  we have:

$$S = I + XN \quad (4)$$

Equation 4 indicates that in equilibrium national saving equals investment plus net exports. Rewriting equation (4) we have:

$$S - I = XN \quad (5)$$

### Sources of financing the current account balance

According to equation (5) a deficit in the current account balance is due to an excess of investment over savings, or insufficient savings relative to investment.

Figure 1 shows that since 1997 in the U.S. investment is greater than the saving. In the period 1997-2004 the percentage of saving to GDP is 16, while the investment is 20%.

These figures drop from 2006, reaching the saving 15% in 2007, while investment continues at 20%. In 2009, the saving is 12% and 17% the investment.

While in 2010 the saving is placed in 11% and investment in 15%. However, always is maintained the trend that the share of investment to GDP is greater than the saving.

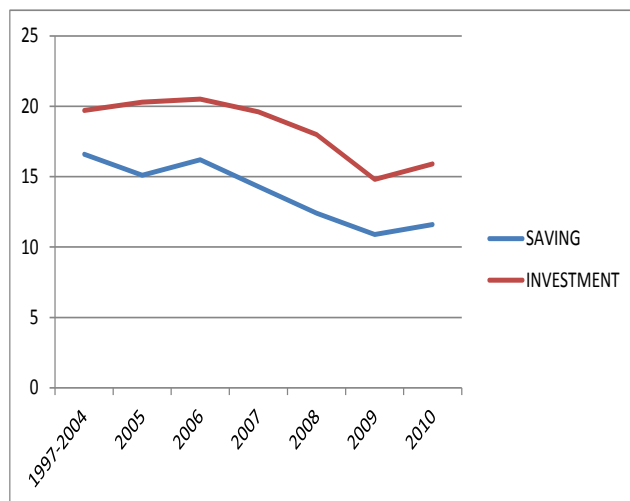


Figure 1

Carranza (1997) affirms that considering the current account balance as the difference between saving and investment.

Result a deficit as consequence of a higher rate of investment this causes increased growth and greater solvency, otherwise, if a rate of saving descend which causes the deficit it originates external passive accumulation that doesn't causes output growth, and the country's solvency deteriorates.

Generally when imports are greater than exports this is a problem of competitiveness.

However in the case of the United States investment is greater than saving implying that is a productive economy is growing (Atish, 2006).

According dates of the World Economic Forum 2009, the competitiveness of the United States passed first place to second, the first place to Switzerland and the second to the United States.

The level of competitiveness of the United States continues to decline from second place in 2009 to fifth in 2011.

However, the weakness of the United States is at the level of macroeconomic stability, in 2008 held the place 63 and in 2009 the 93.

Given that the United States has negative net exports they have to be financed by net foreign investment which "represent the net savings of the United States in the abroad" (Samuelson, 2006: 595).

These negative net exports mean that net foreign investment was negative so the United States debt increases in the abroad.

This represents an accumulation of obligations of the United States to the rest of the world that have to finance through of the financial account balance, at a certain point have to pay (Atish, 2006).

Consistent with this idea, Bernanke (2005) argues that the deficit of the current account balance is financed by an excess global saving.

However, many advanced economies have slow growth and shortage of labor and few unlikely of national investment. So when there is a persistent deficit in the current account balance is convenient to analyze how much will pay the debt and whether if the loans generate an investment with a marginal productivity higher than the interest rate charged by foreign creditors to have the necessary solvency to pay debts that contract.

As is mentioned to finance the current account balance must capture the equivalent of foreign savings that exists in international markets, they have to take global saving surplus (Higgins, 2007: 2).

Thus, the current account deficit of the United States has its counterpart in the surplus of China, Japan and Germany as well as in oil-exporting countries due to high oil prices that occurred in the past decade.

These countries exported the 52.6% of total capital flows in 2008, of which the United States attracted 43% of such flows. The issuance of treasury bonds of the United States was the primary means to capture these flows.

In Figure 2 shows that the placement of treasury bonds have increased substantially moving from 100,000 millions of dollars in 2007 to 530,000 millions of dollars in 2008 and then to 550,000 millions of dollars in 2009 and after in 400,000 millions of dollars in 2010.

These figures reflect that these investments have increased by more than 4 times compared with 2007.

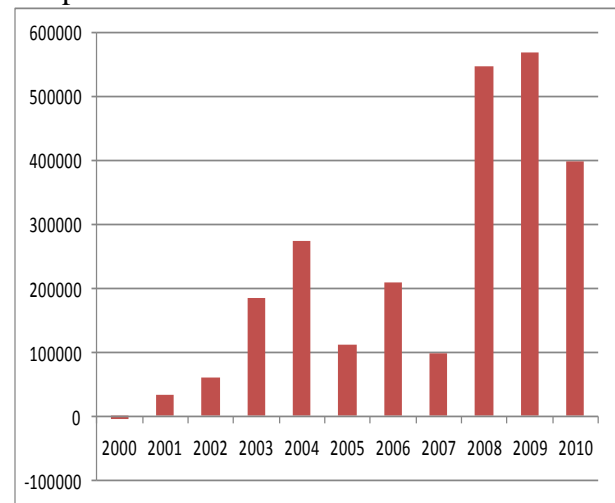


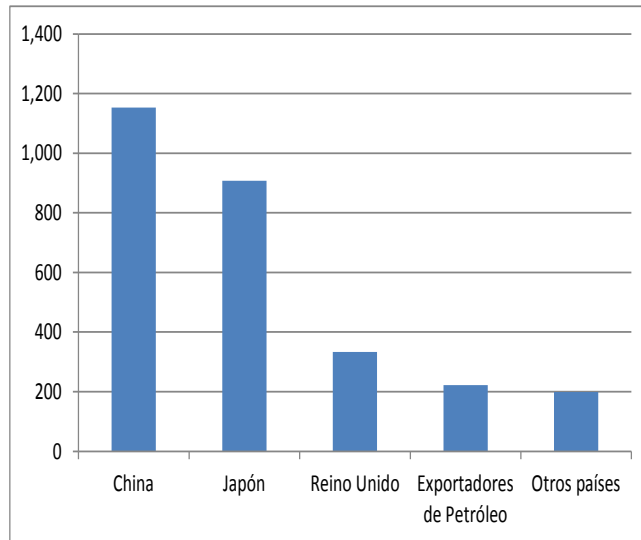
Figure 2

Also in Figure 3 shows that a major foreign bondholders in April 2009 is China with 1,190 millions of dollars, followed by Japan and the UK with 900 and 300 million dollars.

The oil exporting countries and other countries are in 200 billion of dollars.

Another source of external funding for the United States are central banks and others foreign government agencies. In 2006 it was the most important source of funding for the country.

The capital flows come in various ways such as: bank deposits, loans to the government or the private business sector, or the purchase of shares, movables assets and financial instruments with mortgage bonds (Fernandez, 2007).



**Figure 3**

The financiarización of the U.S. economy has allowed to the United States have a greater capture of financial mass that moves in international markets.

Obtaining thus their growth. In addition the United States has an advantage over its debt, because the United States investments in the abroad are more profitable than foreign investments in the United States (Cobarrubias, 2009).

The hegemony of the dollar has helped to the United States to finance its deficit of current account through the entry of foreign capital.

This means that even if the deficit of current account increases, the overvaluation of the dollar may encourage foreign capital inflows.

However there is a risk, if the deficit of current account is continue, the country acquire debt every year with year and if the creditors do not want to finance the current account balance it becomes in a problem and the economy may be in crisis.

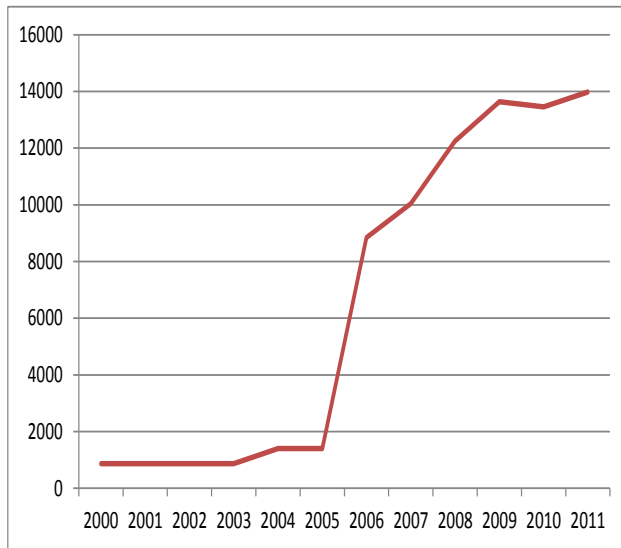
If the debt is short term, there is a problem, the creditors can demand now loans that financed the current account balance from previous years (Stiglitz, 2002).

Nevertheless, some very important, is that the income balance has a surplus.

Although the United States show a debit with the exterior, the assets of the United States in the abroad have a higher return than the cost of its liabilities.

Which help moderate the growth of its debt (Fernandez, 2007).

To respect in Figure 4 shows that external debt increased substantially since 2005 from 6,000 million to 14,000 million dollars in 2011, representing an annual average growth rate of 40.7%.



**Figure 4**

## Conclusions

This article analyzes the sources of financing of the current account balance of the United States in the period 2000-2011.

To this end, part of a theoretical framework that is based on an open economy according Samuelson (2006) which establish that a deficit in the current account balance is due to over-investment relative to saving or failure of saving over investment.

For the United States the share of investment in GDP is always greater than the saving.

In the period 1997-2004 these percentages are 20% and 16% respectively.

While in 2007 are 20% and 15% and in 2010 15% and 11%, which means it is a growing productive economy.

However their competitiveness has declined. En 2009 held second place and in 2011 fifth.

The fact that investment is greater than saving means that net exports are negative, it implying that net foreign investment is negative and the accumulation of obligations of the United States with the rest of the world that have to finance through balance of financial account.

Another way to finance the deficit of the balance of current account is through saving surplus from developed countries like China, Japan and Germany and the oil-exporting countries and other countries.

This surplus is captured through the placement of treasury bonds of the United States, which grew substantially from 2008 recorded a figure of 530,000, 570,000 and finally 400, 000 million of dollars in 2008, 2009 and 2010, respectively.

Also other sources of external financing are central banks and other foreign government agencies and other capital flows such as: bank deposits, loans to the government or the private business sector, or the purchase of shares, movables assets with bonds mortgage.

Other factors that contribute to attracting external resources are the financiarización of the United States, which has allowed have a greater capture of financial mass in international markets.

In addition the United States has an advantage over their debt the investments in the abroad are more profitable than foreign investments in the United States.

The overvaluation of the dollar also has financed its deficit of current account by foreign capital inflows.

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**Spanish saving banks (2000-2009): efficiency and productivity analysis**

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The important role played by the savings banks in the Spanish financial system explains the matter of their performance and development levels during 2000-2009. This paper aims to analyse the efficiency and productivity levels of this sector prior to its current restructuring. The methodology used is the nonparametric approach to efficiency frontiers of Data Envelopment Analysis by estimating the Malmquist productivity index. This methodology is used by many researchers to investigate how to measure the enterprises performance. The results show that the sector reaches its optimal performance level with no change in efficiency, but a positive productive deviation due to the technological change. In conclusion, the Spanish saving banks will have to increase their level of productivity focusing their efforts on boosting the efficiency level in order to step up their competitiveness.

**Savings banks, efficiency, productivity, Data Envelopment Analysis, Malmquist Index.**

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## Introduction

The important role of savings banks in the Spanish financial system along with the impact of the crisis that the world economy has been suffering since 2008, justify the need to analyze their efficiency and productivity developments before the financial restructuring started in 2010, currently underway.

The Data Envelopment Analysis (DEA) is one of the tools used to measure the efficiency.

It was proposed by Charnes et al. (1978) to calculate the efficiency of a set of decision making units (DMU) based on observed best performances.

An advantage of DEA is that the results obtained can measure an entity's productivity between two periods of time, using the Malmquist productivity index. The index can be decomposed into two components: efficiency change and technological change.

The aim of this document is to measure the efficiency and productivity of the Spanish savings banks during the period 2000-2009, providing information on their evolution from two perspectives: static, through scores of efficiency and dynamic, provided by productivity change.

This document has been organized in the manner described below.

The second section explains the methodology, DEA and Malmquist productivity index models, used to measure the efficiency and productivity Spanish savings banks. The third section presents the main results.

Finally, the last section describes the main findings of the investigation.

## Methodology

### *Efficiency estimation*

The research that study the efficiency levels of Spanish banks, highlight those of Pastor (1995), Maudos, Pastor and Pérez (2002), Tortosa-Ausina et al. (2008), Escobar and Guzmán (2010).

Normally, efficiency is used to explain the level of performance that an economic decision unit can achieve from its production possibility set in accordance with existing technology.

Organizations spend various factors of production (inputs) at the same time to produce different goods or services (outputs).

Different techniques are necessary to jointly assess the relationship between these groups of variables, as well as to obtain the optimal production level and check the highest performance from a DMU in its economic environment. In this sense, Farrell (1957) was a pioneer studying the technical efficiency.

He analyzed the highest level of output in relation to a particular composition of inputs, considering that there is a particular production technology.

It is considered two different methodologies to determine the performance of a DMU: (i) parametric models that determine the functional form of the production function.

Using statistical techniques or mathematical programming to estimate the parameters according to the data given by the evaluated DMUs (Coelli et al., 2005) and, (ii) non-parametric models that take into account the properties that should satisfy all production possibilities, considering a boundary formed by the efficient DMUs, not necessary to assume, a priori, a functional form for the function production (Thanassoulis, 2001).

An important advantage of the non-parametric method compared with the parametric method is its high degree of flexibility to easily adapt to multiproduct environments not considering the price variable.

However, it also presents a disadvantage resulting from its deterministic nature, since any deviation from the efficient frontier can be attributed to inefficient behavior of the evaluated DMU.

### *Data Envelopment Analysis (DEA)*

From the doctrinal work of Charnes et al. (1978), DEA has predominated when measuring the efficiency of economic units. In the financial sector, the research done by Berger and Humphrey (1992), Thanassoulis (1999) and Drake et al. (2009) applied the nonparametric estimation for determining bank efficiency.

Casu and Molyneux (2003) applied the DEA to compare bank efficiencies across countries and Barr et al. (1994) applied the DEA to study the prediction of failure of commercial banks.

The mathematical formulation of DEA is developed through a linear programming model under the assumption that all DMUs are operating at their optimal scale of operations with constant returns to scale (CCR<sup>10</sup> model), which allows for overall technical efficiency ( $TCHEF_{CCR}$ ) without considering diseconomies of scale.

According to the objective of the research, to calculate the technical efficiency can take double orientation factors: input orientation which determines the maximum reduction of inputs to obtain a supported level of outputs, or guidance that specifies the maximum output created to a minimal level of inputs.

A way to measure the efficiency of Spanish savings banks, trying to get the best possible results, it is to use the orientation toward maximizing outputs.

According to Charnes et al. (1978) and assuming the existence of  $n$  DMUs that consume  $m$  inputs to produce  $s$  outputs, it can be mathematically formulated the output oriented DEA model under the assumption of constant returns to scale (CCR model) as follows:

$$TCHEF_{CCR} = \text{Max} \phi_o \quad (1)$$

Subject to

$$\sum_{j=1}^n \lambda_j x_{ij} \leq x_{io} \quad i = 1, 2, \dots, m \quad (2)$$

<sup>10</sup> Charnes, Cooper and Rhodes (1978)

$$\left(\sum_{j=1}^n \lambda_j y_{rj}\right) \geq \phi_o y_{ro} \quad r = 1, 2, \dots, s \quad (3)$$

$$\lambda_j \geq 0 \quad j = 1, 2, \dots, n \quad (4)$$

In formulas (1) to (4), grouped vectors  $x_{ij}$  and  $y_{rj}$  grouped respectively the consumed quantities of inputs and outputs by  $DMU_j$  produced, respectively.

The values  $(x_{ij}, y_{rj})$  represent the quantities by  $DMU_o$  consumed and produced. The variable  $(\lambda_j)$  indicates the weight of  $DMU_j$  to construct the virtual unit that can be obtained by linear combination of the other sample units from the unit  $DMU_o$  evaluated.

If we cannot get the virtual drive,  $DMU_o$  for which the problem is solved, it will be solved as efficient.

When solving the above formula (1) to (4), for each DMU it is obtained scalar value  $\phi_o$ , which represents the major output oriented obtaining greater outputs per unit assessed ( $DMU_o$ ).

Taking the unit value when the DMU is efficient and obtaining values bigger than unity for inefficient institutions, their level of technical efficiency is given by the inverse of the scalar value  $\phi_o$  ( $1/\phi_o$ ).

To overcome the difficulties in measuring the technical efficiency from inefficient scale technique, Banker et al. (1984) proposed an alternative model in which the restriction  $\sum_{j=1}^n \lambda_j = 1$  added to CCR model (Charnes et al., 1978), assuming the hypothesis of variable returns to scale (BCC<sup>11</sup> model, Banker et al., 1984). This allows to calculate pure technical efficiency ( $TCHEF_{BCC}$ ) considering the operations scale of organizations regarding the efficient DMU evaluated in each case.

### Malmquist Productivity Index

This methodology was originally introduced in the field of consumption theory from doctrinal research by Malmquist (1953), applied by Caves et al. (1982), to measure productivity in the context of production functions and Färe et al., (1989) under the DEA nonparametric approach.

Grifell-Tatjé and Lovell (1995) reported in their work Malmquist index measures the change in productivity, noting advantages thereof the following: i) it does not need to assume profit maximization or cost minimization, ii) to be functions based on distance, there is no need to know the prices of inputs and outputs and, iii) allows decomposition in certain elements that explain the causes of productive change. The same authors note that this index does not measure accurately the changes in productivity in the context of non-constant returns to scale (Tortosa-Ausina et al., 2008), therefore, assume the hypothesis of constant returns to scale (CCR model) output oriented.

<sup>11</sup> Banker, Charnes and Cooper (1984)

Expressing the Malmquist productivity index ( $M_o$ ) using the following mathematical formula (Färe et al., 1994):

$$M_o(y_{t+1}, x_{t+1}, y_t, x_t) = \left[ \frac{d_o^{t+1}(x_t, y_t)}{d_o^{t+1}(x_{t+1}, y_{t+1})} \cdot \frac{d_o^t(x_t, y_t)}{d_o^t(x_{t+1}, y_{t+1})} \right]^{\frac{1}{2}} \quad (5)$$

Where in (5),

$d_o^{t+1}(x_t, y_t)$ , is the distance function that measures the maximum proportional increase in output vector  $y_t$ , given input vector  $x_t$ , so that the observation  $(x_t, y_t)$  period is feasible  $t + 1$ .

$d_o^{t+1}(x_{t+1}, y_{t+1})$ , is the distance function that measures the maximum proportional increase in output vector  $y_{t+1}$ , given input vector  $x_{t+1}$ , so that the observation  $(x_{t+1}, y_{t+1})$  period is feasible  $t + 1$ .

$d_o^t(x_t, y_t)$ , is the output oriented distance function that measures the maximum proportional expansion of output vector  $y_t$ , given input vector  $x_t$ , so that the observation  $(x_t, y_t)$  is in the frontier of the period  $t$ .

$d_o^t(x_{t+1}, y_{t+1})$ , is the distance function that measures the maximum proportional increase in output vector  $y_{t+1}$ , given input vector  $x_{t+1}$ , so that the observation  $(x_{t+1}, y_{t+1})$  is in the frontier of the period  $t$ .

Rewriting the expression (5) it is possible to decompose the Malmquist productivity index ( $M_o$ ) into two components of technical efficiency change and technological change according to the following formulation:

$$M_o(y_{t+1}, x_{t+1}, y_t, x_t) = \left[ \frac{d_o^t(x_t, y_t)}{d_o^{t+1}(x_{t+1}, y_{t+1})} \right] \cdot \left[ \frac{d_o^{t+1}(x_t, y_t)}{d_o^t(x_{t+1}, y_{t+1})} \cdot \frac{d_o^t(x_t, y_t)}{d_o^t(x_{t+1}, y_{t+1})} \right]^{\frac{1}{2}} \quad (6)$$

In expression (6), the first term refers to the technical efficiency change (close to the frontier) and its compare the technical efficiency relative change from period  $t$  to period  $t + 1$  for the DMU analyzed.

The second term accounts for the variation of the production frontier between the two periods referenced and reveals sector technological change (frontier shift). If both terms are greater than unity implies that there has been an approach to the border and technological progress.

Conversely, if lower than the unit it means that it has produced a greater distance from the technological frontier and return, if the value is equal to the unity produces no change (Thanassoulis, 2001).

### Data description and parameter estimates

The data and the variables used in the empirical study were collected from the annual accounts of the Spanish savings banks published in "Anuarios Estadísticos".

Financial information is provided by the Confederación Española de Cajas de Ahorros (CECA) on the website <http://www.cajasdeahorros.es/balance.htm>.

The analysis has been performed for all the 45 Spanish savings banks at December 31, 2009.

The work has been prepared under the intermediation model that estimated that the savings banks act as financial intermediaries, and its main business of lending funds to claimants bidders and considering the "customer deposits" as an input. This approach has applied nonparametric DEA output oriented.

It is also preferred by most of the research on financial institutions (Wheelock and Wilson, 1999; Portela and Thanassoulis, 2006), by requiring the minimization of costs to maximize profits and not only reduced production costs.

Criterion matching literature to include interest expense paid on deposits (Pastor et al., 1997; Ray and Dabs, 2009).

Table 1 shows the inputs and outputs used in the analysis.

Variables staff costs and administrative expenses constitute a single input to support the discriminatory power of the model.

It is recommended that the total number of units is evaluated approximately three times the number of inputs/outputs selected to measure efficiency (El-Maghary and Ladhelma, 1995).

Inputs	Outputs
- Customer deposits	- Loans to customers
- Interest and fees paid	- Interest and fees received
- Staff and administration	

Table 1

Results

Empirical results: Efficiency

The results were obtained using the program PIM-DEA 3.0, Data Envelopment Analysis Software, exposing in Figure 1, which we observe the trend of the three variables analyzed during the period.

The overall technical efficiency (CCR model) gets its lowest average score in 2006, although it presents no alteration between the first and last years.

The pure technical efficiency (BCC model) shows a decrease of 0.9% and, the scale efficiency shows a cumulative increase of 1%, revealing the influence on the variation of the operations scale.

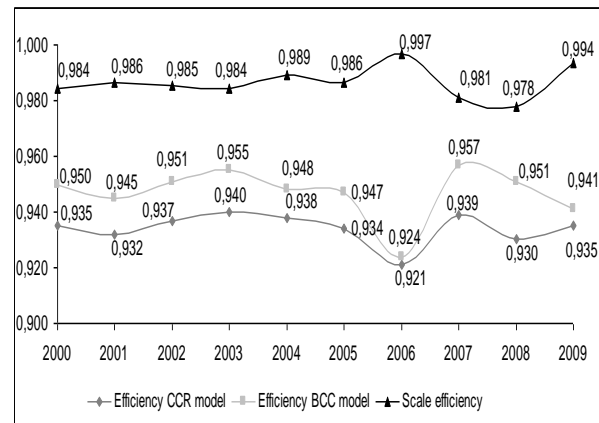


Figure 1

In terms of overall technical efficiency (CCR model) it gives an average performance level of 93.4% (see Table 2).

Indicating that Spanish savings banks should have increased their outputs (customer loans and interest income and commissions) by 6.6% to reach its optimum efficiency.

They are situated at the frontier 22% of the studied saving banks, as seen in Figure 2.

<u>CCR model</u>	<u>BCC model</u>	<u>Scale</u>
<u>Efficiency</u>		
<u>Period</u>	<u>Average</u>	<u>Average</u>
<u>Average</u>		
2000-2009	0,934	0,947
	0,987	

Table 2

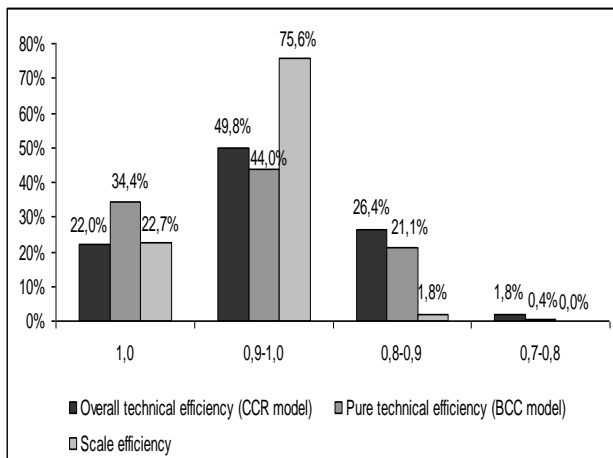


Figure 2

In terms of pure technical efficiency (BCC model), the average yield level is 94.7%, which suggests that Spanish savings banks have an index of inefficiency of 5.3%, with 34.4% of them located in the frontier.

The average level of performance in scale efficiency reaches 98.7%, showing that the entities are in a position close to its optimal scale operations, reaching 22.7% at the frontier. In average values, it is observed satisfactory levels for the period considered, since only 1.8% of the Spanish savings banks have efficiency ratings below 0.8 (see Figure 2).

**Empirical results: Malmquist Productivity Index**

In order to broaden the scope of the analysis, it is important to understand the dynamic that provides productivity change.

We have calculated the Malmquist productivity index (Malmquist, 1953), using the DEA by the criterion of constant returns to scale (Grifell-Tatjé and Lovell, 1995).

In the context of non-constant returns to scale, the index accurately measures productivity changes (Tortosa-Ausina et al., 2008).

Figure 3 shows the results of the decomposition of the Malmquist productivity index, on technological change (frontier shift) and efficiency change (closer to the frontier).

It shows an increase of 4% over the reporting period due to improved technological progress of 3.2% and a positive trend in efficiency of 0.8%.

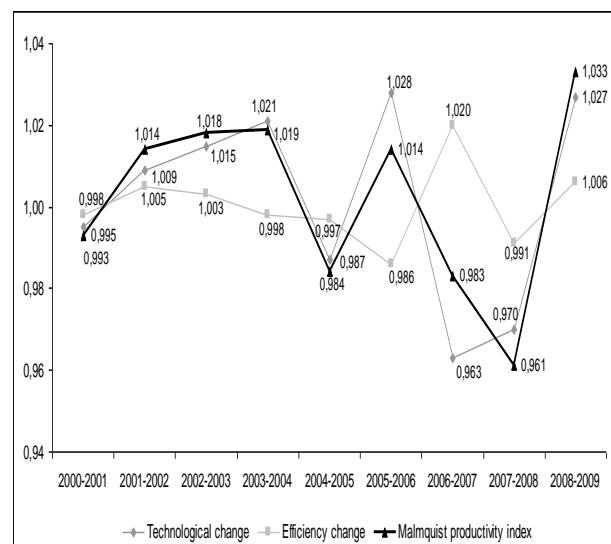


Figure 3

It also shows the trend of the Malmquist productivity index, peaking in 2008-2009 and in 2007-2008 its minimum.

Table 3 presents the average result obtained in the decomposition of Malmquist productivity index over the period.

Period	EC	TC	TFP
2000-2009	1,000	1,002	1,002

**Table 3**

\*EC: efficiency change; TC: technological change; TFP: total productivity change.

This result indicates that the Spanish savings banks have increased the level of productivity by 0.2%, achieving technological change by 0.2%, but they no change in efficiency as they have obtained a value of unity.

## Conclusions

This paper analyzes the level of performance achieved by the Spanish savings banks, measured by efficiency and by changes in the level of productivity during the period 2000-2009, creating efficient frontiers.

For that objective, it has been considered intermediation model comprising a combination of three inputs and two outputs from the nonparametric technique DEA.

The conclusions drawn from the analysis of the results is that the Spanish savings banks have levels of performance close to optimal with respect scale efficiency.

In terms of productivity, it experiences an increase attributed to technological progress obtained by the sector, but it no change in efficiency.

Therefore, it is necessary that the Spanish savings banks must achieve efficiency gains to add value and increase their competitiveness.

The temporal evolution shows variations depending on the model performed.

If we accept the model under constant returns to scale, overall technical efficiency is unchanged.

If the model is admitted under variable returns to scale, pure technical efficiency decreases slightly.

Finally, it is planned to widen this research in the future analyzing the level of efficiency and productivity of Spanish savings banks from of year 2010, which was the origin of the largest and most important financial restructuring of the banking sector in Spain.

The work would be completed to develop a comparative analysis of the results of the other banks that make up the Spanish financial system (banks and credit unions).

Another line of research is the study from the point of view of methodology using stochastic frontiers, comparing and strengthen the conclusions reached in this nonparametric technique.

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## **Analysis of rural entrepreneurship under the theoretical approach of resources and capabilities: The case of a rural microbusiness**

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The aim of this paper is to analyze the case of a joint venture stage to determine the successes and failures to undertake this business, based on the theory of resources and skills of entrepreneurship and business. It is intended to answer the question, what were the successes and failures committed by entrepreneurs to run the business plan in this particular case? The answers were found relating the situations described in the case with the theories of resources and skills and entrepreneurship. The analysis concludes that the empirical knowledge of entrepreneurs, in this case were not sufficient to direct the business to success, and that the lack of structured knowledge and adequate scientific support for this project strongly directed towards the non-permanence on the market.

**Entrepreneurship, women entrepreneurs, PROMUSAG, resources and capabilities, competitive advantage.**

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**Introduction**

The Mexican government through the Ministry of Agrarian Reform supports rural entrepreneurship projects.

One way is PROMUSAG (program for women in agriculture). This is a support program for rural women entrepreneurs, seeking their integration in the productive sector to earn income to help in the fight against poverty in this rural environment.

The support consists of a sum of money to start up the business to undertake, which is repayable but it is considered at lost funds. In 2009, hundreds of projects have benefited from PROMUSAG, one of which has been analyzed for this report.

This case is featuring nine women in the municipality of San Martin de Hidalgo, Jalisco. In that year, nine women was PROMUSAG order required for each project.

The team for this project consisted of women with little or no preparation in business, but the team had a leader with knowledge and skills acquired empirically that gave the project some routing to success.

PROMUSAG central requirements requested to be eligible for funding to the various proposals were teams of nine members, all participants should be female, a project to undertake the business detailing emphasizing the distribution of grant money, it is sent to be developed by an engineer in the agricultural area and the last requirement was to have an area of land sufficient to carry out the purpose of the enterprise activity.

The venture was marked by the fall in leader's illness, which conditioned the project to a resounding lack of profitability, this, coupled with the lack of scientific preparation and support scientists generated a mismanagement of resources and capabilities that had the project, bringing this to its final termination in six months.

**Theoretical framework and literature review**

The enterprise is the basic and elemental production system of an economy, is an indivisible economic unit that is generated in the process of value creation that is the essence, purpose and function of the entire economic system (Alegre, Berne, & Galve, 1995).

Strategic management is the scientific discipline that studies issues related to management of organizations and how are managed the functional areas of the firm. Just as the way the company has designed herself, to set their goals and values, and to relate to their environment.

According to Rumelt (1997), the purpose of the strategy is to provide partial support for the company to survive and be successful. Strategic management analyzes and determines the behavior of the target company specifically focuses on the determinants of competitive advantage and how it can be used to generate profits.

In any organization or company, it is essential to have certain resources and capabilities that are the basis for the generation of competitive advantages.

Which are crucial to the achievement of the objectives of the firm, that is, to generate sales and more importantly, getting benefits.

The theory of resources and capabilities focuses on the analysis of assets owned and / or controlled by companies, as well as their differences, and the importance of this fact to explain the evolution of the results (Barney, 1991).

From this approach, the company is considered as a unique set of resources and capabilities with a unique story (Castro & Lopez, 2006). In this perspective the strategy is defined as a constant search and maintenance benefits, which shows the economic approach model (Reynoso, 2005).

Achieving success in business depends on the performance of the tasks of management and internal coordination and the efficiency with which the company competes.

The theory of resources and capabilities and the structural theory explain the existence of extraordinary benefits of this success, although the empirical analysis shows that the first explains even better.

The value of the company is more related to intangibles than tangibles aspects on which the valuation was done traditionally (Jiménez, 1999).

In turn, intangible resources and capabilities are usually based on information and knowledge, so they have no limits in their ability to use (Guerras & Navas, 2007) and therefore it is necessary to manage knowledge.

Which means managing the processes of creation, development, dissemination and exploitation of knowledge to gain organizational capacity (Revilla , 1995).

This makes every day more evident that the value of the company that is more related to intangible aspects than with tangible on which the valuation was done traditionally (Jiménez, 1999), and thus, with knowledge.

According to Arranz (2000), when the company discusses how to achieve competitive advantage based on resources and capabilities, should take into account that these attributes, to become forms of knowledge, are the result of merging the ideas of the hierarchy with the rest of the organization.

Ferrer (1989) argues that this merger or organizational ethos contains a latent energy of known and unknown resources, used or unused, which tells the company how to progress and change, because it can build on this potential enhanced capabilities and routines.

Also these attributes should have the following characteristics: be valuable, rare or idiosyncratic, imperfectly imitable and transferable, and have hardly substitutes (Barney, 1991; Peteraf, 1993 and Fernández, 1993).

Characteristics of valuable resources in the model of Barney (1991): Simplicity in use, shortages, difficult imitation, difficult to replace, analysis of managers.

In addition there should be strategically equivalent resources, whose existence can be seen as an additional amount in offering a superior resource. Reynoso (2005) mentions three definitions of company capabilities:

1. - The company's capabilities are the skills that are equally to integrate, build and reconfigure internal and external competencies of the company in order to react quickly to the changing environment.

2. - Ability to use resources through organizational processes of the company, with the aim of obtaining a particular purpose.

3. - High level routines (or collection of routines) that, together with resource flows, provides company management a set of decision options for producing significant results.

Efficiency is manifested in three complementary aspects: strategic capabilities allow the company to perform functional activities in a better way than their competitors, will dynamically adjust to the demands of the environment and foster the enterprise to obtain strategic resources (Collis, 1994) Teece, Pisano, & Shuen (1997) mention that the capabilities of the company are supported by organizational processes, i.e., organizational routines that take place in the organizations and they have three functions: integration-coordination as static concept, learning as a dynamic concept and reconfiguration. Implications of learning: skills involves both the organization and the individual, organizational knowledge generated by activities that are performed on a daily basis in the company, reflected in new patterns of activity, in routines or a new organizational logic.

Routines are patterns of interaction that represent successful solutions to particular problems. These behavioral patterns reside in behavioral groups where some simple routines can be represented by individual behaviors.

One of the determinants of the strategic position of the company is the active control, which are plants and specialized equipment and, even more, the knowledge-based assets are difficult to trade and the complementary assets.

These assets determine the market share and profitability at any given time. Asset capabilities relevant to the company can be classified in different ways.

One is to use the following categories: technological, complementary, financial, associated to reputation with structural, institutional derivatives market structure and organizational boundaries (Teece, Pisano and Shuen, 1997).

The orthodox explanatory scheme has eliminated the entrepreneur of this system has had its recognition throughout economic history, making it the fulcrum (pivot) on which everything turns business (Bustamante, 2004).

The Royal Academy of the Spanish Language (La Real Academia de la Lengua Española, 2012) gives the following definition of an entrepreneur: "That undertakes with resolution difficult and eventful actions".

Entrepreneurs are considered an important part of the process of job creation and stimulating factor of growth as they create new businesses, and thus, creating more wealth and prosperity in a country (Martín, 2009).

As defined by Wennekers, Sander, Thurik, & Roy (1999) the entrepreneur is linked to the manifest ability and desire of individuals, either by themselves or by teams within or outside existing organizations.

To create new economic opportunities, that is, new products, new forms of organization, new methods of production, etc. and introduce their ideas in the markets, facing uncertainty and other obstacles, by making decisions on location and in the form and use of resources and institutions.

Bilbao & Pachano (2002, p. 35), proposed the following definition of an entrepreneur:

"The successful entrepreneur is a person with a dream, a goal, a desire to create, to innovate, to capture a business opportunity, which is able to" see "HIS idea into finished form, which is not stopped by obstacles, so the persistence and tenacity are typical characteristics of HIS behavior."

Malagón (2003) found that entrepreneurs meet the following characteristics:

- Constance.
- Sense or business opportunity.
- Knowledge.
- Personal responsibility.
- Leadership.

To develop entrepreneurship, according to Rojas (2003) is:

- Make things, no look for excuses or reasons to prove that you can do.
- Getting stronger every time he falls, never dig in his heels to find the reason for his failure.
- It is worthy, conscious, responsible for his actions.
- The creator of something, a home, a business.

- Understand that honest work, well there is not a need or sacrifice but a privilege and opportunity it gives us life.
- Dreaming of something, do it and discover how special and unique we are, are always positive.

### **The PROMUSAG program**

The Secretary of Agrarian Reform (Secretaría de la Reforma Agraria, SRA) is the institution of the Federal Government that serves women and men who live and work in the rural communities and ejidos or community's owned land across the country.

The SRA provides legal certainty for the owners of the land and promote comprehensive rural development social justice.

One of the ways the SRA supports rural development is through the promotion of entrepreneurial and productive projects in ejidos and communities through its programs Support for Productive Projects in Agrarian Nucleolus Fund (Fondo de Apoyo para Proyectos Productivos en Núcleos Agrarios, FAPPA) Program for Women in the Agricultural Sector (Programa de la Mujer en el Sector Agrario, PROMUSAG) and Young Rural Entrepreneur and Land Fund (Joven Emprendedor Rural y Fondo de Tierras, JERFT).

PROMUSAG is aimed at women who are organized to develop a productive project that allows them to earn an income and thus help fight poverty in rural areas (H., L. V. 2012).

Within PROMUSAG program, projects can be installed in various areas, such as ecotourism, cattle fattening, rural stores, food production or various services.

Women living in the countryside can access the program PROMUSAG women's groups of 3-6 members, over 18 years old, who inhabit agrarian and rural areas owners of community land.

The financial support is of \$30,000.00 per member provided it does not exceed the amount of \$ 180,000.00.

Women may be benefiting from the support of PROMUSAG until they have been supported in the past five fiscal years by himself or by the FAPPA PROMUSAG (Fund for supporting productive projects in agrarian).

### **Method**

The methods employed are the analytical and descriptive.

The first aims to analyze the case and identify failures and successes which led the company for the ensuing year and the descriptive method to detail the situations experienced by the venture.

### **Case to analyze**

The history and details of the case were provided by one of the women who undertook this business which in turn is a daughter of the initial principal leader of the enterprise. To gather the information, a personal informal interview was conducted on May 2012.

What more motivated the business venture was the fact that the main entrepreneur has a great taste an innate ability for this type of business, her personal qualities and characteristics mostly agree with those of a successful entrepreneur.

The main obstacle for this business venture was the lack of funding, which it once existed, the project was launched.

In 2009 the entrepreneurial principal, was blessed with a support of \$ 100,000.00 in cash, with the advantageous feature called "sunk" to the implementation of a rural business in the town of San Martin de Hidalgo, Jalisco, which consisted of raising and fattening cattle.

Support was received from the government body called Agrarian Reform Secretariat by rural support program to women entrepreneurs "PROMUSAG".

PROMUSAG central requirements requested to be eligible for funding to the various proposals were teams of nine members, all participants should be female, a project to undertake the business detailing emphasizing the distribution of grant money.

It is sent to an agricultural engineer to develop the agricultural area and the last requirement was to have an area of land sufficient to carry out the purpose of the enterprise activity.

The selection criteria for the formation of the task force were: being female is the PROMUSAG prerequisite required and indispensable, belonging to the family, time available for the project and interest in it.

The skills and / or abilities that have the formed team made are the leadership, expertise in law, some livestock knowledge and empirical knowledge of small business management.

The way in which it was given the work distribution between women entrepreneurs was by making meeting arrangements, where they defined their roles.

The "lady" was the project leader, his daughter is bachelor in law and has the role of administrator of financial resources, and the other members would act as support staff, i.e. performing operational tasks of supplies purchase, cleaning stalls, feeding cattle and attention to situations that may arise in the production area.

The business plan prepared was paid before the monetary benefit was granted, it just detail issues relating to investment in equipment and production inputs such as instruments, equipment, food, young livestock, among others.

Therefore, only was useful to structure the production plant and neither for business organization or healthy finance to sustain within inside.

The way to get to the end customer and more convenient for the type of business, existing resources and the region where they conducted the enterprise, was to sell the product at a much larger broker to sell the product to the final consumer.

The project lasted only six months from commissioning to decommissioning, which corresponds to a period of fattening cattle.

### **Application of the theory to the case**

It is necessary to analyze the internal aspects of the company to find the main successes and failures committed in undertaking this business, as the main reasons for the success of a company are brewing inside of it.

A business venture begins with the idea and the desire of an individual undertaking, which must have certain qualities and characteristics. In this case, for the entrepreneur's main business was a success in life, as she is a person who has the characteristics and qualities of a successful entrepreneur, which are constancy, sense or business opportunity, knowledge, personal responsibility and leadership skills.

The monetary resource was, together with the decision of entrepreneurship, the main trigger of the business. This financial resource was needed for the purchase of instruments and appliances for conditioning the production plant. These acquired assets would be tangible resources with which the company would have to begin to build a road and build competitive advantage.

Unfortunately these were not innovative or special characteristics that could lead the company to take advantage of some sort as cost leadership, differentiation or focus. It really was the most common for a company to take from this type of business.

The fact that there was no proper business plan to guide this enterprise in the formation of a solid organizational structure led to the existence of a variety of situations, which the organization was not in a proper way as there is no basis for internal coordination.

That is, the organization did not developed intangible resources, neither knowledge nor skills, and also did not took advantage of the existing resources in good way, and there was no strategic plan to guide the company towards a goal through proper orientation of each of the actions to be undertaken.



This due to the existing empirical knowledge and not theoretical basis exists. When it happened the disease of the entrepreneurship leader in the early stages, when the project did not even started to run was one of the situations for which the organization had no way to handle properly.

The lack of evidence document-based to guide the integration of the existent resources and capabilities propelled an unsuitable an inadequate knowledge management tied to hand and feet to the organization in terms of the creation and development of competitive advantages. There were three reasons why the venture was short-lived for only six months:

1. - Failures in the leadership capability, the main leader fell ill soon after received financing and abandoned the project, not permanently but did not have enough contact to conduct business to success, being at the head of the project the daughter of the main leader. Her daughter is Bachelor in Law as a profession, but without certainty in knowledge about business management and effective leadership skills. This created an atmosphere of des governance, which brought conflict among team members and discouragement to work and / or continue in the project.

2. - Lack of capacity in the area of procurement, equipment and supplies were bought at high prices, which were not covered by the investment project.

This situation created a debt in addition to the already acquired through funding from PROMUSAG, turn in a few days unviable the business that was being undertaken, as the rate of return on investment would hardly be necessary for the project to survive in the short term.

3. - Lack of marketing capacity to market the product, at the time it was possible to have a finished product, feedlot cattle in optimum conditions, the price at which it was sold was low. However, it was not possible to recover the investment in the production stage; the money raised was used to pay debts owed to suppliers and creditors, leaving the project without resources and women without encouragement to continue. This happens due to a lack of capacity in the area of negotiation and the lack of market intelligence to analyze the situation and to anticipate future price to implement the actions that were relevant.

### Conclusions and recommendations

Empirical knowledge of entrepreneurs, in this case, was not enough to route this business to success and the lack of structured knowledge and appropriate scientific support to this project strongly directed towards not stay in the market.

The recommendation for PROMUSAG is that it needs to call for a strategic plan as a requirement to be eligible for financial support.

To start a business the entrepreneurs should also count on empirical knowledge, a scientific basis, either by the project members, or by external consultants.

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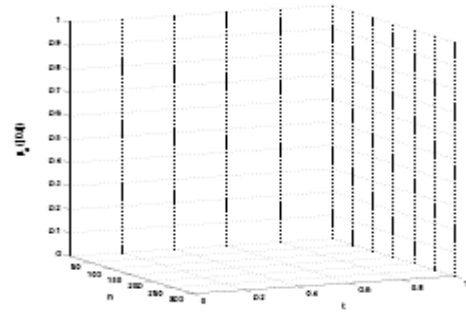
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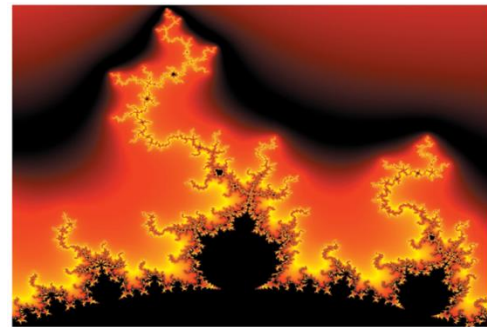
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