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Economic Growth from a Structural Unobserved Component Modeling: The Case of Senegal

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Abstract

Using the structural unobserved component (UC) modeling, this study analyzes the Senegalese economic growth path after 5 decades of independence by focusing on the potential output, the GDP cycle and the type of shocks on the GDP. Empirical evidence suggests that an inventory cycle mainly drives the GDP short-term component with a time-varying extent of fluctuations. The main sources of shocks result from external determining factors with an impact on the long run. However, their persistent effects have been mitigated particularly since the devaluation of 1994. International institutions have partially motivated the relative successful GDP growth path of Senegal. Nevertheless, some structural internal improvements are needed to balance the financial and productive flaws in order to consolidate both the "resilience" to shocks and the macroeconomic stabilization.

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1. Introduction

The occurrence of shocks on the GDP growth path is a crucial issue particularly in the case of developing countries for which the external (hence less controllable) sources of shocks are not negligible. This issue is widely discussed but still topical in the recent literature that deals with economic stabilization (Carmignani 2010; Baldini and Ribeiro 2008) since low-income countries have a too high degree of dependence *vis-à-vis* the rest of the world. However, macroeconomic stability is a necessary condition for achieving sustainable economic growth. In this context, Senegal, like the other WAEMU countries, does not make an exception. Nevertheless, few studies scrutinize the Senegalese GDP fluctuations except, for instance, Fame and Diop (2007) who limit their study to the post-80s period from a VAR approach associated with a stochastic general equilibrium.

The aim of our paper is to complete the knowledge on the sources of shocks that have affected the Senegalese GDP growth path since the independence in 1960 by using another parametric framework. A structural unobserved component [UC] modeling is implemented in order to, not only scrutinize the nature of basic shocks coupled with an analysis of GDP persistence, but also to provide the chronology of economic fluctuations as well as the evolution in the business cycle properties.

Unobserved component modeling gives the opportunity to avoid some drawbacks included in some computer-friendly alternatives such as filters notably. We suggest an algorithm closed to the strategy of Harvey (1989) and Koopman *et al.* (2009) in order to always converge toward a convenient compromise among the diversity of acceptable models that capture the unobserved time components of GDP.

Our estimates give evidence of a smoothed increasing trend for the Senegalese GDP, an inventory cycle with a time-varying volatility and the occurrence of external shocks that take the shape of structural (supply) shocks. We relate the extent of external shocks to some internal factors: dualism (Goldsmith *et al.* 2004) and low productivity (Echeviny and Mutin 2009), credit rationing to finance long-term investment and consumption, deficiencies in the State governance. These domestic shortcomings have strengthened the vulnerability to negative shocks insofar as they contribute to the intensity of external shocks.

Nevertheless, we show that a “resilient" capacity has emerged in Senegal since the 70s insofar as the potential hysteresis effects are lower and lower through time. This emerging capacity contribute to the success of stabilizing policy impulsed by international agency like the IMF in post-80s era. Thus we mitigate the absolute accountability of external policy pressure to the stabilizing process of GDP through time in Senegal. The external sources of reforms have enhanced an emerging internal capacity of Senegal to outperform through time.

The remainder of the paper is organized as follows: Section 2 presents the rationale of our empirical strategy. Section 3 describes the data and details the empirical evidence on the historical changes observable in the short and long run dynamics of the Senegalese GDP. Section 4 concludes by providing some policy recommendations related to the ongoing current situation.

2. Methodology

A statistical analysis is needed to simultaneously distinguish the dynamics of the GDP in the long run from those in the short run and to reveal the nature of shocks that have predominately impacted the GDP growth course.

2.1 Rationale for the UC modeling

Considering a parametric framework, the UC modeling outperforms the Beveridge-Nelson decomposition (1981) since the first reconsiders the perfect correlation between innovations on the trend and innovations on the transitory components that impede to clearly disentangle the contribution of shocks on the long run *vs.* short run to the whole variance of a studied series (Harvey 1985, Watson 1986, Nelson 1988, Clark 1989).

Also, the UC modeling outperforms commonly used filtering methods (Hodrick and Prescott 1997, Christiano and Fitzgerald 2003, for instance). This is particularly true when it comes to extract components from series that show a (pseudo) spectrum in which fluctuations at low frequencies are highly influential in the whole variance. "*When the series is dominated by low frequencies, the HP and BK filters provide a distorted cyclical component. [...] Since most macroeconomic series have the typical Granger shape, the application of these mechanical filters is likely to provide a distorted cyclical component*" (Guay and Saint-Amant 1997). In addition, filters "crudely" specify frequency limits in order to distinguish the cyclical component from the long-term one. Nothing indicates that limits on the frequency of cycles are systematically the same for each economy. *"Detrending with ad hoc procedure should always be used with care because of the danger of creating spurious cycles" (Koopman et al. 2009, p. 129).*The UC modeling has several advantages:

- Unit root and stationary analyses of series are no longer crucial. Hence, the biases induced in the statistical inference by the low power of unit root tests are avoided;
- The periods of cycles are precisely estimated;
- Shocks that have persistent effects can be distinguished from shocks that have transitory effects. Concerning the trend, it is possible to determine whether the shock affects the level or the slope of the trend;
- Multivariate modeling allows identifying common or similar components among endogenous series[1].

2.2 The empirical strategy

Noting y the Senegalese GDP in logarithmic data, two types of models will be estimated.

The first one is univariate:

$$y_t = \mu_{y_t} + \Psi_{y_t} + \varepsilon_{y_t} \tag{1}$$

[1]Using a same estimates, it is possible to reveal cointegration due to common trend and to identify common or similar cycles. Cycles are defined as similar if series share cycles with the same period but with different extents and leads/lags among the cycle series. The cycles are common if they are perfectly synchronous but are not necessarily similar in their extents.

where μ_{y_t} is the trend of y_t, Ψ_{y_t} the cycle. These components may be stochastic or fixed. ε_{y_t} is a white noise. The general form of the trend is decomposed into a level μ_{y_t} and a slope β_{y_t}:

$$\left\{ \begin{array}{rcl} \mu_{y_t} & = & \mu_{y_{t-1}} + \beta_{y_{t-1}} + \eta_{y_t} \\ \beta_{y_t} & = & \beta_{y_{t-1}} + \zeta_{y_t} \end{array} \right. \tag{2}$$

where $\eta_{y_t} \sim \mathcal{NID}(0, \sigma^2_{\eta_y})$, $\zeta_{y_t} \sim \mathcal{NID}(0, \sigma^2_{\zeta_y})$.

Ψ_{y_t} is a higher order cycle component *à la* Harvey and Trimbur (2003) in order to better smooth the cycle from the smoothing parameter j[2].

$$\left[\begin{array}{c} \Psi^{(j)}_{y_t} \\ \Psi^{*(j)}_{y_t} \end{array} \right] = \rho_{\Psi_y} . \left[\begin{array}{cc} \cos\left(\lambda_{c_y}\right) & \sin\left(\lambda_{c_y}\right) \\ -\sin\left(\lambda_{c_y}\right) & \cos\left(\lambda_{c_y}\right) \end{array} \right] . \left[\begin{array}{c} \Psi^{(j)}_{y_{t-1}} \\ \Psi^{*(j)}_{y_{t-1}} \end{array} \right] + \left[\begin{array}{c} \Psi^{(j-1)}_{y_t} \\ \Psi^{*(j-1)}_{y_t} \end{array} \right] \tag{3}$$

where ρ_Ψ represents a dampening factor, λ_c is the cycle frequency[3], $\kappa_t = \Psi^{(0)}_t$, $\kappa^*_t = \Psi^{*(0)}_t$ and knowing that:

$$\left[\begin{array}{c} \Psi_{y_t} \\ \Psi^*_{y_t} \end{array} \right] = \rho_{\Psi_y} . \left[\begin{array}{cc} \cos\left(\lambda_{c_y}\right) & \sin\left(\lambda_{c_y}\right) \\ -\sin\left(\lambda_{c_y}\right) & \cos\left(\lambda_{c_y}\right) \end{array} \right] . \left[\begin{array}{c} \Psi_{y_{t-1}} \\ \Psi^*_{y_{t-1}} \end{array} \right] + \left[\begin{array}{c} \kappa_{y_t} \\ \kappa^*_{y_t} \end{array} \right] \tag{4}$$

with $\left(\kappa_{y_t}, \kappa^*_{y_t}\right) \sim \mathcal{NID}(0, \sigma^2_{\kappa_y})$.

The second model includes the household consumption in logarithm (c_t) as an endogenous variable from a Structural Seemingly Unrelated Time Series Equations representation of the univariate modeling:

$$\begin{pmatrix} y_t \\ c_t \end{pmatrix} = \begin{pmatrix} \mu_{y_t} \\ \mu_{c_t} \end{pmatrix} + \begin{pmatrix} \Psi_{y_t} \\ \Psi_{c_t} \end{pmatrix} + \begin{pmatrix} \varepsilon_{y_t} \\ \varepsilon_{c_t} \end{pmatrix} \tag{5}$$

The general mathematical forms of μ_{c_t} and Ψ_{c_t} are identical to the ones in equation 2 and equation 3 respectively. The components innovations are such that the associated variance/covariance matrices are:

$$\Sigma_v = \left(\begin{array}{cc} \Sigma_{v_{yy}} & \Sigma_{v_{yc}} \\ \Sigma_{v_{cy}} & \Sigma_{v_{cc}} \end{array} \right) \ \forall \ v = (\varepsilon, \eta, \zeta, \kappa) \text{ and } \forall t. \tag{6}$$

Σ_v and v are multivariate normal disturbances which are mutually uncorrelated.

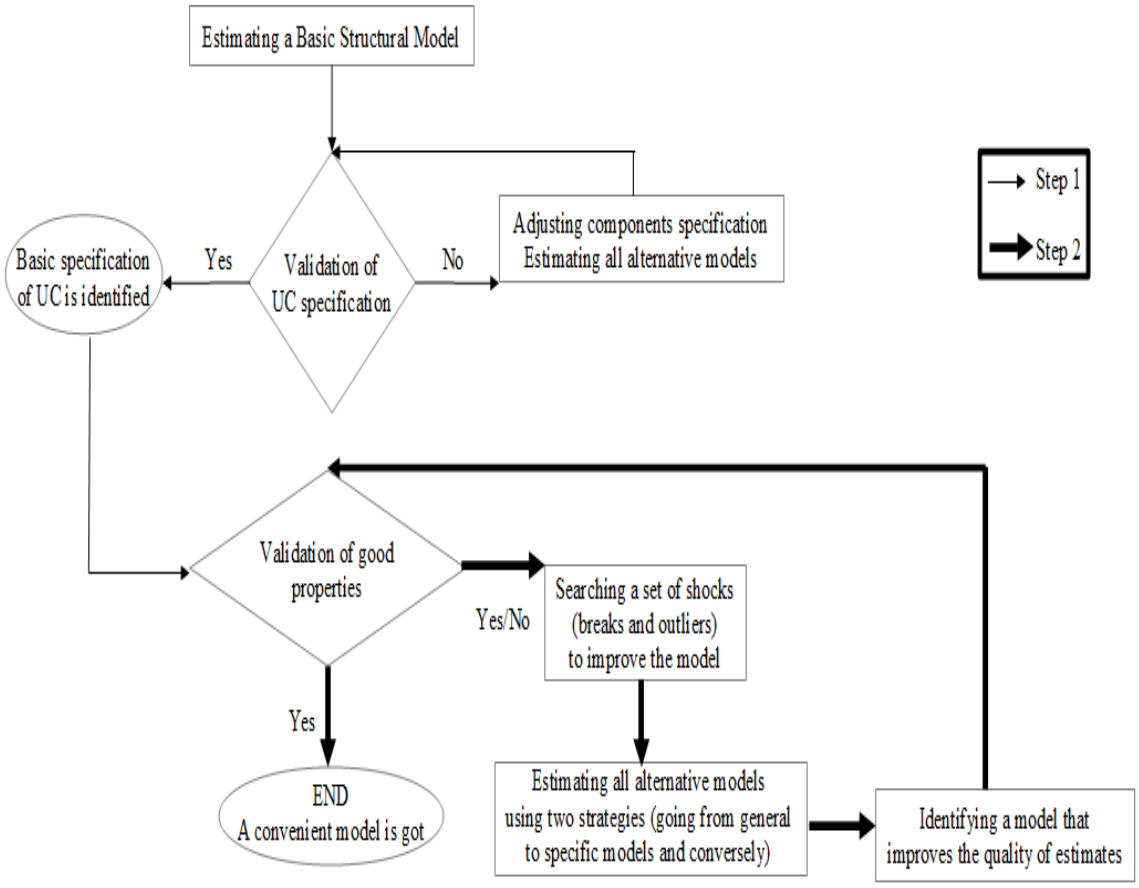
The household consumption is chosen in order to take into account (at least similar) or (at most common) components between two macroeconomic variables (GDP and consumption) since the latter has contributed to more than two thirds of the output per year for the whole post-colonial period.

Crossing the two models estimated from a Kalman filter will give a better confidence in the significance of the shocks as well as in the basic features of the Senegalese GDP growth path. Nevertheless, using UC modeling, there may be a huge amount of models that can be selected to explain the GDP course. Fortunately, the algorithm suggested in Figure 1 warrants to always converge toward a model which is a convenient compromise among the diversity of acceptable models.

[2]It is also possible to smooth the slope of the trend.

[3]The period is equal to $\frac{1}{\lambda_c}.(2\pi)$.

Figure 1. Algorithm to converge toward convenient models



Two steps build the algorithm:

– Step 1: Starting from a Basic Structural Model[4] to end by the basic structure of UCs.

The objective is to obtain the best model as possible without shocks: stochastic *vs.* fixed level of the trend, stochastic *vs.* fixed slope of the trend knowing that a smoothed slope can be useful to better split fluctuations in the short run from the ones in the long run, a cycle with a specific period (or frequency λ), regularity captured by the dampening factor (ρ_{Ψ}). At this stage, a good model should: *(i)* have at least a strong convergence toward the true observations, *(ii)* be consistent in the p-values associated with the UCs when distinguishing a fixed component from an absent one, *(iii)* provide gain functions for each UC the closer as possible to the theoretical ones and *(iv)* have positive values of R^2s.

– Step 2: Introducing the set of significant shocks that impact the GDP course from intervention variables or dummy variables.

The specificity of our algorithm is to provide this set of interventions while maintaining unchanged the basic structure of the unobserved components identified in the first step and selecting models that keep unchanged the parameters associated to shocks. The list of criteria useful to select the receivable models are: *(i)* the ones in step 1, *(ii)*

[4] A BSM considers a stochastic level and (not higher order) slope of the trend, a stochastic season, an irregular component but no cycle.

the normality of innovation residuals or auxiliary residuals[5] that are studied from the normality test statistics of Bowman-Shenton (N_{BS}), *(iii)* appropriate Cusum and Cusum of square dynamics, *(iv)* the minimized mean deviation (md) which computes a relative measure of errors, *(v)* the maximized likelihood as well as *(vi)* the minimized information criteria (Akaike, Hannan-Quinn and Schwarz) and of course *(vii)* parsimony.

The algorithm enables to span a huge variety of UC models. Particularly, the identification of structural components may be improved by adding new variables that may share common components with the variable of interest (here, the Senegalese GDP). In case of necessity, it is important to take into account, common components, phase shifts *à la* Rünstler (2004) among stochastic components, and idiosynchratic components (Koopman and Azevedo 2008, Chen and Mills 2012).

Once the univariate and multivariate models of reference are selected, one aim is to relate the identified shocks to historical events and agents' behavior, knowing that a shock on the trend (shock on the long run) reveals a structural shock that generally refers to a supply shock whereas a shock on the transitory component of GDP (shock on the short run) often induces a demand shock despite hysteresis characteristics may exist in some cases.

3. Data and empirical evidences

3.1 Data

No original quarterly data are available for the Senegalese GDP even for the recent years. The yearly data are taken from the World Development Indicator bases. In order to extend the sample alike Doussou (1998), a quarterly interpolation of the available real GDP is made from the method suggested in Goldstein and Khan (1976). Unfortunately, this procedure has the drawback to lose information on both ends of the sample. That is the reason why a cubic spline curve is also used. A continuous-time approximation of quarterly data is then provided from the yearly observations such as the definite integrals of the spline over years are constrained to equal the given yearly totals. Both quarterly samples obtained from the two alternative interpolations are equivalent for the common non-missing values that go from 1961 to 2010. A third strategy is the interpolation directly obtained from a UC model of yearly data by considering the quarters as missing values. On the Senegalese data, there is no significant differences among three interpolation methods (refer to Figure 2 and Table I for proof[6]). Hence, we are quite confident in the statistical inference that will be implemented on the quarterly data.

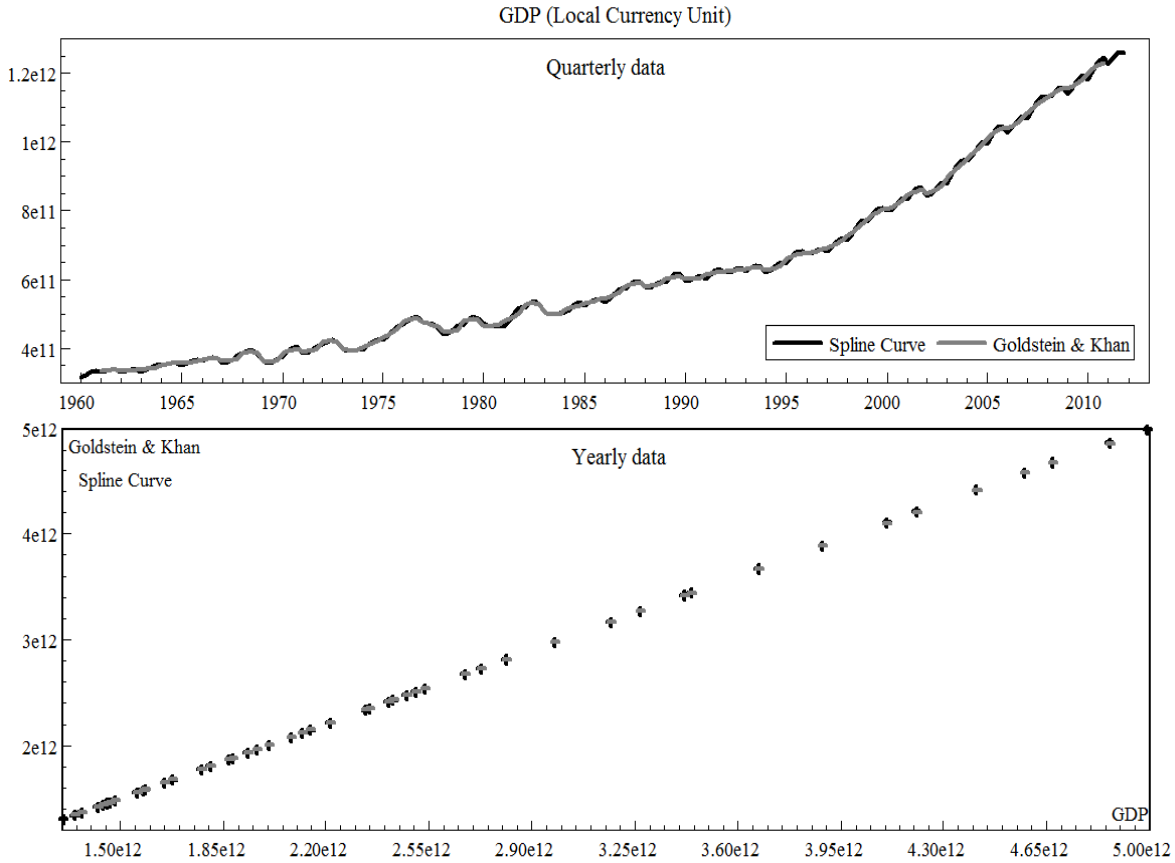
[5] The auxilary residuals are smoothed estimates of the components disturbances that enable to point out by component information invisible from innovation residuals.

[6] Results from several tests of equality among means, medians and variances are available upon request to give additional evidence on the similarity among the three interpolations in the case of Senegal.

Table I. Descriptive statistics

Periods	log(GDP) Local Currency Unit					Average GDP growth rate (%)	Pearson correlations		
	Mean	Median	Maximum	Minimum	Standard Deviation		Interpolated GDPs	Value	Prob.
1960-2011	11.7598	11.7350	12.1010	11.4986	0.1693	2.6123	Spline curve – UC	0.9996	0.0000
1st sub-period (1960-1968)	11.5453	11.5452	11.5936	11.4986	0.0228	1.4356			
2nd sub-period (1968-1984)	11.6467	11.6571	11.7303	11.5534	0.0479	1.5959	Spline curve – Goldstein & Khan	0.9975	0.0000
3rd sub-period (1984-1994)	11.77074	11.7758	11.8068	11.7106	0.0273	2.0091			
4th sub-period (1994-2008)	11.9270	11.9254	12.055	11.7977	0.0776	4.0330	UC - Goldstein & Khan	0.9993	0.0000
5th sub-period (2008-2011)	12.0784	12.0766	12.1010	12.055	0.0160	2.2034			

Figure 2. GDP measures



3.2 Output of algorithm based on UC modeling

Table II and III report the output of the algorithm useful to study the GDP growth. Figure 3 summarizes the results.

Table II. Estimates for the Univariate Models

Dependent variable	GDP (MODEL 1)				Dependent variable	GDP (MODEL 2)			
Trend	Fixed level Stochastic slope *(j)* = 2				*Trend*	Fixed level Stochastic slope *(j)* = 2			
Cycle	Period = 3.3454 years ρ_v = 0.8456 *(j)* = 2				*Cycle*	Period = 3.3920 years ρ_v = 0.8465 *(j)* = 2			
Interventions	*Date*	*Coefficient*	*RMSE*	*Prob*	*Interventions*	*Date*	*Coefficient*	*RMSE*	*Prob*
Level	1968: 2	-0.0048	0.0022	0.0286					
Level	1980: 1	0.0044	0.0022	0.0473					
Level	2008: 2	-0.0053	0.0022	0.0163	Level	2008: 2	-0.0053	0.0022	0.0192
Slope	1994: 2	0.0038	0.0015	0.0136	Slope	1994: 2	0.0038	0.0015	0.0115
Exogenous	*Date*	*Coefficient*	*RMSE*	*Prob*	*Exogenous*	*Date*	*Coefficient*	*RMSE*	*Prob*
-	-	-	-	-	Dummy = 1 after	1984:1	0.0057	0.0022	0.0114
Quality of estimates					Quality of estimates				
Convergence	Strong				*Convergence*	Strong			
Log-likelihood	1153.25				*Log-likelihood*	1158.94			
Prob of N_{BS}	0.2357				*Prob of* N_{BS}	0.1929			
100.md	7.46e-4				*100.md*	7.52e-4			
R^2	0.9997				R^2	0.9997			

(j): Smoothing parameter
ρ_v: Dampening factor
N_{BS}: Normality test of Bowman-Shenton
md: mean deviation

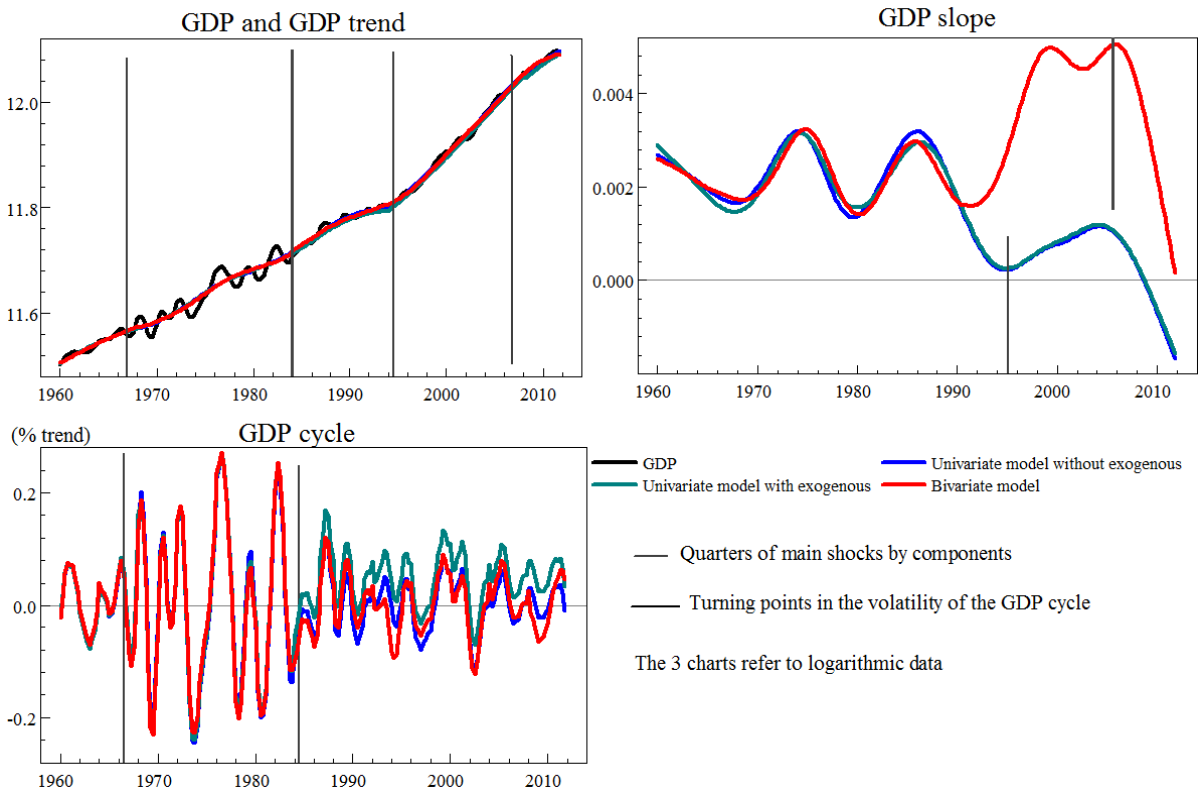
Table II reports the estimates of two alternative models that have the structure of equations (1 to 3) considering the presence of some structural shocks. Model 1 contains no exogenous variable whereas model 2 assumes the significance of a dummy variable in 1984:1, which value is 1 after 1984:1 and 0 before.

Table III. Estimates for the Bivariate Model

	Equation 1					Equation 2				
Dependent variable	GDP					Dependent variable	Household consumption			
Trend	Fixed level Fixed slope *(j)* = 3					*Trend*	Fixed level Stochastic slope *(j)* = 3			
Cycle	Period =4.4814 years ρ_v=0.6947 *(j)* = 4					*Cycle*	Common cycle with GDP Cycles correlation = 100%			
Interventions	*Date*	*Coefficient*	*RMSE*	*Prob*		*Interventions*	*Date*	*Coefficient*	*RMSE*	*Prob*
Level	1968: 2	-0.0039	0.0019	0.0450		Level	1968: 2	-0.0039	0.0019	0.0445
Level	1980: 1	0.0051	0.0019	0.0082		Level	1980: 1	0.0047	0.0019	0.0130
Level	2008: 2	-0.0047	0.0019	0.0146		Level	2008: 2	-0.0045	0.0019	0.0206
Exogenous	*Date*	*Coefficient*	*RMSE*	*Prob*		*Exogenous*	*Date*	*Coefficient*	*RMSE*	*Prob*
Dummy = 1 after	1984: 1	0.0053	0.0019	0.0063		Dummy = 1 after	1984: 1	0.0051	0.0019	0.0074
Quality of estimates						Quality of estimates				
Convergence	Strong					*Convergence*	Strong			
Log-likelihood	2438.85					*Log-likelihood*	2438.85			
Prob of N_{BS}	0.1624					*Prob of* N_{BS}	0.1367			
100.md	5.48e-4					*100.md*	8.09e-4			
R^2	0.9998					R^2	0.9998			

Table III reports the estimates for the two equations in the model (5) and provides additionally the estimates for structural shocks and the dummy variable in both equations.

Figure 3. Unobserved components of the GDP



3.3 Analysis of the GDP trend

Basically, a smooth increasing trend characterizes the growth path of Senegal. Table II and III inform about the several structural shocks that have impacted the GDP course. Two types of shocks on the long run are revealed:

– *The positive shocks*

On one hand, 1980:1 is the starting period of IMF interventions with an impact on the level of the trend that extends from 0.44% (univariate model 1) to 0.51% (bivariate model). The intervention of international institutions were justified by a slowdown in the growth of supply, a deficit in the current and commercial balances with negative consequences on the public finances and on the debt sustainability. Along the 1980s several programs and plans were established. The most important of these are an economic and financial recovering plan (1980-1985) and a medium-term structural adjusting program (1985-1993).

On the other hand, 1994:2 characterizes the starting quarter of observable impacts of the CFAF devaluation that occurred in 1994:1. The devaluation has accelerated the speed of growth, which has contributed to an increase in the GDP slope of 0.38% according to both univariate models in table II. After a quarter of negative price effect due to the devaluation, the positive effect of the devaluation is observable insofar as it has been sustained in the subsequent quarters and years by new adjusting policies and economic reforms. All in all, it was about structural adjustment, poverty reduction and growth facilities. They aimed at stabilizing the main economic aggregates, at rigorously managing public finances and at suppressing the protectionist national policies that threatened to hamper commercial trade.

– *The negative shocks*

Firstly, 1968:2 is a crucial date that generated a decrease in the GDP level between -0.39% (bivariate model in Table III) to -0.48% (model 1 in Table II). This negative supply shock results from the end of trade agreement between France and Senegal concerning the warranted prices for Senegalese exports.

Secondly, the influence of the recent international crisis is conspicuous through the drop in the GDP level after 2008:2 (-0.53% according to Table II). The bivariate estimate in Table III also reveals this shock on the GDP but this is not the case for the devaluation shock. Hence, after the CFAF devaluation, Figure 3 reports a spread between the slopes associated with the univariate models and the one of the bivariate model. Nevertheless, a slowdowning GDP growth is indisputable in the aftermath of the crisis (Figure 3) across the different models. The international crisis has impacted the foreign direct private investment in Senegal as well as the financial transfers from Senegalese abroad. Tourism receipts that represent a leading factor in the Senegalese growth after 2000, have also fallen.

All in all, the shocks basically impact the GDP dynamics in the long run, which means that structural instead of temporary shocks have driven the Senegalese output. Furthermore, in the debate among (*i*) those considering that external shocks (notably due to international prices) are determining factors in the growth path (Mendoza 1995, Kose 2002, Broda 2004), (*ii*) those claiming that internal factors are predominant (Hoffmaister and Roldos 2001, Raddatz 2007) and (*iii*) those arguing an intermediate stance (Kodoma 2006), our results show that there is no doubt about the predominantly external source of shocks for Senegal. Nevertheless, these external shocks have an effect with an extent that surely depends on internal factors.

Domestic factors such as the margin behavior of producers and the State governance that influence the financial and productive sectors surely increase the incidence of external shocks on the course of growth. The margin behavior of exporters is involved for the negative shock in late 60s and in the extent of the positive impact of the 1994 devaluation. In addition, the quality of governance provides resilience to shocks. Unfortunately, a focus on the Worldwide Governance Index (Kaufmann *et al.* 2010) reveals an indisputable lack of State governance in Senegal. This deficiency impacts the management of public finance, which leads to a lack of financial lever to stimulate growth and to mitigate adverse external shocks. Moreover, inefficiency in the decentralization of the state control is conspicuous in the agricultural sector and in infrastructure (water distribution, regular access to energy and electricity, transportation, and telecommunication networks). Hence, some internal factors create a rigidity in the production process.

Nonetheless, even though there is still a propensity of Senegal to be vulnerable to negative external shocks like the recent international crisis, things have changed since the mid 1980s. The consequences of financial and structural reforms, impulsed by international institutions, result in a positive and permanent breakpoint in the GDP level. This is visible by considering the starting period of financial process of stabilizing impulsed by the IMF or by referring to the starting period from which the stabilization is confirmed (positive impact higher than 0.52% on the GDP level after 1984:1 according to the parameters of the dummy variable in table II and III).

3.4 Analysis of GDP cycle

Focusing on the volatility of the GDP cycle, different historical states are distinguished from Figure 3.

– 1960-1968 is a period of stability with good performance in the farming sector, especially in the groundnut farming. But 1968:2 is specific due to a sudden decrease in nominal price that the groundnut farmers earned (Bonnefond and Couty 1988). A period of growth instability is opened thereafter since no counterbalancing mechanism or substitute has emerged.

– 1968-1984 is a period of instability. Even though no transitory shocks are identified from the different models, subsequent droughts affected stocks. Considering Barrios *et al.* (2010), this is a crucial point for growth in sub-Saharan African countries compared to other developing regions. Besides, the increase in commodity prices exported by Senegal had no effects on GDP due to the servicing of debt, which absorbs almost all of the income from exports (Dupuy 1990). As a consequence, the supply growth dropped from a 3% yearly level in 1970-1979 to 1.8% in 1980-1984 while inflation raised at 8.7%. 1984 is the starting year for the output stabilization (decrease in the extent of the output gap). This change mainly results from the effort of stabilization induced by the economic and financial recovering plan that lasted several years.

– 1984-1994 is an intermediate period toward stability. All in all, despite the increase in primary deficits connected to the rise in interest rates and in the exchange rates volatility, the average growth rate was equal to 2.4% between the 1980s and 1994 due to drastic measures imposed through the intervention of international agencies (medium-term structural adjusting program).

– 1994-2008 is a phase of stability. New structural adjusting policies and economic reforms after the CFAF devaluation led to rigorous management of public finances and a suppression of protectionism. The average growth rate followed at a 4.4% level and inflation fell from 32.1% in 1994 to 1.8% in 1997.

– 2008-now is a phase of uncertain stability. The GDP volatility has been kept up through the international context of downward growth, which is consistent with the findings of Berg *et al.* (2011). This context partially explains the less efficient tax revenue and the increasing fiscal deficit.

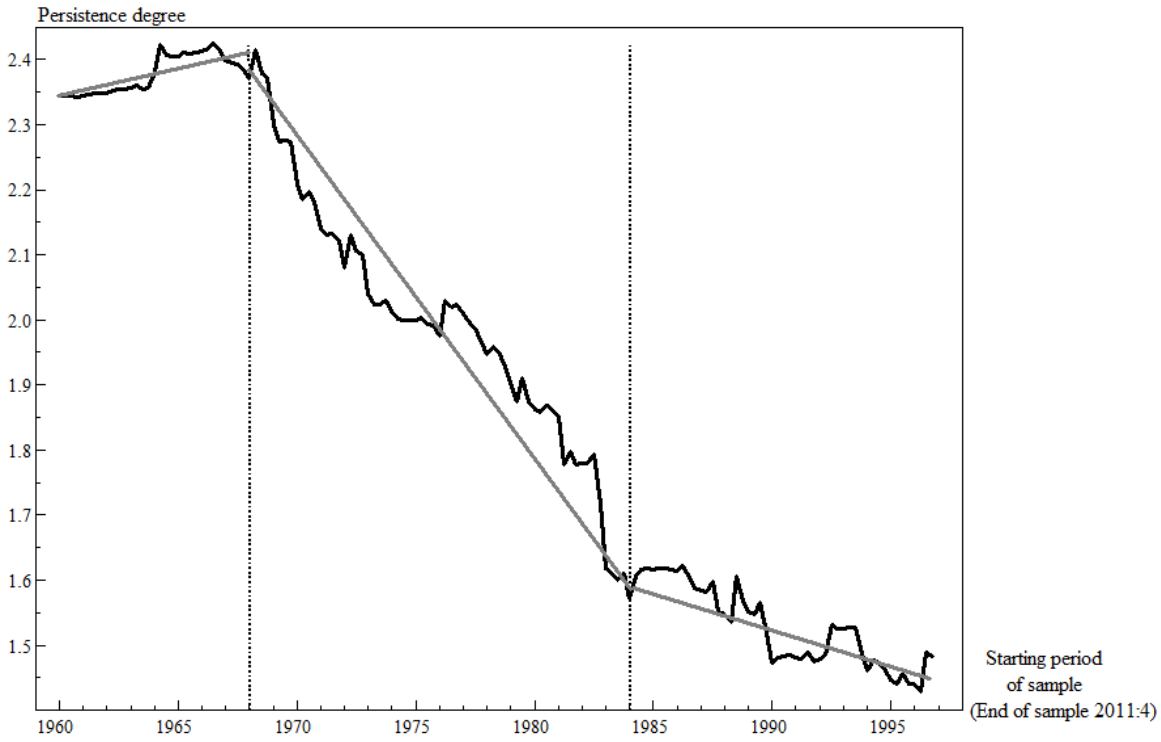
Beyond the output volatility, our estimates in Tables II and III culminate the debate on the nature and the duration of the economic cycles in developing and developed countries. For some authors, the duration of economic cycles is similar in developing and industrialized countries (Agenor *et al.* 2000). In contrast, others show that economic cycles in developing countries are shorter than the cycles in industrialized countries (Rand and Tarp 2002). The Senegalese growth cycle lasts as long as an inventory cycle (40 months). This cycle period is invariant to the different models.

This cycle characteristic is likely to prevent economic agents (consumers and investors) from having a long run outlook in their spending behavior. Agents are actively sensitive to any changes in the current situation even though this is not an event with potential to become a structural factor. Consequently, managing inflation and stabilizing the economy is very challenging and the volatility of the GDP cycle is accentuated in comparison to developed countries.

3.5 Analysis of GDP persistence

Figure 4 reports a measure of the GDP persistence degree throughout the sample, which is captured from subsequent ARIMA models using an increment of one quarter in the starting period of estimates that goes from 1960 to 1997. This computation gives an insight on the persistence of potential shocks that might impacted the Senegalese growth. The higher is the persistence degree for a specific period of estimate, the longer the effect of any shock lasts.

Figure 4. GDP persistence



The potential strength of hysteresis effects as well as the potential impact of supply shocks resulting from external disturbances in the case of Senegal is lower and lower through time. As the duration of shocks impact is less long through time, the capacity of Senegal to recover after a negative shock is increasing. Knowing that resilience is the capacity to recover after having incurred a shock, our results clearly reveals the emergence of a sort of "resilient capacity" of Senegal. This recent resilience is an advantage to manage the vulnerability to shocks.

Three phases are noticeable in the GDP persistence. After the independence, the persistence slightly increased but fortunately the Senegal was in a historical phase of sustained growth, hence no adverse shock with a hysteresis has been registered. From 1968-1984 which corresponds to the period of huge instability, the persistence have started to decrease. The recent resilient capacity of Senegal to adverse shocks has emerged before the policy pressures through the IMF and the WAEMU occur respectively around the early 1980s and in 1994. This allows to mitigate the absolute accountability of external policy pressure to the stabilizing process of GDP through time in Senegal. The resilient capacity has provided a better chance for stabilizing policy to get effective. The external sources of reforms have enhanced an emerging internal capacity of Senegal to outperform through time. After 1994, the GDP persistence pursues its downward trend,

which contributes to confirm the stabilized hence more resilient GDP growth despite its vulnerability to shocks.

4. Conclusion

The UC modeling helps us to characterize some stylized facts of the cycle in Senegal and to identify the sources of fluctuations that have impacted the GDP course since the independence year by reasonning on quarterly basis even though only yearly data are reported from institutional sources (Central Bank of West African States, International Monetary Funds). Results show that if the Senegalese growth is more and more stabilized thanks to a lesser extent of fluctuations and to less persistence, it remains vulnerable to external shocks with effect on the long run. This context is not yet appropriate for any optimal projection of economic agents on durable consumption and on productive investment. This is consistent with the GDP cycle of at most 40 months (inventory cycle) and with the margin behaviors of producers.

Nevertheless, better results in the post-1984 period and particularly after the devaluation in 1994 have provided some hope. After the huge instability from the late 1960s to 1984, some policy interventions initiated from abroad (IMF, World Bank and the WAEMU) have enabled Senegal to gain robustness in its growth path. After two decades of reforms that have mainly focused on the financial sector, it is time to also target the deficiencies in the productive sector (throughout notably the renewing of productive infrastructure in the energy and transportation sectors) while pursing effort of State governance. In addition, more credit facilities dedicated to long-term spending are strategic to gain confidence in the financing of economic activity in the long run. Securing agents solvency while lessening unequal access to credit are of paramount importance. Such policy orientations agree with the following statement for Sub-Saharan Africa: "*while banking systems in SSA may grow in tandem with economic growth, their ability to extend credit to households and firms does not follow suit*" (Demestriades and James 2011, p. 265).

Despite the somewhat optimistic IMF forecasts (IMF 2012), all in all, the Senegalese growth should get into a new phase during the following years through structural reforms that could promote long-term spending in favor of productive investment and consumption as well as an increase in the duration of GDP period – turning from a stock cycle to an effective business (Juglar) cycle.

Future works will generalize the analysis to the WAEMU in order to identify influences among national GDPs and to make forecasts by using a more complete framework based on dynamic factors associated with UC modeling (Brauning and Koopman 2013).

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