An Empirical Characterization of the Dynamic Effects of Changes in Government Spending on Long Term Interest Rate

April 6, 2016

Abstract

This paper investigates the crowding out effect hypothesis in Morocco. Accordingly, the interest rate reacts to the change of the level of government spending. The Empirical results obtained from the impulse response analysis of the structural VAR model indicate the absence of such an effect. Spending in infrastructure, in communication and in welfare seem to build the basis of modern economy that will attract private investments, and the result will not be materialized in the immediat short term.

1 Introduction

During the eighties (1980), Morocco has experienced a structural adjustment program that was intended for debt restructuring, which has attained record levels following the surge in commodity prices on the international market as Morocco is a net importer of energy goods.

The program mainly consisted of the privatization of companies held at the time by the government. As a result, we witnessed an artificial increase in government's revenue which reduced public deficit. Implying that the government spending increased without damaging the government budget or the economy.

As the stock of revenues coming from the privatization depreciated, government expenditure was financed by the debt. According to the international recommendations following the structural program, public debt had

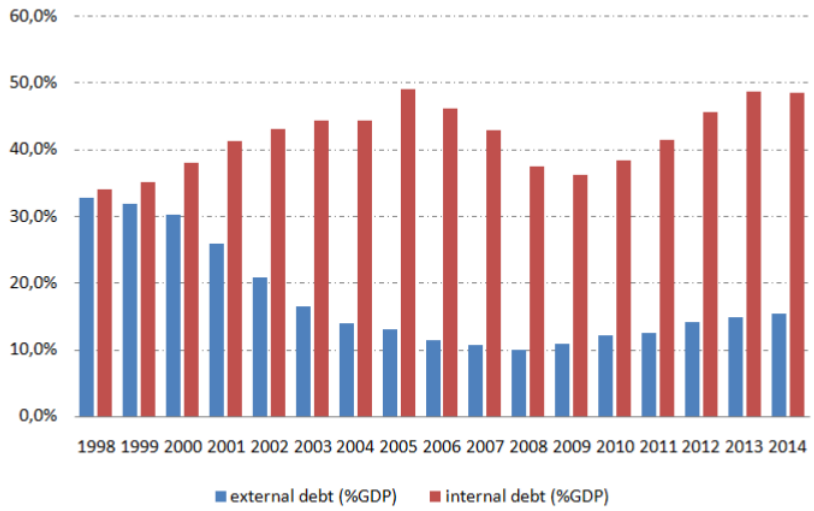

Figure 1: Decomposition of Public Debt

shifted towards internal debt instead of external debt (See Figure 1).

This choice raises the question of the impact of government spending, especially that financed by internal debt, on macroeconomic aggregates, including the interest rate. The question is more topical than ever, as in the Moroccan context the switch toward more and more indebtness from domestic investors is alarming. In the past, assuming that the crowding out effect has long been excluded from the debate because the government intervenes comfortably according to different mechanisms to support the economy. That said, the effects of these interventions, funded recently by domestic debt, are appealing and need to be considered. In this context, the present paper investigates then the dynamic effects of shocks in government expenditure on the behavior of long term interest rate in Morocco during the period 1990-2015.

Certainly, the issue was consumed in developed countries where markets are mature and government spending on infrastructure are already in place. However, in developing and emering market economies this question of crowding out effect is not resolved yet as those countries have some specific features compared to developed countries. In those laters, the relationship is presumably denoting a negative effect. At an advanced stage of development, public spending becomes a competitor to private one. So the government by financing a huge expenditures, it constrains the private agents with higher interest rates on the market. On the other hand, developing countries have

more leeway to implement additional public investment (like infrastructure and logistics), involving an increase in the efficiency of private investment.

Much of the recent litterature has focused on the impact of public spending on private investment in both developing and developed countries. In Habib and Miller (1991), the paper showed for a panel of developing and developed countries that tax-financed government expenditure crowds out more investment than debt-financed expenditure. Spending on social security and welfare reduces investment in all countries in the sample while spending on transport and communication imply more investment in developing countries. Another work for the case of United States and Canada, Cebula (2007), used single equation models and multiequation systems to show that for both US and Canada, the crowding out effect is there and it leads to long term inflation. For the case of developing countries, Fayed (2012) showed for the case of Egypt that debt-financed deficits crowds out the private investment by reducing the available volume of credits to the economy. More older paper of Benjamin M.Friedman (1978) emphasized the effect of public spending by arguing that the direction of the effect depend on the relative substituabilities among the instruments for financing the deficit.

As the empirical litterature does not found any consensus about the effect of public spending on the private investment, one would not think that the task of assessing the crowding out effect would be easy. Our contribution depart from the literature into several levels. This paper constitutes the first empirical investigation for the case of Morocco. Moreover, the data for public spending and revenues are filtered by a multivariate filter in order to eliminate the cyclical components of fiscal variables which can distort the analysis. In fact, the structural VAR modeling must include some fiscal variables that occur with annual frequency which is limiting in term of the number of observations. Moreover, in order to test our basic assumption we do not have to include only the government spending in our model. Once the government spending and revenue are presumably not independent, to estimate the effect of one it is necessary to include the other. One more challenge is related to the step of identification of our SVAR. When we are dealing with annual data, the fiscal variables have time to react to the changes of the interest rate, which imply that we have to proceed to the estimation of elasticities of fiscal variables with respect to interest rate. Finally, it should be noted that the fiscal variables are cyclical, that suggests some treatment before the modeling step. The method of dynamic factor model (DFM) was used to deal with such pattern. The real interest rate used in this study are those of 10 years bond yields, the real interest rate is calculated based on

this nominal rate minus a trend of inflation considered as a proxy for the anticipated inflation.

The rest of the paper is organized as follows, section two discusses the main theories and empirical studies concerned with the crowding out effect. Section 3 then proposes to conduct an empirical investigation and section 4 is dedicated to impulse response analysis. A final section concludes.

2 Theoretical and Empirical Literature

2.1 Some Theory

The issue of government debt and its effects over the economy is largely debated. And there is no consensus yet about its impacts on the consumption, saving or capital formation decisions.

However, one can distinguish between two views mostly related to this issue. On the one hand, the conventional view asserts that government debt has an impact both in the short run and in the long run over the economic activity, which has an important implications for the interest rate setting. On the other hand, neutrality of government debt is the oldest theory underlying the relation between debt and economic decisions, which is commonly known as Recardian Equivalence. Firstly stated by David Ricardo on the case of financing war expenditure, and renewed by Robert Barro in more general form earlier.

Most economists and policymakers are in line with the story of the conventional view, maybe it describes the real world well. According to this theory, we suppose that government indebtedness increases because of some reasons, say a tax cut. This policy affect the economy through different mechanisms. In the short run, household's current disposable income increases in response to this fiscal policy. Household's spending on consumption goods will increase, and thus the aggregate demand. Following the Keynesian analysis, we can conclude that this mechanism will lead to higher national income. This analysis constitutes a justification for such a policy of increasing spending when the economy suffers from recession. In this context, higher demand will create an inflationary pressure that will modify expectations of inflation in the future. Such modification has an important consequences on the real rates of interest.

Out of this framework, there exists other effects of debt over the economy. Large debt may alter the monetary policy, in such an environment interest rates will be higher and monetary policy can act in an expansionary way to reduce this rates. This policy may be proof to be effective in the short run, but in the long run real rates return to the natural level, inflation and nominal rates will be higher. Moreover, with a large debt a country may finance their ongoing deficit by "monetizing debt", in this case the inflation will be not a monetary phenomena as Milton Friedman stated but it will be a fiscal one.

From the previous discussion, the conventional view of debt and its impacts on the economy highlight some evidence on the relationship that can exist between debt and interest rates.

In contrast, Ricardian Equivalence[1] asserts that the choice between financing deficit by issuing debt or by collecting taxes is irrelevant. The policy of indebtedness to finance tax cut will not alter consumption, capital formation or growth. This analysis is based on the simple argument that lower taxes today will generate higher taxes tomorrow, thus cutting taxes and financing deficit by debt represents some form of postponement of taxes and not a reduction on it.

If agents are forward looking, this policy will not affect their consumption decisions but it will have an impact on their saving decisions because they will look ahead to the future taxes implied by government debt. Two fundamental ideas are behind this theory ; the first idea is the government budget constraint. Lowering tax today must lead to higher taxes in the future in order to respect the inter temporal budget constraint. The second idea is the permanent income hypothesis. That is to say that household bases their consumption decisions on the permanent income.

This neutrality proposition "Ricardian Equivalence" deny all sort of impact that can be produced by government indebtedness. Even if this theory may be proved wrong, it provides an important benchmark.

[1]See Barro, R. J. (1988). The Ricardian approach to budget deficits (No. w2685). National Bureau of Economic Research.

2.2 Empirical Literature

In the empirical literature, the issue of crowding out effect is still relevant in the emerging market economies and developing countries as testified by the growing number of papers dealing with this topic.

For the case of India, Mitra (2006) showed a complementarity of private investment and government investment. He used structural VAR including the variables : government investment, private investment and GDP in levels. The identification problemn was performed through the Blachard and Perotti (2002). The findings of this paper showed that in the short run, the government investment depress the private investment, but in the long run the relationship is reversed reflecting the non persistence of this effect. The question was also examined for the case of Pakistan by Khan and Gill (2009). They constructed an invesment function, wich includes public borrowing, GDP and lending rate, using a vector error correction model. The result provide an evidence for crowding in effect explaining the direction of public expenditures towards private sector through contractors, politicians and bureaucrats.

Shetta and Kamaly (2014) took over this question for the case of egypt using a VAR model and they find that as the government issues more instrument for financing, banks shift their portfolios from risky loans to finance government debt which is risk-free loans. Then, private investment depresses causing the decrease of the potential growth.

Another paper from the World Bank tests the effect of public spending in infrastructure on private investment. Agénor and al.(2005) suggests that public infrastructure has both "flow" and "stock" effects on private investment in Egypt, but only a "stock" effect in Jordan and Tunisia. But these effects are small and short-lived, reflecting the unfavorable environment for private investment in this sample of countries.Improvements to the environment in which domestic investment operates are crucial to stimulate growth and job creation in the region.

3 Empirical Investigation

The data used in this empirical analysis are the government's spending and revenue and the real interest rate of 10 years bonds. The data for fiscal variables are corrected for the inflation by deflating them with a GDP deflator.

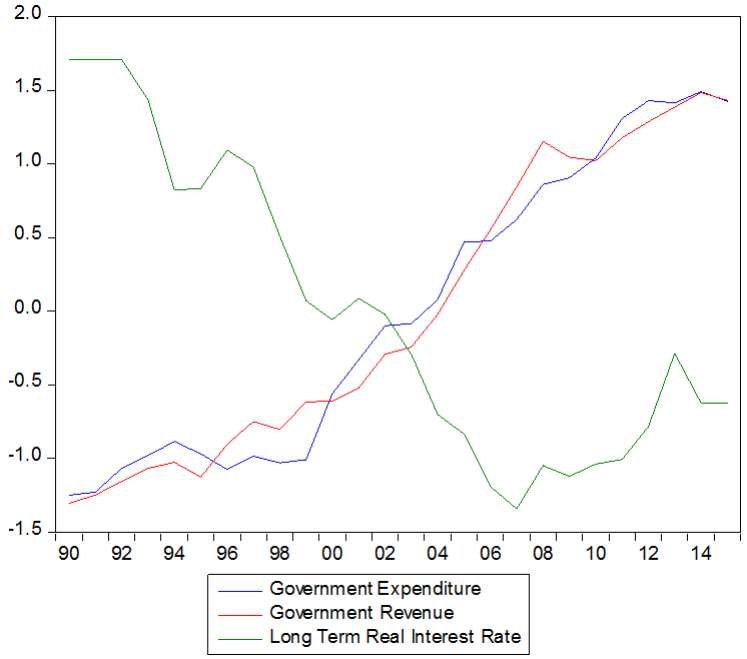

Figure 2: Evolution of fiscal variables and long term real interest rate

Moreover, as this data are cyclical we use a dynamic factor model (DFM) to correct for cyclical factors and the model used for this purpose is explained in the first appendix. For the real interest rate, we calculate it as the nominal rate minus a trend of inflation taken as a proxy for the expected inflation. The data represented bellow are normalized, expressed in annual frequency and it covers the period 1990-2015. [2]

The review of the evolution of fiscal variables and real interest rate in figure 2 reveals two distinct phases. The first phase covers the period 1990-2004, it is characterized by a downward trend for the interest rate and slowing upward trend for government spending and revenue. Several reasons explain those patterns. Firstly, the downward trend of interest rate is related to the development of the bonds market. As markets develop, the interest rate is declining to be in line with the monetary policy stance. Secondly, fiscal variables are growing slowly since the moroccan government had experienced an adjustment program and it must keep the budget deficit at a low level with respect to international obligations. The second phase is that

[2]For fiscal variables we use the data of the IMF data mapper available at http://www.imf.org/external/datamapper/index.php, and for the interest rate we use the data provided by the Ministery of Finance

of 2004-2015 which shows that both government spending and revenues are increasing while the level of the interest rate is much more moderated and slowly increasing. Government revenue reacts to the faster growth known in this period, and the public expenditure was oriented into financing lot of sectoral programs and some social allocations in response to the Global Financial Crisis of 2008. The deterioration in terms of trade, the decline in external demand addressed to Morocco and soaring energy prices were all factors weighing heavy on public finances and therefore have led to an increase in public spending.

According to the figure 2, we cannot distinguish any relationship between government spending and real interest rate. In order to test the existence of such a relationship, more techniques are needed. This is what will be shown in the next two subsections.

3.1 Correlation Analysis

First, it is useful to calculate the correlation between government expenditure and real interest rate to measure the power of the linear relationship between those variables.

Examination of correlation highlighted the following results:

correlations with	Government Expenditure
10 years rate	-0.85

The coefficients of correlation show a strong negative relationship between government expenditure and long term rate. However, these calculations do not suggest the existence of crowding out effect. To do so, we have to dig further by using more advanced techniques.

3.2 Unit root tests

Using a modeling technique instead of another is a choice that depends on the nature of the series with which we are dealing. It is in this sense that we must examine the order of integration of the studied series. The results of the unit root test[3] are shown below:

[3]Detailed results are reported in the appendices

variables	ADF	PP
Government Expenditure (LGE)	I(1)	I(1)
Government Revenues (LGR)	I(1)	I(1)
Long term real interest rate (orig r)	I(0)	I(0)

3.3 Methodological issues

The VAR Specification

In this part, we will estimate a structural VAR model, containing the fiscal variables and long real interest rate.

As a notation, we take r_t for the long real interest rate, s_t for government spending and T_t for government revenues. We construct the vector y_t defined by : $y_t = [dT_t\ ds_t\ r_t]'$ and our basic VAR will be :

$$y_t = \beta_0 + \beta_1 y_{t-1} + ... + \beta_p y_{t-p} + e_t$$

With $e_t = [e_t^T\ e_t^s\ e_t^r]'$ is the vector of forecast errors, and $dX_t = X_t - X_{t-1}$ and β_j are matrices of coefficients.

We define a vector of structural shocks $u_t = [u_t^T\ u_t^s\ u_t^r]'$ and the identification problem will consist of specifying of linear relationship between u_t and e_t.

By examining the lag length of the VAR, we find that $p = 1$, and all the propreties are validated for the present specification[4].

Identification problem

We follow the methodology of Blanchard and Perotti[5] for the identification of our structural shocks u_t, since the errors e_t have a little economic interpretation.

We have to set three equations that link the structural shocks with the error forecasts.

$$e_t^T = a_1 e_t^r + a_2 u_t^s + u_t^T \quad (1)$$

$$e_t^s = b_1 e_t^r + b_2 u_t^T + u_t^s \quad (2)$$

[4]Detailed results for this specification are presented in the appendices

[5]Blanchard, Perotti, R. (1999). An empirical characterization of the dynamic effects of changes in government spending and taxes on output (No. w7269). National bureau of economic research.

$$e_t^r = c_1 e_t^T + c_2 e_t^s + u_t^r \tag{3}$$

The first equation states that unexpected movements in government revenue are due to unexpected movement in interest rate, structural shock in government spending and structural shock to government revenue. The second equation can be inerpreted in the same way. And the third equation allows unexpected movements in real interest rates in respect with movements in government revenue and expenditure as well as a structural shock of the interest rate.

Now we turn to estimate our coefficients a_1 , b_1 , c_1 and c_2 in order to identify our structural VAR. Moreover, a_1 is interpreted as the semi-elasticity of government revenue to real interest rate, b_1 is the semi-elasticity of public spending to real interest rate. c_1 and c_2 will be estimated by a simple regression of e_t^r on e_t^T and e_t^s.

As fiscal variables exclude debt and property income, and according to Perotti (2004) and Parkyn and Vehbi (2013) we set : $a_1 = 0$ and $b_1 = 0$. For the estimation of c_1 and c_2 we find that : $c_1 = -0.01224$ and $c_2 = -0.23611$.

4 Impulse Response Analysis

The results from the impulse response functions are plotted in the figure 3 below. It shows the reaction of our three variables to the structural shocks.

From the results of the impulse response functions, it appears that fiscal variables do not react to the long rate. The interaction between the two fiscal variables is very low, the reaction of the government expenditure shock of government revenue is lower in the first period and fades in the second period and vice versa. This can be explained by the fact that state spending must put an incompressible nature.

Regarding the response of the real interest rate in fiscal structural shock, the reactions are too low, implying the absence of crowding in our economy.

Public spending in Morocco covers mainly critical infrastructures in order to build a modern economy. These spending includes investments in transportation networks, communications and sectoral programs. Which constitutes a necessary precondition for deployment of private investment. In contrast, in developed countries, public investment becomes a competitor

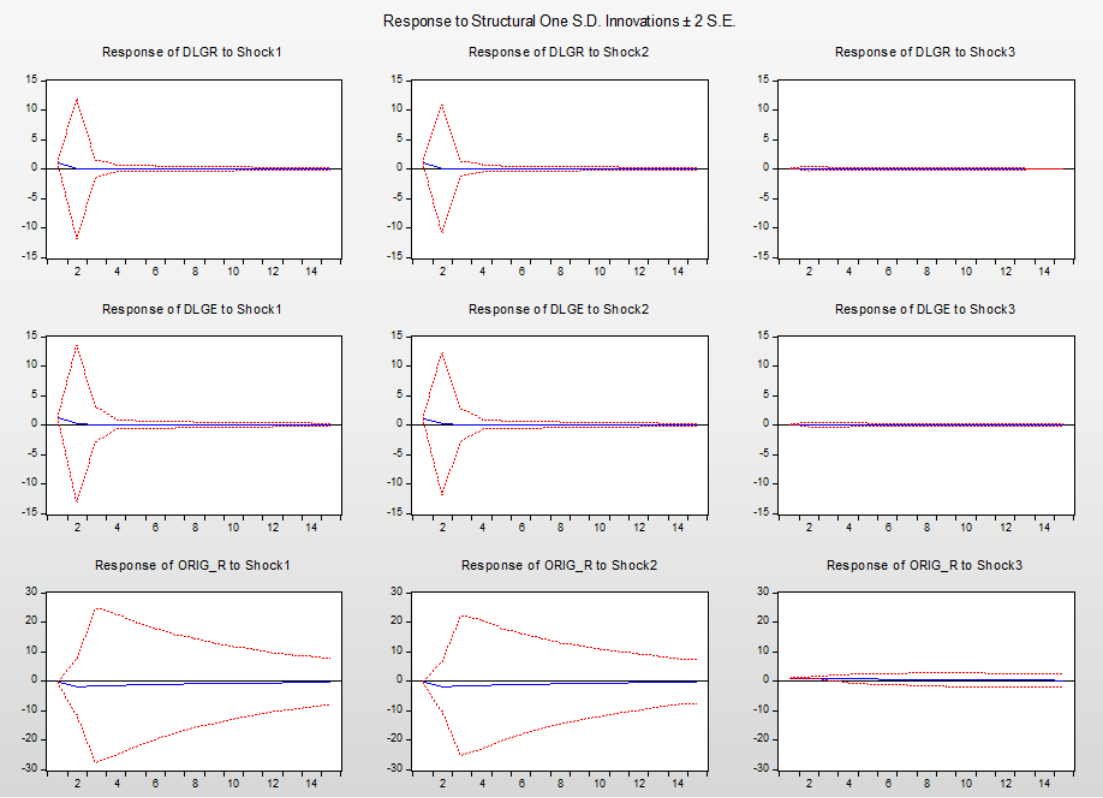

Figure 3: Impulse Response Functions

to private investment; it creates pressure on liquidity and imply then higher interest rates that discourage private investment.

Moreover, in developed countries as in developing countries, the component of public expenditure in destination to investment is characterized by a counter-cyclical behavior. Since the consumption goods and personnel expenditure are incompressible in the budget, the economic stabilization action of fiscal policy goes further through public investment. Thus, it can be an engine of investment in times of recession. However, this action is only possible if fiscal policy remains sustainable. Otherwise, presumably, the debt-financed investment leads to higher costs like the crowding out effect.

In Morocco, the weight of public administration in the effort of national investment accounted for 11 percent in the old System of National Accounts. The overhaul of the system has raised the share of public investment to 15 percent due to the integration of military equipment following the international recommendations. This share may seem modest, particularly, relative to government announcements at annual budget of the State. Note that this is due to two factors; the first is that the data of the annual budget class in terms of investment expenses that are not considered as such by the System of National Accounts. The second reason is that the public sector according to the System of National Accounts does not include all the public entrerises.

From another perspective, we see that before the crisis, in 2004-2008, the growth of public investment was higher than private investment and when public expenditure on capital goods was accelerating, private investment seems to react. Similarly, after the crisis, at first public investment tried to play a countercyclical role, it grows from 9 percent to 15 percent, responding to a total collapse of private investment, which declined from 16 percent to -1.2 percent. Then, in a second step, and following the deterioration of budget deficits, public investment has collapsed too.

Taking into account all this considerations, the results found from the structural VAR seems very well explained and the crowding out effect is far from being a preoccupation in the Moroccan context.

5 Conclusion

The present paper investigates the dynamics of government spending, government revenues and long term real interest rate, in order to state about

the crowding-out effect hypothesis. The analysis was performed through a structural VAR model and the examination of this hypothesis leads to reject this hypothesis for the case of Morocco.

As developing country, Morocco has been engaged in several investments that weigh on the government budget. Spending in infrastructure, in communication and in welfare seem to build the basis of modern economy that will attract private investments, and the result will not be materialized in the immediat short term.

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Appendices

Appendix 1 : Stationarity of Variables

Null Hypothesis: ORIG_R has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.343316	0.0212
Test critical values:	1% level	-2.660720	
	5% level	-1.955020	
	10% level	-1.609070	

*MacKinnon (1996) one-sided p-values.

Figure 4: ADF test for long real interest rate

Null Hypothesis: ORIG_R has a unit root
Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.435725	0.0171
Test critical values:	1% level	-2.660720	
	5% level	-1.955020	
	10% level	-1.609070	

*MacKinnon (1996) one-sided p-values.

Figure 5: Phillip Perron test for long real interest rate

Null Hypothesis: LGR has a unit root
Exogenous: None
Lag Length: 3 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.935374	0.3006
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

*MacKinnon (1996) one-sided p-values.

Figure 6: ADF test for government revenue

Null Hypothesis: LGR has a unit root
Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.536531	0.4743
Test critical values:	1% level	-2.660720	
	5% level	-1.955020	
	10% level	-1.609070	

*MacKinnon (1996) one-sided p-values.

Figure 7: Phillip Perron test for government revenue

Null Hypothesis: LGE has a unit root
Exogenous: None
Lag Length: 3 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.965217	0.2885
Test critical values:	1% level	-2.674290	
	5% level	-1.957204	
	10% level	-1.608175	

*MacKinnon (1996) one-sided p-values.

Figure 8: ADF test for government spending

Null Hypothesis: LGE has a unit root
Exogenous: None
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.503043	0.4882
Test critical values:	1% level	-2.660720	
	5% level	-1.955020	
	10% level	-1.609070	

*MacKinnon (1996) one-sided p-values.

Figure 9: Phillip Perron test for government spending

Appendix 2 : Dynamic Factor Model

The model consists of two blocks of equations : Measurement equations and Transition equations.
We include the GDP because this variable is the best related to cyclical fluctuations. And S_t will be our latent variable that is driving the cycle.

Measurment Equations

$$log(GDP_t) = c_1 S_t + \epsilon_{GDP,t}$$
$$T_t = c_3 S_t + \epsilon_{T,t}$$
$$s_t = c_5 S_t + \epsilon_{s,t}$$

Transition Equations

$$S_t = c_7 S_{t-1} + \eta_{S,t}$$
$$\epsilon_{i,t} = c_i \epsilon_{i-1,t} + \eta_{i,t}$$

With : $i = GDP, T, s$.

Results of Estimation of DFM

Sspace: SS_3
Method: Maximum likelihood (BFGS / Marquardt steps)
Date: 03/26/16 Time: 14:21
Sample: 1990 2015
Included observations: 26
Estimation settings: tol= 1.0e-09, derivs=accurate numeric
Initial Values: C(1)=1.00000, C(2)=0.45632, C(3)=1.00000, C(4)=0.50991, C(5)=1.00000, C(6)=0.55528, C(7)=0.90000, C(8)=0.50000, C(9)=0.50000, C(10)=0.50000
Convergence achieved after 45 iterations
Coefficient covariance computed using outer product of gradients

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.067760	0.028097	2.411677	0.0159
C(2)	-0.039388	0.010188	-3.866199	0.0001
C(3)	0.074352	0.031476	2.362172	0.0182
C(4)	-0.039162	0.019698	-1.988161	0.0468
C(5)	0.079785	0.034696	2.299527	0.0215
C(6)	-0.061990	0.020407	-3.037626	0.0024
C(7)	0.994505	0.055419	17.94527	0.0000
C(8)	0.654424	0.396559	1.650257	0.0989
C(9)	0.622001	0.542508	1.146528	0.2516
C(10)	0.606786	0.200674	3.023745	0.0025

	Final State	Root MSE	z-Statistic	Prob.
S1	10.26590	1.091381	9.406340	0.0000
E_LGDP	0.034215	0.043947	0.778555	0.4362
E_LGR	-0.013969	0.044124	-0.316586	0.7516
E_LGE	-0.009715	0.065541	-0.148225	0.8822

Log likelihood	98.08721	Akaike info criterion	-6.775939
Parameters	10	Schwarz criterion	-6.292056
Diffuse priors	0	Hannan-Quinn criter.	-6.636598

Figure 10: Estimation of Dynamic Factor Model

Appendix 3 : Lag Length Criteria

VAR Lag Order Selection Criteria
Endogenous variables: DLGR DLGE ORIG_R
Exogenous variables: C
Date: 03/26/16 Time: 12:36
Sample: 1990 2015
Included observations: 22

Lag	LogL	LR	FPE	AIC	SC	HQ
0	15.76108	NA	6.29e-05	-1.160098	-1.011320	-1.125050
1	41.52718	42.16271*	1.39e-05*	-2.684289*	-2.089175*	-2.544098*
2	47.18377	7.713529	1.99e-05	-2.380343	-1.338893	-2.135008
3	57.62481	11.39023	2.02e-05	-2.511346	-1.023561	-2.160869

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Figure 11: Selection of the number of lags in the VAR

Appendix 4 : Estimation of the VAR

Vector Autoregression Estimates
Date: 03/31/16 Time: 09:54
Sample (adjusted): 1992 2015
Included observations: 24 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DLGR	DLGE	ORIG_R
DLGR(-1)	0.127961	0.107422	-2.242237
	(0.23917)	(0.29207)	(1.75646)
	[0.53503]	[0.36780]	[-1.27657]
DLGE(-1)	-0.097946	0.046678	0.374452
	(0.19653)	(0.24000)	(1.44331)
	[-0.49839]	[0.19449]	[0.25944]
ORIG_R(-1)	-0.008065	-0.008554	0.875351
	(0.00814)	(0.00994)	(0.05979)
	[-0.99055]	[-0.86033]	[14.6399]
C	0.093800	0.092467	0.496716
	(0.04862)	(0.05938)	(0.35708)
	[1.92921]	[1.55733]	[1.39105]
R-squared	0.073170	0.068021	0.929251
Adj. R-squared	-0.065855	-0.071776	0.918639
Sum sq. resids	0.092042	0.137261	4.964369
S.E. equation	0.067839	0.082844	0.498215
F-statistic	0.526307	0.486569	87.56365
Log likelihood	32.70824	27.91257	-15.14531
Akaike AIC	-2.392353	-1.992714	1.595443
Schwarz SC	-2.196011	-1.796372	1.791785
Mean dependent	0.058075	0.062598	4.414702
S.D. dependent	0.065710	0.080021	1.746663

Determinant resid covariance (dof adj.)	7.12E-06
Determinant resid covariance	4.12E-06
Log likelihood	46.63913
Akaike information criterion	-2.886594
Schwarz criterion	-2.297567

Figure 12: Estimation of the VAR

Appendix 5 : Validation of the VAR

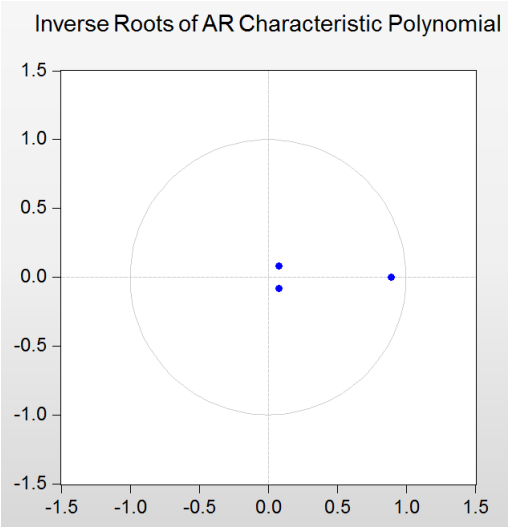

Figure 13: Stability test

VAR Residual Serial Correlation LM T...
Null Hypothesis: no serial correlation ...
Date: 03/31/16 Time: 09:57
Sample: 1990 2015
Included observations: 24

Lags	LM-Stat	Prob
1	8.766855	0.4591
2	17.58805	0.0403
3	6.875477	0.6501
4	7.300115	0.6059

Probs from chi-square with 9 df.

Figure 14: Autocorrelation test

Appendix 6 : Estimation of the Identification system

Structural VAR Estimates
Date: 03/31/16 Time: 09:54
Sample (adjusted): 1992 2015
Included observations: 24 after adjustments
Estimation method: method of scoring (analytic derivatives)
Convergence achieved after 365 iterations
Structural VAR is over-identified (4 degrees of freedom)

Model: Ae = Bu where E[uu']=I
Restriction Type: short-run pattern matrix

A =

1	0	0
0	1	0
0.01224	0.23611	1

B =

1	C(2)	0
C(1)	1	0
0	0	1

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	1.179350	0.016322	72.25623	0.0000
C(2)	0.956520	0.014119	67.74690	0.0000

Log likelihood	-32.18062		
LR test for over-identification:			
Chi-square(4)	144.5123	Probability	0.0000

Estimated A matrix:

1.000000	0.000000	0.000000
0.000000	1.000000	0.000000
0.012240	0.236110	1.000000

Estimated B matrix:

1.000000	0.956520	0.000000
1.179350	1.000000	0.000000
0.000000	0.000000	1.000000

Figure 15: Estimation of the system of identification