Economics
The Open-Access, Open-Assessment E-Journal

Discussion Paper
No. 2017-6 | February 13, 2017 | http://www.economics-ejournal.org/economics/discussionpapers/2017-6

Financial frictions and regime switching: the role of collateral asset in emerging stock market

Haithem Awijen and Sami Hammami

Abstract

This paper examines empirically the nonlinear business cycle dynamics due to the presence of financial frictions. Using a threshold vector auto regression, the authors estimate the behavior of interest rate shocks in which a regime change occurs if the two respective threshold variables namely asset price and exchange rate cross their critical threshold value. The authors find evidence that non linearity is strongly directed by regime-dependency; in fact the results suggest that output growth response is bigger when the economy is initially an appreciation regime.In addition, the empirical findings prove the presence of asymmetric responses to interest rate shocks however this reaction is recognized via asset price ”debt-deflation mechanism” rather than shocks stemming from ”exchange rate depreciation spirals”. The results also show that a response to large shocks to interest rate shows disproportionate effects compared with responses to small shocks.

JEL E51 E32 C20 C63

Keywords Collateral Constraints, Business Cycle Asymmetry, financial frictions, Threshold VAR

Authors

Haithem Awijen, ✉ Unité de Recherche en Économie de Développement (URED), Faculty of Economics and Management of Sfax, Tunisia, haithem.awijen@gmail.Com

Sami Hammami, Unité de Recherche en Économie de Développement (URED), Faculty of Economics and Management of Sfax, Tunisia

Citation Haithem Awijen and Sami Hammami (2017). Financial frictions and regime switching: the role of collateral asset in emerging stock market. Economics Discussion Papers, No 2017-6, Kiel Institute for the World Economy. http://www.economics-ejournal.org/economics/discussionpapers/2017-6

Received January 12, 2017 **Accepted as Economics Discussion Paper** January 25, 2017 **Published** February, 13, 2017

I. Introduction

Business cycles in emerging economies are characterized by large asymmetries due to the existence of unusual crisis events, however the recent financial crisis showed that financial frictions play important role in emerging market business cycle to capture phenomena of asymmetry[3], thus adding financial market frictions in standard macroeconomic models would be necessary[4]. Their inclusion matter for the explanation of EME business cycles as an amplification channel of the effects of various shocks in times of crisis.

Contrary to what has been share in the last couple decades, there is growing consensus on the view that these asymmetries can best be captured in theoretical models by making collateral or credit constraints only bind occasionally. The concept of occasionally binding constraints has been introduced in macroeconomic models with a view to stress the pertinence of financial frictions in generating threshold and in the amplification and propagation of financial accelerator effects - in particular for emerging market business cycles. As shown in Mendoza (2010), if the constraints don't bind, an adverse shock of standard magnitude yield same macroeconomic responses as in a typical RBC-SOE model As a result, the economy exhibit normal business cycle patterns without credit friction.

In this paper, our focus is on studying empirically the issues of occasionally binding constraints to capture asymmetries. Using a threshold vector auto regression (TVAR) approach as a non-linear estimation technique, we estimate the behavior of interest rate shocks as they represent the kind of shock that are likely to make constraints bind endogenously and thus trigger non-linear reactions.

The exogenous character of interest rate shocks facilitates the identification of a shock process in different regimes; its effect can be determined intuitively by calculating amplification coefficients which measure the non-linearity of responses to various regimes[5].

The emphasis of this paper is on studying the quantitative significance of the business cycle transmission mechanism created by the collateral constraints[6] similar to the recent macroeconomics literature on this subject, including (Kiyotaki 1997, Bernanke 1999, Kocherlakota 2000, Mendoza 2006).However the distinct feature of our paper lies several aspects, while there are several papers that study the endogeneity issue based on credit market conditions and business cycle fluctuations. Our papers identify new insights. In fact significant number of empirical studies document asymmetries in the effects of monetary policy on output growth using one threshold variable, and based on two credit regimes, the credit constrained and unconstrained regimes, however our model uses two threshold

[3] Arellano and Mendoza (2002), Mendoza and smith (2004) use two financial frictions such as collateral constraint in the form of a margin requirement that limit the ability of agent to leverage foreign debt on domestic asset holdings and asset trading costs and integrate them in an equilibrium asset pricing model to study its quantitative implications in explaining sudden stops.

[4] Their inclusion is necessary to prove the importance of the financial sector for business cycle fluctuations.

[5] The effect of shocks to the interest rate in different regimes is interpreted as states of the economy where collateral constraints bind to a different degree.

[6] Collateral constraints limit debt to a fraction of the market value of capital.

variables, the real exchange rate and stock price deviations from a trend as directly linked to collateral constraint and hence triggers of non-linearities.
the occasionally binding constraints in our model can conduct to non-linearities whenever there is asset price collapse[7] hence asymmetric effects of collateral constraints set in prior an increase in leverage ratios [8] and when adverse exogenous shocks to fundamentals hit, constraints suddenly bind, setting thereafter in motion the Irving Fishers (1933) debt-deflation mechanism and leading in final to an endogenous business cycle dynamics. This mechanism yields significant, nonlinear feedback between access to credit and the prices of assets on which debt's agent is leveraged,

Others non linear reactions could triggers whenever there is a contractionary exchange rate depreciations that reduce the net worth in the existence of liability dollarization which leads to additional depreciation (Bianchi 2011, Benigno 2010) and binding constraints.

Besides The regime-switching in our model is not only with respect to the regimes based on values of deviations of stock prices or a real exchange rate index from the linear trend but also to positive/negative interest shocks.

The rest of this paper is organized as follows. Section 2 reviews the literature. Section 3 investigates the underlying methodology .section 4 discusses the results. Section 5 concludes.

II. Literature Review

Under New Keynesian paradigm, most of structural model are based on the assumption that markets are complete and, therefore, ignore the presence of financial market frictions Quadrini (2009). In others sense financial markets work perfectly indeed the interest rate set by central banks uniquely determines the cost of credit for borrowers.

However the recent financial crisis 2007-09 highlighted the weakness of this simplifying assumption. Since then there has been a revived interest to incorporate financial market frictions in standard macroeconomic models as a key driver of business cycle fluctuations[9].

A long-standing tradition in macroeconomic literature investigated the mechanism through which monetary policy affects real economic activity over the business cycles[10], however new macroeconomic research is looking for an asymmetric amplification and propagation mechanism that can turn small shocks to the economy into the business cycle fluctuations, Kocherlakota (2000). One of mechanism that has received special attention is credit-market imperfections and their nonlinear effects on business cycle dynamics.

The idea is based on the work of Acemoglu (1997) who pointed that fluctuations in business cycle in the United States have had been characterized by three key properties i.e. Large,

[7] Asset price reductions exhaust entrepreneurs' net worth and result in further asset price collapses. Calvo (2006), Aiyagari Gertler (1999), Mendoza (2010).
[8] Leverage is high during booms and low during busts, indeed, leverage is procyclical.
[9] Most of policy maker pointed out need to allocate a more prominent role to the financial sector for understanding the dynamics of the business cycle in their macroeconomic models.
[10] Credit conditions play an important role as a channel through which monetary policy influences the economy.

highly, persistent and asymmetric movements in Aggregate output[11]. However the authors pointed that sufficiently large shock like this could not be found in any data to account for a large movement of aggregate output, (Summers, 1986). Indeed there is a mechanism who transforms small shocks into a downwardly biased fashion shocks. This mechanism is called credit/collateral constraint.

There are two main contributions considered as classic references for most of the work done in this area. One is referred to the work of Bernanke (1989) and the other to Kiyotaki (1997) who attempted to incorporate financial frictions in a general equilibrium model. We will explain in the following section how this two framework are based.

A. How imperfect credit markets work? : The presence of two frameworks

The effect of credit market imperfections on business cycle dynamics was firstly stressed with the financial accelerator[12] framework of Bernanke (1998). Credit market imperfections in such models materialize from asymmetric information and costly-state verification, Ripoll (2003). The endogenous developments in credit markets may directly contribute to the propagation and amplification of exogenous shocks to the economy, Bernanke (1998), indeed with a presence of asymmetric information in credit markets, balance sheet conditions of borrowers could play a role in the business cycle through their impact on the cost of external finance.

In their model, entrepreneurs do not have sufficient capital to undertake their investment projects, so they seek a bank loan. To judge their ability to repay, banks take into account the net value (net worth) of prospective borrowers, which is the amount of all their assets less the outstanding debt. However, banks will also have to take into account the possibility that once the loan is granted to the borrower, it will not be ultimately destined for the originally announced project, on the other hand, borrowers profitability and repayment ability may deteriorate due to adverse shocks on the economy, which forces lenders therefore to protect themselves against the risk of non-repayment of loans by requiring external finance premium[13] that rises when their leverage increases.

Indeed one may therefore say, there is an inverse relationship between external finance premium and net worth of borrowers Bernanke (1998), the net worth of borrowers will therefore be procyclical, while the external financing premium will be countercyclical.

For example, when there is a negative demand shock or productivity (fundamentals), or tightening in monetary policy, the collapse in profits and asset prices result in deterioration in the net worth of companies. Decrease in net worth increase firm leverage, leading therefore to high external financing costs and thus a reduction in the demand for capital. The fall in demand for capital reinforces the decline in its value. This mechanism is regularly called

[11] downward movements have been sharper and quicker than upward movements.
[12] Changes in short-term interest rates affect not only the cost of capital, but also the external finance premium. In their model the dynamics of the cycle are intrinsically nonlinear: financial accelerator effects are stronger the deeper the economy is in recession.
[13] The authors specifically defined as the difference between the external financing costs and the opportunity cost of internal funding.

accelerator effect, because the lower price of capital has a feedback effect, by lowering the net worth of firms, Christensen (2008). Such a mechanism tends to limit opportunities for profitable investment[14] and decline in output.

Financial accelerators have gained tremendous popularity last couple years and are now an integral part of most macroeconomic models used by central banks.

Their effectiveness is derived from its powerful utility in the amplification of shocks whenever financial frictions generate inefficiencies that shorten the supply of credit. In contrast with these agency-costs models, limited attention has been devoted to analyzing asymmetric amplification and propagation mechanism in a world with endogenous credit/collateral constraints, Ripoll (2003).

Indeed the natural question that any one should ask how Creating business cycle through credit / Collateral constraint, in others sense how Credit/ Collateral constraints (or virtually any form of financial frictions) are an asymmetric propagation mechanism.

(Kiyotaki 1997, Carlstrom 1997, Kocherlakota 2000, Ripoll 2003)[15] pointed out the potential role of collateral constraints as a powerful transmission mechanism. As explained by those authors, assets play a dual role in the economy; in sense they are used to produce goods and services and provide collateral for loans. Indeed when debts need to be fully secured by collateral[16] and it is used at the same time as an input in production, thus a small temporary shock to the economy can be largely amplified[17].

Borrower collateral is a vital piece in financial accelerator model. In others sense, when collateral constraints limit the amount of debt which agents can hold as a function of their value of collateral or net worth .The endogenous credit constraint creates dynamic interaction between borrowing limit and asset prices (i.e. debt capacity and small shock). No doubt that, such interaction will multiply the effect of shock.

However, (Kocherlakota 2000, Christensen 2008, Bianchi 2010) pointed that most of macroeconomic models used to study asymmetries in business cycles such as sudden stop and credit boom rely on *occasionally binding constraints* rather than always binding constraint since they prove their quantitative importance to generate threshold and financial accelerator amplification.

---

[14] This reflects a view that the ability of firms to obtain financing plays an active role in investment behavior.

[15] Moore (1997) develop a dynamic equilibrium model in which endogenous, procyclical fluctuations in asset prices are the principal source of changes in net worth, credit received and spending however Cordoba and Ripoll (2003) introduce a cash-in-advance constraint for consumption and investment in the real-economy model of Kiyotaki and Moore (1997) to studies the potential role of collateral constraints as a transmission mechanism of monetary shocks.

[16] Lenders cannot force borrowers to repay their debts unless debts are secured.

[17] Here we should note that the degree of amplification provided by credit constraints depend crucially on the parameters of the economy

In a financial system, endogenous, pro cyclical fluctuations in asset prices stemming from an occasionally binding constraint display directly on the balance sheets and have an immediate impact on the net value of all components of the financial system.
Asset holdings and capital can serve as collateral ,equivalently, in a system of collateralized assets, the current income and the value of outstanding debt determine the ability to borrow, indeed, any temporary shock to the economy, lowers the value of the existing collateral, which increases the external finance premium Bernanke (1998), reduces the net worth[18] of credit-constrained firms, thus tightens furthermore the debt capacity, causing in turn an additional fall in output and forces credit-constrained firms to curtail their investment and propagates the shock to the economy.

Following an adverse shock, multiple channels have been scrutinized in the literature that can lead to binding constraint. The first is asset price channel, in this spirit; constraints only bind occasionally in nature state where the economy's leverage ratios (the ratios of debt to asset values) are high enough. Therefore constraint set in motion Irving Fisher's (1933) classic debt-deflation mechanism. Indeed when the collateral constraint on debt binds, agents therefore are forced to liquidate their capital in order to regain *"margin calls"*. This fire-sale of assets reduces the price of capital and hence as a result, the collateral constraint is further reinforced, setting off an asset price collapse. This debt deflation spiral has important real effects: it induce contemporaneous drop in output, collapse in the price and quantity of collateral assets and a decline in consumption and investment.

Second contractionary exchange rate depreciations with the assistance of liability dollarization induce a deterioration of net worth, which lead to additional depreciation (Benigno 2010, Bianchi 2011). the theoretical explanation for those authors comes from the idea that when agents make a decision about the amounts they borrow, they forget to internalize pecuniary externalities, as result, after a long period of overborrowing, an exogenous shock which leads to a depreciation of the exchange rate push to a binding credit constraints and triggers therefore an adverse balance sheet effects.

III. Methodology

A. Non linearities

Both macro and micro level studies in the literature on financial market imperfections have provided evidence for the importance of credit market imperfections as a propagator of shocks to the economy, however most of empirical studies are based almost entirely on linear VAR which may have difficulty in detecting the role of credit market conditions as a nonlinear propagator of shocks. The recent empirical studies have emphasized the non-linearities involved in the relationship between financial sector developments and business cycle dynamics.

Most of empirical studies which had employed nonlinear dynamics, such as regime switching associated with fluctuations in output have found asymmetries in responses to shocks. For example credit conditions may play an important role as a channel through which monetary

[18] The net worth of financial intermediaries is especially sensitive to fluctuations in asset prices given the highly leveraged nature of such intermediaries' balance sheets.

policy influences the economy; however the empirical evidence proved that the asymmetric response to monetary policy shocks on the economy is mixed.

(McCallum 1991, Cover 1992, Morgan 1993, Thoma 1994, Rhee 1995, Kandil 1995, Karras1996, Balke 2000) found that a contractionary monetary policy shock induce a decline in output, whereas an expansionary monetary policy shock has no effect on output.

(Blinder 1987, McCallum1 1991, Balke 2000)[19], develops a model in which monetary shocks have diverse effects when the economy is in a credit-rationing regime than at other states. All these authors found that U.S output responds more to a tighting monetary policy in a credit-rationed regime.

Indeed as showed from most of the empirical literature, capturing non-linearities is very challenging, two main questions should be addressed when applying nonlinear time series models:

The First one is related to the characteristics of shocks. In this respect, different shocks can affect macroeconomic variables disproportionally. Shocks can differ with regards to their direction (positive vs. negative shocks) as well as to their size (small vs. large shocks), (Cover 1992, Balke 2000).

Second, non-linearities can arise due to the differences in initial conditions (regime dependencies),Balke (2000). Most importantly this second issue is the key to the heterogeneous propagation of shocks whenever the underlying dynamics are nonlinear.

Indeed regime dependencies[20]or initial conditions can serve an amplification (or attenuation) mechanism of shocks.

As a consequence, initial conditions matter at the first order since it governs to what extent shocks of different size or direction generate non-linearities and to what extent we are depending on whether the economy is very vulnerable or not at the time when the shock hits, Indeed in the next section we use a threshold vector auto regression model to capture asymmetries and regime switching, the threshold model allows the economy to switch between two regimes.

It should be noted that most of regime-switching models applied in the literature on asymmetric effects of monetary policy estimate a threshold vector auto regression (TVAR), in which the system's dynamics revert and forth between credits constrained and unconstrained regimes. However in our empirical part we identify two regimes which correspond to regime of binding and non binding constraints and the non linear effects will be detected by using generalized impulse response function (GIRF).

[19] The tighter the state of recent monetary policy, the more likely it is that the economy's credit constraint will be binding and therefore the greater will be the output effects of monetary policy. Similar implications regarding the effect of credit market imperfections on business cycle dynamics are also emphasised in the literature concerned with the financial accelerator.

[20] Regime-dependencies, describe the point of the business cycle at which the economy is situated when a shock hits.

B. Model specification

A threshold vector auto regression (TVAR) is one of the most widely used classes of models to capture nonlinearities such as regime switching, asymmetries and multiple equilibria implied by the theoretical models of credit market imperfections.

The TVAR models can be classified as a special case of more general regime switching models such as Markov-switching VARs (MSVARs) which often impose exogenous switches.
However, the assumption of exogenous in (MSVARs) is quite unrealistic in a business cycle dynamic where endogenous movements can be expected to lead to regime switches.
This is why we opt for TVARs since it explicitly model the endogenous regime-switching process.

TVAR allows credit regimes to switch endogenously as a result of shocks to other variables besides credit (in our econometric specification to the money market rate TMM). Threshold models work by splitting the time series endogenously into different regimes. Each regime is defined by boundaries or threshold variable. Within each specific regime the time series is supposed to be described by a linear model and its coefficients can consequently be estimated by OLS.
The specification of threshold variable is quite important to endogenize the regime switching and since our goal to study throw which channel non-linearities materialize.

We use asset prices and exchange rates respectively as the switching variables. We use the econometric specification developed by (Balke 2000, Atanasova 2003, Li 2010). The model is specified as follows:

$$\boldsymbol{Y_t} = \Psi_{\mathbf{0}}^{\mathbf{1}} Y_t + \Psi_{\mathbf{1}}^{\mathbf{1}}(\boldsymbol{L})Y_{t-1} + \left(\Psi_{\mathbf{0}}^{\mathbf{2}} Y_t + \Psi_{\mathbf{1}}^{\mathbf{2}}(\boldsymbol{L})Y_{t-1}\right) \mathrm{I}\left(\boldsymbol{c_{t-d}} > \gamma\right) + \boldsymbol{\varepsilon_t}$$

- $\boldsymbol{Y_t}$ A vector containing :

  - The industrial production index as a proxy of output.
  -Tunindex as a proxy of asset price developments.
  -The real effective exchange rate index (increase denotes appreciation).
  -TMM as a proxy of the short-term nominal interest rate.

- $\Psi_{\mathbf{1}}^{\mathbf{1}}$ $\Psi_{\mathbf{1}}^{\mathbf{2}}$ are lag polynomial matrices.
- $\boldsymbol{\varepsilon_t}$ is the vector of disturbances with mean zero and covariance matrix $\sum$
- $\boldsymbol{c_{t-d}}$ is the threshold variable, which determines the prevailing regime of the system.
- $\boldsymbol{\gamma}$ is the threshold parameter at which the regime switching occurs.
- $\boldsymbol{I}(\ )$ is an indicator function that equals :

  1 when credit conditions cross the threshold i.e. $\boldsymbol{c_{t-d}} > \gamma$
  0 otherwise

As demonstrated by Balke (2000), Atanasova (2003), in addition to the lag polynomials changing across on regimes, contemporaneous relationships between variables may change as

well. Ψ_0^1 and Ψ_0^2 reflect the *''structural''* contemporaneous relationships in the two regimes respectively.
We follow a roughly recursive ordering of Bernanke, Gertler, and Watson (1997) , Leeper, Sims, and Zha (1996), balke (2000), Atanasova (2003) that have the form: output, prices, monetary policy variables (we classify the TMM in this order structure), and financial market variables[21].

C. Estimating and Testing the Threshold Vector Auto regression Model

If the threshold value γ were known**,** then to test for threshold behavior all one needs is to employ the conventional Wald test. The null hypothesis H0: $\boldsymbol{\Psi_0^2} = \boldsymbol{\Psi_1^2} = \mathbf{0}$ that the model coefficients are equal across the subsamples.

As it is well known, unfortunately, this testing problem is tainted by the difficulty that the threshold γ is **not known** a priori under H0 and thus it must be estimated[22].

The test procedure that we use Follow Hansen (1996) bootstrap procedure[23], which explicitly take into accounts for the fact that the threshold parameter is not identified under the null hypothesis[24].In order to test for thresholds when γ is not known, the threshold model is estimated by least squares for all possible threshold values.

By definition the LS estimators $(\widetilde{\Psi}, \widetilde{\sum}, \tilde{\gamma})$ minimize jointly the sum of the squared errors Sn . For this minimization, γ assumed to be restricted to a bounded set $\Gamma = [\gamma_1; \gamma_2]$, where Γ is an interval (usually trimmed) covering the sample ranges of the threshold variable[25].

The computationally easiest method to obtain the LS estimates is through concentration.

Conditional on $\boldsymbol{\gamma}$, the squared errors S_n is linear in Ψ and $\sum$, by consequence the estimation yields the conditional estimators $\hat{\Psi}$, $\widehat{\sum}$.

---

[21] This assumption reflects the view that financial variables could respond very quickly to all types of shocks. Indeed, this is consistent with the view that monetary policy shocks (shock to the short-term interest rates) affect output and inflation only after a lag. However, monetary policy shocks can have a contemporaneous impact on the financial stress index.

[22] In this case, testing involves nonstandard inference because $\boldsymbol{\gamma}$ is not identified under the null hypothesis of no threshold behavior.

[23] Following Hansen's procedure, we test the hull hypothesis allowing heteroskedasticity in the error term.

[24] Since γ is not identified, the asymptotic distribution of the test statistic based on the Wald principle F_n is not chi-square. Hansen (1996) shows that the asymptotic distribution can be approximated by a bootstrap procedure.

[25] Note that the LS estimators are the maximum likelihood (ML) estimators when the errors are iid $\mathrm{N}(0, \gamma^2)$.

The concentrated sum of squared residuals is a function of Υ and $\hat{\Upsilon}$ is the value that minimizes$s_n\ (\Upsilon)$.

Since $s_n\ (\Upsilon)$can take on less than n (the time span of the time series) distinct values, Υ can be identified uniquely as:

$$\Upsilon = argmin_{\in \Gamma} s_n\ (\Upsilon)$$

The simulation method of Hansen (1996), which requires simulating an empirical distribution of sup-Wald, is used to conduct inference. Table 1 bellow shows the estimated threshold values[26]which are obtained from the maximization of the log determinant of the residuals. The p-values of the corresponding asymptotic distributions are in turn obtained by replicating the simulation procedure 500 times[27].

D. Generalised Impulse Response Functions

To gain some insight into the dynamic properties of the nonlinear VARs and the possibility of endogenous regime-switching, we calculate the impulse-response analysis. Unfortunately, the nonlinear structure of the model makes impulse-response analysis substantially more complex and considerably more time-consuming than in the standard linear case.

In the linear case, the impulse response function (IRF) is symmetric and history independent and reactions to shocks are strictly proportional to the shock itself, in others sense we compute the response to a shock only under the assumption of zero shocks in intermediate periods thus shocks only hits the economy at a particular point in time but neither before nor during the forecasting horizon[28] .

By consequence this assumption may generate misleading inferences concerning the propagation mechanism of the model Koop (1996).

These properties do not carry over to nonlinear models, in fact the impulse responses for threshold VARs are thus history-dependent and to examine the effect of shocks in a nonlinear system. To resolve this issue, Koop, et.al (1996) introduces Generalised Impulse Response Function (GIRF).

By definition, the Generalised impulse response function is the change in the conditional expectation of y_{t+h} as a result of knowing the value of an exogenous shock u_t ; A GIRF - similar to the notation of Koop et al. (1996) is defined as:

$$GIRF_y(h, \Omega_{t-1}, u_t) = E[y_{t+h} | \Omega_{t-1}, u_t] - E[y_{t+h} | \Omega_{t-1}]$$

---

[26] To guard against over fitting, the possible threshold values were restricted so that at least 15% of the observations plus the number of parameters for an individual equation

[27] Given the large number of parameters to be estimated and the sample size of the dataset, the bottom and top 30% quantiles of the threshold variable are trimmed to ensure that the model is well identified for all possible values of Υ in Γ.

[28] For linear models the assumption of zero shocks in intermediate periods can be justified by the Wold representation: The Wold representation shows that shocks on different periods do not interact.

WhereΩ_{t-1}, the information set at time $t-1$ and U_t is a particular realization of exogenous shocks[29]. The approach relies on the simulation of data depending on which regime the system is in at the time the shock hits the economy (the history Ω_{t-1} up to point t).
The advantage of GIRFs is not only that it allows for the analysis of regime-dependent responses, but also that effects of shocks of different sizes and directions can be analyzed.

Therefore, calculating GIRF[30] requires:

- Specifying the nature of the shock ε_t (its size and sign) and
- the initial conditions Ω_{t-1}

As a result, in nonlinear models, the impulse-response function is mainly sensitive to **the entire past history of the variables (**regime-dependencies), to **the size** (small vs. large shocks) and **direction of the shock (**asymmetries reflected via the positive vs. negative shocks) which give in final the GIRFs an advance over the standards IRF to analyze the above mentioned dimensions of non-linearity.

In contrast to existing studies that use threshold (or smooth transition) VARs, to study the asymmetric effects of monetary policy[31], we are mainly interested in this empirical part to investigate to what extent shocks to TMM induces endogenous regime-switching and how non-linearities materialize by studying The effect of asymmetries (due to shocks of different directions) or disproportionality (due to shocks of different magnitude).

Since our objective to study the effects of pecuniary externalities in generating non linearities, we choose asset price and exchange rate as threshold variable. To do so, we identify to regimes: a binding and non-binding credit constraints and therefore non-linear effects could be observed via impulse response analysis in TVARs.

We define respectively, the two regimes by **R1** and **R2** where:

R1 is the regime in which **asset prices are low** or **exchange rates weak** (depreciation regime); in this regime credit constraint is supposed to suddenly binds.

R2 corresponds to the state of the economy where **asset prices are high** or, respectively, **exchange rates are** in a state of **appreciation[32]** (Appreciation regime) indeed in this regime credit constraint are not binding.

[29] Typically, the effect of a single exogenous shock is examined at a time, so that value of the i^{th} Element in u_t, u_t^i is set to a specific value. The difficulty arises because, in the threshold VAR, the moving-average representation is not linear in the shocks (either across shocks or across time).

[30] a detailed description of the simulation algorithm and the way GIRF are computed is provided in Gary Koop paper (1996) .

[31] Others have been used to assess the effect of fiscal policy in times of crisis in contrast to tranquil times (see for example Auerbach and Gorodnichenko, 2010; Fazzari and Panovska, 2012; Baum et al., 2012).

[32] the exchange rate is strong vis-à-vis other currencies with respect to their long-term average

Based on the TVAR model, we can examine the following questions[33]:

1. Do Positive[34] shocks have a larger impact when the economy is initially in R2 (appreciation regime) rather than in R1 (depreciation regime).

2. If the economy is initially in R2, do large positive shocks have a disproportionally larger impact than small positive shocks?

3. If the economy is initially in R2, do positive shocks have a greater impact than negative shocks?

Data used for this empirical part are at monthly frequency (for the time span 1998M1 to 2015 M3).To identify a threshold and yields estimation, all variables are in log deviations from a linear trend, as stationary variables are required.

IV. Results

A. Standard VAR

Figure 1 below shows the results of a shock to TMM for a standard VAR model: visual inspection of the graph shows that the three main variables namely Tunindex as a proxy of asset price developments decrease, production fall and the exchange rate depreciates. From a theoretical point of view, these responses channels are well-known. An increase in the short-term nominal interest rate leads to higher borrowing costs, falling in asset prices since agents discount the future which in return gives a perception of lower future profits. In addition typical realizations of the exogenous shocks produce Sudden Stops, if firms depend on external finance, output decline as a reaction to higher borrowing costs. As consequence a depreciation of exchange rate is considered as mirrors of these developments.

B. Threshold Endogenous regime-switching

1. Regime dependencies Hypothesis

Shocks to TMM are likely to lead to non linear effects by endogenously[35] generating movements in the respective threshold variable[36], this clearly noticeable from the figures 2.3.4.5.

---

[33] For the non-linear analysis, assuming small shock and a fairly large shock to TMM as 0.5 and 1.5 standard deviation innovations relative to the size of shocks and positive and negative relative to direction of shocks.

[34] The reason behind choosing positive shocks stem from the fact that we want to analyse the detrimental case and stress the relevance of occasionally binding constraint as trigger of non linearities.

[35] The endogenous regime –switch actually exists in the data, indeed we are far away from supposing an intra-regime switch.

By comparing the regimes- switching following shock to TMM for the two threshold variables.

The figures 2 and 3 present the response of TMM to a different size of shocks between two regimes R1 and R2 when asset price is used as the threshold variables.

The figures 4 and 5 present the response of TMM when exchange rate is used as threshold variables.

We observe from figure bellow that the response of TMM when exchange rate is used as threshold variables do not display significant difference between the two regimes for different size of shocks (see figure 4 and 5).

Obviously, a reduced -form innovations of asset prices lead to regime-switches and most importantly innovations to TMM lead to a regime switch when the economy is initially in R2 (appreciation regime) .

We interpret this result as first information for the presence of strong non linearity channel operating via asset collapse rather the exchange rate spirals.

This is also reflected in the reaction of output (i.e. production), Regardless of the initial level of the financial stress condition, the response function of output is stronger when asset price lead the regime (see figure 6 and 7). However when exchange rate lead the regime, the output reaction do not differ substantially between the two regime (see figure 8and 9).

One could therefore conclude that Shocks to the interest rate react strongly via "debt-deflation mechanism" rather than shocks stemming from "depreciation spirals".

Such theoretical finding is consistent with the finding of (Perri and Quadrini, 2011, Gourinchas and Obstfeld, 2011) who prove empirically the more the initial conditions is associated with long periods of credit expansion , the more output collapses react strongly when shocks hit the system , indeed the degree of economic recessions is highly dependent the degree of leverage in pre-crisis periods.

To give a more powerful insight to this first indication, and since our main purpose to analyze the detrimental case, we investigate the first hypotheses:

Do positive shocks have a larger impact when the economy is initially in R2 (appreciation regime) rather than in R1 (depreciation regime).

We study this hypothesis for small positive shocks and large positive shocks to TMM.

---

[36] All the response function from 0.5 standard deviations shocks(small shocks) were multiplied by 2 and 1.5 standard deviations shocks (large shocks) were divided by 1.5 to make in final a comparable IRF with one standard deviations , similarly we had multiplied IRF from negative shocks by (-1).

1) Case 1: Small Positive shock (+0.5sd):

It is logical to not only look at the responses of production, but to also investigate the responses of the threshold variable.

Figure 10. 11. 12. 13 shows the response of the respective threshold variables thereby their responses of Production, as shown from figures above , a small positive shock to TMM had a larger impact on the respective threshold variables and their response of production when the economy is initially in high regime (R2).

2) Case 2: Large Positive shock (+1.5sd):

Same fact is illustrated from the Figure 14.15.16.17, even a large positive shocks had a larger impact on production for the two threshold variables namely asset price and exchange rate, indeed we conclude from the first hypotheses that positive shocks to TMM had a large impact on production when the economy is initially in appreciation regime rather the depreciation regime. Ours findings is similar to (Li and St-Amant, 2010) who found contractionary monetary shocks have larger effects on output in the low financial stress regime than in the high financial stress regime, indeed regardless to size of shocks, if we suppose that the rise of TMM is implicitly due to a contractionary monetary shocks, the effects of small and large shocks to TMM on output is larger when the economy begins in appreciation regime (R2) than in depreciation regime (R1). An explanation for this empirical result is that a raise in interest rate raises the likelihood that the economy will move to the high stress regime. However this contradicts (Blinder, 1987; McCallum, 1991) empirical finding, according to those authors most tightening of monetary policy has stronger effects on the real sector when the economy is credit constrained.

To examine whether the output effect of TMM Shocks vary disproportionately with the size of the shock, especially when the economy is in appreciation regime R2 (i.e. low stress regime), we test the following hypotheses:

When the economy is initially in R2, do large positive shocks have a disproportionally larger impact than small positive shocks[37]?.

2. Disproportionality Hypothesis

1) Size of Shocks: Small Positive VS Large Positive shock in R2

Figure 18.19.20.21 present the non-linear impulse responses for the TVAR system where asset prices and exchange rate are used as threshold variable.

Most notably, responses of production are more pronounced when large positive shocks hit the economy initially in appreciation regime R2 (low financial stress regime).

We conclude then when the economy is initially in a low financial stress regime larger shocks have a disproportionally greater impact on production than small shocks.

---

[37] It should be noted that reason behind the hypothesis is to investigate the second proprieties of TVAR model which is disproportionality (size of shocks).

Finally similar to others hypothesis , we investigate to what extent propagation of shocks differ with its direction in others sense we concentrate on analyzing asymmetries between adverse shocks (i.e. large positive shocks) and beneficial shocks (large negative shocks).

We test the following hypothesis:

When the economy is initially in R2, do positive shocks have a greater impact than negative shocks?.

3. Asymmetry Hypothesis

1) Direction of Shocks : Large Positive VS Large Negative shock in R2

Figure 22.23.24.25 shows the response of the respective threshold variable and production to large positive shocks and large negative shocks when asset price and exchange rate lead the regime respectively.

A similar result holds for the analysis of asymmetries, adverse shocks have a larger impact than beneficial shocks.

V. Conclusion

Using in this paper a threshold vector auto regression (TVAR) to capture nonlinear relationships in Business cycle dynamics. We discover a strong evidence of asymmetric responses to shocks to interest rate.

The regime change occurs if the two respective threshold variables namely asset price and exchange rate cross their critical threshold value.

We find evidence that the non linearity is strongly directed by regime-dependency (i.e. initial condition). The asymmetric response of output is consistent with recent empirical finding in the literature; Output growth response is more strongly when the economy is initially in appreciation regime.

The results show that externalities are enduring the more the financial system features structural frictions such as liability dollarization or leverage. Another testimony from the results comes from the responses to large shocks to interest rate which proves disproportionate effects when compared with responses to small shocks.

The estimated model presented here is especially relevant in studying the vulnerability of an economy and the non linear dynamics due to the presence of financial frictions, which could as to further search for new ways to add international variables especially for small open economies business cycle like Tunisia characterized by high macroeconomic volatility.

References

Acemoglu, D. and S. Andrew. “Asymmetric business cycles: Theory and time-series evidence.”, *Journal of Monetary Economics,* 40(3) (1997), pp. 501-533.

Aiyagari, S. R. and M. Gertler. “Overreaction of asset prices in general equilibrium,” *Review of Economic Dynamics*.2 (1) (1999), pp. 3-35.

Arellano, C. and E. G. Mendoza “Credit frictions and ’sudden stops’ in small open economies: An equilibrium business cycle framework for emerging markets crises.” *National Bureau of Economic Research. NBER* (2002) Working Paper no 8880.

Atanasova, C. “Credit market imperfections and business cycle dynamics: A nonlinear approach,” *Studies in Nonlinear Dynamics and Econometrics,* Volume 7, (2003), issue 4, Article5.

Balke, N. S. “Credit and economic activity: Credit regimes and nonlinear propagation of shocks,” *Review of Economics and Statistics,* 82(2), (2000), pp. 344-349.

Benigno, G., H. C., O. Christopher, and R. Alessandro “Revisiting over borrowing and its policy implications,” *Mimeo,* (2010).

Bernanke, B. and M. Gertler. “Agency costs, net worth, and business fluctuations.” *American Economic Review,* 79(1) (1989), pp. 14-31.

Bernanke, B., M. Gertler, and S. Gilchrist. “The financial accelerator in a quantitative business cycle framework.” NBER Working Paper No. 6455(1998), *National Bureau of Economic Research.*

Bernanke, B., M. Gertler, and M.Watson “Systematic monetary policy and the effects of oil price shocks,” *Brookings Papers on Economic Activity* 1, 91142, (1997).

Bernanke, M., B. S. Gertler and S. Gilchrist. “The financial accelerator in a quantitative business cycle framework, in j. b. Taylor and m. woodford (eds.),” *Handbook of Macroeconomics,* 1, (1999).

Bianchi, J. “Credit externalities: Macroeconomic effects and policy implications.” *American Economic Review,* 100(2), (2010), pp. 398-402.

Bianchi, J. “Over borrowing and systemic externalities in the business cycle,” *American Economic Review,* 101(7), (2011), pp. 3400-3426.

Blinder, A. S. “Credit rationing and effective supply failures,” *Economic Journal* 97, (1987), June, 327-52.

Carlstrom, C. and T. Fuerst .“Agency costs, net worth, and business cycle fluctuations: A computable general equilibrium analysis,” (1997), American *Economic Review*.

Christensen, I. and A. Dib. “The financial accelerator in an estimated new keynesian model.” *Review of Economic Dynamics*, 11(1), (2008),pp. 155-178.

Cover, J. “Asymmetric effects of positive and negative money-supply shocks,” *Quarterly Journal of Economics*, (1992),107, 1261-82.

Gourinchas, P. and M. Obstfeld. “Stories of the twentieth century for the twenty-first.” *National Bureau of Economic Research*.NBER Working Paper No. 17252, (2011).

Hansen, B. “Inference when a nuisance parameter is not identified under the null hypothesis,” *Econometrica*, no. 64, pp.413-430. (1996).

Kandil, M. “Asymmetric nominal flexibility and economic fluctuations,” *Southern Economic Journal* 61, 674-95. (1995).

Karras, G. “Are the output effects of monetary policy asymmetric?, Evidence from a sample of european countries,” *Oxford Bulletin of Economics and Statistics*, 58, 267-78 (1996).

Kiyotaki, N. and J. Moore .“Credit cycles,” *Journal of Polticial Economy* (1997).

Kocherlakota, N. R. “Creating business cycles through credit constraints,” *Federal Reserve Bank of Minneapolis Quarterly Review*, 24(3), pp. 210. (2000).

Koop, G., M. Pesaran, and S. Potter .“Impulse response analysis in nonlinear multivariate models,” *Journal of Econometrics*, no.74, pp. 119-148. (1996).

Leeper, E., C. Sims, and T. Zha. “What does monetary policy do?” Brookings Papers on Economic Activity 2 , 163. (1996).

Li, F. and P. St-Amant .“Financial stress, monetary policy, and economic activity,” *Bank of Canada, Working Paper/Document de travail*. (2010).

McCallum, J. “Credit rationing and the monetary transmission mechanism,” *American Economic Review*, 81, 946-951 (1991).

Mendoza, E. G. “Lessons from the debt-deflation theory of sudden stops,” American Economic Review, 96(2), pp. 411416. (2006)

Mendoza, E. G. “Sudden stops, financial crises, and leverage,” *American Economic Review,* 100(5), pp. 1941 (2010).

Morgan, D. P. “Asymmetric effects of monetary policy,” *Federal Reserve Bank of Kansas City Economic Review* 78, 21-33(1993).

Perri, F. and V. Quadrini “International recessions,” *National Bureau of Economic Research*. NBER Working Paper No. 17201, (2011).

Quadrini, v. “Financial frictions in macroeconomic fluctuations,” *Economic QuarterlyVolume* 97, Number 3Third Quarter 2011Pages 209254 (2009).

Rhee, W. and R. Rich .“Inflation and the asymmetric effects of money on output fluctuations,” *Journal of Macroeconomics,* No. 17 (4), 687-702 (1995).

Ripoll, M. and J. Cordoba. “Collateral constraints in a monetary economy.” *University of Pittsburgh,* Pittsburgh,Department of Economics (2003).

Smith, A. K. and E. G. Mendoza .“Quantitative implication of a debt-deflation theory of sudden stops and asset prices,” *National Bureau of Economic Research* .NBER Working Paper no 10940, (2004).

Summers, L. H. “Some skeptical observations on real business cycle theory.” *Federal Reserve Bank of Minneapolis Quarterly Review* 10 (Fall) 23-27, (1986).

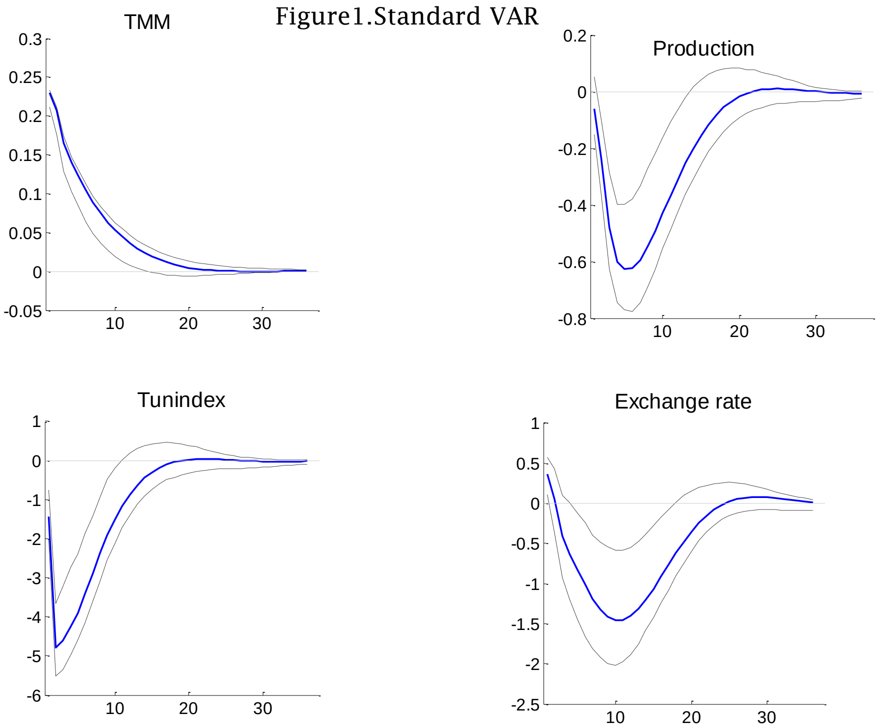
Thoma, M. A. “Subsample instability and asymmetries in money-income causality,” *Journal of Econometrics* 64, 279-306, (1994).

Table 1: Estimation of TVAR and Nonlinearity Test

Threshold	Threshold Value	Estimated γ	Sup-Wald Statistic	P-Value
Asset price	38.86	131.56	53.23	0.030
Exchange rate	2.43	1.92	3.72	0.052

Note: Non-linearity tests follow the bootstrap procedure of Hansen (1996, 1997). The p-values are calculated with 500 replications. The delay for the threshold variable is given by d = 1 and the lag of the TVAR is 3.

Figure1.Standard VAR



Note : response to one standard deviation shock to TMM Dashed line represente 90%

Figure 2. Response: TMM
R2-->R1

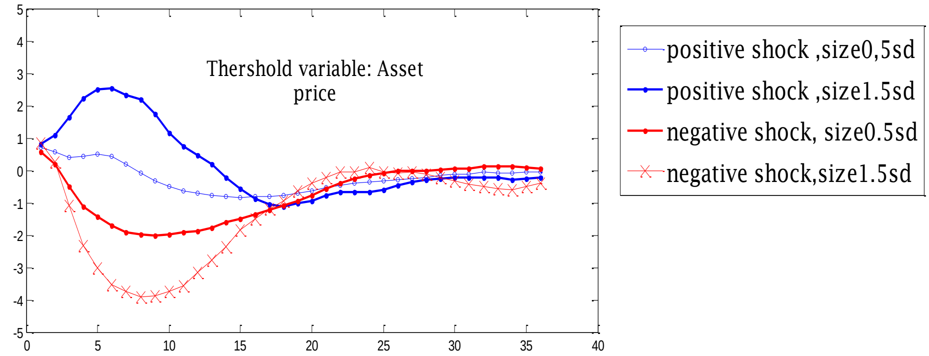


Figure3.Response TMM
R1-->R2

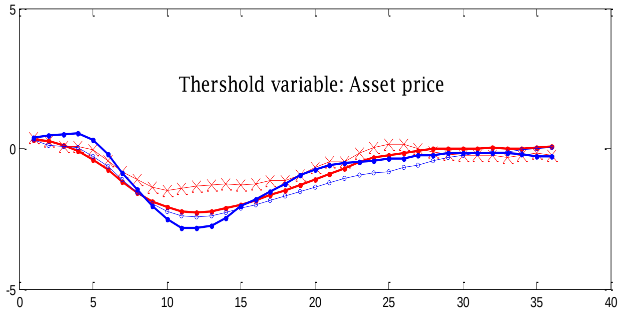


Figure4. Response TMM
R1-->R2

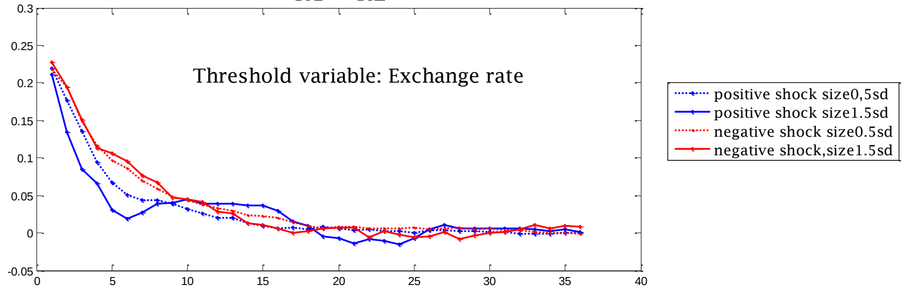


Figure5.Response TMM
R2--> R1

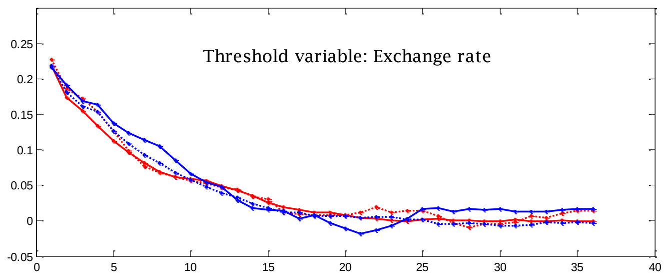


Figure6. Response Production : R2 -->R1

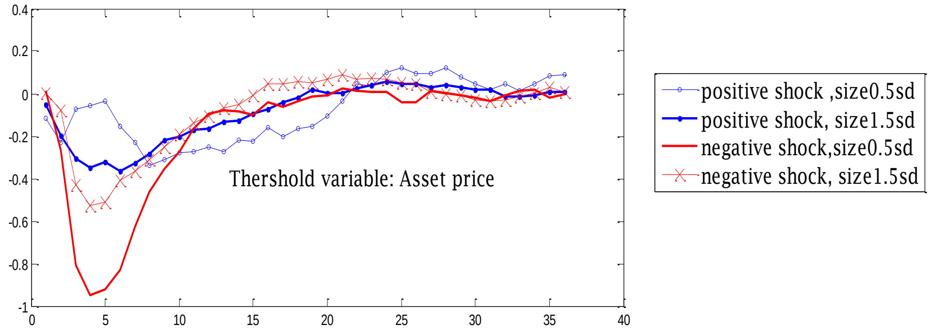


Figure7. Response Production : R1-->R2

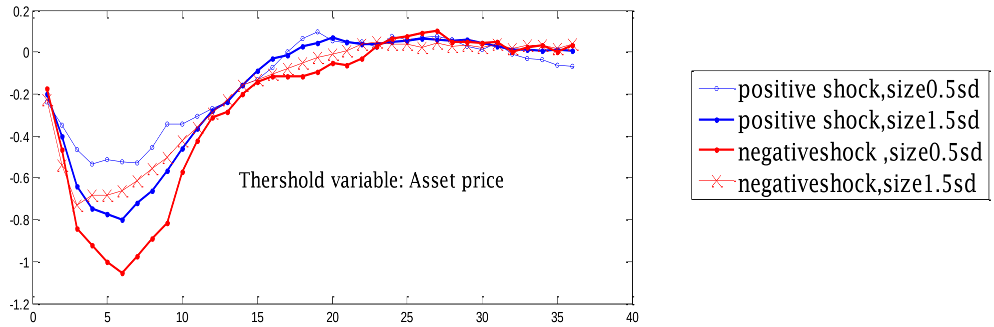


Figure8 :Response Production : R2 -->R1

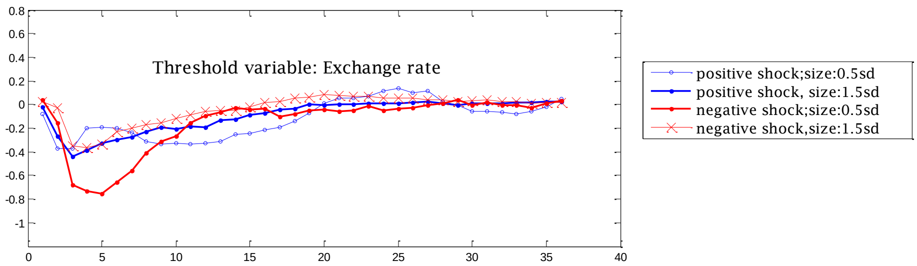


Figure9 :Response Production : R1 -->R2

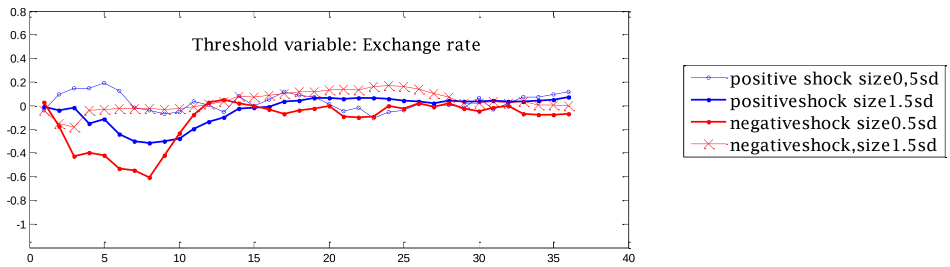


Figure 10: Threshold variable: Asset Price: Response Tunindex: (+0.5sd)

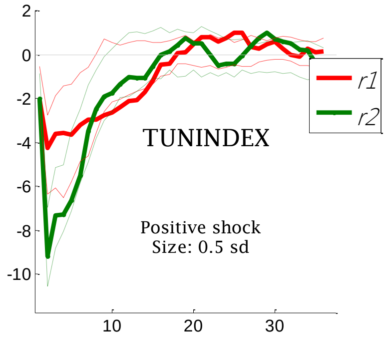


Figure 11: Threshold variable: Asset Price: Response Production: (+0.5sd)

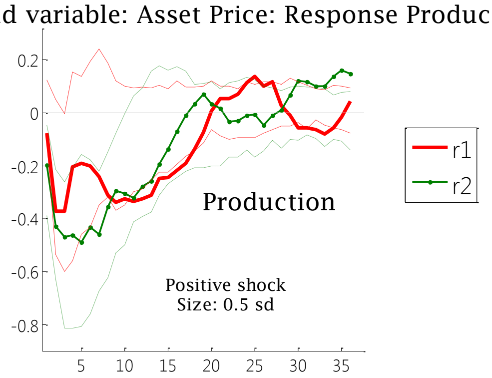


Figure 12: Threshold variable: Exchange rate: Response Exchange rate: (+0.5sd)

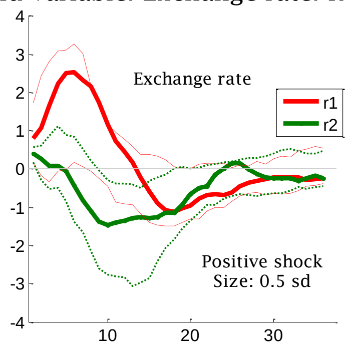


Figure 13: Threshold variable: Exchange rate: Response Production: (+0.5sd)

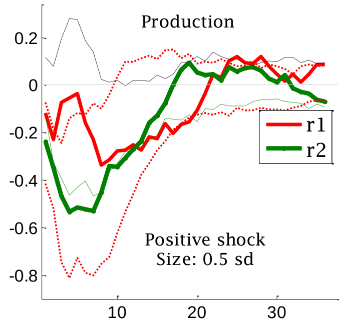


Figure 14: Threshold variable: Asset Price: Response Tunindex: (+1.5sd)

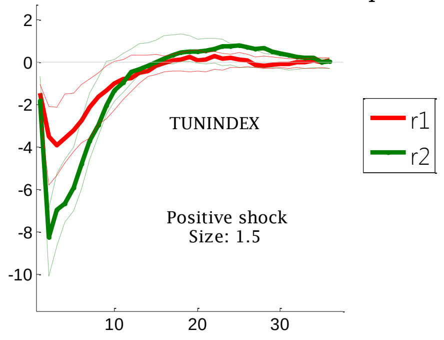


Figure 15: Threshold variable: Asset Price: Response Production: (+1.5sd)

Figure 16: Threshold variable: Exchange rate: Response Exchange rate: (+1.5sd)

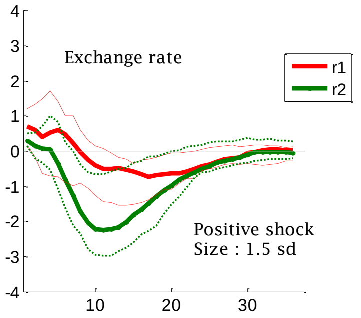


Figure 17: Threshold variable: Exchange rate: Response Production: (+1.5sd)

Figure 18: Threshold variable:Asset Price: Response Tunindex: (+0.5 VS +1.5sd)

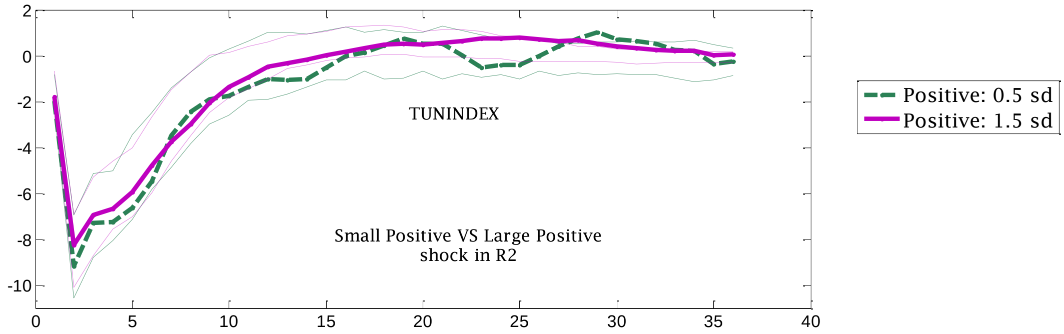


Figure 19: Threshold variable:Asset Price: Response Production: (+0.5 VS +1.5sd)

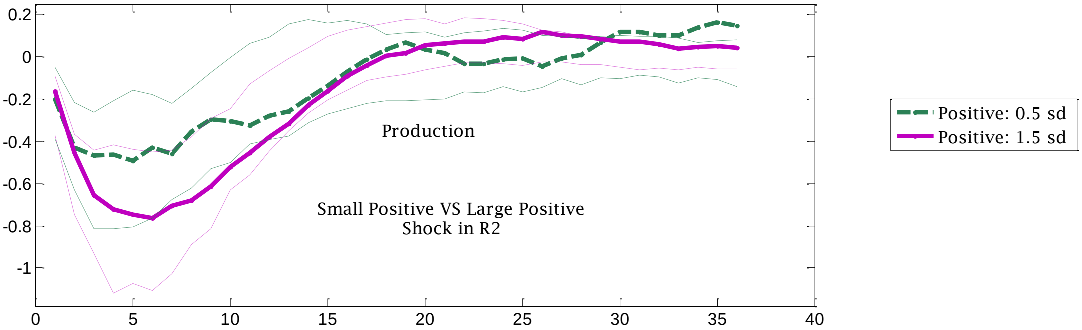


Figure 20: Threshold variable:Exchange rate: Response Exchange rate: (+0.5 VS +1.5sd)

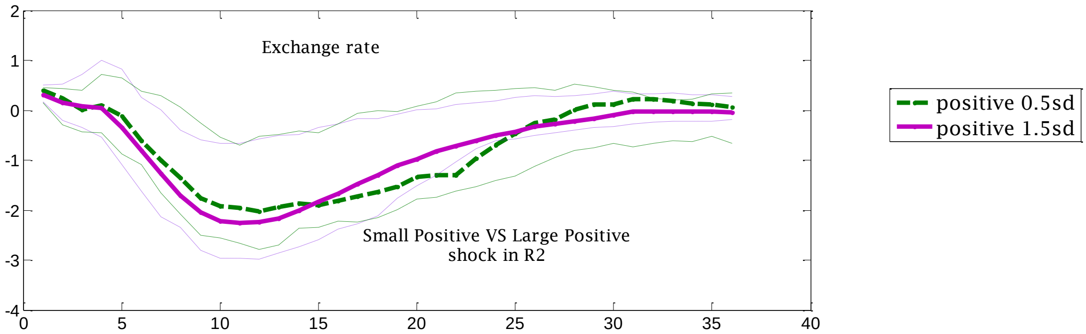


Figure 21: Threshold variable:Exchange rate: Response Production: (+0.5 VS+1.5sd)

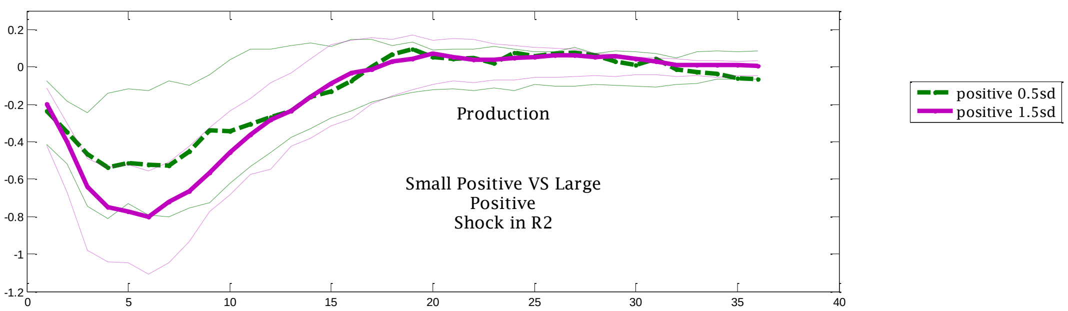


Figure 22: Threshold variable:Asset Price: Response Tunindex: (-1.5 VS +1.5sd)

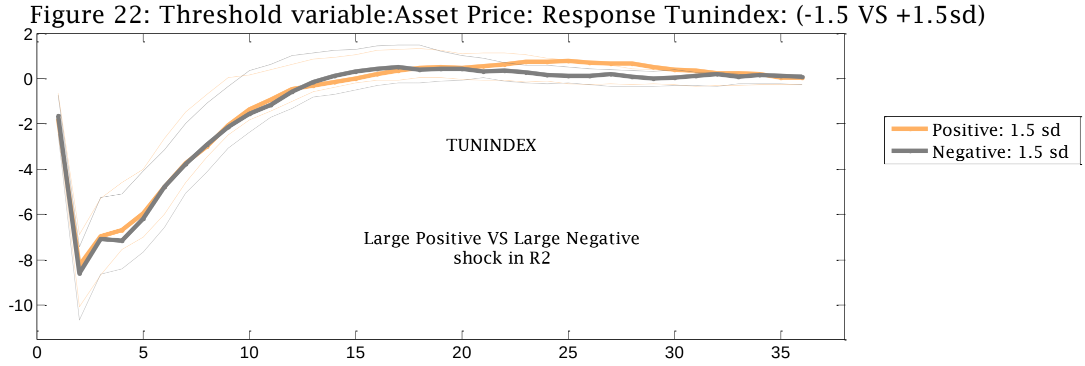


Figure 23: Threshold variable: Asset Price: Response Production: (-1.5 VS +1.5sd)

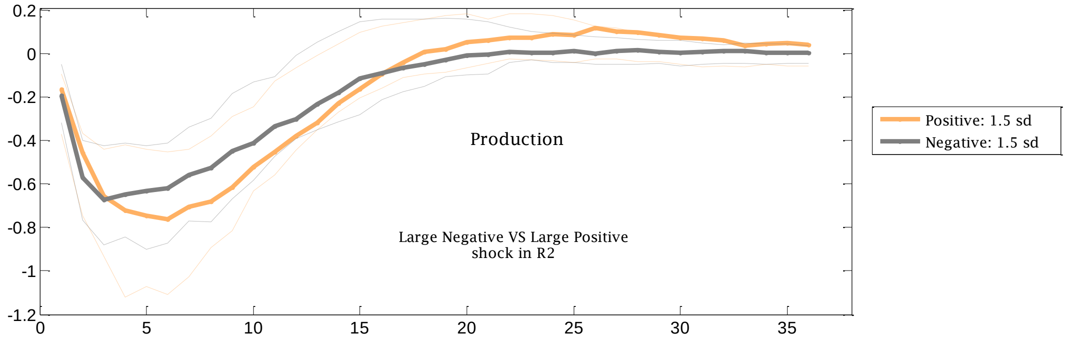


Figure 24: Threshold variable:Exchange rate: Response Exchange rate: (-1.5 VS +1.5sd)

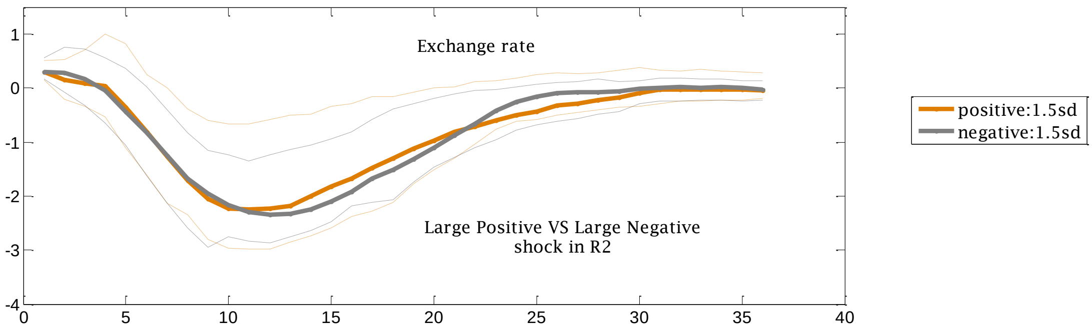


Figure 25: Threshold variable:Exchange rate: Response Production: (-1.5 VS+1.5sd)