BANQUE DE LA REPUBLIQUE D'HAITI

The sacrifice Ratio: An Empirical Investigation of the Output/Inflation Trade-off for the Haitian Economy

By

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Abstract

It is generally accepted that price stability is one of the essential conditions for creating and maintaining a stable macroeconomic environment that can foster sustainable long-term growth. Indeed, institutions such as central banks typically carry out policies designed to smooth out fluctuations of the inflation rate. However, in the short run, these restrictive policies entail sometime substantial costs in term of output loss and unemployment. This paper investigates the output costs of disinflation, i.e. the sacrifice ratio in the context of the Haitian economy using a structural VAR model (SVAR). The results show a sacrifice ratio low and positive, obtained from the cumulative response over six (6) periods. According to these results, a steady decline in inflation of one percentage point following a demand shock implies a 0.907 per cent deviation of the gross domestic product (GDP) below its trend or long-term level.

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I. Introduction

It is a well-established principle among applied economists as well as in the academia that price stability is the main contribution of monetary policy toward the achievement of a macroeconomic environment conducive to lasting growth. There is a wide consensus on this point which reflects one of the dominant paradigms of recent macroeconomic theory[1]. It is related to the new classical analysis which denies any long run tradeoff between inflation and growth. Therefore, monetary policy, while suitable to fight inflation, would have no effects on output and employment in the medium and long term. Moreover, price stability reduces uncertainty over investment and consumption decisions and, hence, helps minimize volatility of output[2].

In the short run, given capacity output, monetary authorities manage aggregate demand through a set of policies designed to minimize pressure on the overall level of prices and to smooth out the undesirable effects of unexpected shocks to aggregate supply or to aggregate demand. Still, disinflation policies are sometimes associated with undesirable side effects on output in the short term. Indeed, achieving price stability or implementing anti-inflation monetary policies entail often substantial costs in the short run in term of output or employment losses.

Economic literature defines the relationship between output losses and inflation gain as the sacrifice ratio, the trade-off between a gain in inflation and a fall (or slowdown) of growth and employment. In other words, a one percent permanent reduction in the rate of inflation carries a slackening of economic activity at least in the short term. Since the loss may be sizable and the costs heavy, the sacrifice ratio, its trends and its determinants, have become important

[1] Central Banks of industrialized countries began adopting price stability as their monetary policy objective in the 1980's.
[2] Low and stable inflation yields low interest rates which, in turn, foster private investment and consumption and then output and employment.

gauges for policy makers committed to full employment and low inflation policies in developed as in developing countries.

This paper aims at estimating the sacrifice ratio for the Haitian economy using structural vector autoregressive model (SVAR) over the 1986-2015 period. Specifically, the sacrifice ratio will be estimated and the results will be examined in relation to the main factors influencing the costs of disinflation in Haiti. Factors other than monetary policy measures will also be considered to the extent that they impact changes in the overall price level.

To this effect, we will review in the second part the leading methodologies used in empirical research on the sacrifice ratio along with the corresponding results. This section precedes a brief description of the Haitian economy. The SVAR model selected to study the sacrifice ratio in Haiti is then presented in the third section along with relevant specifications. This step includes an analysis of the results and a discussion of other variables that may influence the results. Concluding comments are offered on part IV.

II. The sacrifice ratio: Theoretical aspects and stylized facts on the Haitian economy

II.1 From inflation-unemployment trade-off to inflation-growth trade-off

The idea of costly macroeconomic adjustment to the economy originated in the research over the relationships between inflation and growth, particularly on the Phillips curve which initially relates unemployment to the change in nominal wage rates[3]. Changes in the original specifications of the relationship brought about in the 1960’s and the 1970’s have led to a new interpretation which states the cost of permanent drop in the inflation rate in term of a fall in the employment rate[4].

[3] Presented in 1958 by Alban W. Phillips.
[4] Through the transposition of job losses in the Okun law (1962) into production loss.

II.2 Relevance of a measure of the sacrifice ratio

Extensive empirical research and critical analysis on the sacrifice ratio have allowed policy makers to improve on their monetary policy tools to bring about price stability with minimal side effect on output and unemployment. In this regard, a variety of approaches have been applied to reach an accurate and suitable measure of the sacrifice ratio, a necessary beacon for concerned policy makers in general and modern central bankers in particular. Methodologies differ basically in the relative weight assigned to inflation and growth in the analysis. Three distinct lines of research can be observed. The first one follows the Phillips curve trend which can be either a linear or a non-linear relationship but whose slope provides an estimate of the ratio. The second one is non-parametric or rather descriptive. The third one calls for structural vector auto regression model (or SVAR) which allows the researcher to separate effects of genuine monetary policy impulses from effects of other random events. In this section, we will present more details on the three approaches.

II.2.1 The linear Philipps curve approach

Okun (1978) was the first to use the Phillips curve in order to illustrate the inverse relationship between inflation and GDP changes, precisely the changes in output, the loss of economic growth, brought about by disinflation policies. In his study, he obtains the sacrifice ratio by estimating the slope of the following equation:

$$\pi_t - \pi_{t-1} = \beta * (y_t - y_{capacity}) + \epsilon_t; \beta < 0 \qquad (1)$$

where y_t and $y_{capacity}$ are respectively real GDP at time t and capacity output, $(y_t - y_{capacity})$ is the output gap, π_t is the inflation rate at time t, $\pi_t - \pi_{t-1}$, is the change in the inflation rate at t and ϵ_t the error term. Applying the formula, he obtains a sacrifice ratio of 10%, meaning that a **gain** of 1 percentage point in the inflation rate will **cost** a drop of 10% in real GDP[5]. Using the same approach, but excluding from the price level the relative prices of imported goods, Gordon and King (1982) found a sacrifice ratio of 4.3%[6].

II.2.2 The nonlinear Phillips curve approach

Many studies have documented the nonlinearity hypothesis in the Phillips curve; for instance, Turner and Laxton (1995) and Meredith and Rose (1995) have confirmed non-linearity in a study of the G7 countries (including the United States). They have found evidence that the Phillips curve is steeper the closer the economy is to capacity. This finding is consistent with the hypothesis of a convex Phillips curve when the capacity constraint is binding. In this case, an increase in aggregate demand will yield more inflation than growth. The end results, according to the authors, will depend *in fine* on the specifications of the model and also on an appropriate measure of the output gap ($y_t - y_{capacity}$). However, taking the opposite view, Stiglitz (1997) has proposed a concave Phillips curve supported by US data. Results obtained by Eisner (1997) reinforced Stigliz's thesis. Inflation appears less sensitive to production as the economy approaches capacity or full employment[7][8]. In theory, firms operating in imperfect competition, hold power over market prices and can protect their market shares. In case of expansion of aggregate demand, they don't have to lower prices to maintain their sales. Moreover, in times of expansion, i.e. when production and employment are at peak levels, the optimizing firms would maintain stable or lower labor costs by offering lower nominal wages. Hence, inflation does not respond to demand pressures arising from expansion because of the concave shape of the Phillips curve.

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[5] Arthur Okun M.: "**Efficient disinflationary policies**". American Economic Review May 1978.
[6] These authors had used a traditional VAR model including the relative prices of imports and obtained a ratio of 5.8%
[7] Joseph E. Stiglitz: Unpublished study for the Council of Economic Advisors (1997)
[8] Robert Eisner: « **Improving the global economy: Keynesianism and the growth in output and employment – New view of the NAIRU** ». In Paul Davidson and Jan A. Kregel Editions (July 1995).

Filardo (1998) has introduced a more flexible approach, compared to Turner/Laxton and Meredith/Rose in 1995, reviving the nonlinearity hypothesis of the Phillips curve in estimating the sacrifice ratio. He has shown that the relationship between inflation and output varies with the position of the latter compared to its long run trend. In other words, output can be weak or below trend, balanced i.e. close to trend and overheating i.e. above trend, as summarized below:

$$\pi_t = \pi^e_t + \beta_{low}\,(y_t - y_{capacity})[\text{during weak periods}]_{(t-1)} \quad [a]$$
$$\pi_t = \pi^e_t + \beta_{balanced}\,(y_t - y_{capacity})[\text{during balanced periods}]_{(t-1)} \quad [b]$$
$$\pi_t = \pi^e_t + \beta_{overheating}\,(y_t - y_{capacity})[\text{during overheated periods}]_{(t-1)} \quad [c]$$
$$+ \epsilon_t \qquad (2)$$

π^e_t being the expected inflation at t.

Filardo has found a sacrifice ratio of 5 when the economy is at [a], where $y_t < y_{capacity}$. It is estimated at 2.5 when the economy is overheating, i.e. $y_t > y_{capacity}$ as in [c][9]. When output is close to capacity, i.e. $y_t \cong y_{capacity}$, as in [b] the slope is flat, meaning a sacrifice ratio of considerable magnitude for a gain in inflation implies very large output and employment losses.

As for the adjustment speed of the economy from a relatively high to a sustainable inflation level, the jury is still out, between a “cold turkey”, aggressive approach and a gradualism approach. For instance, Sargent (1983) and Ball (1995) favor the former but have shown that credibility of monetary policy makers play a critical role in the disinflation costs. For them, a speedy, “cold turkey” program reinforces the authorities’ credibility and hence reduces on average the value of the sacrifice ratio.

On the other hand, King (1996) stresses that credibility may not be as important a factor in low inflation economies (e.g. the United States) where policy makers don’t have to gain credibility through a swift program. In such environment, the shape of the Phillips curve is the

[9] US data over the 1959-1997 period.

critical element in determining the disinflation costs. In his seminal article on disinflation policies formulation, he explained that a gradual approach is better if the Phillips curve is convex and that a cold turkey is required otherwise (concavity)[10]. This conclusion is supported by results obtained by Filardo (1998): when realized output is below capacity a cold turkey approach is warranted because the disinflation costs would be lower but when production is at or above capacity gradualism is called for because the sacrifice ratio is higher.

II.2.3 The Sacrifice Ratio, Central Bank Independence and Openness of the Economy

Many other factors influence the inflation/output connection through the Phillips curve. For example, empirical studies have shown that central bank independence affects the tradeoff. Alesina and Summers (1993) argue that Central Bank independence lower prices and stable inflation while Jordan (1997 and 1999) has found significant link between monetary policy aggressiveness and central bank independence. For him, a strong independence is conducive to swift disinflations.

The degree of openness of the economy also contributes to the size of the sacrifice ratio. In Barro and Gordon (1983) it is demonstrated that openness influences the weight of foreign prices in the formation of domestic prices (and inflation) as well as output growth. However, others (Daniels, Nourzad and Vanhoose [2005]) have uncovered a positive relation between the sacrifice ratio and a measure of the degree of openness and a measure of CB independence. The ratio rises with the openness of the economy.

II.3. The sacrifice ratio and the non-parametric approach

Pioneered by Ball (1994) and improved by Zhang (2001, 2005), this approach is based on identification of the disinflation periods and on corresponding calculated sacrifice ratios. The ratio for a given disinflation episode is defined by the ratio of cumulated output growth losses by the

[10] Mervin King: "**How should Central Banks reduce inflation? Conceptual issues**", in Achieving price stability. Federal Reserve Bank of Kansas City, 1996.

total reduction of trend inflation over the period. The estimated value of the sacrifice ratio is dependent on the measure of trend inflation which, in turn, allows selection of disinflation episodes. In this respect, trend inflation in period t, for Ball, is obtained as the moving average over the four previous quarters (t-4) and the next four quarters (t+4), as a new smoothed version of the observed inflation. Ball works with the following hypothesis:

a) Observed GDP is at capacity ($y_t = y_{capacity}$) at the beginning of the disinflation period

b) Observed GDP returns to capacity one year (or 4 quarters if quarterly data are used) at the end of the disinflation

c) In between, i.e. between the beginning and the end of the disinflation episode, capacity output ($y_{capacity}$) grows log-linearly.

The Ball model yielded sacrifices ratios ranging from 1.8 to 3.3 for the OECD relatively low inflation countries over the 1960-1991 period, with 2.4 for the United States. It also showed that the sacrifice ratio falls with the speed of disinflation. However, these results were challenged by Zhang (2001) who questioned the measure of potential GDP (or capacity output) used by Ball. Zhang has pointed out that side effects of disinflation policies may last longer than the disinflation period and, therefore, that the sacrifice ratio may be underestimated. He suggested that capacity output be calculated using the Hodrick-Prescott filter of observed GDP in log form. As a result, considering the persistence of side effects, his tests have yielded sacrifice ratios much higher than Ball's.

II.4 The structural vector auto regression (SVAR) approach

The sacrifice ratio obtained through the Phillips curve, whether linear or nonlinear, does incorporate both disinflation policies effects and occasional demand and supply shocks. To isolate specific anti-inflation policy effects, Cechetti and Rich (1999) have introduced an estimation technique for the sacrifice ratio based on a structural vector auto regression (SVAR) model. They have stressed the failure of the Gordon and King model to separate properly impulses from monetary policy changes from changes emanating from random short term events (supply and demand shocks).

Distinction between exogenous monetary shocks from endogenous authority's reaction has become necessary to ascertain the "true" costs of disinflation. The SVAR approach allows this discrimination of monetary policy between a systematic component (monetary policy) and the random component (shocks). The former is viewed as the reaction function of the monetary authorities to the macroeconomic fundamentals while the latter shows the monetary policy actions which are not explained by a reaction function and therefore are treated as "monetary policy shocks". Impulse response functions then help identify the many structural shocks, quantify their effects on real GDP and inflation and finally measure the sacrifice ratio. Precise identification methods, for instance in the design of explicit monetary shocks[11], have been experimented by the authors.

As a result, working with quarterly U.S. data, they have found over the 1959-1997 period a sacrifice ratio of 1.38, 1.28 and 9.87 for a SVAR of 2, 3 and 4 variables, respectively in percentage of cumulated GDP over 5 years. Serju (2008) has obtained relatively low values for Jamaica and Trinidad & Tobago, two open developing economies[12]. In periods of disinflation, the sacrifice ratio stands at 0.029 on average for Jamaica and at 0.113 for Trinidad & Tobago. Moreover, Jamaica has displayed a convex shape for the Phillips curve, meaning diminishing disinflation costs while the inflation appears to be relatively insensitive to the strengthening of the economy.

II.5 Stylized facts

Haiti is a small open developing country with deep rooted economic, political and social problems. There have not been three consecutive years of (per capita) income growth in

[11] However, those shocks are supposed to have no short-term effect not production.
[12] Prudence Serju has used seasonally adjusted date from Q11981 to Q22008 from the IMF database and the Central Bank of Trinidad & Tobago.

decades. The share of agriculture which still employs more than half the population[13] has been declining over the last thirty years because of inefficiencies and poor traditional production techniques. Import substitution policies introduced after World War II and maintained up to the 1980's did not improve economic performances: traditional commodities exports (coffee, sugar, essential oils), hampered by inappropriate taxation, lack of investment and inadequate production techniques, could not resist large swings in relative prices and disappeared as export items, replaced by re-export assembling industries as source of urban employment and foreign exchange. Import substitution had failed to revive the economy from secular stagnation which degenerates into stagflation at the end of the 1970's, following domestic expansionist fiscal and monetary policies and natural disasters (e.g. floods and droughts), external supply shocks (e.g. hurricanes and oil prices), and world economic turmoil. A 1987 structural adjustment program supported international financial lenders succeeded in lowering the inflation rate but at a cost in term of GDP growth.

The three-year program intended to increase public sector efficiency by closing (or stop financing) unprofitable public enterprises, to improve the quality of public investment, to reduce deficit financing, to eliminate protectionist customs tariffs. But widespread popular opposition to the new military government led to a succession of strikes and disturbances unsettling the business environment and preventing a successful reconversion of the economy toward an export led growth. Moreover, the private sector needed more time to shed the crony capitalist reflexes. As a result, economic growth came back at the end but with a stronger inflation until the 2010 earthquake.

[13] In "*disguised unemployment*" whereby for instance 12 persons on a family farm are doing what 2 or 3 persons could do efficiently?

Two distinct disinflation periods can be depicted between 1986 and 2015. The first one lasted five years, from 1995 to 1999 and followed the three-year international economic embargo on the country. Inflation fell from 46.8% in 1994 to 9% in 1999 with a slight average output growth of less than 1%, with in fact three consecutive years of negative growth. The economy registered a strong growth in 1995 but fell on a recession path the following years coinciding with a steady decline of the inflation rate. The second period begins in 2003 up to 2009, with an inflation rate down from 34.6% to -4.7% with a downward trend in output.

III. Methodology and Empirical Evidence

The test covers twenty years with annual data ranging from 1986 to 2015.

III.1 Data

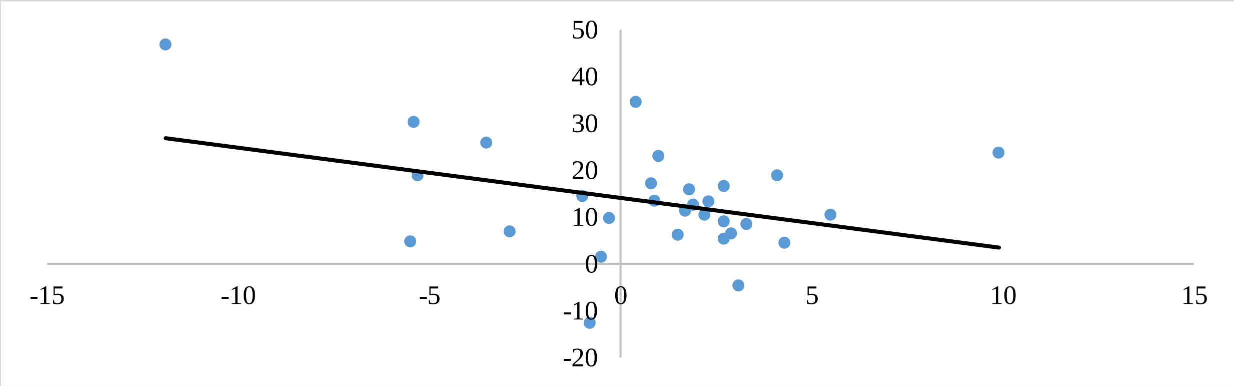
Inflation is measured as the 12-month percentage change in the Consumer Price Index (CPI) as provided by the Institut Haitien de Statistique et d'Informatique (IHSI). It is given at time t as $\pi_t = 100*\log(IPC_t/IPC_{t-1})$, with 2004 as the base year. Also, the exchange is the US dollar price in Gourdes, the local currency, as published by the Central Bank. As for the output, the GDP used is the annual aggregate calculated and published by IHSI. In fact, a measure of the output gap (based on real GDP) is used instead of actual GDP because it yields better results. Basically, potential or capacity output is estimated using the Hodrick-Prescott (HP) filter; then a measure of the gap is derived from the following formula:

$$Gap_t = 100*\log\left(GDP_t^{actual}/GDP_t^{potential}\right)$$

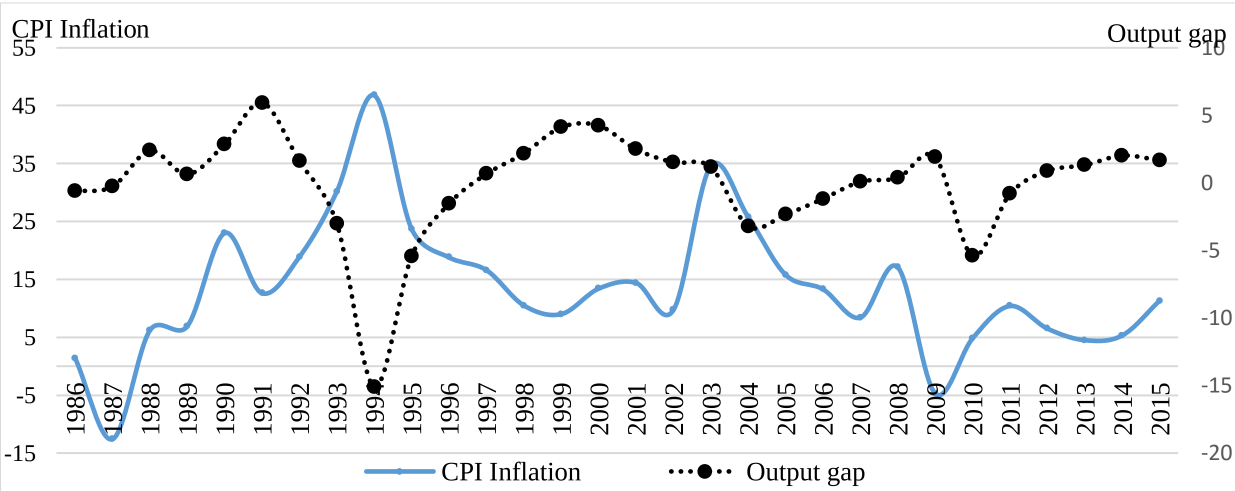
III.2 Output, Inflation and Exchange rate: Initial empirical findings

No precise relation between inflation and growth appears from Graph 1. However, the first six years (1986-1991, in Graph 2) suggest a positive, albeit loose, correlation between the two variables, and many moments of apparent negative correlation during the observation period.

Graph 1. CPI Inflation and GDP growth rate - Scatterplot



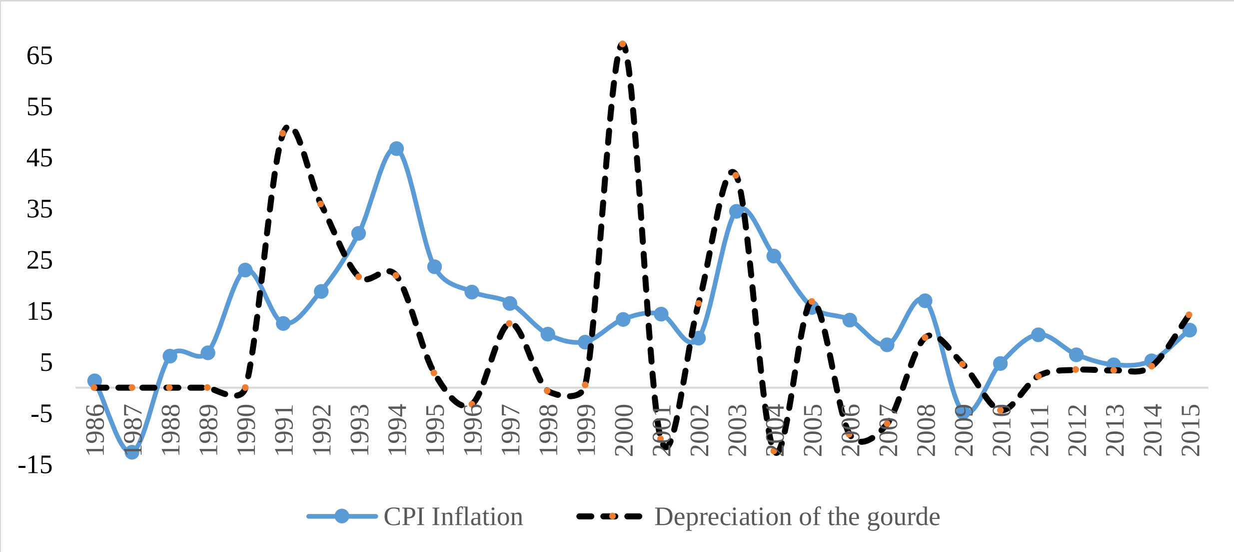
Graph 1. CPI Inflation (%) and output gap



Negative relation between inflation and output gap can also be explained by a third factor, namely the exchange rate. The consumer price index includes a significant portion of imported consumer goods prices which affect the inflation rate when converted in local currency; therefore, any variation of import prices causes variation in the same direction of the overall price level[14].

[14] There may have some asymmetry –or more lags- when foreign prices fall or when the domestic currency is appreciating.

Graph 3. CPI Inflation and local currency depreciation (%)



Theses preliminary observations offer an idea of the results to be achieved on the relation between the output gap, the inflation and the exchange rate. This relation is to be tested with a SVAR model. It is worth mentioning that the final results will depend also on the specification of the model.

III.3 Model specification

We follow the Cecchetti-Rich (1999) approach whereby the sacrifice ratio - for the US economy- is estimated through the SVAR by the sum of temporary changes in real GDP over the change in the inflation rate from an initial monetary policy shock. For them, this shock is measured by the change in the money supply. However, we use the output gap instead of real GDP. Moreover, we have chosen the Choleski decomposition method to assess the SVAR parameters, namely the structural innovations[15]. The sacrifice ratio will come out of the impulse response functions, which will determine the effect of an aggregate demand shock (output gap shock) on the output gap and the inflation rate.

[15] Cecchetti and Rich have used the Blanchard and Quah method

It is worth noting that monetary shocks fall into the category of aggregate demand shocks to the extent that the monetary disturbances follow fiscal or monetary decisions. Since the demand disturbance affects simultaneously prices and quantities, both variables react in the same direction to the adverse monetary shock, yielding a positive sacrifice ratio.

III.3.1 Data stationarity

For the Augmented Dickey-Fuller stationarity test on the three variables, only the output gap was found to be stationary in level (Table 2 in Annex). Stationarity was obtained for the other two, the inflation rate and the exchange rate, in first differences at the 5% threshold. As for the optimal lag choice, the tests (based on the Bayesian Information Criteria) have suggested an optimal number of 1 year.

III.4 The model SVAR

Following Cecchetti and Rich, the tri-variate SVAR is formulated as follows:

$$AX_t = \sum_{i=1}^{p} B_i X_{t-i} + E_t \tag{1}$$

with A as the instantaneous effects matrix, X_t = the column of variables: the inflation $\Delta\boldsymbol{\pi_t}$, the output gap ($\boldsymbol{gap_t}$), and the exchange rate $\Delta\boldsymbol{txchang_t}$ between t and t-1. Inflation rate is given by the year-of-year percentage change of the consumer price index. E = ($\varepsilon_t^{\pi}{}_t$, ε_t^{gap}, $\varepsilon_t^{txchang}$) is the column of structural innovations, the first element being an aggregate demand shock. These innovations are supposed to be of 0 mean. Moreover, their instantaneous covariance matrix of dimension 3 is Var[E_t] = ∑ diagonal, with strictly 0 autocorrelation.

Assuming that monetary shocks are demand shocks, they can influence both output and prices in the same direction, hence, giving a measure of the sacrifice ratio out of the structural impulse responses. Production will then deviate from capacity or long term level. The sum of temporary output deviations over the sum of inflation variations is the sacrifice ratio, obtained from the C(L) coefficients (in Annex) i.e. the impulse responses functions.

In this regard, equation (2) will be used as a reference to obtain the elements of the sacrifice ratio. For instance, effects of the changes in inflation τ periods after a demand shock are represented by the coefficients c^i_{22} and the aggregate effects from t to t+τ are the sum of these coefficients$\sum_{i=0}^{\tau} c_{12}^{i}$. For the output gap, we have $\sum_{i=0}^{\tau} \sum_{j=0}^{i} c_{12}^{i}$ with the cumulated effects from the shock to period τ. Combination of terms yields:

$$\text{Sacrifice ratio } = \frac{\sum_{i=0}^{\tau}\sum_{j=0}^{i} c_{12}^{i}}{\sum_{i=0}^{\tau} c_{22}^{i}} \qquad (3)$$

Where c^i_{12} and c^i_{22} stand for the elements (1,2) and (2,2) of matrix C_i and τ represents the time horizon chosen for the cumulative deviations of real GDP. Since the model described in (2) cannot be estimated directly, structural innovations cannot be observed. Therefore, the estimates have been obtained through ordinary least squares (OLS) of the reduced form VAR of the SVAR model in Annex.

We are able now to calculate the impulse responses functions of the SVAR, i.e., the structural innovations to be used for the assessment of the sacrifice ratio. A zero coefficient in the H matrix (in Annex) implies that real supply shocks are absent. As a reminder, we focus in this paper on the short-term effects of the first shock which depicts an aggregate demand shock to the output gap and the inflation: changes in the money market (e.g. interest rates or monetary base) slow down (or reduce) aggregate money supply and slow down (or reduce) aggregate demand, compressing aggregate supply and prices[16].

III. 5 Results

The SVAR test results over the 1987-2015 period are displayed in the box in Annex (with $\Delta\pi_t \equiv dinfl_t$). To correct the deviant outcomes, we have introduced five dummy variables: namely, *du93, du94, du03, du04* and *du08*. The first and the second ones refer to 1993 and 1994[17], the two last years of the international economic embargo with high inflation rate (over 30 %). The third and the fourth dummies correspond to the years 2003 and 2004 with the high inflation rates during the period, 46.8% and 34.6% respectively due political instability. The last one relates to an inflation rate of 19.8%, linked to an important depreciation (17 %) of the gourde (the local currency). This resulted in riots of hunger in the country.

Use of the elements of the estimated VAR, namely the variance/covariance matrix, to retrieve elements of the SVAR model is allowed when the standard VAR's residuals are white noise. Said otherwise, residuals must be normally distributed and of zero autocorrelation. In our case, these conditions are largely met (Ref: Tables 2.1, 2.2, 2.3, 2.4 in Annex). Moreover, the coefficient of the ratio[18] has the expected sign and, consistent with Tables 1.2, 1.2a and 1.2b in Annex) is significant at the 5% threshold.

[16] Monetary aggregates influence output level through aggregate demand by at least four known channels: money and credit, exchange rate, assets prices and expectations.
[17] *du94* also captures the dramatic GDP fall (-11.2% in 1994) following the world embargo on Haiti, when the output gap reached its highest level (in absolute value).
[18] Relating the inflation rate to the output gap.

III.6 The sacrifice ratio for Haiti

Cumulated responses over six periods have yielded a sacrifice ratio of 0.907 (Table 3), with a standard deviation of 0.052 within a 95% confidence interval[19][20].

Table 3. Sacrifice ratio

Sacrifice Ratio	0,907	
Standard deviation	0.052	
Confidence interval	0.805	1.009

Although the ratio appears low, it is comparable to the results obtained by Serju (2008) for Jamaica and Trinidad and Tobago[21] and Thuy Van Pham (2007)[22] for some countries in Latin America. As for the interpretation, the sacrifice ratio means that a 1 percentage point drop of the inflation rate in Haiti carries a 0.907 per cent deviation of the gross domestic product (GDP) below its long-term level.

As for the factors that would explain the relatively modest sacrifice ratio, one could assume that since price elasticity of aggregate supply has never been high in Haiti. In other words, it takes probably more than a year for aggregate output to react fully to changes in prices. Moreover, since 1986, the economy has been under a protracted structural adjustment punctuated by political instability, external shocks, natural catastrophes and many *stop and go policies* and policy reversals. Therefore, considering this poor economic environment, it is likely that capacity GDP itself has been falling[23], causing significant instability in the output

[19] Through Monte Carlo simulation with 500 iterations (and the Choleski decomposition).
[20] See Table 3 and Graph 34 in Annex.
[21] Using a SVAR with quarterly data, he found very low ratios ranging from -0.044 to 0.0079 for Jamaica and Trinidad and Tobago.
[22] Using the Laurence Ball calculation method.
[23] With large scale emigration and lack of resources for new private and public capital expenditures.

gap itself and affecting the sacrifice ratio. Despite clear incentives offered by the foreign financed structural adjustment program, the private sector could not redeploy capital and trained labor from unprofitable import substitution to export oriented activities in such a bleak environment.

IV. Conclusion

The purpose of this paper was to estimate the sacrifice ratio for the Haitian economy. Such a ratio is of critical importance for policy makers willing to minimize the costs of restrictive monetary policies in term of production and employment losses. Using a Structural Vector Auto regression model (SVAR) over the 1987-2015 period we have obtained a sacrifice ratio of 0.907 meaning that a gain of 1 percentage point as permanent reduction in the inflation rate will end up with a 0.907 per cent deviation of the gross domestic product (GDP) below the capacity GDP.

This value is in line with results obtained from other countries. However, there are reasons to believe it can be higher if we allow for negative effects of multiple (and unexpected) domestic and external shocks on production capacity over this tumultuous period.

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ANNEX

Graph 1.1 GDP growth and CPI Inflation

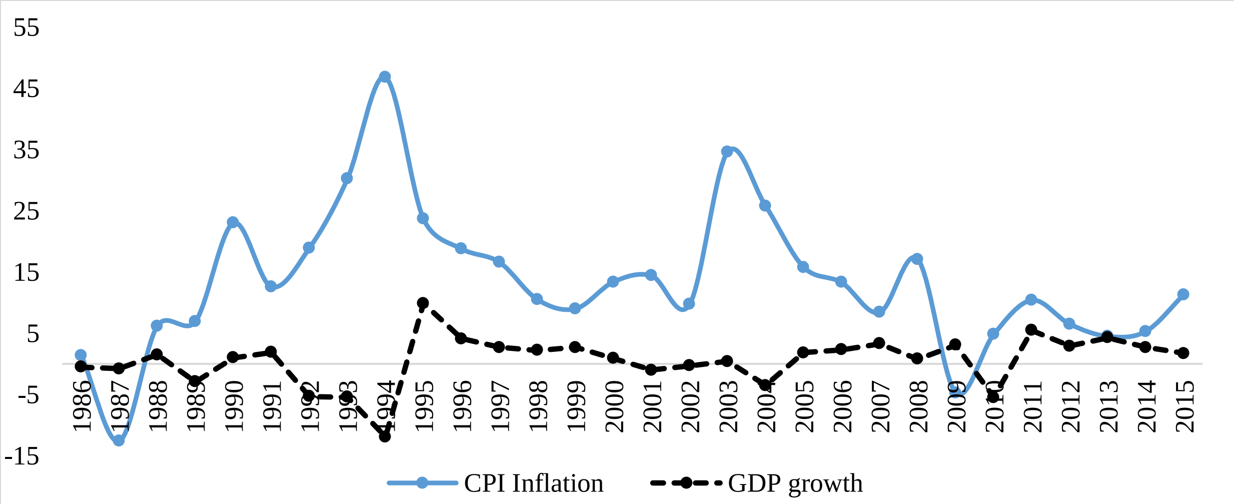

Table 1. GDP growth and CPI inflation in Haiti – Descriptive Statistics

Niveau	GDP growth (%)				CPI Inflation (%)			
	Maximum	Mean	Minimum	Standard deviation	Maximum	Mean	Minimum	Standard deviation
1986-1989	**1,5** (1988)	**-0,7**	**-2,8** (1989)	**1,8**	**8,3** (1988)	**0,2**	**-13,8** (1987)	**10,2**
1990-1999	**10** (1995)	**0,37**	**-1.16** (1994)	**5,8**	**46,8** (1994)	**20,1**	**9** (1999)	**11,1**
2000-2009	**3,3** (2007)	**0,05**	**-3,5** **(2010)**	**2,1**	**34,6** **(2003)**	**15,5**	**-4,7** (2009)	**9,6**
2010-2015	**5,5** (2011)	**1,93**	**-5,5** (2010)	**3,9**	**11,3** (2015)	**7,1**	**4,5** (2013)	**3,0**
1986-2015	**-**	**0,6**	**-**	**4,07**	**-**	**13,6**	**-**	**13,0**

Sources: IHSI and BRH with calculations by author

Table 2. Augmented Dickey-Fuller stationarity test - Results

	Level			First différences	
	gap	**txchang**	**Infl**	**dtxchang**	**dinfl**
Observations	29	31	31	30	30
Number of lags	2	0	0	0	0
Critical value 1 %	-2.653	-2.657	-2.647	-3.689	-2.65
Critical value 5 %	-1.953	-1.954	-1.952	-2.971	-1.953
Critical value 10 %	-1,609	-1.609	-1.61	-2.625	-1.609
Valeur obtenue*	**-3,73**	**-1.08**	**-1.88**	**-7.19**	**-6.4**
Stationnarity	Yes	No	No	Yes	Yes

Table 1.1. VAR Optimal lags

Lags	SBC/BIC
0	263.053292
1	262.965389*
2	273.315654
3	289.174558
4	275.217009

The vector form (Vector moving average or VMA) of the model is as follows:

$$X_t = \begin{bmatrix} \Delta\pi_t \\ gap_t \\ \Delta txchang_t \end{bmatrix} = A^{-1}[B(L)] \begin{bmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{gap} \\ \varepsilon_t^{txchang} \end{bmatrix} = C(L) \begin{bmatrix} \varepsilon_t^{gap} \\ \varepsilon_t^{\pi} \\ \varepsilon_t^{txchang} \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) & C_{13}(L) \\ C_{21}(L) & C_{22}(L) & C_{23}(L) \\ C_{31}(L) & C_{32}(L) & C_{33}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{gap} \\ \varepsilon_t^{txchang} \end{bmatrix}$$

$$= \begin{bmatrix} \sum_{i=0}^{\infty} c_{11}^i \varepsilon_{t-i}^{gap} & \sum_{i=0}^{\infty} c_{12}^i \varepsilon_{t-i}^{\pi} & \sum_{i=0}^{\infty} c_{13}^i \varepsilon_{t-i}^{txchang} \\ \sum_{i=0}^{\infty} c_{21}^i \varepsilon_{t-i}^{gap} & \sum_{i=0}^{\infty} c_{22}^i \varepsilon_{t-i}^{\pi} & \sum_{i=0}^{\infty} c_{23}^i \varepsilon_{t-i}^{txchang} \\ \sum_{i=0}^{\infty} c_{31}^i \varepsilon_{t-i}^{gap} & \sum_{i=0}^{\infty} c_{32}^i \varepsilon_{t-i}^{\pi} & \sum_{i=0}^{\infty} c_{33}^i \varepsilon_{t-i}^{txchang} \end{bmatrix} = \sum_{i=0}^{\infty} C_i E_{t-i} \qquad (2)$$

The reduced form VAR of the SVAR model :

$$X_t = \begin{bmatrix} \Delta\pi_t \\ gap_t \\ \Delta txchang \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^{p}\Phi_{11}\Delta\pi_{t-i} & \sum_{i=1}^{p}\Phi_{12}gap_{t-1} & \sum_{i=1}^{p}\Phi_{13}\Delta txchang_{t-i} \\ \sum_{i=0}^{\infty}\Phi_{21}\Delta\pi_{t-i} & \sum_{i=1}^{p}\Phi_{22}gap_{t-1} & \sum_{i=1}^{p}\Phi_{23}\Delta txchang_{t-i} \\ \sum_{i=0}^{\infty}\Phi_{31}\Delta\pi_{t-i} & \sum_{i=1}^{p}\Phi_{32}gap_{t-1} & \sum_{i=1}^{p}\Phi_{33}\Delta txchang_{t-i} \end{bmatrix} + \begin{bmatrix} u_t^{\pi} \\ u_t^{gap} \\ u_t^{txchang} \end{bmatrix} = \sum_{i=1}^{p}\Phi_i X_{t-i} + U_t \qquad (4)$$

where U_t (u_t^{gap}, u_t^{π}, $u_t^{txchang}$) stands for the residuals vector with mean = 0 and variance $\hat{u}_t = \hat{A}^{-1}\varepsilon_t \rightarrow \varepsilon_t = \hat{A}*\hat{u}_t$ $Var\ (U_t) = \Omega$, the variance/covariance matrix. By Choleski, forecast errors of each variable are linear combinations of the structural innovations. By identification and considering (1) and (4) we have:

$\hat{u}_t = \hat{A}^{-1}\varepsilon_t \rightarrow \varepsilon_t = \hat{A}*\hat{u}_t$

Normalizing A's diagonal at 1 and imposing a recursive structure on matrix A (lower triangular), we have:

$\varepsilon_t = \hat{A}*\hat{u}_t*\hat{A}'$

hence, $Var\ (\varepsilon_t) = \hat{A}*Var\ (\hat{u}_t)*\hat{A}'$

Now, assuming that $Var\ (\hat{u}_t) = H*H'$, we obtain: $Var(\varepsilon_t) = \hat{A}*\hat{H}*\hat{H}'*\hat{A}'$

For $Var\ (\varepsilon_t) = I_2$ (diagonal), we must have: $A = H^{-1}$

The H matrix is the Choleski factor. By this way, we can obtain the parameters of the structural models by adding n*(n-1)/2 restrictions from the variance/covariance matrix of the estimated VAR residuals. From H, the transition matrix obtained from the Choleski decomposition we can write the SVAR representation:

$$X_t = \begin{bmatrix} \Phi_{11}(L) & \Phi_{12}(L) & \Phi_{13}(L) \\ \Phi_{21}(L) & \Phi_{22}(L) & \Phi_{23}(L) \\ \Phi_{31}(L) & \Phi_{32}(L) & \Phi_{33}(L) \end{bmatrix} \begin{bmatrix} \Delta\pi_t \\ gap_t \\ \Delta txchang \end{bmatrix} = \begin{bmatrix} H_{11} & 0 & 0 \\ H_{21} & H_{22} & 0 \\ H_{31} & H_{32} & H_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{gap} \\ \varepsilon_t^{txchang} \end{bmatrix} \qquad (5)$$

The SVAR Estimation output and test

$$D(INFL_t) = -0.37*D(INFL_{t-1}) + 1.37*GAP_{t-1} - 0.5*D(TXCHANG_{t-1}) - 1.358 + 23.16*DU93 + 27.10*DU94 + 32.91*DU03 - 1.196*DU04 + 9.04*DU08 \quad DW=1.74$$

$$GAP_t = 0.066*D(INFL_{t-1}) + 0.45*GAP_{t-1} - 0.087*(TXCHANG_{t-1}) + 1.114 - 5.19*DU93 - 15.938*DU94 - 0.119*DU03 - 5.91*DU04 - 1.089*DU08 \quad DW=1,86$$

$$D(TXCHANG_t) = 0.037*D(INFL_{t-1}) + 0.209*GAP_{t-1} - 0.44*D(TXCHANG_{t-1}) + 1.92 + 0.817*DU93 + 1.66*DU94 + 12.039*DU03 - 3.138*DU04 + 0.41*DU08 \quad DW=1,88$$

Table 1.2. VAR/System - Estimation by Least Squares

VAR/System - Estimation by Least Squares				
Dependent Variable			DINFL	
Annual Data			From 1988:01 To 2015:01	
Usable Observations		28	Degrees of Freedom	19
Mean of Dependent Variable			0.897327517	
Std Error of Dependent Variable			14.05229231	
Standard Error of Estimate			9.725175764	
Sum of Squared Residuals			1797.001829	
Durbin-Watson Statistic			1.745893	
Variable	Coeff	Std Error	T-Stat	Signif
DINFL{1}	-0.3746238	0.15804159	-2.37041	0.028503
GAPT{1}	1.37044776	0.48316983	2.83637	0.010552
DTXCHANG{1}	-0.5004672	0.63639089	-0.78641	0.441323
Constant	-1.3584512	2.16475124	-0.62753	0.53778
DU93	23.161015	10.14189861	2.2837	0.034071
DU94	27.1024154	10.57515635	2.56284	0.019033
DU03	32.9165183	10.16059323	3.23963	0.004313
DU04	-1.1966204	12.98556163	-0.09215	0.927543
DU08	9.04069279	10.23698982	0.88314	0.388199
F-Tests, Dependent Variable DINFL				
Variable	F-Statistic	Signif		
DINFL	5.6189	0.0285027		
GAPT	8.045	0.0105522		
DTXCHANG	0.6184	0.4413233		

Table 1.2a VAR/System - Estimation by Least Squares

Dependent Variable			GAPT	
Annual Data			From 1988:01 To 2015:01	
Usable Observations		28	Degrees of Freedom	19
Mean of Dependent Variable			-0.070871878	
Std Error of Dependent Variable			4.010631508	
Standard Error of Estimate			1.989620505	
Sum of Squared Residuals			75.21320534	
Durbin-Watson Statistic			1.865823	
Variable	Coeff	Std Error	T-Stat	Signif
DINFL{1}	0.06619758	0.03233286	2.04738	0.054703
GAPT{1}	0.45138793	0.09884907	4.56644	0.000211
DTXCHANG{1}	-0.08724458	0.13019573	-0.6701	0.510855
Constant	1.11438278	0.44287461	2.51625	0.021008
DU93	-5.19265468	2.07487555	-2.50263	0.02162
DU94	-15.9388527	2.16351338	-7.36712	5.6E-07
DU03	-0.11960546	2.07870018	-0.05754	0.954717
DU04	-5.91538361	2.65664501	-2.22664	0.038265
DU08	-1.0892459	2.09432974	-0.52009	0.609006
F-Tests, Dependent Variable DINFL				
Variable	F-Statistic	Signif		
DINFL	4.1918	0.054703		
GAPT	20.8523	0.0002109		
DTXCHANG	0.449	0.5108551		

Table 1.2b VAR/System - Estimation by Least Squares

Dependent Variable			DTXCHANG	
Annual Data			From 1988:01 To 2015:01	
Usable Observations		28	Degrees of Freedom	19
Mean of Dependent Variable			1.681071429	
Std Error of Dependent Variable			3.929538979	
Standard Error of Estimate			3.166906902	
Sum of Squared Residuals			190.5566871	
Durbin-Watson Statistic			1.884342	
Variable	Coeff	Std Error	T-Stat	Signif
DINFL{1}	0.03786409	0.05146467	0.73573	0.47088103
GAPT{1}	0.20977233	0.15733946	1.33325	0.19821685
DTXCHANG{1}	-0.44328288	0.20723437	-2.13904	0.0456323
Constant	1.92358247	0.70492974	2.72876	0.01333455
DU93	0.81711871	3.30260856	0.24742	0.80724009
DU94	1.66375446	3.44369464	0.48313	0.6345233
DU03	12.0395633	3.30869628	3.63876	0.00174728
DU04	-3.13847057	4.22861918	-0.7422	0.46704462
DU08	0.41339113	3.33357407	0.12401	0.90261116
F-Tests, Dependent Variable DINFL				
Variable	F-Statistic	Signif		
DINFL	0.5413	0.470881		
GAPT	1.7775	0.1982168		
DTXCHANG	4.5755	0.0456323		

Table 2.1 Covariance/correlation Matrix of residuals

Covariance\Correlation Matrix of Residuals			
	DINFL	GAPT	DTXCHANG
DINFL	64.17863675	0.012876585	-0.143804261
GAPT	0.169068999	2.686185905	0.110986536
DTXCHANG	-3.005384754	0.474538452	6.805595969

Table 2.2 Normality Test

Statistics on Series VRES2(1)			
Annual Data From 1988:01 To 2015:01			
Observations	28		
Sample Mean	0	Variance	0.042552
Standard Error	0.206281	of Sample Mean	0.038305
t-Statistic (Mean=0)	0	Signif Level	1
Skewness	-0.677801	Signif Level (Sk=0)	0.157707
Kurtosis (excess)	1.31513	Signif Level (Ku=0)	0.201955
Jarque-Bera	4.310391	Signif Level (JB=0)	0.115881
Statistics on Series VRES2(2)			
Annual Data From 1988:01 To 2015:01			
Observations	28		
Sample Mean	0	Variance	25.135744
Standard Error	5.013556	of Sample Mean	0.930994
t-Statistic (Mean=0)	0	Signif Level	1
Skewness	0.21704	Signif Level (Sk=0)	0.650979
Kurtosis (excess)	0.425707	Signif Level (Ku=0)	0.679577
Jarque-Bera	0.446661	Signif Level (JB=0)	0.79985
Statistics on Series VRES2(3)			
Annual Data From 1988:01 To 2015:01			
Observations	28		
Sample Mean	0	Variance	2.055931
Standard Error	1.433852	of Sample Mean	0.26626
t-Statistic (Mean=0)	0	Signif Level	1
Skewness	-0.633869	Signif Level (Sk=0)	0.186417
Kurtosis (excess)	1.387966	Signif Level (Ku=0)	0.178086

Table 2.3 Residuals Correlations

Correlations of Series VRES2(1)		
Annual Data From 1988 to 2015		
Autocorrelations		
1	-0.05225	
2	-0.07006	
3	0.04521	
4	-0.19361	
5	-0.2682	
6	-0.2208	
7	0.04304	
8	0.16572	
9	-0.02162	
10	0.36786	
11	0.14173	
12	-0.18663	
Ljung-Box Q-Statistics		
Lags	**Statistic**	**Signif Lvl**
4	1.67	0.796203
8	7.521	0.481573
12	16.79	0.15766

Correlations of Series VRES2(2)		
Annual Data From 1988 to 2015		
Autocorrelations		
1	0.09452	
2	0.20569	
3	0.23419	
4	0.10656	
5	0.29741	
6	-0.14369	
7	0.22852	
8	-0.09482	
9	-0.42709	
10	0.15206	
11	-0.009	
12	-0.00741	
Ljung-Box Q-Statistics		
Lags	**Statistic**	**Signif Lvl**
4	4	0.405991
8	10.639	0.222992
12	19.936	0.068315

Correlations of Series VRES2(3)		
Annual Data From 1988:01 To 2015:0		
Autocorrelations		
1	0.08704	
2	-0.26656	
3	-0.01101	
4	0.08738	
5	0.03635	
6	0.09204	
7	-0.07558	
8	-0.25526	
9	-0.01867	
10	-0.09797	
11	0.02449	
12	-0.07468	
Ljung-Box Q-Statistics		
Lags	**Statistic**	**Signif Lvl**
4	2.888	0.576771
8	6.291	0.614647
12	7.086	0.851881

Table 2.4. Impulse responses

	Shocks in DINFL			**Shocks in DINFL**			**Shocks in DINFL**		
	DINFL	GAPT	DTXCHANG	DINFL	GAPT	DTXCHANG	DINFL	GAPT	DTXCHANG
ENTRY	IMPULSES(1,1)	IMPULSES(2,1)	IMPULSES(3,1)	**IMPULSES(1,2)**	**IMPULSES(2,2)**	IMPULSES(3,2)	IMPULSES(1,3)	IMPULSES(2,3)	IMPULSES(3,3)
1	8.011157017	0.021104192	-0.3751499	**0**	**1.638822906**	0.294391594	0	0	2.564798649
2	-2.784497724	0.572575204	0.474059769	**2.098587837**	**0.714060804**	0.21328095	-1.283597664	-0.223764773	-1.136931325
3	1.590572169	0.032767371	-0.195464614	**0.085661938**	**0.442632262**	0.134707525	0.743205178	-0.086784687	0.408440274
4	-0.4531366	0.137136056	0.153745371	**0.50709669**	**0.193716971**	0.036381974	-0.601767205	-0.025609373	-0.171118819
5	0.28074904	0.018491563	-0.056542945	**0.057300511**	**0.117835947**	0.043709709	0.275979375	-0.036466107	0.047696537
6	-0.051535663	0.031864841	0.039573844	**0.118146598**	**0.053169444**	0.007512588	-0.177233893	-0.002352457	-0.018342931
7	0.043170175	0.007519265	-0.012809396	0.024845614	0.031165632	0.01229679	0.072352152	-0.011194005	0.000926827
8	0.000542868	0.007369417	0.008890119	0.027248972	0.014639681	0.002027487	-0.042909484	-0.000344162	-1.94906E-05
9	0.005446817	0.002586788	-0.002374383	0.008840114	0.008235104	0.003204007	0.015613013	-0.002994154	-0.001688284
10	0.002692851	0.001735363	0.001801398	0.006370562	0.004022889	0.000641938	-0.009107407	-0.000170688	0.000711469