BANQUE DE LA REPUBLIQUE D'HAITI

Exchange Rate and Inflation Dynamics in Haiti

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Abstract

The inflation process is alive and relatively strong in Haiti, a small Caribbean open economy plagued by low growth and saving rates among other debilitating factors. The inflation process is fed by a permanent monetary expansion, consistent with standard theory. However, the monetary effect is also amplified (and somewhat distorted) by other factors such as inertia, price-setting behavior in the stagnating economy and also by the effects of relative price changes, particularly the pass-through of exchange rate changes on the consumer price index, the main gauge of overall price changes measurement in the economy. The paper purports to investigate the effects -and their strength- on the dynamics of inflation in Haiti with some conventional econometric methods, [like VAR and VECM], compare the results and draw some practical conclusions for policy makers. Preliminary results suggest a positive relationship between the inflation rate and the exchange rate, as expected. Still more research is needed to ascertain the strength and the stability of these dynamic –and quite complex- relationships.

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I. Introduction

The inflation process in Haiti has gained a lot of traction over the last two decades owing to a number of factors very hard to isolate from each other. It remains certain that monetary policy has driven the *underlying inflation rate*. However, beside strong downward price rigidity, intense variability of *relative prices* has made the CPI-based or *headline* inflation particularly "noisy" and, supported by an accommodative monetary policy, has contributed to the increase of the average or overall price level.

At the end, it is impossible –from an empirical standpoint-to explain the inflation dynamics by a single factor, e.g. money. In fact, variations of the exchange rate, the external price of the domestic currency, while considered theoretically dependent of money, often appears a stronger determinant of inflation than money growth, when the pass-through effect is taken into account. The rest of the paper is organized as follows. Part II considers the inflation developments over the 1995-2018 period. This period follows a 73-year fixed exchange rate regime (formally abandoned in 1992) and has a distinctive feature the use of indirect –or *market-based*- monetary policy instrument by the Central Bank of Haiti. In Part III, the major sources of inflation pressures are examined before the introduction of the econometric test in Part IV and the results are discussed in Part V before the concluding remarks.

II. Inflation developments

1. Haiti has become over the last twenty years one of the countries with highest inflation rates in the Western Hemisphere, behind Venezuela and Argentina. The 12-month inflation rate –the "headline" inflation- has reached 14.6 % in September 2018, following an upward trend begun at the end of 2014. In fact, discounting the four-quarter through of 2013, inflation has been rising steadily since the January 2010 earthquake from an annual average 6.2% to 9.5 % over the period ending in fiscal year 2018. Changes in the overall price level have reached double digit since the end of 2010 for the actual annual average of 13.7%, far ahead of the United States: 2.5%, the average Caribbean: 4.5% (with Barbados: 5.5%, Jamaica: 4.9%, Dominican Republic: 4.4%, and Trinidad & Tobago: 2.7%) [IMF DataMapper: 2018]. This is the first time the inflation rate has remained this high for so long since the adoption of the floating exchange rate in 1992 (discounting the embargo period).

Table I: Selected Area Countries: Macroeconomic Performances

	Inflation (%, End of period)				Growth (%)				External CA Balance (% of GDP)			
	2016	2017	2018 (Proj)	2019 (Proj)	2016	2017	2018 (Proj)	2019 (Proj)	2016	2017	2018 (Proj)	2019 (Proj)
Haiti	12.5	15.4	13.0	10.0	1.5	1.2	2.0	2.5	-1.0	-4.0	-4.0	-2.0
United States	1.6	2.2	2.1	2.3	2.2	2.2	2.9	2.5	-2.3	-2.3	-2.5	-3.0
Argentina	…	24.8	40.5	20.2	-1.8	2.9	-2.6	-1.6	-2.7	-4.9	-3.7	-3.2
Barbados	3.8	6.6	0.0	1.4	2.3	-0.2	-0.5	0.1	-4.3	-3.8	-3.1	-3.4
Dominican Republic	1.7	4.2	4.1	4.1	6.6	4.6	6.4	5.0	-1.1	-0.2	-1.6	-2.1
Jamaica	1.7	5.2	3.5	5.0	1.5	0.7	1.2	1.5	-2.7	-2.8	-2.9	-2.9
Latin America & Caribbean	4.6	5.9	6.8	4.9	-0.6	1.3	1.2	2.2	-1.9	-1.5	-1.6	-1.8

Source: IMF/WEO/Regional Economic Outlook: Western Hemisphere. October 2018

2. The rate of inflation dropped sharply at the end of the nineties with the implementation of the Camdessus-Préval Initiative[1]. This three-year structural adjustment program committed foreign financial and technical assistance to Haiti to a large scale modernization program, the main features of which were: privatization of public enterprises (main sources of deficit financing), progressive elimination of public sector deficits, adoption of indirect monetary policy instruments along with the abolition of floors and ceilings on interest rates, tight fiscal and monetary policies and a major review of retail oil prices administration toward more price flexibility.

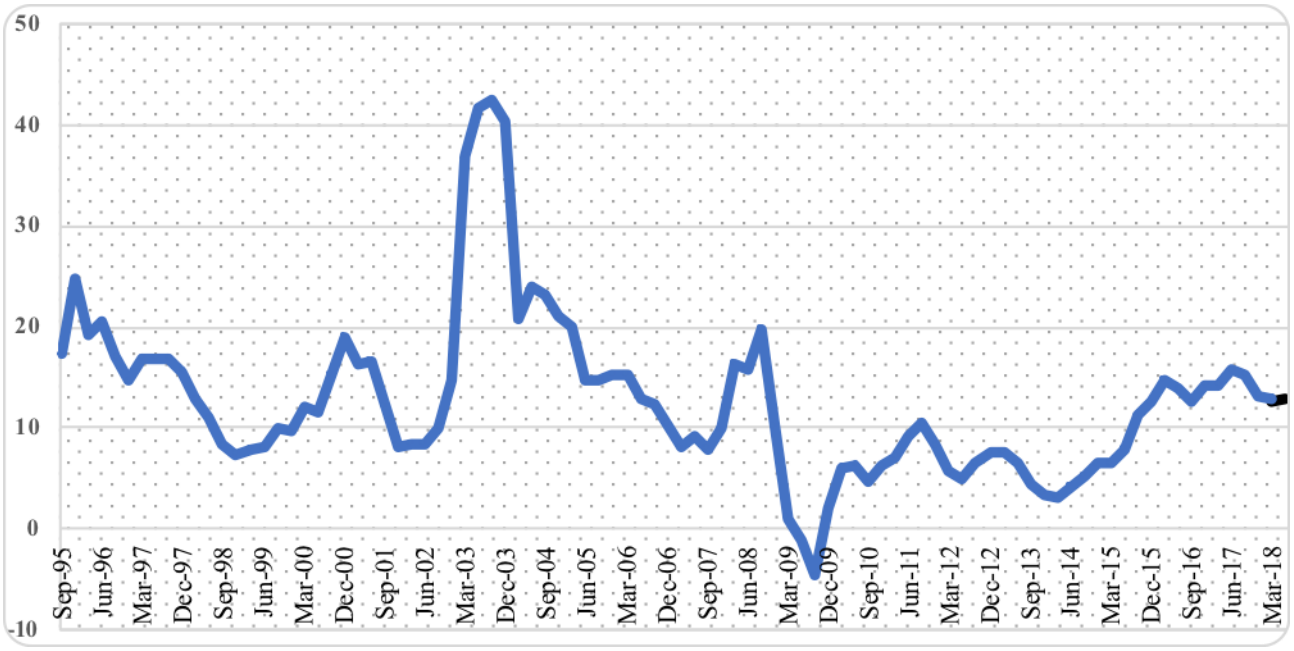
3. By 1998, following the derailment of the structural adjustment program, the rate of inflation increased markedly, when central bank financing replaced foreign financing (to maintain fiscal expansion) and subsequent currency depreciation aggravated inflation pressures along with rising foreign oil prices. Inflation accelerated at the turn of the century approaching 20%, fed by monetary expansion aggravated by a major correction in the forex market. For the whole period, inflation tends to (fall) rise whenever base money grows (slower) faster than the CPI.

4. Inflation rates have been quite volatile and erratic with, for instance, a low of 8% in March 2002 followed six quarters later by a high of more than 40% (in September 2003) and with a high of close to 20% in September 2008 preceding a low of -4.7% in September 2009. Efforts have been made to find a better measure of inflation, the "*underlying*" or "*core*"

[1] An IMF/World Bank/IADB-sponsored program introduced at the end of the 1992-94 embargo

inflation[2]. Although the long-term means of the two measures converge, it is not sure that the "*core*" measure has been completely shielded of the effects of the "*headline*" inflation.

Figure 1. Inflation (% 12-month)



5. Like most countries, the « *headline inflation* » rate in Haiti is the 12-month change of the Consumer Price Index (CPI) computed every month, using an arithmetic mean. This *Laspeyres* index, updated in 2005, covers 140 items broken into 8 groups with fixed weights adding up to 100, as shown in Table II below. The weights are derived from the 2000 comprehensive *Household Consumption Budget Survey* (EBCM-2000). Among the distinctive features of the new Haiti's CPI is the addition of two new price indexes to the main one: a locally-produced goods price index and an imported goods prices index, all three based on August 2004. Information is gathered simultaneously but separately for the three agregates but IHSI, the collecting agency has yet to publish the weight of each group (in total consumption expenditures) in the global CPI. From Table II, food and clothing make up 70% of consumption expenditures on imported goods but less than 57% of consumption expenditures on domestically produced goods.

[2] See Jemley Marc Jean-Baptiste and Dudley Augustin (2010) and Jean Marie Cayemitte and Julnor Georges (2010).

Table II: Haiti: Structure of the Consumer Price Index

Groups		Weights (%)	Consumption Expenditures on Locally Produced (%)	Consumption Expenditures on Imported (%)
I	Food	50.35	52.75	49.03
II	Clothing	6.86	4.24	20.7
III	Rent/ Energy	11.05	11.77	4.37
IV	Home furniture & Maintenance	4.70	5.65	6.78
V	Health	2.90	3.37	3.94
VI	Transportation	13.74	12.17	9.02
VII	Entertainment/Education/Leisure	5.84	8.49	2.04
VIII	Others	4.56	1.55	4.12
	Total	100.0	100.0	100.0

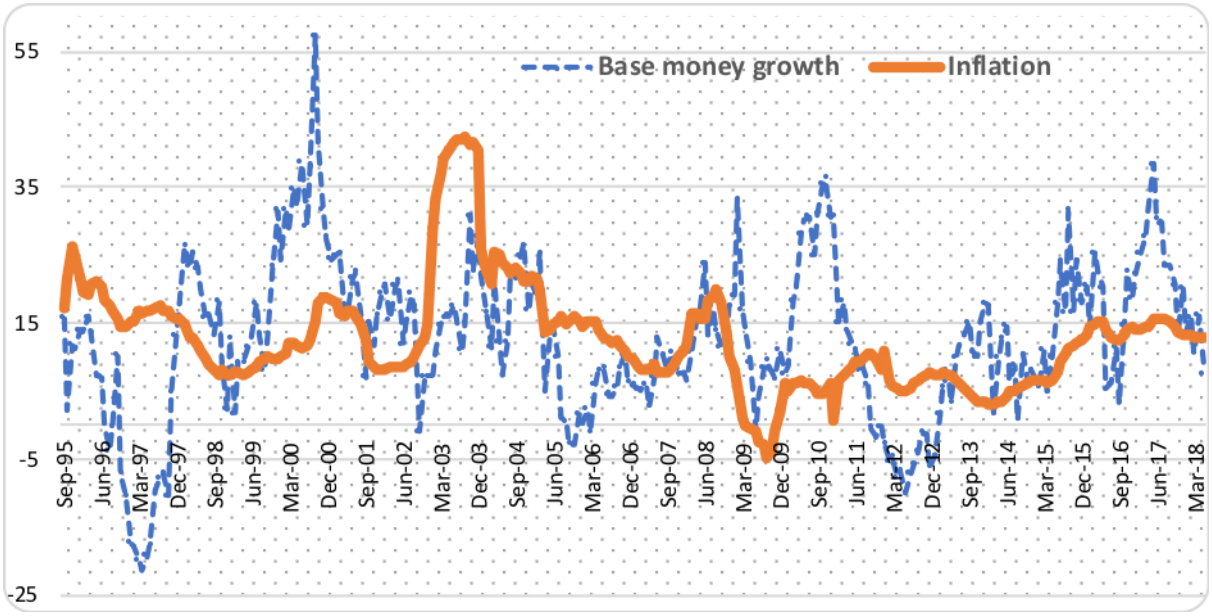
Source: « *L'Indice des Prix à la Consommation. Base 100 en Août 2004* ». IHSI, MEF. Juillet 2005.

III. Sources of inflation pressures

a. Money supply

1. Monetary stance remains the main determinant of inflation, consistent with standard theory, albeit with lags. Graph II shows how the erratic base money growth tends to pull up and down the inflation rate over the observation period i.e. money is running faster than prices when inflation is rising and slower otherwise. This volatility of money base growth points to a critical feature of the monetary policy framework: the deficit financing ***constraint*** which makes it impossible to target other monetary agregates or inflation measures.

Figure II. Inflation & Base Money growth (% 12-month)



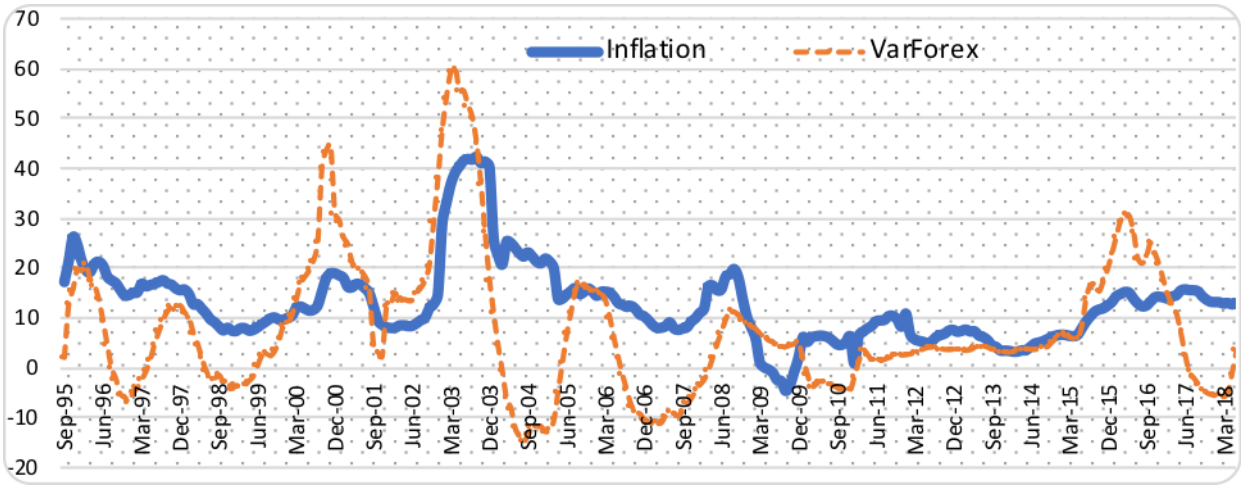
2. This "*fiscal dominance*" issue makes it harder to anticipate the inflation outcome and is conducive to exagerated inflation expectations in order for agents to be on the safe side (loss minimizing behavior). As a result, in an environment where price and wage settings are far from competitive, inflation tends to be persistent as it is difficult for monetary policy to be credible[3].

3. *Current* inflation in Haiti appears to be quite sensitive to *past* inflation, ceteris paribus. Autocorrelation is indeed significant over many quarters. This inertia or sluggishness[4] can be explained also by past policies, substantial imperfections in the structure of the economy, inflation expectations , preexisting contracts, etc. Agénor (2002) has explained the "*strong degree of persistence in developing countries*" by the "*lack of confidence in the policymakers' commitment to or ability to maintain low inflation*"[5].

b. Inflation persistence

4. Money and inflation *inertia* –or inflation *persistence*- however are not the only drivers of the *headline* inflation rate. Relative price changes –or "shocks" - have been found to exert significant and lasting effect on the CPI or headline inflation. In Haiti, for instance, it has been shown that there is a positive although weak causal relationship between inflation and the variance and the dissymetry of relative prices over a 24-month period ending in 1998 and that this relation is not less strong than the causal relationship between money and inflation[6].

Figure III. Inflation and Foreign Exchange variations (% 12-month)

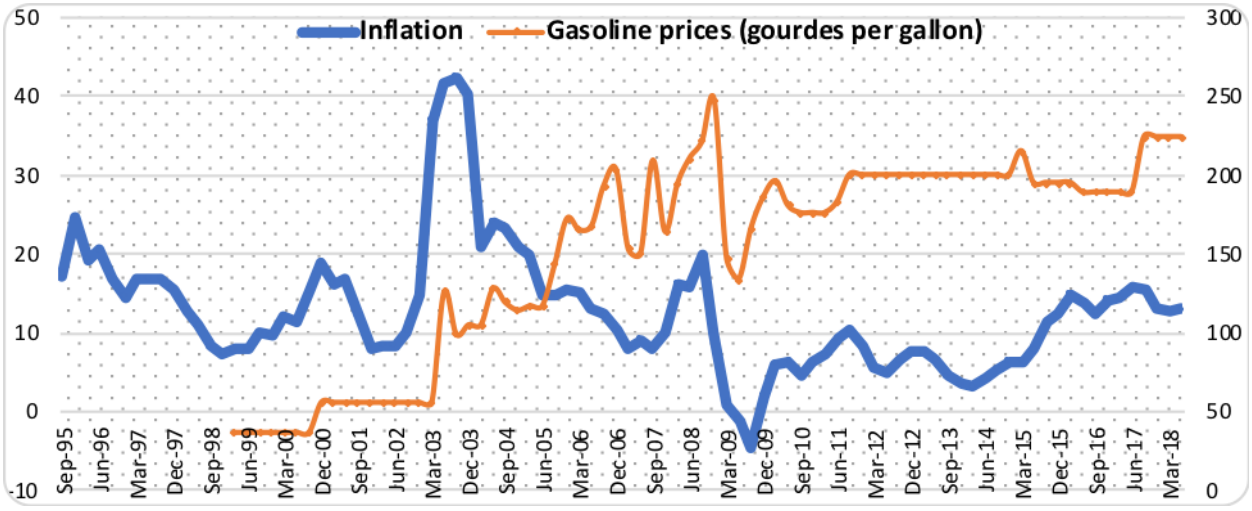


[3]See « **Monetary Policy in Haiti: Improving Effectiveness** » by Laure Redifer and Kristian Hartelius in "**Haiti – Selected Issues and Statistical Appendix**". IMF/SM/07/239, July 10, 2007, for a technical discussion of this issue.
[4] Documented in Haiti by Christine Justinville (2008)
[5] Agénor (2002). P. 101.
[6] See Henry Robert Dubois (1999)

c. Oil prices

5. More than money growth, the exchange rate changes seem to pull the CPI rates up and down, reflecting a significant pass-through from import prices to overall consumer prices. Adding to the strength of the pass-through is the effect of individual prices –like retail oil prices- on the price index through the exchange rate[7], as in Figure IV, along with the more subtle effect of financial dollarization on exchange rate variability[8]. In Haiti, bank deposit dollarization (both currency substitution and asset substitution) has reached 60% in 2018.

Figure IV. Headline inflation (%) and Gasoline prices (HTG/gallon)



d. Money depreciation

6. Exchange rate pass-through to CPI seems to explain a lot of the inflation dynamics in Haiti[9].This empirical evidence contradicts somewhat standard *anticipated* inflation theory: "*Other things equal, the higher the expected rate of inflation, the higher the level of market interest rates, the higher the rate at which wages rise and the faster the rate of currency deperciation. Furthermore, these effects will all be one on one. An **x per cent** higher anticipated inflation will be associated with **x per cent** higher nominal interest rates, with wages rising **x***

[7] March 1995 law: Retail prices of gasoline, gasoil and kerosene must be adjusted upward or downward whenever the CIF prices in local currency rise or fall by at least 5%. Therefore, whenever the algebraic sum of changes in the US$CIF prices and the exchange rate is ≥ 5%. Although the adjustments have not been automatic, the effect is evident on the CPI.

[8] In a recent study, W. Kavila and P. le Roux have concluded that "*exchange rate pass-through to prices is greater in economies that are highly dollarized"* in "**Inflation dynamics in a dollarised economy: The case of Zimbabwe**". Southern African Business Review Vol 20 2016. IMF presents the reasons for increased exchange rate volatility in "**Monetary Policy in Dollarized Economies**". Occasional Paper 171. 1999.

[9] Documented empirically in Haiti in many papers notably in Redifer and Hartelius (2007)

percent *faster and with currency depreciating* ***x percent*** *faster*."[10] In other words, consistent with the monetary approach of the exchange rate, inflation implies currency depreciation[11], not the other way around as suggests the exchange rate pass-through theory.

7. Conventional monetary theory does not exclude relative price effects (like exchange rate pass-through) on absolute prices to the extent that they are temporary. In his famous 1974 article, Milton Friedman wrote: "**It is essential to distinguish changes in *relative prices* from changes in *absolute prices*. The special conditions that drove up the prices of oil and food required purchasers to spend more on them, leaving less to spend on other items. Did that not force other prices to go down or rise less rapidly than otherwise? Thanks to delays in adjustment, the rapid rises in oil and food prices may have temporarily raised the rate of inflation somewhat**." And he added: "**The basic source of inflation is the faster growth in the quantity of money than in output.**"[12] It follows that an accomodative monetary policy in the form of permanent growth of the monetary base (irrespective of output growth) will *not allow* "…**other prices to go down or rise less rapidly**" and therefore will transform a temporary change in *relatives prices* into a permanent change in *absolute prices*[13].

IV. The tests : Why two ?

8. The *Vector Autoregression Approach* (VAR) provides a convenient way to treat these issues. Inflation, money growth and exchange rate changes are assumed to be endogeneous, each one depending on its lagged values and on the lagged values of the other two variables. This approach allows to ascertain how much of a change in a variable (e.g. inflation) is due to inflation and how much is due to shocks to other variables (money and exchange rate changes (*variance decomposition*) and also to help us determine and trace over time the effect of a one-time on current and future values of the endogeneous variables. Building on this VAR, a *Vector Error Correction Model* (VECM) is set up with the three variables to study the short run adjustment dynamics and the gradual correction over the long term.

[10] Michael Parkin (1994) P. 395
[11] As observed empirically in Haiti by Ludmilla Buteau (2008).
[12] "**Perspectives on Inflation**", Newsweek, 24 June 1974, p. 73.

[13] From September 1995 to June 2018, the average money supply growth was 12.7 % while the average GDP growth was only 1.9 %.

Data and Methodology

1. Due to the fact that all three variables are integrated in the same order I(1) and we want to capture the short-run and long-run effect, we use a VECM since it combines short-run information with long-run (static) information to provide long-term relationship and also the short-term dynamics between the CPI inflation, the base money and the exchange rate. Through this model, we will verify the basic hypothesis: the CPI inflation depends on the base money (asymmetric shocks from the monetary policy and fiscal dominance) and the nominal exchange rate movements (relative prices).

2. In this paper, we use quarterly data from 1998:4 to 2018:2. Three significant events mark this period: a) the end of the embargo which lasted from 1991 to 1994) b) the formal adoption of a floating/flexible exchange rate regime and c) the introduction of an indirect monetary policy instrument bearing market interest rates. This central bank security called ***BRH Bond*** is issued in 7, 28 and 20-day to manage liquidity in the banking system

3. The price level (cpinfl) is represented by the Consumer Price Index provided by the ***Institut Haitien de Statistique et d'Informatique*** (IHSI). Also, the exchange rate[14] (txchfp) is measured as the US dollar price in Gourdes, the local currency, as published by BRH (***Banque de la République d'Haiti)***, the central bank. In Haiti, we have dual currency circulation. The base money –or high-powered money- (bms) directly controlled by the central bank is the sum of local currency in circulation and gourde deposits at BRH. Regarding the estimation's needs, all the series have been log-linearized. Exchange rate and base money data are from the central bank.

Data stationarity

4. For the Augmented Dickey-Fuller stationarity test on the three variables, all the log-linearized series were found to be non-stationary in level. Stationarity was obtained for all of them (CPI inflation, base money, and the exchange rate) in first differences at the 5% threshold. As for the optimal lag choice, the test (based on the Schwartz Information Criteria) has suggested an optimal number of 5 quarters (Table 2 in Annex).

[14] Indirect quotation

Table III. Augmented Dickey-Fuller (ADF) Test

	Level			First difference		
	lcpinfl	**lbms**	**ltxchfp**	**dlcpinfl**	**dlbms**	**dltxchfp**
Observations	85	85	85	84	84	84
Lags	5	5	5	5	5	5
Critical value 1 %	-3.5093	-3.5093	-3.5093	-3.5093	-3.5093	-3.5093
Critical value 5 %	-2.8959	-2.8959	-2.8959	-2.8959	-2.8959	-2.8959
Critical value 10 %	-2.5852	-2.5852	-2.5852	-2.5852	-2.5852	-2.5852
Value	**-1,123**	**-1,023**	**-1,137**	**-11,742***	**-10,787***	**-7,303***
Stationarity	No	No	No	Yes	Yes	Yes

i) VAR

a) Specifications

To estimate the VAR model, using the Schwartz information criteria (SIC), we found 1 as the number of lags and all the three variables are in first difference.

b) Results

5. As for the variance decomposition from an unrestricted estimated VAR Model (table 4 in Annex), it shows that the variance in the forecast error of CPI inflation is completely explained by CPI inflation for more than 80 percent over a period of 10 quarters. A shock to the exchange rate impacts the (variance of the) forecast error of CPI inflation. It starts from the second quarter (0.52 %) and goes up until it reaches 13 % at the tenth quarter. Indeed, 13 % of the variance in the forecast error of CPI inflation seems to be explained by shocks in exchange rate. Moreover, a shock to the money supply rate explains more 16 % the (variance of the) forecast error of exchange rate after 10 quarters while it counts only for 7.5 % the (variance of the) forecast error of CPI inflation.

ii) VECM

a) Specifications

6. To perform the trace test, we need to determine the number of lags in the VAR. Using the Schwartz information criteria (SIC), we found 1 as the number of lags. Applying the Johansen procedure, we note that there is one vector of co-integration between the three variables and an intercept in the equation. Moreover, we found that all the adjustment

coefficients are negative but only the one associated to CPI inflation is statistically significant. This information is summarized in the (table 5 in Annex).

Long run equilibrium

7. The vector's coefficients are normalized in the coefficient of CPI inflation, a variable which is considered as the endogenous one. Theoretically, the signs of the estimated coefficients of base money and exchange rate are correct, and they are statistically significant according to the *t-statistics*. As showed in table 6 in Annex, the normalization of the co-integration vector in the coefficient of CPI inflation leads to the co-integration equation below:

$$lcpinfl_t = -2.779763 + 0.366134 * lbms_t + 1{,}069020 * ltxchfp_t \quad (1)$$

(-2.17417) (-3.39085)

Short run dynamics

8. In the short run, the results indicate that all the adjustment coefficients are negatives but only the CPI inflation's one is statistically significant (2). This shows that:

$$d(lcpinfl) = -0.114872359926 * (LCPINFL(-1) - 0.366133939194 * LBMS(-1) - 1.06901978419 * LTXCHFP(-1) + 2.77976293468) - 0.335673066896 * D(LCPINFL(-1)) - 0.0598603950689 * D(LBMS(-1)) + 0.0607594660384 * D(LTXCHFP(-1)) + 0.0388431860216 + 0.00947835388518 * DUMMY \quad (2)$$

$$d(lbms) = -0.00791135485503 * (LCPINFL(-1) - 0.366133939194 * LBMS(-1) - 1.06901978419 * LTXCHFP(-1) + 2.77976293468) - 0.0533243069536 * D(LCPINFL(-1)) - 0.191683658958 * D(LBMS(-1)) + 0.0561372649698 * D(LTXCHFP(-1)) + 0.040432899276 - 0.0296549528454 * DUMMY \quad (3)$$

$$d(ltxchfp) = -0.00675301846008 * (LCPINFL(-1) - 0.366133939194 * LBMS(-1) - 1.06901978419 * LTXCHFP(-1) + 2.77976293468) - 0.0226607279389 * D(LCPINFL(-1)) + 0.0621546677706 * D(LBMS(-1)) - 0.139166358599 * D(LTXCHFP(-1)) + 0.0184033022379 + 0.00796246150506 * DUMMY \quad (4)$$

Diagnostic test

9. Diagnostic tests of the estimated VECM indicate that the residuals are free of serial correlation (LM) and heteroscedasticity. Nevertheless, we found a lack of normality of the residuals. For this reason, we introduced a binary variable (dummy) to take into account the structural breaks that could help resolve the problem. Stability tests were also performed to

assess the stability of the estimated VECM. As showed in table 10 and figure 1 in Annex, the inverse roots of the characteristic AR polynomial are equal to unity. This indicates that all the coefficients in the VECM are stable.

a. Results

10. The co-integration equation (1) above describes the dynamics and the adjustment path of CPI inflation, base money and exchange rate toward the long-term equilibrium. As for the results, we found that money supply (base money) and exchange rate are the foremost determinants of CPI inflation in Haiti in the long-run (over 40 quarters). This is consistent with the predictions of a small open economy, where exchange rate movements while strongly dependent on money supply which determines price level exerts also significant influence on the CPI inflation. A 1 percent depreciation of the Gourde causes a jump of 1.069 % in CPI inflation, as expected by conventional theory. This result suggests a strong role in Haiti for the direct exchange rate channel for the transmission of monetary policy to inflation.

11. Regarding the impact of money supply, we found that a 1 % increase in the base money will lead to a 0.366 percent change in CPI inflation. As it is expected from the economic theory, money supply affects directly the inflation movements in the long-run: the usual aggregate demand and expectation channels, weaker in Haiti because of the openness of the economy, cannot be ruled out as transmission mechanism.

12. The analysis of the short run dynamics and adjustment to the long-term equation shows that the return to equilibrium is achieved only through CPI inflation (reflecting inflation inertia). The speed of adjustment is however slow (0.1148). As a matter of fact, a 1 percent change in past inflation rate is likely to affect current inflation rate by 0.11 %. Moreover, short run dynamics in CPI inflation depend only on changes in past CPI inflation whose coefficient (0.335673) is statistically significant.

V. Concluding remarks

Inflation has reached -and seems to stay at – new highs in Haiti while growth remains sluggish. This paper has found evidence that exchange rate fluctuations plays a significant role in the inflation dynamics in Haiti, in aggravating the effects of an accommodating monetary policy, of downward price stickiness and of inflation persistence. Given the strong exchange rate pass-through observed, the direct exchange rate transmission channel seems to be the most efficient way for monetary policy to stabilize CPI inflation, to anchor exchange rate expectations (under the current floating rate system) and to build up policy credibility.

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ANNEX

Table 1. Granger Causality Test

Pairwise Granger Causality Tests
Date: 10/26/18 Time: 17:26
Sample: 12/01/1996 6/01/2018
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
LTXCHFP does not Granger Cause LCPINFL	85	8.46956	0.0005
LCPINFL does not Granger Cause LTXCHFP		0.06822	0.9341
LBMS does not Granger Cause LCPINFL	85	2.89291	0.0612
LCPINFL does not Granger Cause LBMS		0.29341	0.7465
LBMS does not Granger Cause LTXCHFP	85	1.51292	0.2265
LTXCHFP does not Granger Cause LBMS		0.03178	0.9687

Table 2. Lags number determination

VAR Lag Order Selection Criteria
Endogenous variables: LCPINFL LBMS LTXCHFP
Exogenous variables: C
Date: 10/23/18 Time: 18:18
Sample: 12/01/1998 6/01/2018
Included observations: 79

Lag	LogL	LR	FPE	AIC	SC	HQ
0	17.09919	NA	0.000140	-0.356942	-0.266963	-0.320893
1	356.7997	645.0010*	3.25e-08*	-8.729107*	-8.369191*	-8.584913*
2	365.2607	15.42250	3.30e-08	-8.715460	-8.085607	-8.463122
3	372.9869	13.49644	3.41e-08	-8.683213	-7.783422	-8.322729
4	376.5382	5.933797	3.94e-08	-8.545271	-7.375543	-8.076642

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

Table 3. Unrestriced VAR results

Vector Autoregression Estimates
Date: 10/26/18 Time: 17:21
Sample: 12/01/1998 6/01/2018
Included observations: 79
Standard errors in ( ) & t-statistics in [ ]

	DLCPINFL	DLTXCHFP	DLBMS
DLCPINFL(-1)	-0.231334	-0.057305	-0.011422
	(0.09480)	(0.22040)	(0.06398)
	[-2.44011]	[-0.26001]	[-0.17853]
DLTXCHFP(-1)	0.134134	-0.165880	0.018405
	(0.05122)	(0.11908)	(0.03457)
	[2.61861]	[-1.39299]	[0.53242]
DLBMS(-1)	-0.207887	0.238121	-0.196487
	(0.17559)	(0.40820)	(0.11850)
	[-1.18395]	[0.58335]	[-1.65813]
C	0.004978	0.004610	0.003529
	(0.00127)	(0.00296)	(0.00086)
	[3.90604]	[1.55570]	[4.10263]
DUMMY	0.015366	0.006741	0.001620
	(0.00258)	(0.00600)	(0.00174)
	[5.94939]	[1.12260]	[0.92951]
R-squared	0.394829	0.048337	0.044349
Adj. R-squared	0.362117	-0.003104	-0.007307
Sum sq. resids	0.005523	0.029848	0.002515
S.E. equation	0.008639	0.020084	0.005830
F-statistic	12.06989	0.939653	0.858541
Log likelihood	265.8522	199.2066	296.9179
Akaike AIC	-6.603853	-4.916623	-7.390327
Schwarz SC	-6.453888	-4.766658	-7.240361
Mean dependent	0.006330	0.005340	0.003207
S.D. dependent	0.010817	0.020053	0.005809

Determinant resid covariance (dof adj.)	8.95E-13
Determinant resid covariance	7.36E-13
Log likelihood	767.2667
Akaike information criterion	-19.04473
Schwarz criterion	-18.59483

Table 4. Variance Decomposition

Variance Decomposition of DLCPINFL:

Period	S.E.	DLCPINFL	DLTXCHFP	DLBMS
1	0.040509	100.0000	0.000000	0.000000
2	0.056380	99.38444	0.519561	0.096000
3	0.068160	98.07313	1.572143	0.354722
4	0.077893	96.20064	2.995298	0.804057
5	0.086386	93.89530	4.646547	1.458156
6	0.094054	91.27446	6.407373	2.318167
7	0.101137	88.44169	8.184139	3.374173
8	0.107789	85.48540	9.906816	4.607780
9	0.114106	82.47880	11.52636	5.994840
10	0.120157	79.48059	13.01141	7.508004

Variance Decomposition of DLTXCHFP:

Period	S.E.	DLCPINFL	DLTXCHFP	DLBMS
1	0.065380	3.234620	96.76538	0.000000
2	0.088318	2.766280	96.72776	0.505965
3	0.103727	2.387242	96.02838	1.584378
4	0.115266	2.085723	94.79328	3.121001
5	0.124414	1.848983	93.15192	4.999102
6	0.131939	1.664539	91.22699	7.108468
7	0.138294	1.521028	89.12748	9.351487
8	0.143763	1.408723	86.94491	11.64637
9	0.148537	1.319731	84.75226	13.92801
10	0.152748	1.247973	82.60479	16.14724

Variance Decomposition of DLBMS:

Period	S.E.	DLCPINFL	DLTXCHFP	DLBMS
1	0.059493	3.102504	2.597507	94.29999
2	0.082310	3.639176	2.662563	93.69826
3	0.098750	4.200357	2.750588	93.04905
4	0.111838	4.778177	2.859784	92.36204
5	0.122788	5.365100	2.988622	91.64628
6	0.132239	5.954133	3.135689	90.91018
7	0.140579	6.538965	3.299578	90.16146
8	0.148064	7.114070	3.478826	89.40710
9	0.154873	7.674755	3.671881	88.65336
10	0.161137	8.217163	3.877097	87.90574

Cholesky Ordering: LCPINFL LTXCHFP LBMS

Table 5. Johansen Cointegration Test

Date: 10/23/18 Time: 18:15
Sample: 12/01/1998 6/01/2018
Included observations: 79
Trend assumption: No deterministic trend (restricted constant)
Series: LCPINFL LBMS LTXCHFP
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.445128	62.32596	35.19275	0.0000
At most 1	0.115810	15.79358	20.26184	0.1843
At most 2	0.073958	6.070020	9.164546	0.1854

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.445128	46.53239	22.29962	0.0000
At most 1	0.115810	9.723557	15.89210	0.3602
At most 2	0.073958	6.070020	9.164546	0.1854

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 6. Vector Error Correction Estimates

Date: 10/23/18 Time: 17:47 Sample: 12/01/1998 6/01/2018
Included observations: 79 Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LCPINFL(-1)	1.000000
LBMS(-1)	-0.366134
	(0.16840)
	[-2.17417]
LTXCHFP(-1)	-1.069020
	(0.31527)
	[-3.39085]
C	2.779763

Error Correction:	D(LCPINFL)	D(LBMS)	D(LTXCHFP)
CointEq1	-0.114872	-0.007911	-0.006753
	(0.02964)	(0.04062)	(0.04751)
	[-3.87505]	[-0.19476]	[-0.14213]
D(LCPINFL(-1))	-0.335673	-0.053324	-0.022661
	(0.10710)	(0.14676)	(0.17165)
	[-3.13422]	[-0.36336]	[-0.13202]
D(LBMS(-1))	-0.059860	-0.191684	0.062155
	(0.08528)	(0.11686)	(0.13669)
	[-0.70191]	[-1.64029]	[0.45473]
D(LTXCHFP(-1))	0.060759	0.056137	-0.139166
	(0.07854)	(0.10762)	(0.12588)
	[0.77363]	[0.52163]	[-1.10559]
C	0.038843	0.040433	0.018403
	(0.00634)	(0.00869)	(0.01017)
	[6.12406]	[4.65215]	[1.81033]
DUMMY	0.009478	-0.029655	0.007962
	(0.02236)	(0.03065)	(0.03584)
	[0.42381]	[-0.96768]	[0.22214]
R-squared	0.259636	0.050566	0.019948
Adj. R-squared	0.208926	-0.014464	-0.047179
Sum sq. resids	0.135515	0.254447	0.348105
S.E. equation	0.043086	0.059039	0.069055
F-statistic	5.120030	0.777583	0.297162
Log likelihood	139.4447	114.5592	102.1795
Akaike AIC	-3.378347	-2.748334	-2.434924
Schwarz SC	-3.198389	-2.568376	-2.254966
Mean dependent	0.029114	0.032235	0.017722
S.D. dependent	0.048442	0.058616	0.067481

Determinant resid covariance (dof adj.)	2.75E-08
Log likelihood	360.7192
Akaike information criterion	-8.600487
Schwarz criterion	-7.970634

Table 7. Serial correlation

VEC Residual Serial Correlation LM Tests

Null Hypothesis: no serial correlation at lag order h

Date: 10/23/18 Time: 18:10

Sample: 12/01/1998 6/01/2018

Included observations: 79

Lags	LM-Stat	Prob
1	9.664562	0.3783
2	8.460894	0.4884
3	7.873299	0.5470

Probs from chi-square with 9 df.

Table 8. Normality Test

VEC Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)

Null Hypothesis: residuals are multivariate normal

Date: 10/23/18 Time: 18:20

Included observations: 79

Component	Skewness	Chi-sq	df	Prob.
1	0.580899	3.443012	1	0.0550
2	0.260830	0.895760	1	0.3439
3	0.888074	5.038424	1	0.0513
Joint		5.72301	3	0.0553

Component	Kurtosis	Chi-sq	df	Prob.
1	2.226233	1.970771	1	0.1604
2	3.500680	0.825156	1	0.3637
3	5.632757	2.815880	1	0.0812
Joint		1.90181	3	0.15572

Component	Jarque-Bera	df	Prob.
1	5.013783	2	0.0517
2	1.720916	2	0.4230
3	4.968121	2	0.0519
Joint	5.011482	6	0.0506

Table 9. Heteroskedasticity

VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 10/23/18 Time: 18:10
Sample: 12/01/1998 6/01/2018
Included observations: 79

Joint test:

Chi-sq	df	Prob.
59.60333	54	0.2792

Individual components:

Dependent	R-squared	F(9,69)	Prob.	Chi-sq(9)	Prob.
res1*res1	0.318148	3.577217	0.0011	25.13368	0.0028
res2*res2	0.047510	0.382415	0.9397	3.753321	0.9269
res3*res3	0.130730	1.152993	0.3388	10.32766	0.3246
res2*res1	0.144483	1.294780	0.2557	11.41418	0.2484
res3*res1	0.213075	2.075893	0.0436	16.83290	0.0514
res3*res2	0.019744	0.154420	0.9975	1.559783	0.9967

Figure 1. Stability of the VECM

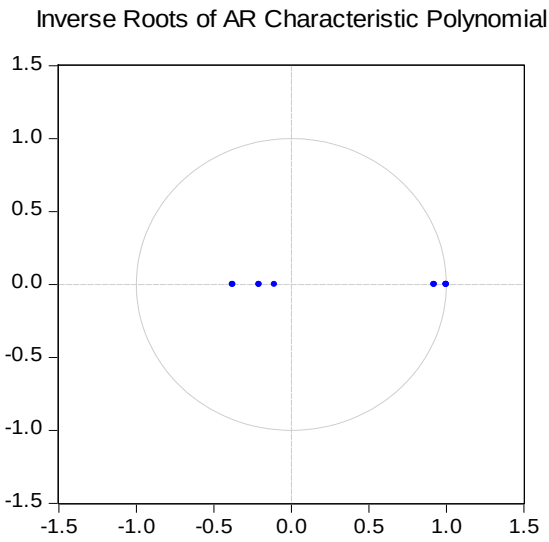

Table 10. AR roots of characteristic polynomial

Roots of Characteristic Polynomial
Endogenous variables: LCPINFL LBMS LTXCHFP
Exogenous variables: DUMMY
Lag specification: 1 1
Date: 10/24/18 Time: 10:42

Root	Modulus
1.000000 - 9.79e-17i	1.000000
1.000000 + 9.79e-17i	1.000000
0.921246	0.921246
-0.378572	0.378572
-0.206804	0.206804
-0.107149	0.107149

VEC specification imposes 2 unit root(s).