MONEY, INCOME, PRICES, AND EXCHANGE RATES IN THE DOMINICAN REPUBLIC

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Abstract

This paper investigates the information content of money, exchange rates, and foreign variables on real income and prices in the Dominican Republic. The results show that the change in the exchange rate -adjusted to account for financial conditions in the US- is a robust predictor of both real income and prices. Money and foreign reserves also contain significant information on prices. These outcomes highlight the pervasive role of the exchange rate and foreign financial conditions on macroeconomic developments in small developing economies.

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1. Introduction

The impact of money and other key macroeconomic fundamentals on developments in real income and prices is a topic of great importance in the design and implementation of monetary policy. Not surprisingly, there is a substantial literature that scrutinises such a relation. Amongst the earliest systematic attempts to measure the effect of money on the economy is the work of M. Friedman and Schwartz (1963). In their seminal work M. Friedman and Schwartz analyse the behaviour of macroeconomic time series for the United States (US) economy during the period 1867-1960, finding a strong role for money on macroeconomic and financial developments.

Subsequently, the measurement of monetary policy has mainly been undertaken by applying the vector autoregression (VAR) econometric technique advanced by Sims (1972, 1980a, b). Sims (1972) first applied the VAR methodology to address the impact of monetary shocks on the US economy, finding that money Granger-causes nominal GDP in a bivariate VAR. However, Sims (1980b) shows that a nominal interest rate appears to be more important than money as a predictor of output when included in a VAR alongside money, output, and prices.

A notable addition to this literature is the work of B. Friedman and Kuttner (1992). The authors revisit the role of money on output and prices in the US economy using the information variable approach. They analyse the results of F -tests derived from autoregressions and forecast error variance decompositions from VARs. B. Friedman and Kuttner's main finding is that the relationship between the changes in money and output, or money and nominal output and prices, weakened from the 1980s. In contrast, they report strong information content in the US Treasury bill rate on future

movements in real income. In contrast to this evidence, recent work by Aksoy and Piskorski reveals that money does contain valuable information about future movements in US real output and inflation, after considering the *domestic* component of the US monetary aggregates in their econometric modelling.

This paper employs the information variable approach to monetary policy to delve into the usefulness of monetary aggregates in predicting real income and prices in a small developing economy -the Dominican Republic (DR). The paper's contribution is to analyse central variables, such as the exchange rate and foreign financial conditions, alongside more traditional macroeconomic fundamentals. There is a large literature addressing the exchange rate's weighty role in developing economies.[1] But, to the best of the author's knowledge, there is little evidence on the importance of this variable in a 'horse race' exercise attempting to unveil its information content for monetary policy.

For instance, on the role of the exchange rate Calvo and Reinhart (2002, page 394) note that "…central bankers in emerging market economies appear to be extremely mindful of external factors in general and the foreign exchange value of their currency, in particular". In line with the authors' predictions, this paper unveils that accounting for the exchange rate in this type of analysis for the Dominican Republic is relevant. Particularly, the exchange rate -adjusted to account for financial conditions in the US, its main trading and financial partner - provides significant information on real income and prices, with money playing a role only in predicting the latter.

This upshot highlights the cardinal importance of the exchange rate, and the difficult balancing task faced by monetary policymakers in small developing economies like the DR. Moreover, it is also somewhat in harmony with, for instance, Sims' (1980)

[1] See, for instance, the paper by Kamin and Rogers (2000).

and B. Friedman and Kuttner's (1992) enquiries for the US economy. These authors also find an interest rate indicator dominating in terms of information content on income and prices.

The rest of the paper is organised as follows. Section 2 introduces the time series data employed in the research. Section 3 runs auto regressions of income and prices, and tests the stability of the coefficients of interest. Section 4 contains concluding remarks.

2. Data

The paper employs annual time series data ranging from 1950 to 2000. The variables to be considered in the econometric exercises that follow are real output (y/p), money (m), prices (p), exchange rates (e), the US Treasury bill rate (R^*), net foreign reserves (NFR), oil prices (oil), and government expenditures (g). All the variables are in logs (small caps), with the exception of NFR and R^*, which are expressed in millions of Dominican Pesos and percentage points, respectively. (Further details on data sources and definitions can be obtained from the data appendix.) For modelling purposes, in what follows all the variables are expressed in growth rates denoted by the difference operator Δ. Finally, it is worth noting that all the growth rate variables were found to be stationary, i.e. integrated of order zero $\left[I\left(0\right) \right]$, using standard tests.

A visual impression of the time series at hand can be obtained by glancing at Figures 1, 2, and 3. Figure 1 displays the growth rates of Δm, $\Delta\left(y/p\right)$, Δp, and Δe, while Figure 2 exhibits Δg, ΔNFR, and Δoil.[2] Interestingly, Figure 3 conveys the

[2] Note that ΔNFR is calculated as $NFR - NFR_{t-1}/NFR_{t-1}$.

relatively close pattern between Δe and R^*: developments in R^* seem to precede changes in Δe.[3] This reflects the financial link between the Dominican Republic and the United States, and lends support to thinking of the underlying rate of return in domestic currency as being proxied by $R \approx \Delta e + R^*$.[4]

This interpretation is particularly useful for the case of the Dominican Republic, since a consistent series of R does not exist for the full sample period. Even if this series exist it would not be economically appealing to use them in econometric modelling, since domestic interest rates were subject to a ceiling (financial repression) that was only lifted at the beginning of the 1990s, as a by-product of a substantial reform of the financial sector (See Young, 2001). The role of $\Delta e + R^*$ as an indicator variable, and consequently its usefulness for policymakers, will be formally tested in the next sections alongside a battery of macroeconomic fundamentals.

3. Econometric analyses

The econometric analyses to be carried in what follows are motivated by the information approach to monetary policy (e.g. B. Friedman and Kuttner, 1992). Basically, such an approach endeavours to determine if there is useful information in money or other macro variables (e.g. exchange rates) *beyond* that contained in the variable being forecasted, e.g. real income or prices. If so, monetary policy can exploit

[3] Note that the exchange rate of Dominican Pesos per United States Dollars (DR$/US$) was at par until the late 1960s.

[4] Hereafter, in calculating $\Delta e + R^*$ the change in the exchange rate is expressed in percentage points, as is R^*. I.e. $R \approx \Delta e + R^*$ is denoted in percentage points. Note that this variable is also stationary, i.e. $I(0)$.

this information, independently of whether or not any observed significance in fact reflects reverse, true, or mutual causation.

Henceforth, causality is not relevant in the information approach to monetary policy. It is also worth noting that this method tries to disentangle the relation amongst *changes* in variables, and not the co-movement (co-integration) of the *levels* of the series. The latter is the subject of a copious literature (e.g. King et al, 1991). With these provisos in mind, the research proceeds to examine real income and prices autoregressions using the data described in section 2.

3.1. Real income

The basic strategy is to test the significance of money, prices, exchange rates, and ancillary variables included in real income autoregressions of the general form

$$\Delta\left(y/p\right)_t = \alpha + \sum_{i=1}^{n}\beta_i\Delta\left(y/p\right)_{t-i} + \sum_{i=1}^{n}\phi_i\Delta m_{t-i} + \sum_{i=1}^{n}\lambda_i\Delta p_{t-i} + \sum_{i=1}^{n}\eta_i\left(\Delta e + R^*\right)_{t-i} + ... + \zeta_t . \tag{1}$$

F and Hansen (1992) coefficient instability tests corresponding to the variables in the above equation are displayed in Table 1. This Table contains 5-double columns, starting with a 'baseline' real income autoregression alongside money and prices. In this autoregression only income itself seems to be significant and stable. However, once $\Delta e + R^*$ is added (column 2) it becomes the only variable that contains significant

information on real income. This coefficient is also stable, according to Hansen's test. Adding the remaining ancillary variables Δg , ΔNFR, and Δoil -columns 3, 4, and 5- does not alter the outcome displayed in Table 1's column 2.

Table 1's results are not surprising, given the important role played by the exchange rate and foreign financial conditions in developing economies like the DR. It somehow also lends validity to arguments such as Calvo and Reinhart's (2002) *fear of floating*. Other authors have also found a non-negligible impact of the exchange rate on output in developing economies (e.g. Kamin and Rogers, 2000). In order to gain a further insight on the link between the economic time series under analysis, recursive coefficient t-values are graphed for the coefficients exhibited in column 5.

The only statistically significant coefficient, that affecting $\Delta e + R^*$, seems to have become so after 1985, according to the corresponding recursive t-statistic displayed in Figure 4. This finding is well supported by the institutional developments in the Dominican economy around that time. Notably, the country signed three agreements with the IMF (in January 1983, September 1984 and January 1985), and the first devaluation of the official exchange rate took place in January 1985. Inspecting Figure 4 the reader should also perceive the increased significance of the t-values for money, inflation, and foreign reserves around 1985, portraying the importance of closely monitoring a wider array of macroeconomic fundamentals during a crisis.

Additionally, an increase in the significance of the coefficient affecting $\Delta e + R^*$ is apparent from 1991. This might be reflecting the greater prominence of the foreign component of this variable, R^*, after the major economic reforms and stabilisation policies undertaken in the 1990s as a response to the misfortunes of the 1980s.

Particularly, the impact of the financial reforms is probably embodied in the trajectory of $\Delta e + R^*$'s recursive t-statistic.

Turning to the t-values of oil prices exhibited in Figure 4, it is clear that these provide valuable information on real output, over and above that contained in the rest of the variables considered, only in the mid-1970s. This pattern coincides with the sizeable oil price shocks that occurred in that decade as an upshot of OPEC's influence on the international markets. Needles to say these results do not imply that policymakers monitoring the DR's economy can neglect oil prices.

3.2. Prices

The inquiry moves on to the analysis of prices using the general autoregression

$$\Delta p_t = \alpha + \sum_{i=1}^{n} \lambda_i \Delta p_{t-i} + \sum_{i=1}^{n} \phi_i \Delta m_{t-i} + \sum_{i=1}^{n} \beta_i \Delta \left(y/p \right)_{t-i} + \sum_{i=1}^{n} \eta_i \left(\Delta e + R^* \right)_{t-i} + ... + \zeta_t . \quad (2)$$

Analogously to the analysis for real income, F and Hansen (1992) coefficient instability tests corresponding to the variables in (2) are displayed in Table 2. In the first autoregression (column 1) only prices are significant. However, similarly to the outcome for real income, once $\Delta e + R^*$ is added (column 2) it seems to be the only variable containing significant information on real income. This coefficient is also stable, according to Hansen's test.

Adding the remaining ancillary variables Δg , ΔNFR, and Δoil -columns 3, 4, and 5-, however, does alter the outcome displayed in Table 1's column 2. Notably, ΔNFR seem to play a significant role in predicting prices (column 3), while Δm also becomes statistically significant once oil prices are accounted for (at the 10% level, shown in column 4) and even more so after accounting for Δg (at the 5% level, exhibited in column 5). However, note that in columns 4 and 5 Δoil and Δg are not statistically significant. In summary, money, the adjusted exchange rate, and reserves all contain statistically significant information on prices, and controlling for variables such as Δoil and Δg appears to underpin this finding.

In attempting to disentangle the origins of the increased significance in these two variables it is intuitive to think that in economies like the DR the monetary authorities generally accommodate large shocks of external (e.g. oil prices) or internal (e.g. fiscal) nature. Henceforth the pattern observed in Table 2 arises: money is a strong contender indicator on domestic prices in a 'horse race' alongside other fundamentals.

These findings are further clarified by the analysis of the recursive t-values corresponding to the price autoregression contained in Figure 5. Remarkably, the t-values of all the variables that are significant in Table 2's column 5 are permanently boosted after 1985, signalling the impact of the first devaluation of the official DR$/US$ exchange rate elucidated in the previous sub-section. Evidently, the official nominal exchange rate was helping to *anchor* the economy, generating an unsustainable macroeconomic situation. The end product of that policy was an exacerbated crisis in 1985.

Finally, it is worth to highlight the behaviour of the t-values corresponding to the oil price coefficient exhibited in Figure 5. They show that oil prices were very

important in determining domestic inflationary developments during the late 1970s and early 1980s. Although the first-round impact of the large OPEC related oil price hikes in the mid-1970s was substantial, it was somewhat smoothed-out by favourable export commodity prices for the Dominican Republic (e.g. sugar) at that time. When these prices declined, roughly at the end of the 1970s, the new oil price level further passed-through to internal prices. Notably, a relatively low impact after the mid-1980s conveyed by Figure 5 may be accounted for by, at least in part, the fact that the Dominican Republic buys oil in favourable terms since 1980 via the *San José Agreement* between Central America & the Caribbean, Mexico and Venezuela.

4. Conclusion

This paper investigates the information content of money, exchange rates, and foreign variables on real income and prices in the Dominican Republic, using annual data comprising the second half of the 20th century. The results show that the change in the exchange rate -adjusted to account for financial conditions in the US- is a robust predictor of real income and prices. Money and foreign reserves also contain significant information on prices. Notably, the study also controls for the impact of government expenditures and oil prices. Overall, the outcomes highlight the pervasive role of the exchange rate and foreign financial conditions on macroeconomic developments in small developing economies.

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Figure 1
Money, income, prices, and exchange rates, 1951-2000

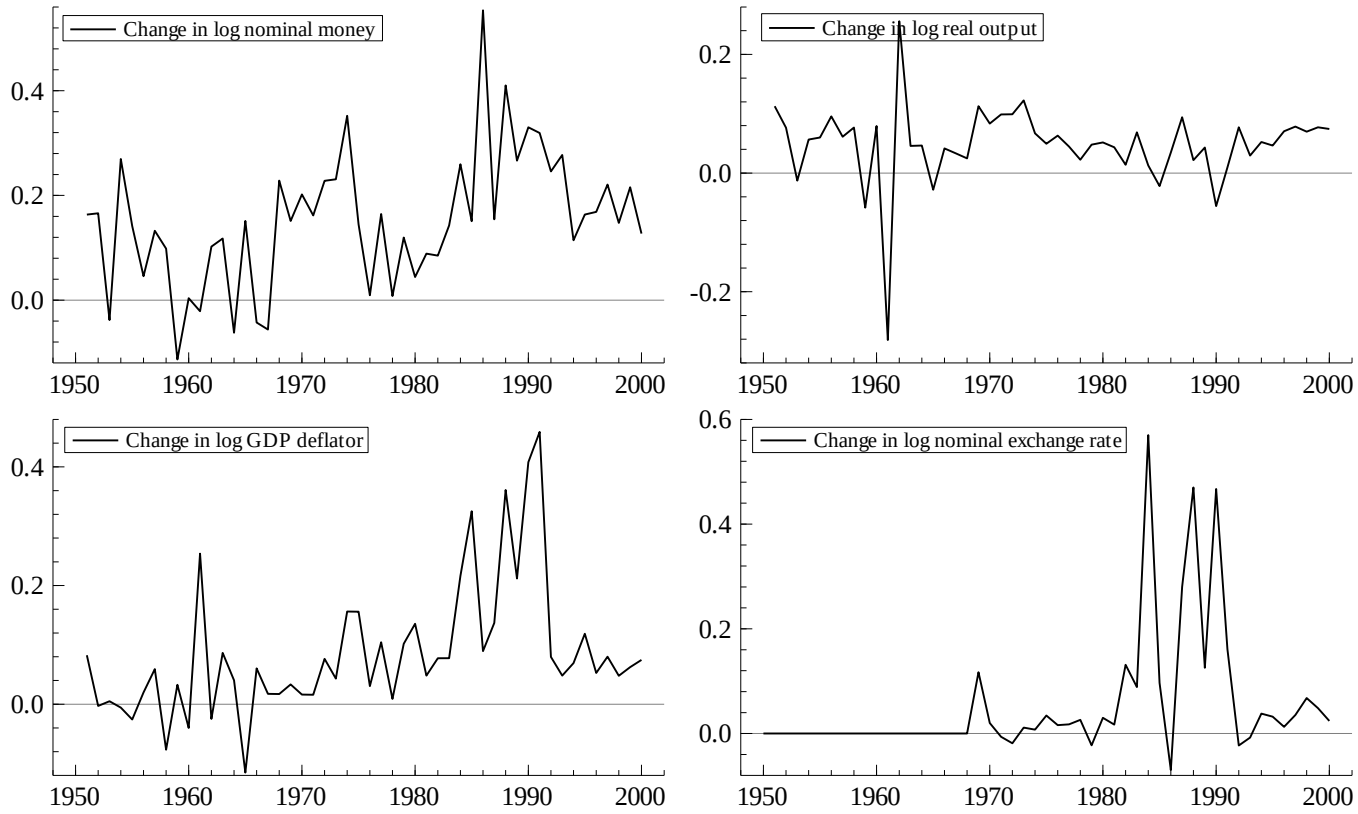

Figure 2
Government expenditures, foreign reserves, and oil prices, 1951-2000

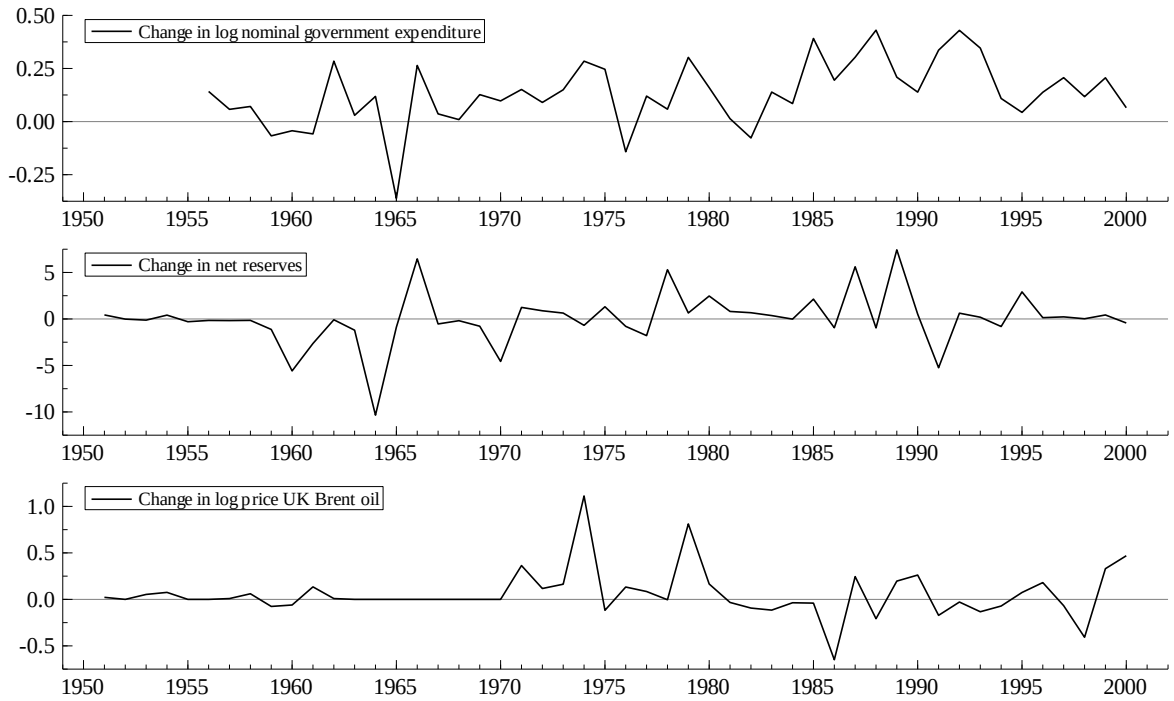

Figure 3
Change in log nominal exchange rate (%) (left hand side)
and US Treasury bill (%) (right hand side)

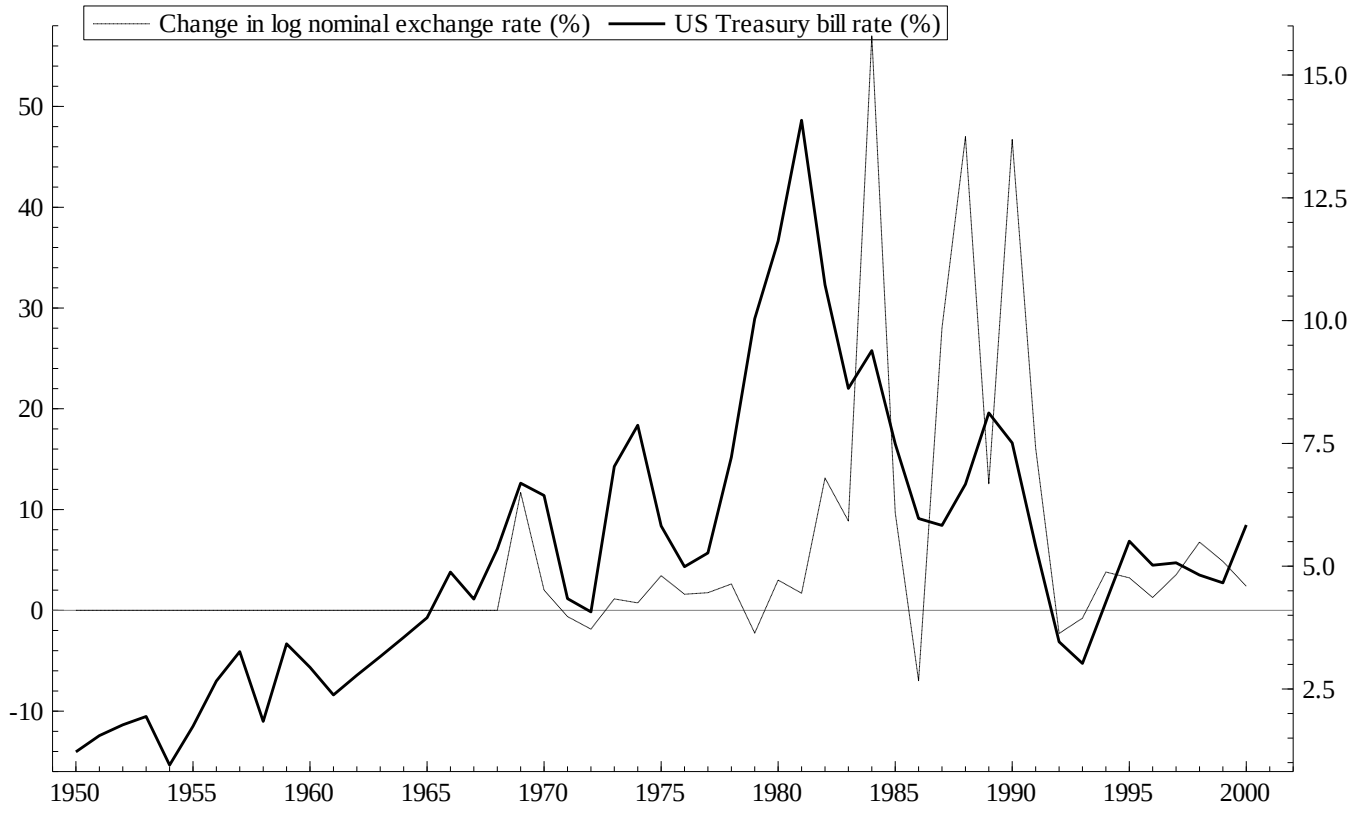

Figure 4
Recursive t-statistics of the coefficients in the real income autoregression

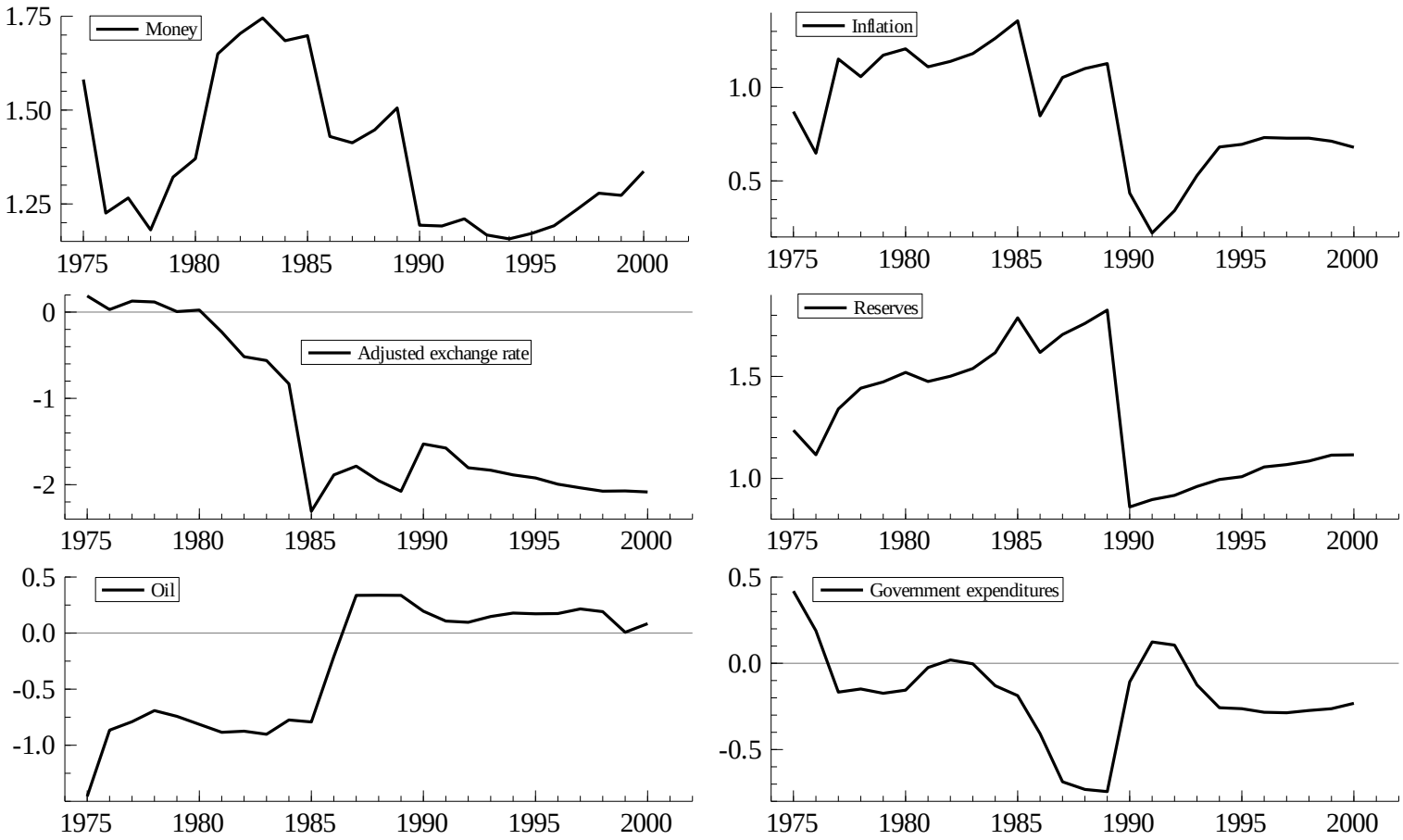

Figure 5
Recursive t-statistics of the coefficients in the price autoregression

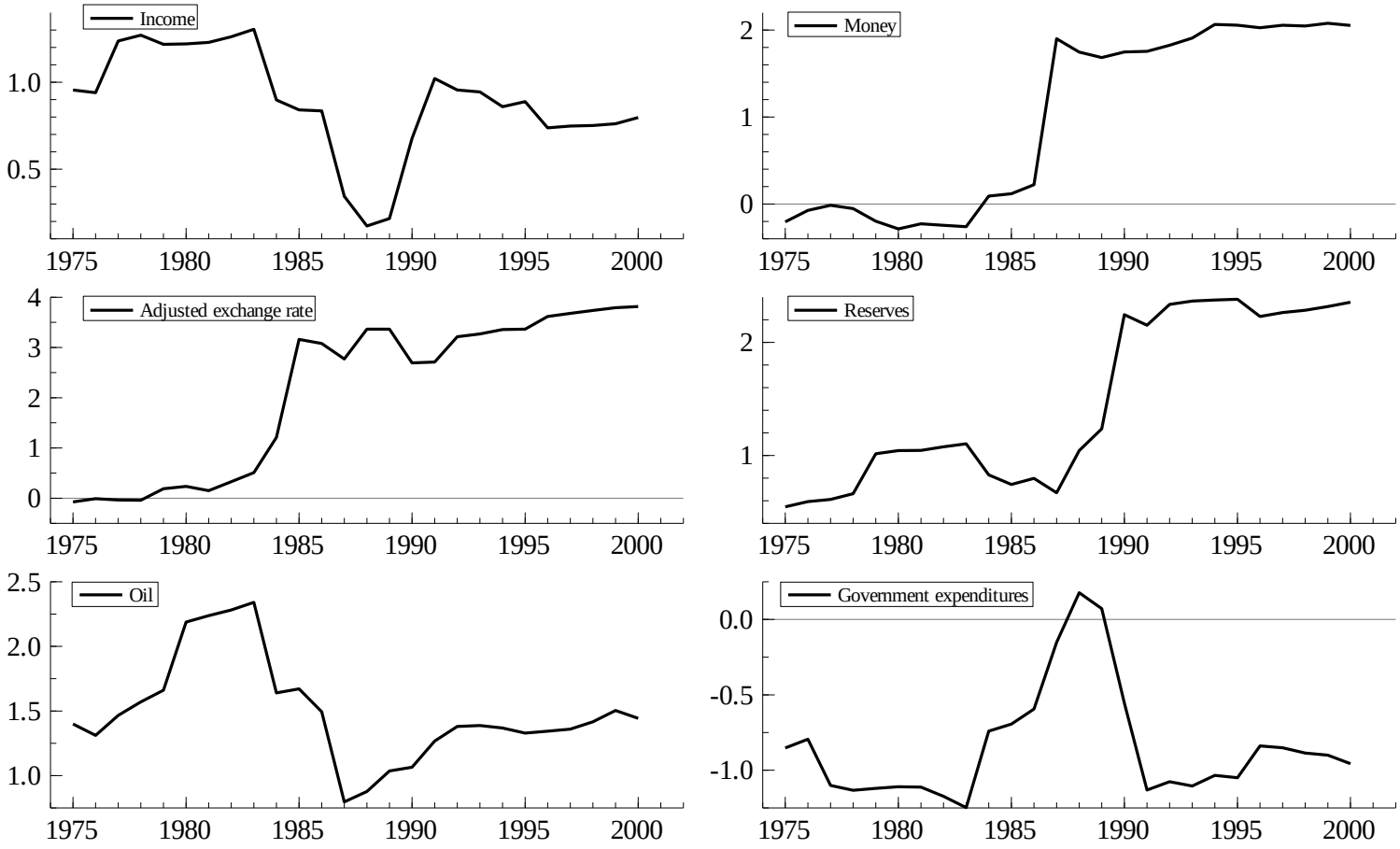

Table 1
Probability values of the F statistics and Hansen instability tests for information variables in real income OLS autoregressions, 1952-2000

Variable	Equation number									
	1		2		3		4		5	
	F	Hansen	F	Hansen	F	Hansen	F	Hansen	F	Hansen
$\Delta(y/p)_{t-1}$	0.032*	Y	0.050	Y	0.039*	Y	0.041*	Y	0.165	Y
Δm_{t-1}	0.224	Y	0.173	Y	0.170	Y	0.175	Y	0.190	Y
Δp_{t-1}	0.597	N	0.407	N	0.391	N	0.404	N	0.501	N
$\left(\Delta e + R^*\right)_{t-1}$	-	-	0.031*	Y	0.022*	Y	0.024*	Y	0.044*	Y
ΔNFR_{t-1}	-	-	-	-	0.240	Y	0.255	Y	0.272	Y
Δoil_{t-1}	-	-	-	-	-	-	0.946	Y	0.933	Y
Δg_{t-1}	-	-	-	-	-	-	-	-	0.818	Y

Notes on Table 1: all variables are expressed as the change in the *log* of the corresponding level. The exceptions are R^* which is expressed in %, and NFR that is expressed as the percent change in the *level* of the original variable. To save degrees of freedom, all the autoregressions consider one lag of the information variables. Details on the data definitions and sources can be obtained in the appendix. Significance of an F test indicates that a variable has information content on *real* income. ** and * denote significance of an F test at the 1 and 5 percent levels, respectively. Probability values are displayed. Hansen's (1992)-instability test indicates if a parameter is stable (Y) or not (N). Note that for equation (5) the sample runs from 1957 to 2000.

Table 2
Probability values of the F statistics and Hansen instability tests for information variables in prices OLS autoregressions, 1952-2000

Variable	Equation number									
	1		2		3		4		5	
	F	Hansen	F	Hansen	F	Hansen	F	Hansen	F	**Hansen**
Δp_{t-1}	0.013*	Y	0.815	Y	0.846	Y	0.710	Y	0.816	Y
Δm_{t-1}	0.165	Y	0.138	Y	0.118	Y	0.086 †	Y	0.047*	Y
$\Delta(y/p)_{t-1}$	0.287	Y	0.489	Y	0.627	Y	0.723	Y	0.431	Y
$\left(\Delta e + R^*\right)_{t-1}$	-	-	0.000**	Y	0.000**	Y	0.000**	Y	0.013*	Y
ΔNFR_{t-1}	-	-	-	-	0.019*	Y	0.033*	Y	0.024*	Y
Δoil_{t-1}	-	-	-	-	-	-	0.152	Y	0.158	Y
Δg_{t-1}	-	-	-	-	-	-	-	-	0.345	Y

Notes on Table 2: all variables are expressed as the change in the *log* of the corresponding level. The exceptions are R^* which is expressed in %, and NFR that is expressed as the percent change in the *level* of the original variable. To save degrees of freedom, all the autoregressions consider one lag of the information variables. Details on the data definitions and sources can be obtained in the appendix. Significance of an F test indicates that a variable has information content on *prices*. **, * and † denote significance of an F test at the 1, 5, and 10 percent levels, respectively. Probability values are displayed. Hansen's (1992)-instability test indicates if a parameter is constant (Y) or not (N). Note that for equation (5) the sample runs from 1957 to 2000.

Table A1
Data appendix

Variables	Sources
Money, M2	CBDR. Millions of Dominican Republic Pesos (DR$).
Nominal output	IMF IFS printed edition: *line 99b*.
GDP deflator	IMF IFS printed edition: *line 99bip*.
Exchange rate, nominal market rate	CBDR. DR$/US$.
Interest rate, US Treasury Bill rate	IMF IFS CD-ROM. % Series code: 11160C..ZF…
Net foreign assets	IMF IFS CD-ROM. Millions of Dominican Republic Pesos (DR$). Series code: 24331N..ZF…
Oil, UK Brent spot price	IMF IFS CD-ROM. US$/per barrel. Series code: 11276AAZZF…
Government expenditures	IMF IFS CD-ROM. Millions of Dominican Republic Pesos (DR$). Series code: 24382…ZF..

Notes. - *CBDR*: Central Bank of the Dominican Republic. *IMF IFS*: International Monetary Fund International Financial Statistics.