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The rigidity of energy retail prices in Curaçao

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The views expressed in this paper are those of the author and do not necessarily represent those of the Bank van de Nederlandse Antillen.

Abstract

This paper analyzes the frequency of retail price changes and the duration of price spells in the energy components of the consumer price index in Curaçao in the period 1999-2009. The tariffs on energy components are regulated by the government. The results reported in this study underscore the system of regulation of energy prices in Curaçao; price changes have low frequencies. The price setting of motor fuels is based on attractive pricing, as prices of these energy components are frequently rounded to 0 or 5.

JEL Classification: E31, D49, C41.

Keywords: Price rigidity, duration analysis, frequency of price changes.

1. Introduction

This research focuses on the pass-through mechanisms of energy retail prices in Curaçao on the demand for energy during the period 1999 to 2009. This study also analyzes the frequency, magnitude, and duration of price changes in the energy component of the CPI. The main questions addressed in this paper are: What factors determine the domestic energy prices and the frequency of price change? Does the price setting exhibit time- or state-dependent behavior? Are the domestic energy prices stickier than those in other countries?

This study is based on the framework of the Euro system's Inflation Persistence Network (IPN). The framework has been described in working papers coordinated by the European Central Bank (ECB 2004, ECB 2005). The research on inflation persistence for the Caribbean region was initiated in 2008 by the Caribbean Centre for Money and Finance and was coordinated by Prof. Roland Craigwell of the University of the West Indies. The Bank van de Nederlandse Antillen contributed to the project with this paper, which is the first empirical study on this topic using micro data for Curaçao. The study uses monthly data from 1999 to September 2009 and is organized as follows. Section 2 presents a general overview of the energy components and their share in the CPI. Section 3 gives the theoretical background. The empirical results are presented in section 4. Section 5 provides the study's conclusions.

2. Energy retail prices

This section analyzes the price setting of energy retail prices and the impact of these prices in a small non-oil-producing economy. The impact of any oil price shock has a short-term, but serious impact on a macroeconomic level. In the long-run, oil price shocks dissipate. Despite the oil price shocks of recent decades, Curaçao has had low inflation of approximately 2%. The low inflation is the result of the peg to the U.S. dollar. According to the PPP theory, the inflation in Curaçao is equal to the U.S. inflation rate in the long run. A study by Carolina (2006) did not reject the PPP theory.

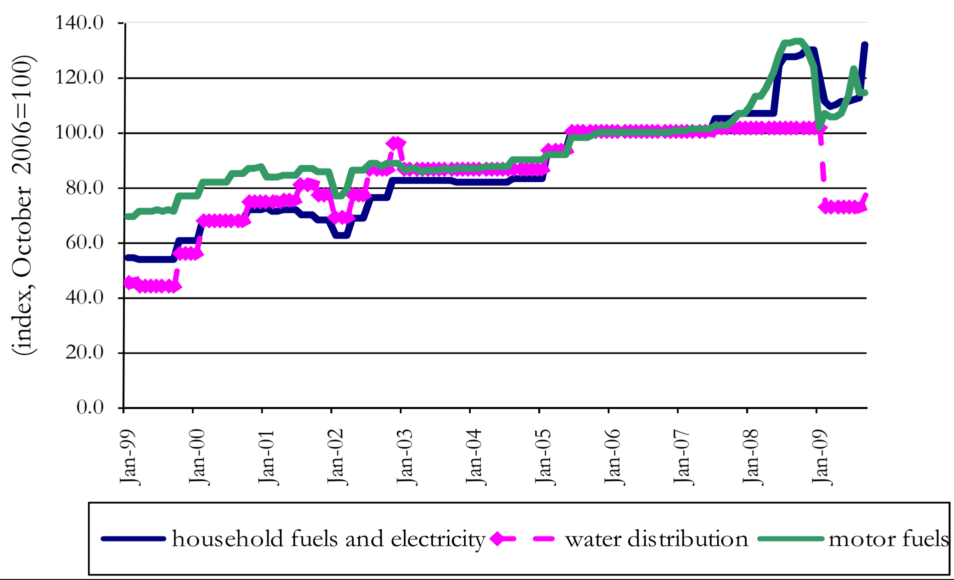
Factors that may influence domestic price setting of energy components are the world crude oil price, indirect taxes, and wages. These factors are explained in more detail below.

- *Price setting policy*

In Curaçao, the government regulates the setting of energy prices (prices of energy-related products and services), selected food products, healthcare services, public transportation services, drugs, and some other selected items. Energy prices include the prices of oil derivatives products, water, and electricity. The price setting behavior of the regulator is time-dependent. Prices of oil derivates on the international oil markets determine (with a lag) the price setting of the domestic energy prices. The procedure is as follows. The government-owned companies, which distribute the energy products, regularly submit to the government a proposal for price changes. The government approves or rejects the proposal. In the period under review, the data reveal the regulators' (the government) resistance to increase energy retail prices: an upward price rigidity policy.

The distribution of motor fuels and household fuels in Curacao is carried out by one company, the government-owned Curoil. In the period 1990 till mid-2005, the prices of motor fuels (gasoline and gas oil) were regulated by law to be set quarterly. During the period of the oil price hike -- mid 2005 to May 2008 – domestic motor fuel prices were held constant. From May 2008 to date, the government proposed that motor fuel prices be changed monthly. The production and distribution of water and electricity in Curacao is coordinated by one government-owned company, Aqualectra. Since November 2007, the law regarding the price setting policy for water and electricity has been amended; from quarterly to every two months. In the period under review (1999-2009), however, the price setting of water, household fuels (propane gas cylinder and kerosene), and electricity occurred less frequently than the lawfully regulated monthly price setting. Figure 1 shows the price trajectories of selected energy components in the period under review.

Figure 1: Partial CPI of household fuels, utilities and motor fuels



Source: Central Bureau of Statistics

Another remarkable characteristic of the domestic price setting of energy components is attractive pricing. Attractive pricing in the price setting occurs when prices are rounded down/up so the last digit is 0, 5, or 9. An analysis in the United States and the Euro area shows that the use of attractive pricing affects the frequency of price adjustments. Attractive pricing can result in sticky prices, as any change in price can result in a 'non-attractive' price, i.e., a price not so appealing to the consumer.

In Curaçao, motor fuels price setting meets the criteria of attractive pricing. In the period under review, motor fuel prices were rounded down/up to 0 or 5. In the case of Curaçao, the attractive price setting behavior of the regulator was for the convenience of the consumer; consumers do not need to look for pennies (1, 2, 3, or 4 cents) at the gas station.

- *Data on energy prices*

Monthly data from 1999 to September 2009 were used in the analysis. The data on motor fuel prices are available on the Curoil website (www.curoil.com). Curoil distributes oil products and oil derivatives. The data on utility prices are available on the Central Bureau of Statistics (CBS) website (www.cbs.an). The monthly price of water is based on usage of 9.3 m^3 and the price of electricity is based on usage of 357 KWH. The dataset consists of retail energy prices. A price change is defined as an observed price change or a forced product replacement[1].

- *Weights of the energy components in the CPI*

The classification system (Table 1, appendix) used by the CBS of the Netherlands Antilles resembles the international classification systems. The base year of the CPI weights is 2004 - 2005. The energy components represent approximately 13% of the CPI with electricity accounting for almost half (Table 2, Appendix).

- *The impact of indirect taxes on energy retail prices*

The government levies excises and sales/turnover tax on energy components. The sales tax of 6% was replaced by a 2% turnover tax (NAOB) in March-May 1999. This tax was raised to 5% in October 1999 and has not been amended since.

- *The impact of wages on energy retail prices*

In Curaçao, data on contract wages are not collected. Therefore, the impact of changes in wages on the pricing of the energy components and vice versa cannot be measured. According to economic theory, an indication of inflation persistence may be related to a price-wage adjustment process. In Curaçao, the price setting for energy components is based on the price of international oil products, a profit margin and indirect taxes. The profit margin is the only component that could have been raised as a result of a price-wage spiral. In the period under review, this component remained constant, hence not supporting the assumption of a wage-price adjustment in the price setting of energy components in Curaçao.

[1] An example of a forced product replacement is the motor fuel " Mogas92." The sale of this fuel was discontinued in 2009.

3. Theory

The main indicators for price adjustment are the frequency of price changes, the frequencies of price increases and price decreases, the average sizes of price increases and decreases, the average duration of price spells, and the degree of synchronization of price changes. The computation of these indicators is presented in the Appendix (Empirical methods: Definitions and modeling). Fisher and Konieczny (2000) proposed a measure to assess the degree of synchronization of price changes. Price synchronization is an index (or ratio) that takes the value 1 (or 100%) in the case of perfect synchronization of price changes, and takes the value 0 in the case of perfectly staggered price changes across price setters.

Because oil price shocks affect a non-oil-producing economy like Curaçao, measuring the inflation persistence is useful. Moreover, not only can external shocks trigger inflation persistence, but domestic wage-price adjustment also can lead to inflation persistence. Inflation persistence or the relationship between monthly price changes is measured by the following equation:

$$\psi_{j\,t} = \rho * \psi_{j\,t-1} + \varepsilon_{jt} \qquad \text{(eq. 1)}$$

Where

$\psi_{j\,t}$: Month-to-month change in price of category j at time t

A small ρ means a low degree of inflation persistence. Another test to determine inflation persistence is the unit root test. Rejection of a unit root of inflation is equivalent to a low degree of inflation persistence. The tests on persistence are the OLS estimates or the unit root tests on inflation.

The pass-through of inflation will have a lag of more than 1 month (equation 1) due to the (quarterly) regulation of energy prices. In Curaçao, the lag of 1 month has to be adjusted according to the period of the duration spells, as prices have not changed during the duration spells. In general, Curaçao has low inflation levels. Hence, inflation persistence is highly unlikely.

To determine the factors affecting the prices of the energy components and to model the demand equations, a time series analysis is applied. The regressions of the energy retail prices and the energy components' demand equations have the ARDL (autoregressive distributed lag) / ARMAX (autoregressive moving average) form:

$$y_t = \mu + \gamma_1 * y_{t-1} + \gamma_2 * y_{t-2} + \cdots + \gamma_p * y_{t-p} + \ldots + \beta_1 * x_{t-1} + \beta_2 * x_{t-2} + \cdots + \beta_r * x_{t-r} + \theta_1 * \varepsilon_{t-1} + \theta_2 * \varepsilon_{t-2} + \cdots + \theta_q * \varepsilon_{t-q} \qquad \text{(eq. 2)}$$

Where

y_t: dependent variable at time t

x_t: explanatory variable at time t

Equation 2 is an ARMAX (*p, r*) autoregressive moving average model with *p* indicating the lags of the polynomials in the lag operators of the dependent variable and *r* the lag of the polynomials of the explanatory variables[2] (Greene 2000). The ARMAX model is a non-linear model and is estimated by non-linear least-squares estimation. The model with q=0 is an ARDL(*p, r*) model with OLS as an efficient estimator. The empirical results are presented in sections 4.4 and 4.5.

Frequencies are fractions. The fraction $F_{i\,t}$ is restricted to the interval [0,1]. For a fraction-dependent variable, fractional logit models are applicable, as linear models are not appropriate. Given the explanatory variable *x*, the most appropriate model for a fraction *y* ($y = F_{it}$) is the logistic function (eq. 3):

$$E(y|\,x) = exp\,(x\beta)/[1 + exp(x\beta)] \qquad \text{(eq. 3)}$$

[2] In the ARDL model, q=0.

β is estimated by using the quasi-log likelihood estimator (QMLE), where the quasi-likelihood function is the binary choice log likelihood (Woolridge 2002). The partial effects are $\frac{E(y|x)}{x_j} = \beta_j\, g(x\beta)$. Where $g(z) = \exp(z)\,/(1 + \exp\,(z)^2$. For γ_j being the OLS estimates of the linear regression of *y* on *x*, E(y|x), then $\gamma_j \approx \hat{\beta}_j g(\bar{x}\beta)$. The empirical results are presented in section 4.6.

4. Results

4.1. Frequency and duration analysis

In Table 3 (Appendix), the frequencies of price changes of the energy components in the consumer price index and the duration of price spells are presented. In the energy sector, price increases occurred more frequently than price reductions with the exception of the gasoline Mogas 92 and the gas cylinder of 100 lbs. For Mogas 92, the frequency of price increases was 12% compared to a frequency of 18% for price decreases. The frequencies of prices increases of gas cylinders were similar to the declines.

The combination of "motor fuels" (used for transportation, see Table 3, Appendix, category 72) showed price changes in 30.5% of the observations. This rate is similar to the lapse of 2.7 months between price changes of fuels. The result coincides with the government pricing policy in the period 1990 – 2005, which was based on quarterly price adjustments. Although the frequencies of price increases for both types of gasoline (Mogas 92 and Mogas 95) differ from the frequencies of price decreases, the magnitudes of increases were relatively similar to those of price decreases. In this group of products, gas oil had a higher magnitude of price changes, namely, a 23% price increase and a 16% price decrease.

The prices of the group of "fuels and utility" (category 42) were proposed to change every quarter (gas) and every 2 months (electricity), however, the frequency of price changes in this group was 19.9%, equivalent to a price change every 4.5 months. The sub-item "electricity" had the longest price duration, with a change in prices every 6.2 months. In this group, the magnitude of price increases was higher than that of the decreases.

According to the price setting policy of the government, the price of “water” (category 45) was proposed to adjust every two months. However, the duration spell for prices in this category was 6.6 months, coinciding with a low frequency of the price change of 14.1% for “water.” The magnitude of price decrease (12.0%) of “water” was higher than the magnitude of price increase (9.0%). Tables 4 and 5 compare the frequencies of price changes and duration spells for motor fuel prices in Curaçao and in two of our main trading partners, i.e., the United States and the Netherlands.

Table 4: Comparison of frequency of price changes (in %)

	U.S.	Netherlands	Curaçao
Motor fuels	**74.1 (**)**	**94.1 (*)**	**30.5**

Notes: (*) Fuel type 1 (gasoline) and Fuel type 2 (gas oil) have approximately similar results.

(**) Premium unleaded gasoline, mid-grade unleaded gasoline, and regular unleaded gasoline have frequencies of, respectively, 72.2%, 77.5%, and 78.9%.

Source: Working paper series no 413, ECB and Bils, A and P. Klenow (2004).

The comparison shows that Curaçao has a lower frequency of price changes in motor fuels than the United States and the Netherlands, the result of the regulation of energy prices in Curaçao. In line with the high frequencies of price changes in the United States and the Netherlands, duration spells of motor fuel prices in these countries are short (Table 5): US motor fuels have bi-monthly price changes, and in the Netherlands price changes occur every week. The duration spell for the price of the energy component “water” is longer in the United States (12.1 months) than in Curaçao (6.6 months), while the duration spell for the price of “electricity” is shorter in the United States (1.8 months) compared to Curaçao (6.2 months).

Table 5: Comparison of average and median price spell duration (in months)

	U.S.		Netherlands		Curaçao	
	average	median	average	median	average	median
Motor fuels	**0.7**	**0.48**	**0.353**	**0.245**	**2.7**	**1.9**
Water	**12.1 (*)**	**8.4**	**-**	**-**	**6.6**	**4.5**
Electricity	**1.8**	**1.2**	**-**	**-**	**6.2**	**4.3**
Housing, water, electricity and other fuels	**-**	**-**	**4.96**	**3.3**	**-**	**-**

Notes: (*)Residential water and sewer service

The median duration is calculated by using the formula: ln (0.5)/(ln(1-Fj)

Source: Working paper series no 413, ECB, Bils, M. and P. Klenow (2004)

4.2. Price rigidity in the energy components in Curaçao

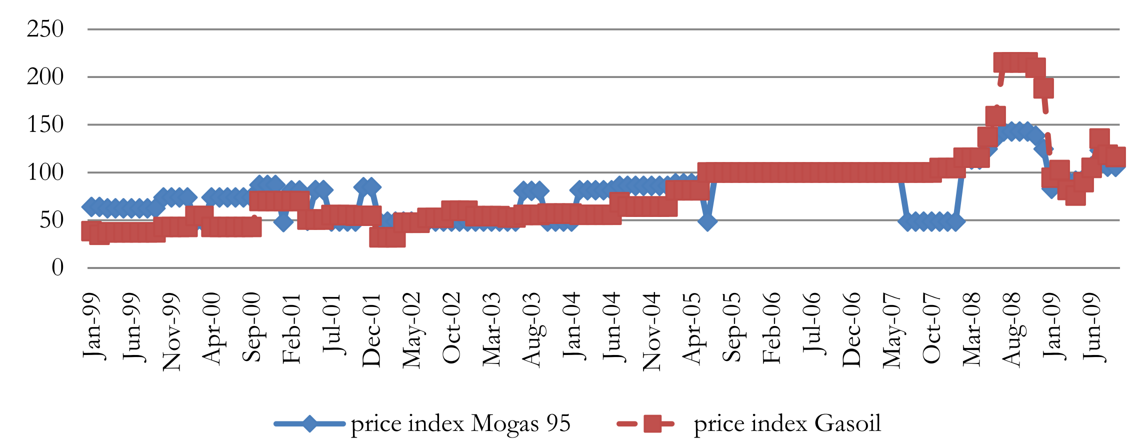
In Curaçao, the energy prices are sticky, supported by the low frequency of price changes. The low frequency is mainly the result of the government's price setting policy. In addition, the energy components "water" and "electricity" have not been changed as frequently as the lawfully regulated price setting, resulting in lower-than-expected frequencies. Deviation from the lawfully regulated price setting is based on government resistance to change energy prices. This resistance can be classified as either a sticky downward (resistance to lower prices) or a sticky upward approach (resistance to increase the prices).

To gain insight into the rigidity of motor fuel prices, the average price of motor fuels and data on the West Texas Intermediate crude oil prices are useful. As already noted, our domestic energy prices are adjusted periodically based on international price setting. A comparison between the actual government intervention (Table 6, column 4, Appendix) and the expected government interventions (Table 6, column 5, Appendix) reveals that the government price policy on gasoline was rigid upwards. A government that is expected to raise prices but abstains from taking action can be classified as having a sticky upward approach. In general, as shown in Table 6, column 6 (Appendix), Curaçao's government has used the sticky upward approach more frequently than the sticky downward approach with respect to energy prices. For further analysis on this topic, see section 4.6.

4.3. Price synchronization and inflation persistence

Price synchronization measures the process of simultaneous prices changes. When prices of goods of the same category change at the same time, the ratio is 100%. The quarterly regulated prices of the energy components are expected to have a synchronization ratio per group of close to 100%. The results (Table 3, Appendix) show synchronization ratios of 89.2% for the category "fuels and utility" and 93.6% for the group "motor fuels." Figure 2 shows the synchronization in prices for "motor fuels".

Figure 2: Price indexes of motor fuels



Inflation persistence (see eq. 1, section 3) is the process of a price change in the previous month affecting the price change in current month. As the duration spells indicate the number of months in which the prices remain constant, the lag in each energy component is adjusted to the duration spell (average or median). The regressions in Table 7 show small ρ-coefficients. This means an absence of inflation persistence in the energy components of the CPI for Curaçao.

Table 7: Inflation persistence by energy category

Variables in logs	lags	ρ	t-statistics
ψ of fuels and utility:			
. electricity	4	0.25	2.69 (**)
. household gas (LPG 100)	3	0.16	1.74 (*)
ψ of water	4	0.22	2.49 (**)
ψ of Motor fuels:	3		
. Mogas 95	3	0.10	1.07
. Gas oil	3	-0.08	-0.92

Note: (**) significant at 5%, (*) significant at 10%

The lack of inflation persistence also can be determined by testing for unit roots on inflation (see section 3). The unit root tests on inflation of the energy components (Table 8, third column) are rejected, which means a low degree of inflation persistence. Data in Table 8 shows that energy prices excluding motor fuel Mogas 95 are I (1). The null hypotheses of unit root cannot be rejected in most of the energy variables. The motor fuel Mogas 95 is I(0). The null hypotheses of the first differences having unit roots were all rejected.

Table 8: Unit roots tests

	ADF-test level	ADF-test difference
CPI Curaçao	4	-9.1
Price index of electricity	-3.1	-9.6
Price index of water	0.3	-11.2
Price index of motor fuels:	1.52	-7.1
. Mogas 95	-3.3	-12.9
. Gas oil	-1.33	-8.7
Price index WTI	-0.55	-6.7

Notes: 1% : ADF-test :-2.58 (none exogenous), -3.48 (constant exogenous), -4.03 (constant linear trend)
5% : ADF-test :-1.94 (none exogenous), -2.88 (constant exogenous), -3.44 (constant linear trend)
10% ADF-test :- 1.62 (none exogenous),-2.58 (constant exogenous), -3.18 (constant linear trend))

4.4. Price equations of the energy components

The impact of the energy components on the CPI can be measured by direct effect (using weights). The weights of motor fuels (Table 9) in the consumer price index in the

Netherlands and the United States are comparable to Curaçao's. The weights of "water distribution" and "electricity" in the CPI are higher in Curaçao than in the United States and the Netherlands because these countries use alternative sources of energy besides oil. The higher weight of Curaçao in the CPI indicates that energy components have a higher impact on our inflation compared to the impact of energy prices on the inflation of our main trading partners, the United States and the Netherlands.

Table 9: Comparison of weights in the consumer price index (in %)

Motor fuels:	U.S.	Netherlands	Curaçao
. Gasoline	3.2	3.1	3.4
. Gas oil (*)	0.2	0.4	0.2
Housing (**)	37.3	24.4	30.8
Water distribution (***)	0.7	1.3	3.4
Fuels and utilities: (****)	5	5.3	5.9
. Electricity . Other household fuels	2.7 0.09		5.3 0.2

Source: CBS Nederland (statline, persbericht pb09-2009), CBS Nederlandse Antillen, Bureau of Labor Statistics
Notes: (*) U.S.: other motor fuels (excluding gasoline)
(**) Excluding furnishing, appliances
(***)U.S.: Water and sewerage maintenance
(****) Netherlands, Curacao: household fuels

What are the determinants of the domestic prices of energy products? The energy prices are modeled by equation 2, ARMAX/ARDL models (section 3). The price index of electricity (price electricity) is modeled by ARDL (1,4) (Table 10). The WTI[3] crude price index (WTI index) has a lag effect of 4 months on the price index of electricity. In the long run, a 1% increase in the WTI price leads to a 0.86% increase in the price of electricity. Growth in the money supply (M1), which probably reflects an increase in production, influences positively the price of electricity.

The price index of water (price of water) is modeled by ARDL(1,3). The WTI crude price index (WTI-index) has a lag effect of 3 months on the price index of water. In the long run, a 1% increase in the WTI price leads to a 2% increase in the price of water. This

[3] Aqualectra uses oil and gas derivatives for the production of electricity and water. The WTI index correlates with gas derivatives (EIA (2006). Furthermore, oil derivates are correlated with the crude oil benchmark WTI because crude oil is the raw material for oil derivates.

accumulated increase in price is the result of the recovery index (recovery of Aqualectra's past losses due to noncompliance by the government to consent to the lawfully regulated change in price) and withdrawal of the government subsidy on water.

The price index of Mogas 95 (Mogas 95) is modeled by ARDL(1,3) and the gas oil price index by ARDL(1, 2). The WTI crude price index (WTI index) has a lag effect of 2 to 3 months on the price indexes of motor fuels. In the long run, a 1% increase in the WTI price leads to increases of 1.12% and 1.58%, respectively, in the prices of Mogas 95 and gas oil.

Table 10: Regressions on price indexes

	Log(price electricity)	Log(price water)	Log(price Mogas 95)	Log (price gas oil)
No. of observations	124	125	125	126
Log(WTI-index (-2)				0.57(***)
Log(WTI-index (-3))		0.15(***)	0.38 (***)	
Log(WTI-index (-4))	0.16 (***)			
Log(M1)	0.48(***)			0.44(***)
Log(price of water (-1))		0.93 (***)		
Log(price electricity (-1))	0.78 (***)			
Log(price Mogas 95 (-1))			0.66 (***)	
Log (price gas oil (-1))				0.65(***)
Constant	0.48	3.8 (***)	2.71 (***)	-1.52(*)
R-squared	0.98	0.95	0.66	0.94
AIC	-3.9	-3.31	-0.39	-1.58
SC	-3.8	-3.24	0.32	-1.49
Breusch-Godfrey	0.05	4.3	2.03	0.13
Long-run price effect	0.86	2	1.12	1.58

Notes: (***), (**), (*) indicate significance at 1%, 5%, and 10%, respectively

The Breusch-Godfrey test 5% critical chi-squared value with 2 degrees of freedom is 5.99.

4.5. The demand equations of the energy components

The demand for each energy component is determined by its price index, the number of households, and the total production. In the demand equations, population (pop) was used as a proxy for the number of households. The dependent variable is the demand for the energy component per person, e.g., demand for water usage per person.

Higher production in the economy will raise the demand for water and electricity. As a proxy for production, total sales in constant prices were used (sales06). Monthly data for the period 2005 - 2009 were used since sales data are available from 2005. The demand equations (ARDL models) were estimated using OLS. For detailed information on the variables, see Appendix, Table 13.

The long-term price elasticities of electricity, water, and motor fuels (Mogas 95 and gas oil) are, respectively, -0.69, -1.47, and -0.05, indicating inelastic price elasticities for the items electricity and motor fuels. Consumers adjust slowly to a price change in electricity; it takes 7 months for them to adjust their demand for electricity. Consumers adapt their water consumption one month subsequent to its price change. A change in the consumption pattern for motor fuel Mogas 95 will occur immediately following a change in the price. Gas oil users reduce their consumption 2 months after the price increase.

The demand for electricity per person is determined by the proxy of production i.e., the sales in constant prices (sales06), with a lag of 8 months. Construction activities (bouwtotaal) also positively influence the demand. Higher temperature (temp) increases the demand significantly; a 1% increase in temperature results in a rise in demand by 1.15%. A rise in the price of electricity will result in a drop in demand. The number of stay-over tourists is not significant in this equation.

The demand for water per person also is determined by the proxy of production i.e., the total sales in constant prices (sales06), with a lag of 8 months. An increase in the density of cars (carsper1000) raises the demand for water consumption. Higher temperature (temp) increases the demand; an increase of 1% in temperature results in a 0.67% rise in demand. More rainfall results in less demand for water (with a lag of 1 month). In contrast, a rise in the price of water will result in a drop in demand. Current price increases lower the demand for water significantly; a 1% inflation results in a 6.5% decline in water consumption.

The demand for gasoline (Mogas 95) per person is determined by the density of cars (carsper1000). The density of cars raises the demand for gasoline after 8 months. A rise in the price of Mogas 95 will result in a drop in demand. The policy change of eliminating the motor fuel, Mogas 92, in the second half of 2009 resulted in an increase in the demand for the only available gasoline motor fuel: Mogas 95. A dummy (dummo95) is included for this product replacement. The variables sales06 (the proxy of production) and the number of stay-over tourists are not significant. The regression (not shown) found that a price increase in other motor fuel substitutes (gas oil) did not influence the demand for Mogas 95 gasoline.

The demand for gas oil is determined by production, its price, and the density of cars. A seasonal variable (dumchristmas) as an indicator of the fourth quarter increase in activities (e.g., increase in car rentals) showed a significant and positive relationship.

Table 11: Demand equations

	Log(electricity/pop)	Log(water/pop)	Log(Mogas95/pop)	Log(gas oil/pop)
No. of observations	39	39	51	52
Log(price electricity (-7))	-0.97 (***)			
Log(price water(-1))		-2.24 (**)		
Log(price Mogas 95)			-0.06 (***)	
Log(price gas oil (-2))				-0.06(**)
Log(CPI)		-6.54 (***)		
Log(sales06 (-4)			0.12	0.2(**)
Log(sales06 (-8)	0.24(***)	0.18(**)		
Stay-over/10,000	0.002		0.01	
Log(bouwtotaal)	0.04 (***)			
Log(cars per 1000)		6.72 (***)		
Log(cars per 1000(-8))			0.59(**)	
Log(cars per 1000 (-9))				
				0.41(**)
Log(temp)	1.15(***)	0.67(***)		
Rain(-1)		-0.0001(**)		
Dummo095			0.35(***)	0.05
Dumchristmas				0.04(**)
Log(M1)		0.38 (**)		
Log(electricity/pop (-1))	-0.38 (**)			
Log(water/pop(-1))		-0.52(**)		
Log(Mogas95/pop (-1))			-0.15	
Log(gas oil/pop(-1))				-0.25(*)

Table 11: Demand equations (cont'd)

	Log(electricity/pop)	Log(water/pop))	Log(Mogas95/pop)	Log(gasoil/pop)
Constant	-7.92 (***)	-14.39 (*)	-0.27	-0.32
R-squared	0.70	0.64	0.69	0.43
Breusch-Godfrey test	1.92	4.4	4.85	2.9
Long run price elasticity	-0.69	-1.47	-0.052	-0.05

Notes: (***), (**), (*) indicate significance at 1%, 5%, and 10%, respectively.
The Breusch-Godfrey test 5% critical chi-squared value with 2 degrees of freedom is 5.99.

4.6. The frequency equations

The frequencies of energy price changes (see equation 3, section 3) are determined by the world's crude oil price changes, government regulation, the demand for the particular energy component, and overall inflation. World crude oil inflation will lead to a change in domestic energy prices. The results of the frequency equations are presented in Table 12.

The frequency of price changes in electricity is determined by the frequency of past quarterly changes regulated by the government. General inflation, with a lag of 4 months, affects the costs of electricity production and increases the likelihood of a price change. The inflation of crude oil, with a lag of 2 months, lowers the likelihood of price changes in electricity, an indication of upward price stickiness. The demand for more electricity (lagged for 4 months) increases the likelihood of a price change in electricity. The frequency of price changes of water is determined similarly to that of electricity. The frequency of price changes of water also shows an indication of upward price stickiness.

The frequency of price changes of motor fuels is determined by the frequency of past quarterly changes regulated by the government. The inflation of crude oil, with a lag of 3 months, lowers the likelihood of price changes in motor fuels, an indication of upward price stickiness. Higher demand for motor fuels increases the likelihood of price changes in motor fuels.

Table 12: Frequency equations

	F_electricity	F_water	F_motor fuels
No. of observations	104	104	110
F_electricity (-3)	3.7 (***)		
F_electricity (-6)	3.59(***)		
F_water (-3)		3.78 (***)	
F_water (-6)		3.75(***)	
F_motor fuels (-3)			1.8(***)
F_motor fuels (-6)			2.7(***)
Dlog(CPI(-4))	147.7 (**)	158.26(**)	
Dlog(WTI_index (-2))	-7.86 (*)	-14.62(**)	
Dlog(WTI_index (-3))			-5.9 (***)
Log(demand electricity (-4))	16.86 (*)		
Log(demand water (-4))		31.59 (**)	
Log(demand Mogas95 and gas oil (-6))			4.6(*)
Constant	-89.83 (*)	-157.6 (**)	-75.2(**)
Mc Fadden r squared	0.54	0.6	0.4
log likelihood	-18.82	-16.48	-41.2

Notes: (***), (**), (*) indicate significance at 1%, 5%, and 10%, respectively.

5. Conclusion

Frequencies of price changes in the energy components are determined by government regulation, international crude oil inflation, the demand for the energy component, and the domestic inflation. The energy components in the CPI of Curaçao have a low frequency of price change with duration spells varying from 3 to 6 months. The low frequency of price changes is attributed mainly to regulated prices in the energy sector. In general, price rigidity exists in the energy sector with a government policy in favor of upward price rigidity, despite the lawfully regulated energy retail price setting. There is also evidence of attractive price policy for motor fuel prices, as the last digit of these prices are 0 or 5. The demands for electricity, Mogas 95 and gas oil (motor fuels) are inelastic. The demand for the energy component "water" is price elastic.

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APPENDIX

Table 1: The Classification System

1	**FOOD**
11	Cereals and bakery products
12	Meats, poultry and fish
13	Fats and oils
14	Dairy and related products
15	Fruit and vegetables
16	Sugar and sweets
17	Full service meals and snacks
18	Food away from home
19	Other miscellaneous foods
2	**BEVERAGE AND SMOKING PRODUCTS**
21	Beverages
22	Smoking products
3	**APPAREL**
31	Apparel
32	Footwear
4	**HOUSING**
41	Shelter
42	Fuels and utilities
43	House maintenance
44	Gardening and lawn care services
45	Water distribution
5	**HOUSEHOLD FURNISHINGS AND OPERATIONS**
51	Furniture and lightings
52	Coverings and other linens
53	Appliances
54	Household equipment
55	Other housekeeping expenses
56	Domestic services
59	Miscellaneous
6	**MEDICAL CARE**
61	Medical care
7	**TRANSPORTATION AND COMMUNICATION**
71	Private transportation
72	Motor vehicle parts, equipment and fees
73	Public transportation
74	Communication

Table 1: The Classification System (cont'd)

8	**RECREATION**
81	Recreation
82	Recreation services
83	Recreational reading materials
85	Education
86	Hobbies and related goods and services
9	**MISCELLANEOUS ITEMS**
91	Personal care services
92	Insurances
93	Goods and services not elsewhere mentioned

Table 2: Structure and composition of the sample

Code/Category	Code/Group of product	Type of product	Selected product Categories	Regulated/Non-regulated	CPI weight (in %, 2004)
42 Fuels and utility:					
	42110 Gas	Energy	2 Gas cylinders: lgp200, lgp 20	Regulated	0.4
	42120 Electricity	Energy	357 KWH	Regulated	5.3
	42140 Other household fuels	Energy	Kerosene	Regulated	0.2
45 Water distribution:					
	45000 Water	Energy	9.3 m^3	Regulated	3.4
72 Motor vehicle parts, equipment and fees:					
	72120 Gasoline	Energy	2 fuels: Mogas 95, Mogas 92	Regulated	3.4
	72121 Gas oil	Energy		Regulated	0.2

Table 3: Frequency and duration of price changes

Code/Category	Code/Product	Frequency of price changes (in %)	Frequency of price increases (in %)	Frequency of price decreases (in %)	Average price increase (in %)	Average price decrease (in %)	Average duration of price spells	Synchronization ratio by group (in %)
42 Fuels and utility		19.9	11.3	8.6	15.3	13.8	4.5 months	89.2
	42110 Gas:							
	lgp 200=100lbs	20.3	10.2	10.2	16.1	9.2	4.4 months	
	lgp 20 =20lbs	19.5	10.9	8.6	12.0	11.0	4.6 months	
	42120 Electricity(357 KWH)	14.8	9.4	5.5	9.4	3.7	6.2 months	
	42140 Other use of energy	24.8	14.7	10.0	20.0	26.0	3.5 months	
45 Water distribution								
	45000 Water (9.3 m3)	14.1	10.2	3.9	9.0	12.0	6.6 months	
72 Motor vehicle parts, etc: Energy components	Motor fuels:	30.5	18.6	11.9	10.0	11.0	2.7 months	93.6
	72120 Mogas 95	33	20	13	7.0	7.7	2.5 months	
	72120 Mogas 92	28	12	18	7.5	8.7	3 months	
	72121 Gas oil	29.6	17	12.6	23.0	16.0	2.8 months	

Table 6: The rigidity in energy components of the CPI

Quarter	Monthly change internat'l oil prices	Monthly change Curoil prices	Change internat'l price	Expected gov't intervention	Gov't intervention	Rigidity upward	Rigidity downward
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Q1 1999	-0.2	-4.2	-	-	-		
Q2 1999	5.0	0.0	+	-	=		*
Q3 1999	5.1	0.0	+	+	=	*	
Q4 1999	3.8	16.4	+	+	+		
Total	13.7	12.2					
Average 1999	3.4	3.1					
SD 1999	2.5	9.1					
Q1 2000	3.2	8.2	+	+	+		
Q2 2000	0.2	0.0	+	+	=	*	
Q3 2000	3.6	0.0	+	+	=	*	
Q4 2000	-0.2	14.6	-	+	+		
Total	6.7	22.8					
Average 2000	1.7	5.7					
SD 2000	2.0	7.1					
Q1 2001	-4.1	-5.1	-	-	-		
Q2 2001	0.8	-4.4	+	-	-		
Q3 2001	-1.7	8.6	-	+	+		
Q4 2001	-6.8	-3.6	-	-	-		
Total	-11.9	-4.4					
Average 2001	-3.0	-1.1					
SD 2001	3.2	6.5					
Q1 2002	1.8	-15.3	+	-	-		
Q2 2002	4.9	5.8	+	+	+		
Q3 2002	2.0	7.0	+	+	+		
Q4 2002	-0.2	-1.6	-	+	-	*	
Total	8.5	-4.1					
Average 2002	2.1	-1.0					
SD 2002	2.1	10.2					
Q1 2003	5.3	3.1	+	-	+		*
Q2 2003	-5.6	-6.3	-	+	-	*	
Q3 2003	2.2	0.0	+	-	=		*
Q4 2003	1.1	2.0	+	+	+		
Total	3.0	-1.2					
Average 2003	0.8	-0.3					
SD 2003	4.6	4.2					

Quarter	Monthly change internat'l oil prices	Monthly change Curoil prices	Change internat'l price	Expected gov't intervention	Gov't intervention	Rigid ity upwa rd	Rigidity downward
Q1 2004	3.2	0.0	+	+	=	*	
Q2 2004	4.0	0.0	+	+	=	*	
Q3 2004	5.6	8.3	+	+	+		
Q4 2004	2.5	0.0	+	+	=	*	
Total	15.3	8.3					
Average 2004	3.8	2.1					
SD 2004	1.4	4.2					
Q1 2005	3.9	5.1	+	+	+		
Q2 2005	5.3	20.0	+	+	+		
Q3 2005	10.5	0	+	+	=		*
Q4 2005	-3.9	0	-	+	=		*
Total	15.8	25.1					
Average 2005	4.0	6.3					
SD 2005	6.0	9.5					
Q1 2006	5.1	0	+	-	=	*	
Q2 2006	8.4	0	+	+	=	*	
Q3 2006	0.5	0	+	+	=	*	
Q4 2006	-11.1	0	-	+	=	*	
Total	2.8	0.0					
Average 2006	0.7	0.0					
SD 2006	8.5	0					
Q1 2007	-2.1	0.0	-	-	=		*
Q2 2007	10.2	0.0	+	-	=		*
Q3 2007	8.6	3.0	+	+	+		
Q4 2007	16.0	11.5	+	+	+		
Total	32.7	14.5					
Average 2007	8.2	3.6					
SD 2007	7.6	5.4					
Q1 2008	9.0	10.0	+	+	+		
Q2 2008	29.4	18.3	+	+	+		
Q3 2008	-6.5	34.7	-	+	+		
Q4 2008	-68.0	-20.5	-	-	-		
Total	-36.1	42.4					
Average 2008	-9.0	10.6					
SD 2008	41.9	23.1					
J- 2009	0.3	-75	+	-	-		
F- 2009	-3.0	18.7	-	+	+		
M- 2009	10.1	-3.1	+	-	-		
A-2009	2.1	-0.4	+	+	-	*	
M-2009	10.7	3.8	+	+	+		
J- 2009	12.0	23.3	+	+	+		

Quarter	Monthly change internat'l oil prices	Monthly change Curoil prices	Change internat'l price	Expected gov't intervention	Gov't intervention	Rigid ity upwa rd	Rigidity downward
J- 2009	-6.2	30.2	-	+	+		
A-2009	7.9	-15.45	+	-	-		
S-2009	-1.9	-0.2	-	+	-	*	

Curoil prices: Mogas 92 and Mogas 95

International oil prices: WTI oil prices

Note: In Table 6, the actual government intervention and the expected government intervention is shown. The government intervention is "+" when the government increased the domestic gasoline price and " – " to indicate a decrease in price.

Table 13: Definition of variables

Bouwtotaal	Value of finished construction projects	DROV
Carsper1000	Number of cars per 1000 inhabitants	www.cbs.an
Demand electricity	Index electricity production, December 1986=100	Assumption: demand=production
Demand Mogas 95 and gas oil	Total sales Mogas 95 and gas oil in liters at the pump stations	Curoil
Demand water	Index water production, December 1986=100	Assumption: demand=production
Dumchristmas	Dummy for the 4th quarter	
Dummo95	Dummy in year 2009 due to policy change (Mogas 92 not sold anymore)	
Electricity	Index electricity production, December 1986=100	Aqualectra
F_electricity	Frequency of electricity	
F_motor fuels	Frequency of Mogas 95 and gas oil	
F_water	Frequency of water	
Gas oil	Total sales of gas oil in liters at the pump stations	Curoil
M1	M1	www.centralbank.an
Mogas 95	Total sales of Mogas 95 in liters at the pump stations	Curoil
Pop	Total population of Curaçao	www.cbs.an
Price electricity	Price index of electricity, October 2006=100)	CBS
Price gasoil	Price index of gasoil, October 2006=100	www.curoil.an
Price Mogas 95	Price index of Mogas 95 , October 2006=100	www.curoil.an
Price water	Price index of water, October 2006=100	CBS
Rain	Average monthly rainfall in mm	www.cbs.an
Sales06	Sales in constant prices=(sales tax*100/5) /CPI	Department of Finance
Stay-over/10.000	Number of stay-over tourists/10.000	www.cbs.an
Temp	Average monthly temperature in degrees centigrade	www.cbs.an
Water	Index water production, December 1986=100	Aqualectra
WTI-index	West Texas Intermediate (crude oil) index	IFS

Empirical methods: Definitions and modeling

Each product in category j in store i at time t is defined to have a price $P_{ij\,t}$.

The following variables characterize the price setting behavior of the product in category j :

a binary variable for observation of the price at time t-1 and t in store i.

$x_{ijt} = 1$ if P_{ijt} and $P_{ij,\,t-1}$ are observed

$x_{ijt} = 0$ if P_{ijt} exists but not $P_{ij,\,t-1}$

a binary variable indicating a price change in t.

$y_{ijt} = 1$ if $P_{ijt} \neq P_{ij,\,t-1}$

$y_{ijt} = 0$ otherwise

a binary variable indicating a price increase in t.

$y_{1ijt} = 1$ if $P_{ijt} > P_{ij,\,t-1}$

$y_{ijt} = 0$ otherwise

a binary variable indicating a price decrease in t.

$y_{2\,ijt} = 1$ if $P_{ijt} < P_{ij,\,t-1}$

$y_{ijt} = 0$ otherwise

Using these 4 variables, the following 8 indicators are defined:

the frequency of price changes:

$$F_j = \sum_i \sum_t y_{ijt} \;/\; \sum_i \sum_t x_{ijt} \qquad i=1,2,\ldots n_j;\ t=2,3,\ldots,\tau$$

the frequency of price increases:

$$F_j^{+} = \sum_i\sum_t y_{1ijt} / \sum_i \sum_t x_{ijt} \qquad i=1,2,\ldots n_j;\ t=2, 3, \ldots,\tau$$

the frequency of price decreases:

$$F_j^{-} = \sum_i\sum_t y_{2ijt} / \sum_i \sum_t x_{ijt} \qquad i=1,2,\ldots n_j;\ t=2, 3, \ldots,\tau$$

the frequency of price changes at time t for product category j:

$$F_{jt} = \sum_i y_{ijt} / \sum_i x_{ijt} \qquad i=1,2,\ldots n_j$$

average price duration of the product category j:

$$T_j = -1 / \ln(1-F_j)$$

average size of price increases:

$$\Delta_j^{+} = \sum_i\sum_t y_{1ijt} (\ln P_{ijt} - \ln P_{ij,t-1}) / \sum_i \sum_t y_{1ijt} \qquad i=1,2,\ldots n_j;\ t=2, 3, \ldots,\tau$$

average size of price decreases:

$$\Delta_j^{-} = \sum_i\sum_t y_{2ijt} (\ln P_{ij,t-1} - \ln P_{ijt}) / \sum_i \sum_t y_{2ijt}$$

the synchronization ratio, FK_j (Fisher and Konieczny (2000)) :

$$FK_j = \sqrt{[1/(\tau-1) * \sum_t (F_{jt} - F_j)^2 / F_j(1-F_j)]} \qquad t=2, 3, \ldots,\tau$$