Box 1

EXCHANGE-RATE AND INFLATIONARY DISTURBANCES IN COLOMBIA[1]

[1] Hernán Rincón-Castro
and Norberto Rodríguez-Niño*

1.   Introduction

Abrupt and sudden movements in the exchange rate are a cause for concern among monetary authorities, because they can jeopardize compliance with the inflation target as a result of higher import and other prices in the economy, and given their impact on inflation expectations. This concern has been evident since July 2014, when the peso depreciated sharply. That depreciation peaked in February 2016 and coincided with the collapse of oil prices. Between those two dates, the representative market exchange rate (TRM by its acronym in Spanish) increased 81% and the consumer price index (CPI) rose 11%.

It is, therefore, essential to look at how, how much, and in what time frame disturbances in the exchange rate are passed through to prices all along the distribution chain in the economy. In other words, it is important to analyze what is referred to in the literature as "exchange rate pass-through" on prices, and to assess what variables affect the degree of that pass-through. Consequently, given the significance of this issue for Banco de la República, the purpose of this section is to answer these questions through the use of advanced econometric techniques and monthly statistics on the Colombian economy for the 2002-2015 period.

Recent theoretical and empirical literature highlights the fact that the degree of exchange-rate pass-through to prices is less than proportional, because it depends on the market power of importing companies and producers in the domestic market, the degree of price rigid-

ity in the economy, the sign, size, volatility and nature of fluctuations in the exchange rate (temporary versus permanent), and the state of the economy. To control for the latter, we use measures of the output gap, the degree of real exchange-rate misalignment, the degree of economic openness, accelerating inflation, etc. Then, we define two regimes (high and low) for each of them, and estimate the degree of pass-through in each case.

2.   Channels of Exchange-rate Pass-through on Prices

Fluctuations in the peso exchange rate are passed through on prices all along the distribution chain. This occurs through at least three channels: two direct and one indirect (Diagram B1.1). The first channel operates via the direct impact of exchange-rate disturbances on the prices of imported goods (input and capital goods) and, from there, on producer costs and prices, which ultimately affect the CPI.

The second direct channel acts on the prices of imported consumer goods (imported consumer channel), which press directly on the CPI. This channel also manifests itself through an increase in demand for domestic goods that compete with imported ones. This raises their prices and, eventually, will exert upward pressure on CPI inflation.
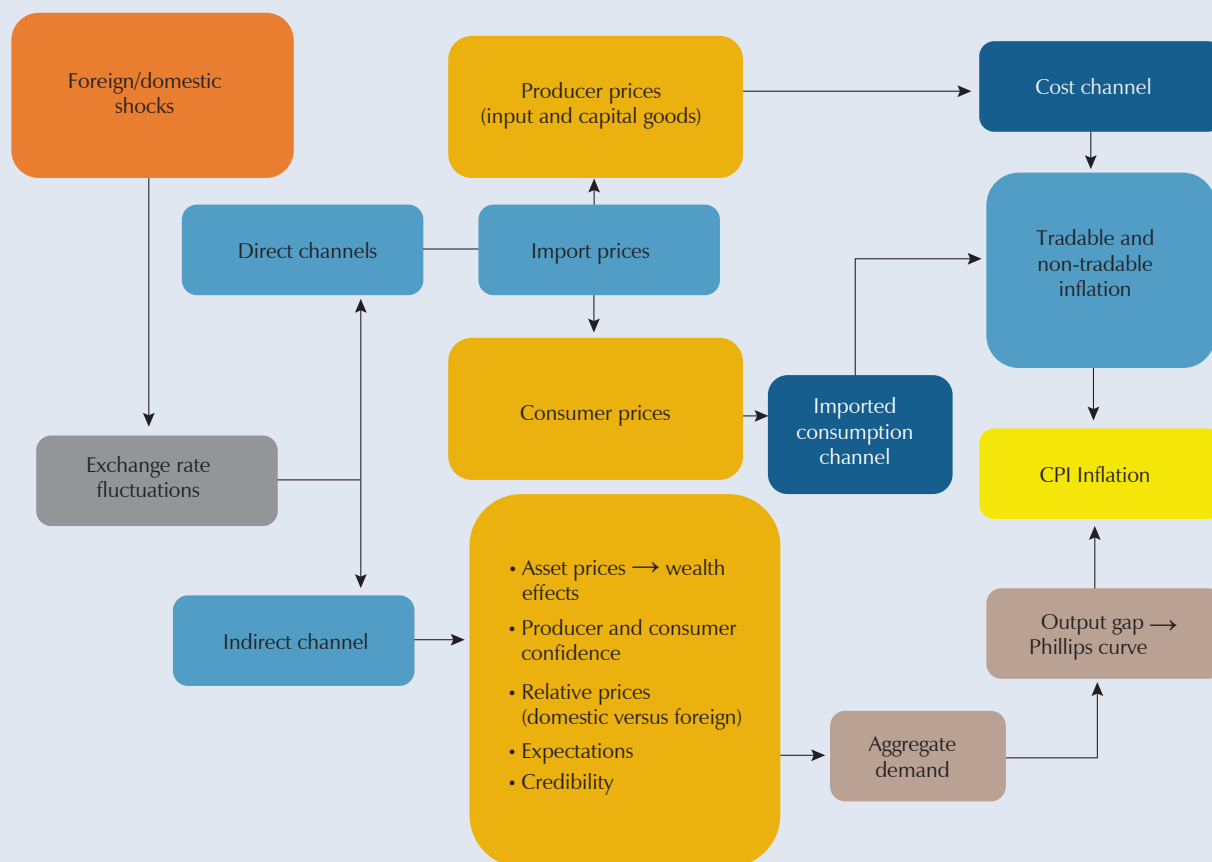
As mentioned, the degree of pass-through by way of these channels will depend on factors such as the market power of importing companies and producers in the domestic market and how fast and expensive it would be for them to change prices, since the higher the cost, the less frequent these changes are.

The indirect channel operates through multiple mechanisms and disturbances that affect aggregate demand and, with it, aggregate supply and the CPI (the Phillips curve mechanism). These mechanisms include asset prices, relative domestic prices versus external ones, business and consumer confidence, and business and consumer expectations in the face of these changes. Obviously, the behavior of these variables and their impact on CPI inflation is subject to the way monetary authorities react in an effort to comply with their inflation target.

Diagram B1.1
Pass-through channels of exchange rate shocks on prices

Source: Rincón-Castro & Rodríguez-Niño (2016).

3. Estimate of Exchange-rate Pass-through on Prices

Charts B1.1 and B1.2, B1.3 and B1.4, B1.5 and B1.6, and B1.7 and B1.8 show the respective estimated degree of accumulated exchange rate pass-through of positive and negative variations (depreciation and appreciation) of 1.0% and 10% on import prices, producer prices, prices of imported consumption goods and the CPI, the time path (columns) and states (regimes) for the different macroeconomic variables (rows). Notice that pass-through is estimated not with respect to movements in the TRM, but by movements in the nominal effective exchange rate for the peso (nominal multilateral exchange rate for the peso, weighed by imports from our major trading partners). Each number in the tables should be read as the accumulated percent response of the i-th price to the disturbance (shock) in the exchange rate, relative to the accumulated percent response of the exchange rate to the disturbance itself up to the period indicated in the columns. Note that, when correcting by the endogenous response of the ex-

change rate to its own variation, the possibility of overestimating the degree of pass-through is avoided.

The first conclusion to be drawn from the results reported in the tables is that the degree of pass-through is not one to one, neither in the short and medium term, nor for all prices, including import prices. For example, the first number in the upper left corner of Table B1.1 shows that import prices in response to a sudden depreciation of the peso by 1.0%, increased by 50% of that depreciation (50 basis points) the first month after the shock. Note that, to facilitate reading the results, all the values reported in the tables are positive, regardless of the sign of the change in the exchange rate. Consequently, when there is a negative fluctuation in the exchange rate; that is, when the peso appreciates, the reported values should be interpreted as negative values.

From the results, we can summarize the estimated historic minimum and maximum degrees for the accumulated exchange rate pass-through on prices at each of

the distribution stages and at each point in time, given the "regimes" of each of the macroeconomic variables (known technically as "transition variables").Thus, the accumulated pass-through on import prices of a 1.0% positive shock in the exchange rate ranges between 48% and 52% in the first month and between 55% and 67% in the first year. The equivalent figures on producer, imported consumer and total consumer prices range from 18% to 27%, 8.0% to 14%, 6.0% to 11% in the first month, respectively, and from 27% to 46%, 19% to 42%, and 13% to 21% in the first year. The degree of minimum and maximum accumulated pass-through to the same prices in the fourth year is 43% and 76%, 20% and 65%, 25% and 68%, and 13% and 40%, respectively. When the magnitude of the disturbance increases to 10%, the results are counterintuitive, since the pass-through degree declines, except for import prices. For example, the estimated pass-through on the CPI now ranges between 2.0% and 3.0%, 5.0% and 13%, and 13% and 33% for the same periods. Finally, it is worth noting that the results clearly show the degree of pass-through takes longer and is lower the further down the distribution chain one goes.

The second conclusion is the dependence (endogeneity) of pass-through on the state of the economy (measured by the different macroeconomic variables). In other words, pass-through is "state-dependent". This link means the degree of pass-through changes with the macroeconomic situation over time.

The third conclusion points to the nonlinear nature of exchange-rate pass-through. For example, if the volatility of the exchange rate is low, 9.0% of the 1.0% depreciation of the peso is passed through on the CPI in the first month and 20% in the first year (see the fifth row in Table B1.7). On the other hand, if volatility of the exchange rate is high, the pass-through increases from 7.0% to 18% in the same period and for a disturbance of the same size.

The fourth conclusion is that pass-through generally responds differently to the sign of the exchange rate shock. In other words, the pass-through is asymmetric. Notice that the degree of asymmetry is quite low though-. This result can be illustrated by reviewing the estimated degree of pass-through on import prices when deviation from the inflation target set by Banco de la República is "high" (the third row in Table B1.1). The results show the degree of pass-through is slightly higher when the peso appreciates, than when it depreciates.

4. Conclusions

The pass-through of sudden exchange-rate shocks on prices is incomplete, endogenous, non-linear and asymmetric. In general, pass-through is greater when inflation increases, when it is high and its volatility is low, when depreciation increases and exchange-rate volatility is low, when the output gap is positive and the interbank interest rate (operating variable of monetary policy) is low.

The estimated degree of historical pass-through of a 1.0% positive exchange-rate shock to import prices, producer prices, imported consumption prices and the CPI ranges between 48% and 52%, 18% and 27%, 8.0% and 14%, and 6.0% and 11% in the first month, respectively, and between 55% and 67%, 27% and 46%, 19% and 42%, and 13% and 21% in the first year. The minimum and maximum degrees of accumulated pass-through to the same prices in the fourth year are between 43% and 76%, 20% and 65%, 25% and 68%, and 13% and 40%, respectively. When the size of the disturbance increases to 10%, the estimated pass-through to the CPI ranges between 2.0% and 3.0%, 5.0% and 13%, and 13% and 33%, for the same periods.

Table B1.1
Estimated Pass-through on Import Prices

Variable	Shock (% points)	Peso Depreciation				Peso Appreciation			
		1 month	6 months	1 year	4 4 years	1 month	6 months	1 year	4 years
		Inflation increase							
Change in inflation	1	50	62	65	68	49	62	65	69
	10	50	62	62	64	50	62	63	65
		Inflation decline							
	1	49	62	65	68	49	62	64	67
	10	50	62	62	65	50	62	62	65
		High inflation volatility							
Inflation volatility	1	49	66	67	71	49	67	69	71
	10	50	67	68	70	50	68	68	70
		Low inflation volatility							
	1	51	59	62	74	49	57	62	76
	10	51	58	60	74	50	57	59	74
		"High" inflation							
Deviation from the inflation target	1	50	62	65	71	50	62	65	71
	10	50	61	63	66	50	62	63	66
		"Low" inflation							
	1	51	62	65	70	50	61	66	70
	10	50	61	63	65	51	62	63	65
		Peso depreciation/appreciation increases							
Variation in the change in the exchange rate	1	49	62	65	72	50	63	66	74
	10	51	63	63	70	51	62	63	69
		Peso depreciation/appreciation decreases							
	1	50	62	64	72	51	62	65	72
	10	51	63	63	68	51	63	63	68
		High exchange-rate volatility							
Exchange-rate volatility	1	50	60	62	64	51	61	63	64
	10	50	62	60	61	50	61	60	62
		Low exchange-rate volatility							
	1	48	60	64	66	50	60	63	64
	10	49	59	61	64	49	60	62	65
		Undervalued Real exchange rate							
Real exchange-rate imbalance	1	48	64	65	72	48	64	64	72
	10	49	65	65	73	49	65	65	72
		Overvalued Real exchange rate							
	1	48	62	62	64	49	62	62	64
	10	48	61	60	60	49	62	60	61

Source: Rincón-Castro & Rodríguez-Niño (2016)

Table B1.2
Estimated Pass-through on Import Prices

Variable	Shock (% points)	Peso Depreciation				Peso Appreciation			
		1 month	6 months	1 año	4 years	1 month	6 months	1 año	4 years
Output gap		Positive							
	1	49	58	55	47	53	60	56	47
	10	51	59	55	43	52	61	56	52
		Negative							
	1	49	57	54	45	50	57	55	45
	10	50	59	55	43	50	59	55	44
Economic openness		High openness							
	1	50	65	66	64	51	66	65	64
	10	51	65	63	62	51	65	63	63
		Low openness							
	1	50	65	67	75	50	65	66	74
	10	51	65	67	76	50	65	66	75
Change in commodity prices		High							
	1	49	62	63	69	50	63	63	70
	10	51	62	61	66	50	62	61	67
		Low							
	1	51	63	64	70	49	63	63	70
	10	50	62	61	67	50	62	61	67
Interbank interest rate		"High"							
	1	49	60	63	56	50	59	63	56
	10	49	61	64	54	50	61	64	54
		"Low"							
	1	50	60	60	66	50	60	59	66
	10	50	59	57	65	50	59	57	64
Trend		Since April 2009							
	1	50	64	65	65	51	65	66	65
	10	51	65	64	64	51	65	64	64
		Prior to April 2009							
	1	51	66	67	74	53	67	67	74
	10	51	65	66	72	52	66	66	72

Source: Rincón-Castro & Rodríguez-Niño (2016)

Table B1.3
Estimated Pass-through on Producer Prices

Variable	Shock (% points)	Peso Depreciation				Peso Appreciation			
		1 month	6 months	1 year	4 years	1 month	6 months	1 year	4 years
		Inflation increases							
Change in inflation	1	22	31	33	43	22	32	33	43
	10	15	23	22	32	15	23	22	31
		Inflation decreases							
	1	20	30	33	43	21	31	33	43
	10	15	23	22	33	16	23	22	32
		High inflation volatility							
Inflation volatility	1	21	29	31	59	18	28	30	56
	10	16	22	21	45	15	22	22	44
		Low inflation volatility							
	1	22	32	36	57	21	32	36	56
	10	16	24	26	50	16	24	26	50
		"High" inflation							
Deviation from the inflation target	1	21	30	33	48	19	29	33	49
	10	14	22	23	37	14	23	24	37
		Inflación "baja"							
	1	21	30	34	48	19	29	32	45
	10	15	22	23	34	15	22	23	35
		Peso depreciation/appreciation increases							
Variation in the change in the exchange rate	1	21	30	33	46	23	32	35	47
	10	16	23	23	34	16	23	23	34
		Peso depreciation/appreciation decreases							
	1	23	33	34	44	23	32	33	45
	10	15	23	23	33	15	23	23	33
		High exchange-rate volatility							
Exchange-rate volatility	1	23	33	35	63	20	28	27	45
	10	18	24	24	40	16	22	22	35
		Low exchange-rate volatility							
	1	23	38	46	58	21	35	43	57
	10	17	29	33	47	17	29	36	48
		Undervalued Real exchange rate							
Real exchange-rate imbalance	1	22	30	28	30	21	29	28	29
	10	15	21	20	24	15	22	20	23
		Overvalued Real exchange rate							
	1	22	30	32	41	23	33	35	42
	10	16	23	23	30	17	24	23	31

Source: Rincón-Castro & Rodríguez-Niño (2016).

Table B1.4
Estimated Pass-through on Producer Prices

Variable	Shock (% points)	Peso Depreciation				Peso Appreciation			
		1 month	6 months	1 year	4 years	1 month	6 months	1 year	4 years
Output gap		Positive							
	1	27	33	29	43	25	31	30	42
	10	16	22	21	32	17	24	23	42
		Negative							
	1	21	28	30	33	21	30	28	30
	10	15	22	20	23	16	23	21	26
Economic openness		High openness							
	1	23	32	32	30	21	31	30	28
	10	15	22	21	22	17	24	21	22
		Low openness							
	1	25	31	35	43	24	30	33	44
	10	17	23	25	35	17	22	25	35
Change in commodity prices		High							
	1	25	33	32	44	24	32	31	43
	10	17	23	22	34	17	24	22	34
		Low							
	1	24	32	31	44	25	32	31	45
	10	17	24	22	33	17	23	22	34
Interbank interest rate		"High"							
	1	19	27	27	35	17	25	26	33
	10	14	22	22	33	14	22	22	32
		"Low"							
	1	22	30	32	65	21	29	32	63
	10	16	22	24	58	17	22	24	56
Trend		Since April 2009							
	1	17	28	28	27	23	34	35	28
	10	15	23	21	20	16	24	23	21
		Prior to April 2009							
	1	24	30	33	42	24	30	33	43
	10	17	22	25	33	17	22	24	33

Source: Rincón-Castro & Rodríguez-Niño (2016).

Table B1.5
Estimated Pass-through on Prices for Imported Consumer Goods

Variable	Shock (% points)	Peso Depreciation				Peso Appreciation			
		1 month	6 months	1 year	4 years	1 month	6 months	1 year	4 years
		Inflation increases							
Change in inflation	1	11	23	30	55	11	22	30	54
	10	4	14	22	45	4	14	22	45
		Inflation decreases							
	1	11	23	31	55	10	21	28	53
	10	5	14	22	47	4	14	22	46
		High inflation volatility							
Inflation volatility	1	11	21	31	58	11	21	31	60
	10	4	14	23	51	4	13	23	51
		Low inflation volatility							
	1	10	22	34	66	10	22	33	66
	10	4	16	27	64	4	16	27	62
		"High" inflation							
Deviation from the inflation target	1	12	24	33	61	11	22	32	61
	10	5	14	23	51	5	14	23	52
		"Low" inflation							
	1	10	22	31	58	11	23	32	59
	10	4	14	22	50	5	14	23	50
		Peso depreciation/appreciation increases							
Variation in the change in the exchange rate	1	12	22	32	58	11	23	33	59
	10	4	15	24	49	5	15	24	49
		Peso depreciation/appreciation decreases							
	1	11	22	32	56	12	23	33	57
	10	5	15	24	46	4	14	24	47
		High exchange-rate volatility							
Exchange-rate volatility	1	8	18	25	36	8	22	29	42
	10	4	14	21	32	4	13	21	31
		Low exchange-rate volatility							
	1	10	21	28	53	9	20	27	53
	10	4	14	22	46	4	14	22	44
		Undervalued Real exchange rate							
Real exchange-rate imbalance	1	10	21	28	48	11	20	27	48
	10	4	13	19	37	5	13	19	37
		Overvalued Real exchange rate							
	1	11	21	30	49	10	21	30	48
	10	4	13	22	38	4	14	22	38

Source: Rincón-Castro & Rodríguez-Niño (2016).

Table B1.6
Estimated Pass-through on Prices of Imported Consumer Goods

Variable	Shock (% points)	Peso Depreciation				Peso Appreciation			
		1 month	6 months	1 year	4 years	1 month	6 months	1 year	4 years
		Positive							
Output gap	1	11	20	28	57	12	20	27	53
	10	5	10	16	49	4	15	24	55
		Negative							
	1	11	17	21	48	12	17	21	45
	10	5	10	14	42	4	10	14	42
		High openness							
Economic openness	1	8	15	21	42	10	16	22	44
	10	4	10	16	34	3	10	16	37
		Low openness							
	1	9	25	35	53	8	25	35	51
	10	4	18	28	45	4	18	28	44
		High							
Change in commodity prices	1	9	21	32	60	11	22	33	61
	10	4	16	26	55	4	16	26	55
		Low							
	1	11	22	32	61	11	22	32	60
	10	4	16	26	55	5	16	26	56
		"High"							
Interbank interest rate	1	14	17	20	31	12	15	19	32
	10	5	9	11	27	5	8	11	27
		"Low"							
	1	11	27	42	68	10	25	42	68
	10	4	21	37	67	4	21	38	66
		Since April 2009							
Trend	1	9	14	19	32	8	14	19	33
	10	3	9	14	25	3	9	13	24
		Prior to April 2009							
	1	9	22	32	44	9	22	31	43
	10	4	16	25	36	4	17	25	36

Source: Rincón-Castro & Rodríguez-Niño (2016).

Table B1.7
Estimated Pass-through on the CPI

Variable	Shock (% points)	Peso Depreciation				Peso Appreciation			
		1 month	6 months	1 year	4 years	1 month	6 months	1 year	4 years
Change in inflation		Inflation increases							
	1	8	13	16	28	8	13	16	28
	10	3	6	7	17	3	6	7	17
		Inflation decreases							
	1	8	13	15	29	8	12	15	27
	10	3	6	7	18	3	6	7	18
Inflation volatility		High inflation volatility							
	1	8	12	15	38	8	12	15	39
	10	3	6	8	25	3	6	8	24
		Low inflation volatility							
	1	6	12	17	40	7	13	18	43
	10	3	6	10	33	3	6	10	32
Deviation from the inflation target		"High" inflation							
	1	9	13	16	32	8	13	16	33
	10	3	6	8	20	3	6	8	20
		"Low" inflation							
	1	8	12	15	30	8	13	16	32
	10	3	6	8	18	3	6	8	20
Variation in the change in the exchange rate		Peso depreciation/appreciation increases							
	1	8	14	17	32	8	13	17	33
	10	3	6	8	18	3	6	8	19
		Peso depreciation/appreciation decreases							
	1	8	13	16	29	9	14	17	31
	10	3	6	8	18	3	7	8	19
Exchange-rate volatility		High exchange-rate volatility							
	1	7	13	18	36	9	13	15	23
	10	3	7	8	19	3	6	8	17
		Low exchange-rate volatility							
	1	9	15	20	36	8	14	18	37
	10	3	8	10	23	3	7	9	23
Real exchange-rate imbalance		Undevalued Real exchange rate							
	1	8	11	13	27	8	12	14	28
	10	3	5	6	18	3	5	6	18
		Overvalued Real exchange rate							
	1	7	12	15	30	8	12	16	31
	10	3	6	8	17	3	6	8	18

Source: Rincón-Castro & Rodríguez-Niño (2016).

Table B1.8
Estimated Pass-through on the CPI

Variable	Shock (% points)	Peso Depreciation				Peso Appreciation			
		1 month	6 months	1 year	4 years	1 month	6 months	1 year	4 years
		Positive							
Output gap	1	8	17	20	32	7	14	18	29
	10	3	8	10	23	3	10	13	27
		Negative							
	1	11	15	17	29	10	14	15	25
	10	3	7	8	20	3	7	9	21
		High openness							
Economic openness	1	8	11	12	28	8	11	14	25
	10	3	5	6	17	3	5	6	15
		Low openness							
	1	7	15	21	34	7	15	21	34
	10	3	9	13	24	3	9	13	24
		High							
Change in commodity prices	1	7	12	15	30	8	12	15	30
	10	2	6	8	20	2	6	9	20
		Low							
	1	7	12	14	30	7	12	15	30
	10	2	6	8	20	2	6	8	20
		"High"							
Interbank interest rate	1	10	12	12	23	9	11	11	20
	10	3	5	5	21	3	5	5	19
		"Low"							
	1	7	14	19	33	6	14	19	33
	10	2	8	12	26	2	8	12	27
		Since April 2009							
Trend	1	8	12	14	21	8	11	15	23
	10	2	5	6	13	3	5	6	12
		Prior to April 2009							
	1	7	15	21	35	7	15	21	35
	10	3	9	13	24	3	9	12	23

Source: Rincón-Castro & Rodríguez-Niño (2016).