A first approach to the impact of the real exchange rate on industrial sectors in Colombia

Lya Paola Sierra and Karina Manrique L.

ABSTRACT

Much has been said about possible symptoms of Dutch disease in Colombia in the wake of a marked upsurge in commodity prices and the significant real appreciation of the national currency. This paper examines whether the real effective exchange rate had an impact on industry during the period 2000-2010. Specifically, it evaluates the effect of the appreciation of the real exchange rate on the value added of 63 industrial sectors in Colombia using the Arellano and Bond (1991) generalized method of moments (GMM) estimator. Overall, our results confirm a negative relationship between real exchange rate appreciation and industry. The analysis showed that real exchange rate appreciation had a significant impact on the value added of 21 sectors: a negative effect for 18 sectors and a positive effect for 3 sectors.

KEYWORDS

Currency instability, industry, industrial development, competitiveness, econometric models, statistical data, Colombia

JEL CLASSIFICATION

O24, L60, F31

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I
Introduction

In 2003, the Colombian currency began one of the most marked periods of real appreciation in the country's recent history. Apart from the decrease recorded during one year owing to the global financial crisis, the real exchange rate appreciated by 51% in the period 2003-2011. This is the seventh highest rate of real appreciation out of a group of 95 countries, according to a World Bank index of real exchange rates.

One factor that contributed to the appreciation was the dramatic increase in oil prices during the period. Since oil makes up about half of the country's total exports, the 275% rise in real oil prices resulted in windfall profits and pushed up the nominal exchange rate.

The real exchange rate can influence the competitiveness of industrial products in international markets. As the Colombian peso appreciates in real terms it drives up the prices of local goods with respect to those from the rest of the world. This makes Colombian products less competitive than their overseas competitors and may have a negative impact on output and employment in sectors that produce tradable goods. In response to this problem, newspapers and journals, encouraged by the industrial sector, have recently issued warnings about the possible contagion of the Dutch disease in Colombia. The possible effects on manufacturing of this real appreciation of the exchange rate in Colombia have motivated this research, which sets out to determine the effect of the real exchange rate on industrial value added for the period 2000-2010.

We used data for 63 sectors from the Annual Manufacturing Survey, along with macroeconomic data, to conduct estimations using the Arellano and Bond (1991) generalized method of moments (GMM) estimator. We used cross-departmental, cross-sectoral information to evaluate the impact of real appreciation on each of the industrial sectors in Colombia.

The rest of the paper is organized as follows: in the next section, we briefly review the relevant literature; in section III we review the data and the econometric approach used in the study; in section IV we present the results of the model; and lastly, conclusions are drawn in section V.

II
Literature review

The real appreciation of the peso against the dollar since 2003 (see figure 1) has raised fears among politicians and the industrial sector of de-industrialization in Colombia. As the period of appreciation coincided with the great upsurge in real oil prices (see figure 2) —a major export for Colombia— national newspapers started to debate whether Colombia was already suffering from symptoms of Dutch disease.[1] Many economic analysts have written columns on this subject and the President of Colombia even made a reference to the topic in a keynote speech given at the headquarters of the Economic Commission for Latin America and the Caribbean (ECLAC) in Chile:

> "We are trying to attract investors to sectors other than oil and mining because we are now facing a prelude to the Dutch disease owing to the concentration of investment in these sectors."
>
> President Juan Manuel Santos, 17 August 2011.

However, despite the media interest in the subject, few articles have been written on the possible symptoms of Dutch disease caused by the recent real appreciation of the currency in Colombia.

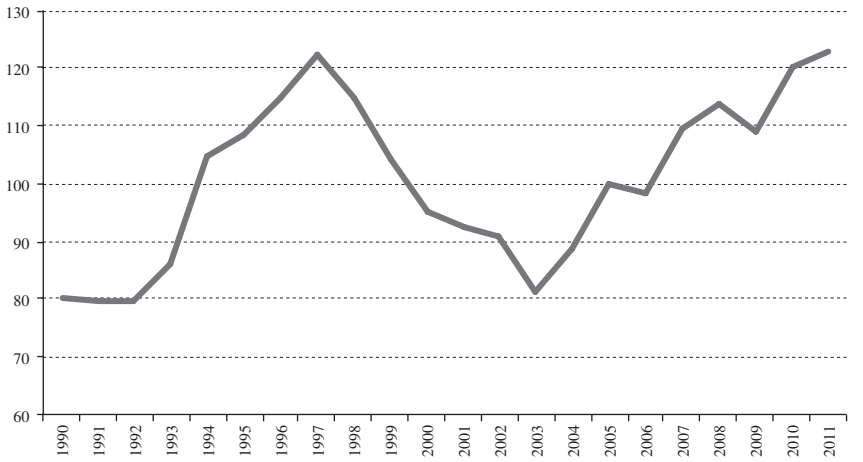
Dutch disease refers to the fallout caused by windfall profits from a resource discovery (Corden and Neary, 1982; Corden, 1984; Beverelli, Dell'Erba and Rocha, 2011), a resource price boom (Egert and Leonard, 2008; Algieri, 2011; Poncela, Senra and Sierra, 2012), an

☐ Lya Paola Sierra gratefully acknowledges the financial support received from the Pontifical Javeriana University in Cali.

[1] Other possible causes of the real appreciation of the exchange rate could have included the positive trends in foreign direct investment, the increased privatization of State agencies and, externally, excess liquidity in the United States and Europe.

FIGURE 1

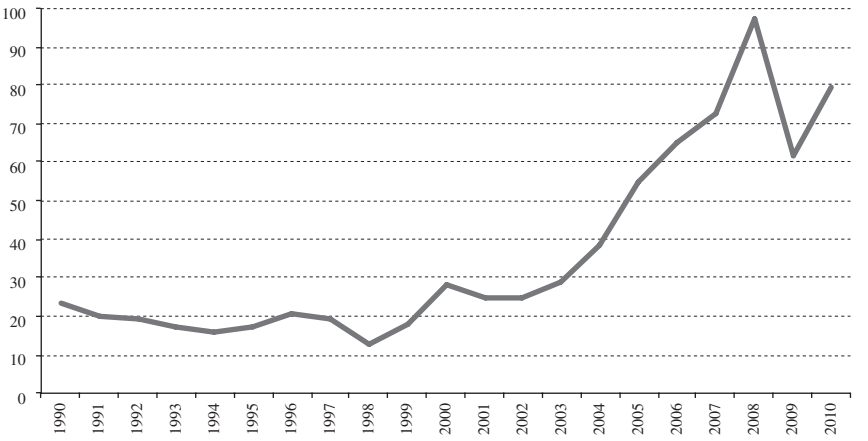
Colombia: real effective exchange rate index, 1990-2011
(Index 2005 = 100)



Source: World Bank.

FIGURE 2

Annual average Brent crude oil spot prices, 1990-2010
(Dollars per barrel)



Source: Energy Information Administration.

upsurge in remittances (Acosta, Lartey and Mandelman, 2009; Guha, 2013) or higher capital inflows in the form of foreign aid or foreign direct investment (Lartey, 2011; Arellano and others, 2005; Prati and Tressel, 2005).[2] The term "Dutch disease" is attributed to an article in *The Economist* in 1977, which described the detrimental impact on the industrial sector in the Netherlands following the discovery of major gas deposits in the North Sea. Corden and Neary (1982) formulated the core theoretical model of Dutch disease. They used a Salter-Swan framework (Salter, 1959; Swan, 1960) to describe how windfall profits in a country can cause real appreciation followed by reductions in competitiveness and output in the non-resource tradable sector. A resource boom may lead to a real appreciation through two channels. First,

[2] Buiter and Purvis (1983) examine the relative importance of different shocks as causes of de-industrialization, by looking at the impact on the real exchange rate of factors including higher oil prices, a domestic oil discovery and monetary disinflation.

newfound wealth can lead to higher rates of national absorption, through spending either by the government or directly by the owners of the factors. This increase in demand drives up the prices of non-tradable goods, forcing real appreciation. Second, the nominal exchange rate can appreciate in a flexible exchange rate regime owing to burgeoning inflows to the country. Given the traditional real exchange rate equation (see equation (1)), where the real exchange rate (Q) is represented in the equation as the price of domestic goods (P) relative to those from abroad (P*) adjusted by the nominal exchange rate (S), both forces lead to real exchange rate appreciation. Corden and Neary (1982) referred to this as the "spending effect".

$$Q = S * \frac{P}{P^*} \tag{1}$$

Taking logs, the real exchange rate is also denoted as:

$$q_t = s_t + p_t - p_t^* \tag{2}$$

Here, s_t is the log of the foreign currency price of domestic currency (United States dollars per Colombian peso), p_t and p_t^* are the logs of the national and foreign country price indices, respectively. In this definition of the real exchange rate, an increase in q_t means a real appreciation of the local currency and a decrease in q_t reflects a real depreciation.

Apart from the "spending effect", Corden and Neary (1982) describe a "resource movement effect", referring to the reallocation of factors, especially labour, from the manufacturing sector to the booming resource sector. The reduction of labour in the manufacturing sector contributes to the de-industrialization process.

The literature seems to point to a clear causal link between a resource boom and a real appreciation of the national currency. However, the subsequent link between real appreciation and relative de-industrialization remains unclear (see Magud and Sosa (2010) for a judicious review of the literature on Dutch disease). In fact, a theoretical article by Buiter and Purvis (1983) posits that a resource boom might have a positive effect on manufacturing on the basis of the coexistence of real appreciation and an upsurge in growth. Manufacturing is thus contemporaneously influenced by appreciation, which shrinks international competitiveness, and local demand for manufacturing, which pushes up sales. Since Colombia, which is a small economy, takes the world price of manufactures as a constant, manufacturing output could be maintained through the higher domestic demand associated with the resource boom. That is, losses in competitiveness would be compensated by gains in domestic demand.

Moreover, real appreciation can potentially increase competitive pressures and force industrial restructuring, which can in turn boost productivity. The effect of the real exchange rate on manufacturing output depends on the exposure of industries to international markets. Industries that export most of their output, for example, might see their profits fall as they lose competitiveness in periods of real appreciation. Whereas industries that import most of their intermediate inputs could benefit from local currency appreciation, since real appreciation tends to make these inputs cheaper. To summarize, a real appreciation shock has an ambiguous effect on profitability and industrial performance. Some of the papers that examine the real exchange rate and industrial performance include Burgess and Knetter (1998); Campa and Goldberg (1995 and 2001); Goldberg, Tracy and Aaronson (1999); Goldberg (1993); Campbell and Lapham (2004); Ekholm, Moxnes and Ulltveit-Moe (2012), and Berman, Martin and Mayer (2012).

Although the relationship between the real exchange rate and industrial output remains unclear, there appears to be strongly supported cross-country statistical evidence that overvalued currencies are associated with slow growth, especially in less developed countries (Rajan and Subramanian, 2011; Rodrik, 2008, and Berg, Ostry and Zettelmeyer, 2012). Tradable sectors, particularly those in manufacturing, seem to be the link between the real exchange rate and economic growth. Rodrik (2008), for example, shows that the bigger a tradable industrial sector is in a less developed country, the more overvaluation hurts growth.

In the case of Colombia, there are few articles that examine the real exchange rate in relation to manufacturing performance. The article bearing the closest resemblance to this study is Echavarría and Arbeláez (2003), who measured the effect of the exchange rate on investment, sales and profits in Colombian companies in 1994-2002. Unlike our article, however, Echavarría and Arbeláez (2003) took into account a devaluation period in a firm-level analysis, which included only manufacturing firms. Carranza and Moreno (2013) analysed the vertical industrial chain of Colombia for the period 1990-2010, evaluating possible industrialization, but did not specifically assess the effect of the exchange rate on industry. Other studies addressing the subject include Clavijo (1990), which evaluated the effect of the real exchange rate on

productivity, and Rhenals and Saldarriaga (2007), which explored the relationship between the real exchange rate and Colombia's economic growth. In this paper we concentrate exclusively on the effects of the Colombian real exchange rate on manufacturing value added. Further research should be carried out to evaluate the potential impact of a resource boom on economic growth in Colombia.

III
Econometric approach and data

1. Data

We used annual data from the Annual Manufacturing Survey conducted by the National Administrative Department of Statistics (DANE) of Colombia. The survey contains information on 63 industrial sectors in 23 departments (geographical areas) in Colombia from 2000 to 2010. The names of the sectors are listed in annex 1. We used variables from the Annual Manufacturing Survey such as employment, number of firms per industry and wages paid to personnel.

In addition, we used data on macroeconomic variables such as the real effective exchange rate from the International Monetary Fund, the per capita income for each department from DANE and the lending rate from the central bank of Colombia. We constructed the ratio of imported intermediate goods, which takes into account the ratio of industrial intermediate imports to total intermediate goods, with a view to controlling for each industry's openness to foreign markets.[3]

As a first look at the evolution of the sectors from 2000 to 2010, we grouped the data using the two-digit numerical codes of the International Standard Industrial Classification of All Economic Activities (ISIC) adapted for Colombia by DANE (see annex 2). According to this information, the sector with the greatest value added in 2000 was the manufacture of food products and beverages, followed by the manufacture of chemicals and chemical products; the manufacture of coke, refined petroleum products and nuclear fuel; the manufacture of furniture; and the manufacture of other non-metallic mineral products. From 2000 to 2010, the top two sectors, food and chemicals, saw their share in the total value added slide from 28% to 27% and from 16% to 14%, respectively. Likewise, the contribution to total value added of the manufacture of other non-metallic mineral products contracted from 7.5% to 7.2%. By contrast, the manufacture of furniture and the manufacture of coke and refined petroleum products increased their share in total value added between 2000 and 2010. The furniture sector accounted for 7.7% of total value added in 2000, increasing to 8.7% in 2010, and the manufacture of coke and refined petroleum products saw the largest increase in the whole sample of sectors, from 7.9% to 12.8%.

As we can see from this information, industrial value added is concentrated in a small number of sectors in Colombia. The top five sectors accounted for 67% of total value added in 2000, and by 2010 their share had risen to 70%.

2. The model

We propose the following model:

$$y_{dst} = \beta_0 + \beta_1 w_{dst} + \beta_2 i_t + \beta_3 q_t + \beta_4 IIR_{dst} + \varepsilon_{it} \quad (3)$$

$$y_{dst} = \alpha_0 + \beta_2 q_t D_s + \beta_3 rgdp_{dt} + \beta_2 i_t + \beta_4 w_{dst} + \beta_6 IIR_{dst} + \varepsilon_{it} \quad (4)$$

where $D_s = \sum_1^{23} D_i$.

The variable y represents the value added of industrial sector s in department d, in year t. The real exchange rate is represented by the variable q_t and D_s is a dummy per industry. The rest of the variables are: real per capita income for each department, $rgdp_{dt}$, real wage per industry w_{dst}, real interest rate, i_t, and the variable IIR_{dst} representing the intermediate input ratio. In equation (3) we aim to measure the overall impact of the real exchange rate on the industry in general. The marginal effect of fluctuations in the real effective exchange rate, whether real appreciation or depreciation, on each industry is captured by parameter β_2 in equation (4).

[3] All data have been log-transformed.

We are aware of some known identification problems regarding the estimation, such as the multi-causality of industrial value added and the real exchange rate, as well as the possibility of multicollinearity between dependent variables. In order to address these problems, we estimated a dynamic linear panel data model, using the Arellano-Bond GMM estimator. The advantage of this model is that it relaxes the strong exogeneity assumption, allowing the explanatory variables to be correlated with the error term. The strategy is to use the lags of the variables as instruments. A brief analysis of the characteristics and assumptions of this model is shown below.

Consider a model that includes the lag of the dependent variable, Y_{it} as a regressor (the dynamics introduced in the model are given by this feature). The basic dynamic autoregressive model panel data can be represented as follows:

$$Y_{it} = \alpha Y_{i,t-1} + X'_{it}\beta + \eta_i + u_{it} \quad (5)$$

where t = 1,…,T.

X'_{it} is the row vector of observed explanatory variables for individual i at time t; β is the vector of parameters to be estimated; η_i represents the time invariant individual effect and u_{it}, represents the idiosyncratic errors.

In equation (5), as in equations (3) and (4), lags of the dependent variable are taken as explanatory variables. This fact introduces bias to the estimation by ordinary least squares (OLS), since these violate the strict exogeneity assumption. To tackle this issue Anderson and Hsiao (1981) and Arellano and Bond (1991) suggested differencing the model and then using instrumental variables estimations.

$$\Delta Y_{it} = \alpha \Delta Y_{i,t-1} + \Delta X'_{it}\beta + \Delta v_{it} \quad (6)$$

By transforming the regressors by first-differencing, as shown in equation (6), the fixed specific effect, η_i, is removed, because it does not vary with time. We follow Arellano and Bond (1991) and use the GMM estimator, which takes into account the passing information from Y and X as instruments.

As a robustness check, we also estimated the Arellano and Bover (1995) system GMM estimator. According to these authors, if the autoregressive process is persistent, or when T (number of years) is small, then the lagged levels are weak instruments. They proposed using additional moment conditions in which lagged differences of the dependent variable are orthogonal to levels of the disturbances.

IV
Estimation results

Before looking at the results disaggregated by industrial sector, we first show the results for equation (3), which give an initial overview of the effect of the real exchange rate on industry.[4]

We obtained estimates of equation (3). We report the results for the two-step GMM estimator for both the first-differenced equation and the system equation. We take as instruments the lagged levels dated *t*-2 and earlier. As additional instruments, we take the lagged differences dated *t-1*. The estimation results are reported in annex 3. Annex table A.3.1 provides estimates for equation (3) using the first-differences GMM and the system GMM estimator. The results in column (2) are controlled for departmental per capita income, whereas those in column (1) are not. The lower part of table A.3.1 includes the results of the Sargan test and Arellano-Bond test used to evaluate the overidentifying conditions and the serial correlation in the first-differenced disturbances.

The results show that fluctuations in the real exchange rate significantly affect the industrial sector in general. In fact, a 1% appreciation of the real exchange rate produces a 0.29% decrease in value added, ceteris paribus, in both the first-differences and system GMM estimations. The real appreciation of the Colombian peso creates a loss of competiveness in international markets since local prices are higher than those of international competitors. Also, domestic consumers replace expensive national goods with cheaper imports.

When departmental per capita income is controlled for, the results of the estimations for equation (3) show that the real exchange rate has slightly less of an

[4] In this section we refer to the sectors listed in table A.1.1 of annex 1, disaggregated at the three-digit level of the International Standard Industrial Classification of All Economic Activities (ISIC), Rev. 3, adapted for Colombia by DANE.

impact on the value added of the industrial sector. An appreciation of 1% generates a reduction in the value added of 0.26% in both the first-differences and system GMM estimations (columns numbered (2) in table A.3.1). Interestingly, even though there is a negative effect of an appreciation in the same year, we found that industrial value added is affected significantly and in a positive way by the lag of the real exchange rate.

With respect to the results disaggregated by industrial sector corresponding to equation (4), as with previous estimations, we report results for the two-step GMM estimator for the first-differenced equation, using as instruments the lagged levels dated *t-2* and earlier. We evaluated two models: the first (in column (1) in table A.3.2) does not take into account the variable of departmental per capita income, while the second model (in column (2)) does control for the $rgdp_t$ variable.[5]

We found that the real effective exchange rate had significant marginal effects in 21 industries. Real appreciation generated a reduction in the value added of 18 of those industries. The manufacturing sectors that were hit hardest were: television and radio receivers, veneer sheets, finishing of textiles not produced in the same production unit, rubber products, non-metallic mineral products, and sugar mills and refineries. In contrast, appreciation generated positive effects in the value added of only three sectors: manufacture of optical instruments and photographic equipment, publishing and the manufacture of insulated wire and cable. Annex table A.3.3 contains a summary of the sectors that are significantly affected by fluctuations in the real exchange rate (only the sectors significantly affected by the variable q_t in equation (4)).

It is striking that most of the sectors that are negatively influenced by the real exchange rate are those that account for the largest share in industrial value added. The exception is the manufacture of furniture, which is not significantly affected by real exchange rate fluctuations. Surprisingly, the value added of the manufacture of refined petroleum products has a negative relationship with q_t, that is, a real appreciation of 1% leads to a loss in the value added of this sector of about 1.13%.

The specification tests do not produce evidence against any model. The Sargan test leads to non-rejection of the null hypothesis of that model and overidentifying conditions are correctly specified. Furthermore, the autocorrelation tests c1 and c2 (see notes to tables A.3.1 and A.3.2) are consistent with the structure that we proposed for the idiosyncratic error term.

In sum, the 18 sectors that are hit by appreciation account for approximately 53% of total value added, on average, between 2000 and 2010. Conversely, the three sectors that benefit from appreciation represent 4% of total value added (see annex table A.3.4). Our results show, therefore, that real appreciation is detrimental to the sectors representing more than half of total manufacturing value added; however, for the 38 sectors that account for 44.8% of total manufacturing value added, the real exchange rate does not have a significant effect. This non-significance may have to do with the degree of openness of the Colombian economy: from 2000 to 2010, trade accounted for a 35% share in total gross domestic product (GDP) on average. An appreciation of the real exchange rate erodes the competitiveness of domestic firms in the international market, which reduces net exports and shifts part of domestic demand from domestic goods to foreign goods. As a consequence, according to the Dutch disease hypothesis, this leads to a drop in production and employment. However, when the degree of openness of the economy is not large, as is the case in Colombia, these effects do not necessarily spread to all the manufacturing sectors. Moreover, for manufacturing, the domestic market is more important than the external market. For the period 2000-2009, for example, domestic sales represented about 83% of total manufacturing sales, according to DANE. A further avenue for research would be to evaluate the long-term impact of the real exchange rate on manufacturing as the country becomes increasingly open to trade. This paper should persuade policymakers to consider the possible impacts of real exchange rate fluctuations on manufacturing in an economy that is wide open to trade.

It is important to note that the share of manufacturing in GDP for the period 2000-2010 was only 15.4% on average, while services accounted for 59.3%. Therefore, we cannot be conclusive about the effects of the real exchange rate on Colombia's GDP. In fact, as shown in figure 3, there was a huge decline in the contribution of industry to Colombian GDP in the 1990s, coinciding with the introduction of trade liberalization policies. In our period of analysis, from 2000 to 2010, industry recovered to some extent. According to some authors, such as Echavarría and Villamizar (2006), the de-industrialization process in Colombia started in 1960, with the decrease in industry's share of employment, and in 1970, with the decrease in its share of overall production. Echavarría and Villamizar (2006), as well as Poncela, Senra and Sierra (2012), did not find evidence of de-industrialization related to Dutch disease in the long term.

[5] We also estimated the system GMM model in this equation, however, the Sargan statistic rejected the different models we proposed.

FIGURE 3

Colombia: share of services and industry in gross domestic product, 1965-2011
(Percentages)

Source: Data Service & Information, [online] http://www.dsidata.com/default/page/slug/about.

V
Conclusions

In view of the national interest in the possible impact on industry of real appreciation caused by the upsurge in oil prices after the year 2000, we sought to evaluate one of the symptoms of the Dutch disease by analysing the impact of the appreciation of the real effective exchange rate on the value added of 63 industrial sectors in Colombia during the period 2000-2010.

We used the annual panel data set of the Annual Manufacturing Survey carried out by DANE, and conducted estimations using the first-differenced GMM estimator of Arellano and Bond (1991).

Our results suggest that the real exchange rate had a significant impact on the industrial sector in general. We found that the effect was negative: that is, a 1% appreciation of the real exchange rate produced a decrease in industrial value added of between 0.26% and 0.29%.

The estimation results for individual industrial sectors showed that real exchange rate appreciation had a negative impact on 18 sectors and a positive impact on 3 sectors. It is striking that the real exchange rate had no significant impact on most of the sectors (38) during the period 2000-2010. The sectors that were affected most markedly were those with a larger share in total industrial value added. Overall, the sectors that suffered as a result of the real appreciation of the Colombian peso accounted for 53% of total manufacturing value added, 39% of all manufacturing employees and 36% of firms in the manufacturing sectors.

The results in this paper provide initial insight into the effects of the real exchange rate on the industrial sectors in Colombia. Although this article cannot confirm an acceleration of the de-industrialization process in the period of study because a large number of sectors were not affected by the real exchange rate, it gives a list of sectors that are potentially sensitive to fluctuations in the real exchange rate. Government policy should focus special attention on these sectors, which are potentially harmed in periods of appreciation. Measures such as tax breaks or credit facilities could provide temporary relief to those sectors. Further research is needed to examine how the real exchange rate affects other important variables such as industrial employment, productivity and number of firms per sector in order to evaluate the total impact of the real exchange rate on manufacturing.

ANNEX 1

Table A.1.1

Sectors included in the study

Sector	International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 3 adapted for Colombia
Production, processing and preservation of meat and fish	151
Processing of fruits, vegetables, oils and fats	152
Manufacture of dairy products	153
Production of grain mill products, starches and starch products, and prepared animal feeds	154
Manufacture of bakery products, macaroni, noodles, couscous and similar farinaceous products	155
Manufacture of coffee	156
Sugar mills and refineries	157
Manufacture of other food products	158
Manufacture of beverages	159
Manufacture of tobacco products	160
Preparation and spinning of textile fibres	171
Weaving of textiles	172
Finishing of textiles not produced in the same production unit	173
Manufacture of other textile products	174
Manufacture of knitted and crocheted fabrics and articles	175
Manufacture of wearing apparel, except fur apparel	181
Tanning and preparation of leather	191
Manufacture of footwear	192
Manufacture of travel goods, handbags and similar articles	193
Sawing, planing and impregnation of wood	201
Manufacture of veneer sheets, manufacture of plywood, laminboard, particle board and other panels and boards	202
Manufacture of builders' carpentry and joinery	203
Manufacture of wooden containers	204
Manufacture of other products of wood, manufacture of articles of cork, straw and plaiting materials	209
Manufacture of paper, cardboard and paper and cardboard products	210
Publishing	221
Printing	222
Service activities related to printing	223
Manufacture of coke oven products	231
Manufacture of refined petroleum products	232
Manufacture of basic chemicals	241
Manufacture of other chemical products	242
Manufacture of synthetic and artificial fibres	243
Manufacture of rubber products	251
Manufacture of plastics products	252
Manufacture of glass and glass products	261
Manufacture of non-metallic mineral products n.e.c.	269
Manufacture of basic iron and steel	271
Manufacture of basic precious and non-ferrous metals	272
Manufacture of structural metal products, tanks, reservoirs and steam generators	281
Manufacture of other fabricated metal products and related metalworking service activities	289
Manufacture of general purpose machinery	291
Manufacture of special purpose machinery	292
Manufacture of domestic appliances n.e.c.	293
Manufacture of office, accounting and computing machinery	300
Manufacture of electric motors, generators and transformers	311
Manufacture of electricity distribution and control apparatus	312

Table A.1.1 (conclusion)

Sector	International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 3 adapted for Colombia
Manufacture of insulated wire and cable	313
Manufacture of accumulators and electrical batteries	314
Manufacture of electric lamps and lighting equipment	315
Manufacture of other electrical equipment n.e.c.	319
Manufacture of electronic valves and tubes and other electronic components	321
Manufacture of television and radio receivers, sound or image recording or reproducing apparatus, and associated goods	323
Manufacture of medical appliances and instruments and appliances for measuring, checking, testing, navigating and other purposes, except optical instruments	331
Manufacture of optical instruments and photographic equipment	332
Manufacture of motor vehicles and their engines	341
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	342
Manufacture of parts and accessories (auto parts) for motor vehicles and their engines	343
Building and repairing of ships and boats	351
Manufacture of aircraft and spacecraft	353
Manufacture of other transport equipment n.e.c.	359
Manufacture of furniture	361
Manufacturing n.e.c.	369

Source: prepared by the authors, on the basis of the International Standard Industrial Classification of All Economic Activities (ISIC Rev. 3) adapted for Colombia, as included in the Annual Manufacturing Survey conducted by the National Administrative Department of Statistics (DANE) of Colombia.

n.e.c.: not elsewhere classified.

ANNEX 2

Industrial sector data

TABLE A.2.1

Colombia: value added of industrial sectors, 2000-2010
(Thousands of Colombian pesos and percentages)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Share 2000 (*percentages*)	Share 2010 (*percentages*)
Manufacture of food products and beverages	7 608 895	8 381 305	9 470 550	9 957 251	10 880 544	11 951 754	13 761 894	15 224 634	18 001 494	19 627 647	124 865 969	28.5	27.1
Manufacture of tobacco products	1 420	1 134	1 535	0	3 274	3 280	4 421	4 809	5 326	3 258	28 457	0.0	0.0
Manufacture of textiles	1 242 219	1 280 019	1 295 873	1 430 800	1 594 966	1 659 680	1 869 509	1 951 739	1 846 630	1 693 138	15 864 573	4.7	3.4
Manufacture of wearing apparel; dressing and dyeing of fur	1 215 924	1 360 344	1 443 904	1 626 685	1 816 660	1 938 674	2 143 461	2 088 167	2 218 742	2 018 181	17 870 744	4.6	3.9
Tanning and dressing of leather; manufacture of footwear; manufacture of travel accessories, luggage, handbags, saddlery and harness	271 280	285 223	284 834	346 945	360 758	392 524	468 904	524 803	519 861	512 624	3 967 757	1.0	0.9
Processing of wood, manufacture of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	55 213	34 478	44 587	41 910	53 138	56 619	66 181	73 609	84 705	134 435	644 875	0.2	0.1
Manufacture of paper, paperboard and paper and paperboard products	1 350 012	1 438 933	1 567 476	1 711 585	1 929 763	1 829 561	2 008 245	2 205 896	2 359 955	2 268 686	18 670 111	5.1	4.1
Publishing, printing and reproduction of recorded media	849 054	931 382	1 067 624	1 229 704	1 275 004	1 557 755	1 559 679	1 850 557	2 219 561	2 170 731	14 711 050	3.2	3.2
Manufacture of coke, refined petroleum products and nuclear fuel	2 121 031	2 482 134	2 761 632	3 642 836	5 291 157	6 612 653	8 579 633	9 413 412	10 001 524	8 318 727	59 224 740	7.9	12.8
Manufacture of chemicals and chemical products	4 285 615	4 574 087	5 065 855	5 711 664	5 920 572	6 081 515	6 851 308	7 215 348	8 472 098	8 781 966	62 960 026	16.0	13.7
Manufacture of rubber and plastics products	1 187 576	1 385 012	1 546 592	1 700 688	1 930 744	2 231 217	2 485 124	2 780 749	2 766 491	2 990 309	21 004 502	4.4	4.6
Manufacture of other non-metallic mineral products	2 004 414	2 250 868	2 551 045	3 055 937	3 208 584	2 903 819	3 776 549	4 535 001	4 590 775	4 442 766	33 319 757	7.5	7.2
Manufacture of basic metals	538 232	574 607	578 345	808 361	1 158 038	1 254 836	1 351 551	1 296 366	1 631 329	1 369 326	10 560 992	2.0	2.3
Manufacture of fabricated metal products, except machinery and equipment	617 062	559 232	644 992	747 463	832 751	932 479	1 120 715	1 245 303	1 462 750	1 549 845	9 712 592	2.3	2.1
Manufacture of electrical machinery and apparatus n.e.c.	424 112	498 740	517 303	580 462	684 379	754 396	864 007	957 309	983 698	1 138 936	7 403 344	1.6	1.6
Manufacture of motor vehicles, trailers and semi-trailers	345 235	367 440	387 859	366 266	464 979	585 253	556 724	545 196	719 666	812 536	5 151 153	1.3	1.1
Manufacture of radio, television and communication equipment and apparatus	32 597	37 065	47 318	47 995	47 234	10 380	13 509	27 181	27 414	18 493	309 188	0.1	0.1
Manufacture of medical, precision and optical instruments, watches and clocks	58 053	74 692	80 937	88 549	102 238	103 450	114 961	121 966	109 493	142 964	997 303	0.2	0.2
Manufacture of motor vehicles, trailers and semi-trailers	371 644	539 818	645 634	586 952	913 087	1 131 345	1 429 111	1 887 402	1 371 686	1 272 541	10 149 219	1.4	2.2
Manufacture of other transport equipment	72 707	145 158	106 687	161 908	286 143	413 447	551 619	540 087	493 701	540 704	3 312 162	0.3	0.7
Manufacture of furniture; manufacturing n.e.c.	2 055 458	2 271 306	2 601 694	3 171 306	3 834 319	4 053 404	5 614 699	6 888 757	4 968 192	4 730 273	40 189 407	7.7	8.7

Source: prepared by the authors, on the basis of the International Standard Industrial Classification of All Economic Activities (ISIC Rev. 3) adapted for Colombia, as included in the Annual Manufacturing Survey conducted by the National Administrative Department of Statistics (DANE) of Colombia.

Note: share 2000 and share 2010 correspond to the sector's share of value added in the total industrial value added for 2000 and 2010, respectively.
n.e.c.: not elsewhere classified.

ANNEX 3

Estimation results

TABLE A.3.1

Colombia: estimation results for equation (3) showing the aggregate impact of the real effective exchange rate on industrial value added

	Generalized method of moments (GMM) estimates			
	First-differences		System	
	(1)	(2)	(1)	(2)
y_{t-1}	0.603 (0.055)[a]	0.689 (0.062)[a]	0.615 (0.040)[a]	0.658 (0.038)[a]
y_{t-2}	0.023 (0.019)	0.047 (0.023)[b]	0.029 (0.017)	0.049 (0.020)[b]
w_t	0.732 (0.043)[a]	0.758 (0.047)[a]	0.727 (0.041)[a]	0.744 (0.045)[a]
w_{t-1}	-0.402 (0.063)[a]	-0.439 (0.067)[a]	-0.39 (0.051)[a]	-0.395 (0.050)[a]
i_t	-0.102 (0.038)[b]	-0.126 (0.039)[a]	-0.087 (0.034)[b]	-0.118 (0.037)[b]
i_{t-1}	-0.295 (0.056)[a]	-0.361 (0.060)[a]	-0.286 (0.052)[a]	-0.360 (0.061)[a]
q_t	-0.297 (0.087)[b]	-0.269 (0.0893)[a]	-0.297 (0.084)[a]	-0.261 (0.088)[b]
q_{t-1}	0.05 (0.067)	0.165 (0.081)[b]	0.011 (0.064)	0.138 (0.076)[c]
IIT_t	-1.00E-08 (6.49E-09)[a]	-1.14E-08 (6.71E-09)[c]	-1.12E-08 (0.00)[a]	-1.11E-08 (6.37E-09)[c]
$rgdp_t$		0.022 (0.024)		0.02 (0.023)
$rgdp_{t-1}$		-0.529 (0.176)[b]		-0.484 (0.154)[b]
cons	1.806 (0.416)[a]	7.084 (1.786)[a]		6.565 (1.622)[a]
Number of observations	2 906	2 906	3 355	3 355
Observations per group (average)	7.21	7.21	7.712	7.712
Sargan test *p*-value	0.1404	0.380	0.3047	0.638
c1 (*p*-value)	0.000	0.000	0.000	0.000
c2 (*p*-value)	0.2184	0.354	0.2907	0.502

Source: prepared by the authors.

[a] p<0.01.
[b] p<0.05.
[c] p<0.1.
Note: standard errors in parentheses. Sargan test for overidentifying restrictions. c1 and c2 tests for first and second order correlation in first-differenced residuals.

TABLE A.3.2

Colombia: estimation results for equation (4) showing the disaggregate impact of the real effective exchange rate on the industrial sectors

	(1)		(2)	
	Coefficient	Standard error	Coefficient	Standard error
y_{t-1}	0.579	(0.054)[a]	0.661	(0.061)[a]
y_{t-2}	0.018	(0.018)	0.039	(0.021)[c]
w_t	0.762	(0.041)[a]	0.765	(0.045)[a]
w_{t-1}	-0.390	(0.059)[a]	-0.429	(0.062)[a]
$rgdp_t$			0.027	(0.023)
$rgdp_{t-1}$			-0.344	(0.208)[c]
$rgdp_{t-2}$			0.062	(0.199)
i_t	-0.109	(0.037)[b]	-0.110	(0.038)[a]
i_{t-1}	-0.313	(0.057)[b]	-0.331	(0.066)[a]
IIT_t	-1.160E-08	(6.62E-09)[a]	-1.340E-08	(6.870E-09)[a]
$q_t D_s$				
Production, processing and preserving of meat and fish	0.224	(0.482)	0.256	(0.478)
Processing of fruits, vegetables, oils and fats	-0.013	(0.340)	0.006	(0.324)
Manufacture of dairy products	-1.142	(0.482)[b]	-0.984	(0.482)[b]
Production of grain mill products, starches and starch products, and prepared animal feeds	0.118	(0.328)	0.240	(0.350)
Manufacture of bakery products, macaroni, noodles, couscous and similar farinaceous products	-0.085	(0.170)	-0.075	(0.199)
Manufacture of coffee	0.420	(0.383)	0.618	(0.417)
Sugar mills and refineries	-1.151	(0.401)[a]	-1.203	(0.412)[a]
Manufacture of other food products	-0.279	(0.289)	-0.247	(0.262)
Manufacture of beverages	-0.045	(0.366)	0.154	(0.379)
Manufacture of tobacco products	0.299	(0.354)	0.143	(0.473)
Preparation and spinning of textile fibres	-0.825	(0.521)	-0.836	(0.537)
Weaving of textiles	-0.822	(0.329)[b]	-0.839	(0.343)[b]
Finishing of textiles not produced in the same production unit	-1.789	(0.625)[a]	-1.916	(0.703)[a]
Manufacture of other textile products	-0.107	(0.494)	-0.041	(0.553)
Manufacture of knitted and crocheted fabrics and articles	0.424	(0.299)	0.459	(0.313)
Manufacture of wearing apparel, except fur apparel	0.506	(0.435)	0.544	(0.455)
Tanning and preparation of leather	-0.179	(0.288)	-0.172	(0.277)
Manufacture of footwear	-0.538	(0.195)[a]	-0.545	(0.226)[b]
Manufacture of travel goods, handbags and similar articles	-0.583	(0.558)	-0.603	(0.610)
Sawing, planing and impregnation of wood	0.228	(0.802)	0.205	(0.802)
Manufacture of veneer sheets, manufacture of plywood, laminboard, particle board and other panels and boards	-3.681	(0.214)[a]	-3.810	(0.184)[a]
Manufacture of builders' carpentry and joinery	0.803	(0.509)	0.835	(0.534)
Manufacture of wooden containers	-1.258	(0.364)[a]	-1.335	(0.287)[a]
Manufacture of other products of wood, manufacture of articles of cork, straw and plaiting materials	-0.357	(0.228)	-0.386	(0.180)[b]
Manufacture of paper, cardboard and paper and cardboard products	-0.912	(0.385)[b]	-0.850	(0.398)[b]
Publishing	0.679	(0.359)[c]	0.717	(0.381)[c]
Printing	-0.582	(0.257)[b]	-0.675	(0.306)[b]
Service activities related to printing	-0.536	(0.955)	-0.685	(0.981)
Manufacture of refined petroleum products	-1.137	(0.542)[b]	-1.125	(0.519)[b]
Manufacture of basic chemicals	-0.337	(0.551)	-0.146	(0.567)
Manufacture of other chemical products	-1.033	(0.507)[b]	-0.962	(0.533)[c]
Manufacture of rubber products	-1.326	(0.389)[a]	-1.352	(0.332)[a]
Manufacture of plastics products	-0.143	(0.168)	-0.128	(0.155)
Manufacture of glass and glass products	0.428	(0.420)	0.515	(0.441)
Manufacture of non-metallic mineral products n.p.c.	-1.278	(0.308)[a]	-1.227	(0.315)[a]
Manufacture of basic iron and steel	-0.726	(0.335)[b]	-0.791	(0.325)[b]
Manufacture of basic precious and non-ferrous metals	-0.636	(0.868)	-0.726	(0.955)

Table A.3.2 (conclusion)

	(1)		(2)	
	Coefficient	Standard error	Coefficient	Standard error
Manufacture of structural metal products, tanks, reservoirs and steam generators	-0.770	(0.378)[b]	-0.819	(0.413)[b]
Manufacture of other fabricated metal products and related metalworking service activities	-0.336	(0.382)	-0.348	(0.396)
Manufacture of general purpose machinery	0.529	(0.425)	0.604	(0.428)
Manufacture of special purpose machinery	0.123	(0.285)	0.175	(0.270)
Manufacture of domestic appliances n.p.c.	0.048	(0.506)	-0.010	(0.547)
Manufacture of electric motors, generators and transformers	0.218	(0.891)	0.233	(0.944)
Manufacture of electricity distribution and control apparatus	-0.588	(0.728)	-0.645	(0.748)
Manufacture of insulated wire and cable	2.953	(0.148)[a]	3.013	(0.153)[a]
Manufacture of accumulators and electrical batteries	0.244	(0.561)	0.330	(0.352)
Manufacture of electric lamps and lighting equipment	-1.033	(0.310)[a]	-1.036	(0.340)[a]
Manufacture of other electrical equipment n.p.c.	0.398	(0.340)	0.405	(0.262)
Manufacture of electronic valves and tubes and other electronic components	0.931	(0.615)	0.996	(0.681)
Manufacture of television and radio receivers, sound or image recording or reproducing apparatus, and associated goods	-4.076	(0.280)[a]	-3.831	(0.323)[a]
Manufacture of medical appliances and instruments and appliances for measuring, checking, testing, navigating and other purposes, except optical instruments	-0.981	(0.891)	-1.042	(0.972)
Manufacture of optical instruments and photographic equipment	0.320	(0.110)[a]	0.380	(0.094)[a]
Manufacture of motor vehicles and their engines	0.702	(0.646)	0.668	(0.823)
Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers	0.643	(0.704)	0.622	(0.736)
Manufacture of parts and accessories (auto parts) for motor vehicles and their engines	-0.349	(0.388)	-0.406	(0.450)
Building and repairing of ships and boats	-3.440	(3.111)	-3.409	(3.203)
Manufacture of aircraft and spacecraft	0.212	(0.412)	-0.272	(0.318)
Manufacture of other transport equipment n.p.c.	0.357	(0.261)	0.274	(0.301)
Manufacture of furniture	0.338	(0.396)	0.360	(0.408)
Manufacturing n.p.c.	-0.825	(0.318)[a]	-0.809	(0.330)[a]
_cons	1.812	(0.425)[a]	4.344	(1.618)[a]
Number of observations	2 906		2 906	
Observations per group (average)	7.210		7.210	
Sargan (*p*-value)	0.074		0.144	
c1 (*p*-value)	0.000		0.000	
c2 (*p*-value)	0.096		0.133	

Source: prepared by the authors.

[a] p<0.01.
[b] p<0.05.
[c] p<0.1.
Note: standard errors in parentheses. Sargan test for overidentifying restrictions. c1 and c2 tests for first and second order correlation in first-differenced residuals.
n.p.c.: not previously classified.

TABLE A.3.3

Colombia: estimation results for equation (4) for the sectors significantly affected by the variable

$q_t D_s$	(1)		(2)	
	Coefficient	Standard error	Coefficient	Standard error
Manufacture of television and radio receivers, sound or image recording or reproducing apparatus, and associated goods	-4.076	(0.280)[a]	-3.831	(0.323)[a]
Manufacture of veneer sheets, manufacture of plywood, laminboard, particle board and other panels and boards	-3.681	(0.214)[a]	-3.810	(0.184)[a]
Finishing of textiles not produced in the same production unit	-1.789	(0.625)[a]	-1.916	(0.703)[a]
Manufacture of rubber products	-1.326	(0.389)[a]	-1.352	(0.332)[a]
Manufacture of non-metallic mineral products n.p.c.	-1.278	(0.308)[a]	-1.227	(0.315)[a]
Manufacture of wooden containers	-1.258	(0.364)[a]	-1.335	(0.287)[a]
Sugar mills and refineries	-1.151	(0.401)[a]	-1.203	(0.412)[a]
Manufacture of dairy products	-1.142	(0.482)[b]	-0.984	(0.482)[b]
Manufacture of refined petroleum products	-1.137	(0.542)[b]	-1.125	(0.519)[b]
Manufacture of other chemical products	-1.033	(0.507)[b]	-0.962	(0.533)[c]
Manufacture of electric lamps and lighting equipment	-1.033	(0.310)[a]	-1.036	(0.340)[a]
Manufacture of paper, cardboard and paper and cardboard products	-0.912	(0.385)[b]	-0.850	(0.398)[b]
Manufacturing n.p.c.	-0.825	(0.318)[a]	-0.809	(0.330)[a]
Weaving of textiles	-0.822	(0.329)[b]	-0.839	(0.343)[b]
Manufacture of structural metal products, tanks, reservoirs and steam generators	-0.770	(0.378)[b]	-0.819	(0.413)[b]
Manufacture of basic iron and steel	-0.726	(0.335)[b]	-0.791	(0.325)[b]
Printing	-0.582	(0.257)[b]	-0.675	(0.306)[b]
Manufacture of footwear	-0.538	(0.195)[a]	-0.545	(0.226)[b]
Manufacture of optical instruments and photographic equipment	0.320	(0.110)[a]	0.380	(0.094)[a]
Publishing	0.679	(0.359)[c]	0.717	(0.381)[c]
Manufacture of insulated wire and cable	2.953	(0.148)[a]	3.013	(0.153)[a]

Source: prepared by the authors.

[a] p<0.01.
[b] p<0.05.
[c] p<0.1.
Note: we present in this table the significantly estimated results for the parameter β_2 in equation (3). Standard errors in parentheses. The shaded rows correspond to the sectors that have been affected positively by the real appreciation of the Colombian peso.
n.p.c.: not previously classified.

TABLE A.3.4

Colombia: share of value added, employees and firms of the sectors that saw a significant impact on value added as a result of real exchange rate appreciation

Sectors significantly impacted by real exchange rate appreciation	Percentages of total		
	Value added	Number of employees	Number of firms
Negative effect	52.7	38.7	35.9
Positive effect	4.0	2.1	5.7

Source: prepared by the authors.

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