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The Impact of Transportation Infrastructure on the Colombian Economy

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Abstract

The Impact of Transportation Infrastructure on the Colombian Economy 1905-1990: An Historical and Econometric Approach.

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This paper measures some of the impacts that development in transportation infrastructure could have on the Colombian economy during the period 1905-1990. The first section of the paper analyzes the responsiveness of the economy to changes in transportation costs and changes in transportation length network, by estimating the demand elasticities for railroads' freight and passenger services. This enables us to calculate the social savings on railroad freight. The lack of data on highways' transportation rates and freight volumes narrows the analysis to the railway sector alone. The second section studies the correlation between coffee expansions and transportation infrastructure improvements. The hypothesis is that improvements in transportation have been trigged by, and subsequently have contributed to, the expansion of coffee exports during the first half of the twentieth century. To test this hypothesis a time series technique, vector auto-regression (VAR) estimation, is implemented. The last section examines whether declines in transportation costs, due to expansions in transportation infrastructure, can explain reductions in the divergences of the agricultural prices gap among Colombian cities. The study of this issue relies on cointegration analysis. Our main result is that railroads did not play an overwhelming role in the Colombian economy. The main problem was the topographical conditions of the country that made railroad constructions very costly, the lack of economic resources, and the not competing forces of alternative transport modes. The results suggest that even highways did not help draw the country together.

The Impact of Transportation Infrastructure on the Colombian Economy 1905-1990

1 Introduction

This paper measures some of the impacts that development in transportation infrastructure could have on the Colombian economy. The first section analyzes the responsiveness of the economy to changes in transportation costs and changes in transportation length network, by estimating the demand elasticities for railroads' freight and passenger services. The lack of data on highways' transportation rates and freight volumes narrows the analysis to the railway sector alone. The second section studies the correlation between coffee expansions and transportation infrastructure improvements. The hypothesis is that improvements in transportation have been trigged by, and subsequently have contributed to, the expansion of coffee exports during the first half of the twentieth century. To test this hypothesis a time series technique, vector auto-regression (VAR) estimation, is implemented. The last section examines whether declines in transportation costs, due to expansions in transportation infrastructure, can explain reductions in the divergences of the agricultural prices gap among Colombian cities. Our main result is that railroads did not play an overwhelming role in the Colombian economy. The main problem was the topographical conditions of the country that made railroad constructions very costly, the lack of economic resources, and the not competing forces of alternative transport modes. The results suggest that even highways did not help draw the country together.

2 Railroads' Price elasticity of demand for freight and passenger transport services estimations

To estimate the responsiveness of the economy to changes in transportation costs we need to estimate price elasticity of demand for railroads' freight and passenger services. This enables us to calculate the social savings on railroad freight.

In Colombia railroad' freight rates and passenger fares were steadily reduced as a consequence of subsidies from the government. Because revenues came mainly from freight and passenger fares, railroads net operating revenues were often insufficient to cover all the spending.

In fact, net revenues were always negative after 1947. The hypothesis is that railroad rate reductions were the primary cause for net losses of railroad revenues. To support this hypothesis it is necessary to estimate price elasticity of demand for transportation service to see how the demand responded to fare reductions. In particular, if the demand for transport services is elastic then it would not be clear that reductions in the rates led to operating losses in the railroad companies. We also want to estimate if railway transportation services were sensible to additions in railroad tracks length, opening of new lines. Lastly, social savings are estimated to infer how much the economy saved due to reductions in transportation cost.

2.1 Data

We assembled railroad data on total freight service per ton-km, passenger service per km, freight rates, passenger fares, and railroad track length for fifteen railway companies for the period 1914-1980. Our main sources of information are the official statistical yearbooks, the railroads national council review, and the yearly memoirs of the ministry of public works. The study sample goes up to 1980, since desegregated information by railroad companies is only available until that year. Data for ton-km and passenger-km were only published since 1931. However, data for tons of freight and number of passengers are available for early years. Then using this information and information on average km we constructed these variables for the period 1914-1930.

On the other hand, data on variables that capturing network quality[2] by railroad companies such as number of stations, locomotives, freight cars, freight yards, doubly tracking, signaling equipment, among others, are too sporadic to be used. As we will see below, to capture network externalities we add to the regressions the total length of nationwide railroads and the population of the department in which the railroad companies had tracks. The latter is a proxy to control for the population of the regions connected by each railroad.

2.2 Econometric set up

The elasticity of demand for freight and passenger transport service is estimated for several specifications, using annual data from fifteen companies for the period 1914-1980. The exercise

[2] D. Puffert (1992) emphasized the role of spatial dimensionality of network externalities in the railroad system.

starts by defining a constant price demand elasticity specification for each given company i, $i = 1, \ldots, N$, in year t, $t = 1, \ldots, T$. In log form, we specify:

$$\ln Q_{it} = \alpha_0 + \varepsilon \ln P_{it} + \beta \ln K_{it} + \gamma \ln Z_{it} + \alpha_i + e_{it}, \qquad (1)$$

where:

Q_{it} is total freight service in terms of ton-km.

P_{it} is the unit price: real freight rate per ton-km.

K_i is kilometers of railroad track in operation.

Z_i is the set of control variables for other determinants of demand.

α_i is a company effect.

ε is the price elasticity of demand for freight, i.e., $\frac{\partial \ln Q}{\partial \ln P} = \varepsilon < 0.$

β is the railroad track length elasticity of transportation demand, i.e.; $\frac{\partial \ln Q}{\partial \ln K} = \beta > 0.$

e_i is the residual, and it is assumed to have mean zero $E[e_{it}] = 0$, and $Var[e_{it}] = \sigma_i^2$;

The set of control variables, Z, includes real GDP, population, and the opening date of each railroad that controls for the creation of railroads own demand for freight. The expected effect is that older companies had a larger level of ton-km or passenger-km, because they had more time to create their own demand.[3] Also we include a dummy for the companies that had tracks in the coffee regions because it is expected that they carry higher volumes of freight.[4] We also include the length of national highways[5] to control for inter-modal competition.[6] This variable may also capture some network externalities between railroads and highways. To capture the network externalities of the railroad system itself, we add the total length of nationwide railroads and the population of the department in which each railroad company had tracks as other

[3] The idea of introducing this dummy variable in the specification came from Summerhill, W. (1996). He estimated railroad demand function for freight in Brazil by 1887.

[4]McGreevey, W. (1975) classified the Antioquia, Cucuta, La Dorada, Girardot-Tolima, and the Pacifico railroad as the railroads of the coffee regions. This dummy is only included in the estimation of the freight demand function.

[5] Data on highways' length are published after 1930, thus estimations with this variable were only made for periods after that date.

[6] A better indicator of inter modal competition could be the unit prices that trucks and buses companies charge for freight and passenger transportation service. Unfortunately, a complete information is not available.

control variables. Finally, equation (1) is also used for estimating the demand function for passenger transportation service, in which Q is total passenger per km, and P is the real passenger fare per km.

The estimation of (1) assumes that prices are exogenous, or they are not controlled by supply shifts, because the observed fares are regulated prices. However, in later estimations this assumption is relaxed.

Two parametric approaches are used. The first uses pooled data equations, which assume that the intercept is the same across companies. The second approach uses fixed effects equations, which assume each railroad has a separate intercept.

Individual effects, α_i, can be fixed or random.[7] The random effect model is excluded because: i) there are not enough degrees of freedom to get consistent between estimator, and ii) the sample of individuals is equal to the population (the fifteen railroad companies).[8]

The model of fixed effects eliminates all the time invariant variables, which in this study case are dummy variables. The presence of fixed effects is usually evaluated by means of the common slope test, which is an F test based on the restricted (pooled) and unrestricted (fixed) sum of square residuals,[9] where the null is the common intercept hypothesis. The rejection of the null favors the model of fixed effects. In addition, all panel estimations took into account the correction for heteroscedasticity across and within panels.[10]

An extension of (1) is to allow endogenous prices for freight and passenger transport services. Then instrumental variables are used in the estimation of both pooled and fixed effects

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[7] The *within estimation* fixes the individual effects by transforming the data into deviation from the mean, and the *between estimation* transforms the data into means. Then, GLS regression combines the information of within and between estimations to obtain the random effect. Following Green (1993) the basic heterogeneity model can be written as $Y_{it}=\alpha_i+\beta'X_{it}+\varepsilon_{it}$ where the individual effects are present in α_i. To obtain the random effect specification the equation can be reformulated as $Y_{it}=\alpha+\beta'X_{it}+\varepsilon_{it}+\mu_i$, where μ_i is the random disturbance characterizing the i^th observation and it is constant through time. To run the GLS regression the data need a transformation through the variance component $\alpha = 1-(\sigma_e/\sigma_1)$, where $\sigma^2_e = e'e/(NT\text{-}N\text{-}K')$ from the within estimation, and $\sigma^2_1 = T.V^{*'}V^{*}/(N\text{-}K)$ from the between estimations

[8] According to Green (1993) the random effects model is appropriate when the population is large. Then the sample of individuals can be randomly withdrawn from the population.

[9] The F test is of the form:

$$F = \frac{(Sr - Su)/(N-1)}{Su/[N(T-1)-K)}$$

where: Sr = restricted sum of squared residuals, Su = unrestricted sum of squared residuals.

See Judge G. et al. (1985), and Hsiao C. (1995).

[10] Heterocedasticity was tested through the White heterocedasticity test.

estimations (i.e., *within* two least square estimations). Besides the exogenous variables in the model the set of instruments for rate includes the rate lagged one period, and a group of dummy variables. This group includes a dummy for railroad ownership (i.e., if the railroad is owned by the nation or by the private sector), a dummy for the period in which railroads were administrated by the *National Railroad Administrative Council*[11], and a dummy for the period in which the railroads financed with the American indemnity for the separation of Panama[12] entered in operation.

A second functional form is based on non-constant price elasticity model. This specification assumes a quadratic term in prices. Using the same definitions as before the non-constant model is given by:

$$\ln Q_{it} = \alpha_0 + \varepsilon \ln P_{it} + \beta \ln K_{it} + \gamma \ln Z_{it} + \phi_1 \ln P_i \cdot \ln K_{it} + \phi_2 \ln P_i \cdot \ln Z_{it} + \delta \cdot [\ln P]^2 + e_{it} \qquad (2)$$

where the price elasticity of demand for freight is given by the following parametric equation:

$$\frac{\partial \ln Q}{\partial \ln P} = \varepsilon + \phi_1 \ln K + \phi_2 \ln Z + 2\delta \ln P$$

and the railroad track length elasticity of transportation demand is

$$\frac{\partial \ln Q}{\partial \ln K} = \beta + \phi_1 \ln P$$

This specification is employed using both exogenous and endogenous rates. Testing the functional form of the demand functions, constant price elasticity against non-constant price elasticity, is done through Wald's tests.

2.3 Results

[11] The National Railroad Administrative Council (Consejo Administrativo de los Ferrocarriles Nacionales) was created in 1931. The *Council* has the function of organizing, regulating all the issues related with railroad constructions and maintenance. It is important to mention that the *Council* decided that rates and fares should be fixed according to social public interest rather than to railroad profit maximization. Therefore, the *Council* reduced both freight and passenger fares.

[12] During the government of Pedro Nel Ospina (1922-1926), the United States paid to the Colombian Government US$25,000,000 as an indemnity for the separation of Panama (that took place in 1903). This indemnity was a windfall gain for the economy that joined with an increase in the international coffee price in 1924 and the insertion of the country in the financial world markets contributed to end the recession of the early twenties. Large percentage of the resources from the indemnity were oriented towards public works constructions, especially to transportation infrastructure.

The estimations of demand elasticities are carried out for 1914-1980 period. This sample is divided in three sub-periods. They are broken according to the main institutional changes in the development of railroad infrastructure in Colombia. The first includes the years from 1914 to 1930. This period is characterized by an active and strong government support in the building of the main track lines.[13] The second phase goes from the thirties to the mid-fifties,[14] which the completion of some lines, and the changes in government transportation policy in favor of highway constructions are the main features of that period. In addition, during these years the *National Railroad Administrative Council* was created and the policy of low rates were fully implemented. The last,[15] covers from the mid-fifties up to the eighties in which railroads become a state enterprise known as *Ferrocarriles Nacionales* and all the railroads were nationalized.

The exercise starts contrasting the null hypothesis of homogeneous intercepts against the fixed effects model in which individual differences are captured by the regression intercept. In the presence of heterogeneous individuals the pooled OLS estimations may lead to serious bias.[16] Thus, the fixed effects model yields unbiased estimators because it controls by non-observable variables associated with each company characteristics. For all periods, the results from the F-test reject the hypothesis of homogenous intercepts in favor of the fixed effects. Regarding the functional form the results from the Wald's test indicate that the null hypothesis of constant price elasticity is not rejected.[17] In sum, the relevant results on the demand elasticity parameter come from the fixed effects, and the constant price elasticity specification.

Table 1 shows a summary of the results of freight and passenger demand elasticities.[18] Column (2) and (6) has the results from the fixed effect estimations based on the constant price

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[13] The Antioquia, Barranquilla, Caldas, Cartagena, Norte section 1 and 2, Cucuta, Cundinamarca, Girardot, La Dorada, Magdalena, Pacifico Sur, Nariño and Nordeste railroads constituted the panel units for the first period.

[14] The panel units that are included in the second period are the Antioquia, Barranquilla, Caldas, Cartagena, Norte section 1 and 2, Cucuta, Cundinamarca, Girardot, La Dorada, Magdalena, Nordeste, Nariño and Pacifico railroads.

[15] The panel units included in this period are the Antioquia, Centrales, Magdalena and Pacifico railroads.

[16] See, Hsiao C. (1995).

[17] We estimate the non-constant price elasticity for the entire period. Then, based on these coefficients, elasticities for each sub-period are evaluated at the means of the explanatory variables.

[18] Ramírez María Teresa (1999) presents the complete results from the constant price elasticity for the pooled and fixed effects estimations.

elasticity model. In particular, the former reports the inferences when exogenous prices are assumed, while the latter shows the estimations for the case of endogenous prices.

For the entire sample, the demand for freight and passenger transportation tends to be inelastic to changes in rates.[19] In fact, the elasticity for freight is –0.81 and –0.96, when rates are considered exogenous and endogenous respectively. Concerning passengers, that elasticity is lower [–0.58 and –0.66]. These results suggest that the government's policy of reducing rates did not attract substantial increments in the volume of freight and passengers. Rates were set below the optimal level, because public authorities set them according to social service criteria rather than monopolists' profit maximizing prices. Thus, railroads operated in the inelastic proportion of their demand curves. Regarding railroad tracks, transport service for freight is elastic to tracks' length [1.63 and 1.66], while transport service for passenger is not [0.69 to 0.72].

In addition, it is important to analyze by periods the railroad's activity. The evolution of the operating revenues is a good indicator for that purpose.[20] Graph 1 depicts that revenues had a positive trend from 1915 to 1946.[21] Thereafter, that trend is decreasing.[22] In particular, from 1915 to 1930 railroads operating revenues grew at annual rate of 7.5%, along with an increase in the operating capacity. In fact, the transported freight grew on average in ton-km in 15% per-year, and passenger movement grew 18%. Nonetheless, between 1931-1946 revenues grew only 3% per-year. During this period new railroads entered in operation. These projects were financed with the American Indemnity resources and external debt.[23] Despite this network extension, railroad revenues were less than half of those in the previous period; the growth rate fell to 8% per-year in freight and 7% for passengers (graph 4). The demand elasticity also fell for this period. The price elasticity for freight is considerably lower [–0.18 and –0.38] than those reported for 1914-1930 period [–0.44 and –0.54].[24] In contrast, the demand elasticity for passengers was slightly higher

[19] This result is according to the international evidence. Oum Tae. H. et al. (1990) concluded from a survey of estimates of price elasticities of demand for transport that since transportation is a derived demand, it is not surprising that it tends to be inelastic.

[20] See Gómez, A. (1982).

[21] The annual rate of growth was 5.4% for total railroads, and 8.2% for national railroads.

[22] The years after 1946 were characterized by the nationalization of the railway system that results in large reduction in railroad rates .

[23] For instance, four national railroads, which their construction started in the previous decade, were opened in 1931.

[24] Summerhill, W. (1996) found that the price elasticity of demand for railroad transportation in Brazil by 1887 was –0.7. Coatsworth, J. (1976) found that this elasticity was –0.558 in Mexico by 1910.

passing from –0.58 to –0.67 between both periods when prices are exogenous, and from –0.59 to –0.88 when prices are endogenous in the system. Regarding the demand elasticity for railroad tracks, this coefficient fell drastically between these periods for both freight and passengers (table 1).

The above results suggest that the economy responded in large magnitude to the earlier railroad expansion, while the later additions in track length had only a moderate impact on railroad's transportation services. In fact, according to graph 2c the last expansion of railroads' tracks did not increase the volume of freight. The average ton-km by line was almost constant between 1914 and 1942. At least two arguments explain this outcome. The first one is associated with the development of highway construction since 1930. Highways gave competitive pressure to railroads with higher quality service, providing more coverage and flexibility, despite higher fares (table 2).[25] Second, the economic situation in both domestic and international markets created a sharp drop in Colombia's international trade, due to i) the economic recession of the thirties, and ii) World War II. In sum, railroad companies were not able to sustain their own demand or create a new one. The drop in the demand elasticity also reflects the relative inefficiency of Colombian railroads.

After 1955, freight price elasticity and track elasticity are much more elastic than in previous periods (table 1), while passenger price elasticity remained the same. This result is mainly explained by the construction of the Atlantic Railroad, which connected new strategic regions to the nation's capital.

Regarding the other control variables, it is important to mention that, in general, the total length of nationwide railroads was not significant in the estimations while population by department was significant with the expected sign in the equations of passenger demand; and the length of national highways was also significant with the expected sign in both freight and passenger demand equations.

2.4 Social Savings Estimation

According to Robert Fogel (1964) the social saving methodology consists in calculating in any year the difference between the actual cost of shipping goods in that year and the alternative cost

[25] See *Memorias del Ministerio de Obras Públicas y Transporte* during the 1930's.

of shipping exactly the same bundle of goods without the railroads.[26] He used this methodology to evaluate the proposition that railroads were indispensable to American economic growth during the nineteenth century. He found that railroads did not make an overwhelming contribution to American economic growth.[27] After Fogel's study, the counter-factual methodology, social savings estimations, was applied to different countries by a large number of researchers.[28] However, social savings methodology has generated large controversy because its calculation assumes a counter-factual scenario that involves very strong assumptions.[29] Despite the criticisms on this methodology,[30] we decided to calculate the social saving for 1927 because i) there is a complete information on rates for this year, and ii) social saving estimations keep in accordance with the new line of research on railroads, and allow us to contrast the Colombian experience with other studies.

Railroads in Colombia were constructed with the purpose to connect productive regions with the Magdalena River,[31] and then with seaports. For this reason, railroads were a complementary system to fluvial transportation[32] rather than a substitute. Indeed, railroads were mainly a substitute to the costly earlier land transportation, say mules, human porters and animal-drawn carts.

Table 2 presents the rates by mode of transportation taken from different sources. For instance, McGreevey (1975) calculated that the average rate for freight transportation by mule between 1845-1930 was $0.416 per ton-km, while the average rate for freight transportation by

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[26] See also, P. O'Brien (1977).

[27] Fogel (1964) states that " Economic growth was a consequence of knowledge acquired in the course of the scientific revolution of the seventeenth, eighteenth and nineteenth centuries. This knowledge provided the basis for a multiplicity of innovations that were applied to a broad spectrum of economic process. The effectiveness of the innovations was facilited by political, geographic and social rearrangements. All of these developments began before of the birth of the railroad and the railroad was not needed for transformation in economic life that followed from them". (Page 235).

[28]For instances, John Coatsworth (1981) estimated the social savings of railroads in Mexico, William McGreevey (1975) calculate the social savings for Colombia's coffee railroads, Antonio Gomez Mendoza (1982) for Spain, William Summerhill (1996) for Brazil, G. R. Hawke (1970) among others.

[29] For a survey on this controversy, see Fogel, R. (1979).

[30] Calculations of social savings on backward economies received major criticisms. For instance, G. Toniolo (1983) stated that the social savings approach is not fruitful for the study of the contribution of railways to the economic growth in backward economies (page 227).

[31] The *Magdalena* River is the main navigable river in Colombia.

[32] Graph 5 shows the in spite of railroads constructions freight transported by the Magdalena River presented a positive tendency.

railroads between 1905-1929 was $0.15 per ton-km. According to the Ministry of Public Works[33] in 1927 the rates for freight by mode of transportation were by human porters $1 per ton-km, by mules $0.4 per ton-km, by animal-drawn wagons $0.2 per ton-km, by the Magdalena River $0.024 per ton-km, and by railroads $0.05 per ton-km. Thus, transportation rates by animal-drawn wagons were four times larger than railroads' rates, and mules' rates were eight times larger. It is important to note that the Magdalena River's freight rates were always lower than railroads' rates.

Social savings generated by railroads are calculated based on the above information. Table 3 presents the estimations for 1927. This year seems a good choice since the government strongly supported the construction and maintenance of railroads, and the alternative modes to railroad transportation were still mules and animal drawn carts.

The results indicate that by 1927 the social savings represented 7.8% of the GDP, assuming that mules were the alternative mode of transportation to railroads, and 3.37% of the GDP, assuming that animal-drawn carts were the alternative mode. Comparing these values with the international evidence, their magnitude is very similar to those estimated for the United States for the nineteenth century (see Fogel, 1964 and Fishlow, 1965). These values are higher than those calculated by William McGreevey (1975) for the Colombian coffee railroads of 3.2% of the GDP in 1924, assuming mules as the main alternative mode of transportation to railroads. However, they are considerably lower than the estimated social savings for countries with pre-rail conditions similar to Colombia. For instance, William Summerhill (1996) estimated a social saving for the Brazilian Railroads of 5% of the GDP for 1887, and 22% of GDP for 1913, and John Coatsworth (1976) estimated a social saving for Mexico equal to 24% of the GDP for 1910.

Finally, one of the main criticisms to the social saving methodology is that in its calculation a price elasticity of demand is assumed equal to 0. To correct for this problem Fogel (1979) proposed to adjust the social saving as: $\frac{S_t}{S_0} = \frac{\varphi^{1-\varepsilon} - 1}{(1-\varepsilon)(\varphi - 1)}$ for $\varepsilon \neq 1$, where S_t is the true social savings, S_0 is the social saving computed on the assumption that $\varepsilon=0$, φ is the ratio between the alternative mode of transportation rate and the railroad rate.

Following this suggestion, the social saving indicator for Colombia was adjusted assuming a price elasticity of demand of $|0.5|$. The new result is a social saving of 4.11% of GDP if mules were the alternative mode of transportation, and 2.25% of the GDP if animal-drawn cart is assumed as the alternative mode of transportation. Adjusted for the same price elasticity of

[33] See *Memorias del Ministerio de Obras Públicas y Transporte,* 1927

demand the social savings on railroads freight service in Mexico by 1910 was 16.6% of the GDP, and the social savings in Brazil by 1913 was 11.2% of the GDP.[34] Again these values are considerably higher than those estimated for Colombia in 1927.

This result suggests that the gains from railroads' construction in Colombia were lower than the gains in other countries with similar pre-rail transportation systems.

3 Link between railroads and the Colombian export sector: The coffee case

The economic historians have emphasized the existence of a close inter-relationship between railroad development and the rise of coffee exports in Colombia. Most of the literature has characterized that link as indispensable (Beyer, 1947, McGreevey, 1975, Urrutia, 1979, and Poveda, 1986, among others)[35]. The literature emphasizes this interrelationship based on the fact that former railroads were constructed with the purpose to move coffee to the ports. For example, the *Cucuta* railroad constructed in 1888 crossed the main coffee zones at that time. Thus, to make competitive coffee exports from other regions it was necessary to reduce the transportation cost through railroad constructions.[36]

Historically, from the last years of the nineteenth century up to the beginning of 1990's coffee was the main exported commodity (Graph 6).[37] The expansion of coffee production started by the end of the 1880's and by 1898 the share of coffee in total exports was more than 50%. However, coffee production declined during the *one thousand days' war* (1899-1902), and only by the mid 1910's did coffee exports reach again the observed values of 1898. The periods of coffee expansions coincided with the impulse of railroad constructions. Beyer (1947) estimated that 71% of the total kilometers of railroads by 1898, and 80% by 1914, were utilized for coffee transportation (table 4). In addition, coffee exports represented more than 70% of total freight moved by the Antioquia railroad in 1895, 70% of the total freight moved by the Girardot railroad

[34] See Summerhill, W. (1997)

[35] For instance, Urrutia, M. (1979) states that "The coffee history is closely related with the railroad history. Without coffee, railroads would not have been economically feasible, and coffee would not have been expanded without railroads."

[36] See Urrutia, M. (1979) and Poveda, G. (1986).

[37] From 1942 to 1962 coffee represented more than 80% of the value of total exports and, until 1985 coffee represented more than 50% of this value.

in 1908, and a similar percentage was observed for the Barranquilla railroad in 1891.[38] These figures have been used[39] to highlight the influence of railroads on the expansion of the coffee sector. However, railway lengths were insufficient and unconnected among regions. Consequently, these numbers have to be interpreted with caution. According to Palacios (1980), by the 1910's mules continued to be the main means of transporting coffee.[40]

Figure 7 depicts railroad freight by sectors since the mid 1920's. The graph shows that in relative terms the agricultural economy was closely related with railroads. Agricultural commodities represented 30% of the total volume of goods transported by rail in 1930's. Hereafter, its share remained constant, around 25%, until 1970. Graph 8 depicts the quantity of coffee shipped by railroads during the period 1926-1981. As we can observe, the absolute amount of total coffee freight fell throughout the period. For instance, railroads shipped 518,412 tons of coffee by 1946, while they only shipped 271,526 tons in 1966, and only 168,103 tons in 1978. In addition, graph 8a shows the share of coffee in total railroad freight. By the end of 1920's the share of coffee was 16%. Thereafter, it started to decline, and by 1961 that share represented 5% of the total freight. One reason that explains such a decline was the appearance of truck competition, which covered large parts of the coffee regions. Another factor was that the *Buenaventura* port, located in the Pacific Ocean, became the main port for coffee exports. In fact, more than 60% of coffee exports were shipped by the *Pacific* railroad to the *Buenaventura* port in 1950,[41] so the other coffee railroads[42] lost their importance in transporting coffee. For instance, the share of coffee in the total freight transported by the *Antioquia* railroad passed from 70% in 1895 to 20% in 1933 and to 7% in 1950. Similarly, for the *Girardot* railroad that share passed from 70% in 1908 to 7% by 1950.[43]

To sum up, railroads appear to have played an important role in coffee expansions, because early lines were constructed mainly to transport coffee.[44] The purpose of this section is

[38] See Beyer, 1947

[39] See Poveda Ramos, G. (1986).

[40] See Palacios, M. (1980)

[41] See Anuario General de Estadistica, several years.

[42] Such as the Antioquia Railroad, The Girardot Railroad, The Caldas Railroad, The Cucuta Railroad and La Dorada Railroad.

[43] Own calculations based on data from the *Anuario General de Estadistica* (several years).

[44] As pointed out by Bayer(1947) the pattern to transport coffee during the XIX century was fairly uniform: from plantation to river by mule, from river port to coastal port by boats.

not to determine if there was or was not a relation between railroads and coffee expansion. Instead, the interest is in answering the questions: i) to what extent railroads affected coffee expansions? , ii) How large were those effects?, iii) There was a two way causality? Or what was the direction of the causality?

3.1 Data

Time series information are available for railroad tracks (in km) and coffee exports (in bags of 60 kilograms) from 1896 to 1990. However, the analysis is narrowed for the period 1904 to 1955, for two reasons. First, during the *one thousand days' war* (1899-1902) coffee's crops were destroyed, railroad construction was stopped, and railroad companies stopped operations. Second, because of the consolidation of the highway system by mid 1950's, railroads lost their importance in coffee transportation.

3.2 Results

This section employs time series techniques, *Granger Causality* tests and Vector Autoregresive (VAR) estimations, to answer the above questions. To avoid the problem of spurious regression, the starting point is to determine the stationarity of the series, that is, to evaluate if the series have a unit root. These tests are carried out through the Augmented Dickey-Fuller (ADF) test.[45] Table 5 reports the results for the log of the volume of coffee exports and railroad track length.[46] The result indicates that the null hypothesis of a unit root is rejected at 5% of significance for both cases. Therefore, the series are stationary, i.e., I(0).[47] Then, the *Granger Causality* test is used to determine whether railroad constructions influenced coffee exports. Table 6 summarizes the

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[45] The most general form of the ADF model is:

$\Delta y_t = \alpha_0 + \alpha_1 t + \gamma_1 y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + \varepsilon_t$, where α_0 is the *drift* or intercept parameter, t is a linear time term , ε is the error term, and p is the lag length. There must be as many lags of Δy_t necessary to whiten the errors. Under the null hypothesis $\gamma_1 = 0$ meaning that the variable contains a unit root. For more details on unit roots tests see for instance Enders, W. (1995) and Harris, R. (1995).

[46] The lag structure was chosen according to the Akaike Information Criteria (AIC). The number of lags must be the adequate to make the residuals be white noise, and pass the test of serial correlation and normality.

[47] This result was confirmed through Phillips-Perron Tests.

results.[48] They suggest that there was a two-way relationship between these two variables, as the literature has suggested. Coffee exports helped to explain the expansion in the railroads system, and railroads helped to explain the expansion in coffee exports. This result is not surprising because railroads were built to transport coffee to the ports. In addition, coffee was the compensated freight for railroads that guaranteed their economic feasibility, at least in the first years of operation. The following relevant question is to establish the magnitude of such effects. The estimation of the following VAR system is carried out to study the dynamic interrelationship between coffee exports and railroad track length for the period 1905-1955:

$$y_t = \alpha_1 + A_{11}(L)y_{t-1} + A_{12}(L)x_{t-1} + \mu_{1t} \quad (3)$$

$$x_t = \alpha_2 + A_{21}(L)y_{t-1} + A_{22}(L)x_{t-1} + \mu_{2t} \quad (4)$$

where y_t is the log of coffee exports during time t, x_t is the log of railroad track length during time t, α_i is the constant, A_{ij} are the polynomials in the lag operator L, and μ_{1t}, μ_{2t} are the white-noise error terms. An important issue is the determination of the optimal lag length. The ACI and the SBC indicate that 2 lags are the most appropriate lags for the system.[49]

Graphs 9 and 10 depict the results from the impulse response function. In this case, the impulse response function quantifies the effects of an initial shock of the railroad track length on coffee exports, and the effects of a shock of coffee exports on the railroad length.[50] In the VAR models the shocks are measured as a first period standard error shocks. To standardize the response of one variable to the other, the units of the impulse response function are in terms of residual's standard deviation.[51]

Graph 9 depicts the effects on railroad length of a one standard deviation shock to the error term in the coffee export equation (μ_{1t}). The vertical axis measures the response of the

[48] To carry out the test, it is necessary to determine the optimal lag length, since the results would be sensible to the number of lags, *p*, included in the equations. The AIC selects a lag length equal to two.

[49] The selection of an optimal lag length has to guarantee white noise residuals.

[50] The identification issue it is very important here. To orthogonalized the innovation we used the Choleski decomposition. The order of the variable was: log of railroad tracks, log of coffee exports. However, in our results the order of the variables had not qualitative effects since the contemporaneous correlation between the errors is very small (0.092). Therefore, in this case the order of the factorization makes little difference.

[51] We divide the response of a variable by the standard deviation of its residual variance. Then all the responses are in fractions of standard deviations. This is the method used by the statistic package RATS. See RATS user's manual, version 4 (1996)

shock, while the horizontal axis measures the time horizon following the shock. The results indicate that increases in coffee exports affected positively railroad track length. That is, expansions in coffee exports induce new construction or expansion in the railway system. After one year of the innovation, railroads constructions began to increase, reaching their maximum response at four years; after that the effects decline. However, the magnitude of this response is low, because it represents at most one-third of the standard deviation.

Graph 10 plots response of coffee exports due to a shock in railroad tracks length. Increases in railroad length led increases in coffee exports. After four periods these effects start to vanish. The magnitude of these effects is also low (one-fifth of the standard deviation).

Table 7 presents the variance decomposition for a forecasting horizon of 10 years. The variance decomposition of the error indicates what proportion of the movements in a series is due to its own shocks against shocks to the other variables.[52] The results from Table 7 are consistent with those from the impulse response function. At the first steps, much of the variance of the error in both series is explained by their own shocks. After the third period, the series gain importance in explaining each other's innovations. For instance, the change in coffee explains 8.7% of the forecast error variance of railroad length in the fourth period. Similarly, railroad length explains 7.4% of the forecast error variance of coffee exports. These almost symmetrical results confirm the feedback relationship suggested by the results of the Granger Causality test.

The results suggest that there was a feedback relationship between coffee exports and railroads' expansions, but the magnitude of the response of one variable to changes in the other was small. One reason is that the Colombian railway system had few and unconnected tracks that could not substitute completely for the traditional means of transportation for coffee by land, mules, at least during the first thirty years of the century. Then railroads were replaced by the highway transportation system, and the importance of railroads in transport coffee declined drastically. This result leads to the question of what was the interrelationship between highway developments and coffee expansions?

The same procedure is applied for the log of coffee exports and kilometers of highways. The exercise covers the period 1936-1990. Table 5b indicates that both series are stationary. The second step is to estimate the VAR system. According to the ACI the optimal lag are 2 periods. Graphs 11 and 12 plot the time path resulting from the impulse response function. In particular, Graph 11 plots the effects on coffee exports of a one standard deviation change in highways'

[52] See Enders (1995)

length. Increases in highways' length lead to increases in coffee exports. The magnitude of this effect is considerably larger than that produced by increasing railroads' tracks. The coffee exports response to changes in highway's kilometers represents half of the standard deviation while the response to changes in railroad tracks' kilometers is one-fifth of the standard deviation. On the other hand, graph 12 plots the response of highway's length to increases in coffee exports. The graph indicates that increases in coffee exports affected positively the length of highway. One interpretation could be that increases in coffee's exports raised the economy's income enhancing investment highways. The results from the variance decomposition confirm the above results (table 8). At period four, highway length explains 20% of the forecast error variance of coffee exports, a larger percentage than that explained by railroad length (7.4%). In addition, the same exercise is applied for the log of coffee exports and the log of highways plus railroads kilometers. The estimations reported in graphs 13 and 14 confirm the above results.

In sum, the results from those exercises suggest that railroads did not play the overwhelming role in the expansion of coffee exports in Colombia, in contrast to the traditional hypothesis.

Finally, the construction of railroads favored the export sector in other Latin America countries to a greater extent than in Colombia. In particular, larger gains took place in Mexico, where half of the social savings on railroads freight services were attributed to the export sector.[53] On the other hand, Summerhill (1995) points out that coffee growers in Brazil obtained large benefits from the decrease in transport costs made possible by railroads, but over time, similar to Colombia, the impulse to coffee production from cheap transport declined.[54]

4. Transportation's infrastructure developments and its effects on market integration: Convergence in agricultural commodity's price among regions.

Developments in the transportation infrastructure lower the cost of freight and reduce commodity prices in the market. In this way transportation's developments link distant markets and reduce the price gaps for the same commodity across regions. In other words, as a consequence of reduction in transportation costs, commodity prices among regions tend to converge resulting in an integration of the market. This is the hypothesis that this section attempts to test empirically

[53] See J. Coatsworth (1981)

[54] See W. Summerhill (1995), page 165.

for agricultural prices in Colombia. The primary result is that price dispersion across region declined sharply during the thirties with the development of highway infrastructure, and the expansion of the railway system, but after that no further major declines in inter-regional price dispersion took place.

4.1 Data

To examine whether declines in transportation costs, due to expansions in transportation infrastructure, can explain reductions in the divergences of agricultural prices among Colombian cities, we assembled annual price series for eight agricultural commodities for the twelve larger cities in the country. The goods in the sample are potato, rice, corn, sugar, salt, *panela,*[55] plantains and red beans, which are typical components of a household consumer basket in Colombia;[56] and the cities are Bogotá, Barranquilla, Bucaramanga, Cali, Manizales, Medellín, Pasto, Cartagena, Cucuta, Naiva, Pereira and Villavicencio[57]. Our main sources of information are the *Anuario General de Estadística de Colombia*, the *Anuario Estadístico del Ministerio de Agricultura*, and the *Boletín Mensual de Estadístical del DANE*. Price data were assembled for the period 1928-1990.

4.2 Agricultural Price Convergence in Colombia: 1928-1990

In this section we are going to use three different approaches to measure agricultural price convergence across main regions in Colombia. The first one is to examine the evolution of a coefficient of variation among cities for each agricultural price series.[58] W. Summerhill (1995) uses this approach to illustrate the degree of intra-regional market integration due to transportation improvements that took place during the second half of the 19th century in Brazil.[59]

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[55] *Panela* is a kind of brown sugar that is compacted in small blocks. *Panela* is a commodity broadly consumed in Colombia.

[56] Actually, sugar, salt and *panela* are not indeed agricultural goods. Sugar and *panela* can be classified as manufactured agricultural goods, while salt is a manufactured mineral good.

[57] As in Slaughter (1995), it is assumed that city's prices reflect the overall regional price. Of course, as he pointed out rural prices probably exceed urban price because of additional transportation costs.

[58] The coefficient of variations is defined as the standard deviation of the series divided by its mean.

[59] Because of data problems William Summerhill (1995) limited the analysis to the intra-regional price convergence instead of the inter-regional price convergence.

To this end, he computes a coefficient of variations for local coffee prices among thirty-six counties in the province of Sao Paulo. His main result is that intra-regional price dispersion fell from 0.27 in 1854 to 0.14 in 1906.[60]

Following this approach, we construct a coefficient of variation for eight agricultural commodity prices among the twelve larger cities[61] of Colombia from 1928 to 1990. Table 9 and Graph 15 illustrate the evolution of price dispersion among regions. The results suggest that inter-regional price dispersion was substantial for the earlier years of the thirties. That large dispersion could be the result of the deficiency in transportation infrastructure, partly because of geographical barriers, that results in higher transportation costs[62] and isolation of the regions. The lack of an adequate transportation infrastructure explains that the production of some commodities was oriented mainly to supply local markets making the quantity of goods moved across regions very small. However, during the thirties, the coefficient of variation declined sharply. In fact, by the end of 1930's regional price dispersion was considerably smaller than in the previous decade. For instance, the coefficients of variation of some agricultural prices in 1938 were three times smaller than those recorded in 1928. This decline might be associated with the development of highway infrastructure, and the consolidation of the railway network[63], which lowered freight fares and interconnected markets. From 1945 to 1990 coefficients of variations, in general, maintained a rough constancy. This result suggests that no further major declines in inter-regional price dispersion took place in Colombia.

In particular, graph 15 shows that *panela* and potatoes were the goods in which the reductions in inter-regional price dispersion were larger. In fact, the coefficient of variation for *panela* fell from 0.60 in 1928 to 0.17 in 1940, and for potatoes it fell from 0.41 in 1928 to 0.22 in 1940. It is important to mention that these two commodities are produced mainly in the central region of country where major developments in transportation infrastructure took place. On the other hand, the price of rice presented the smaller dispersions among cities. This result is

[60] See William Summerhill (1995), page 67

[61] Under the assumption that the price of each city represents the price of its own region.

[62] Higher transportation cost were also the results of higher charges imposed for transferring cargo, higher terminal handling costs, and higher insurance rates. According to Currie (1950), the combination of these costs raised 20 to 25 percent the transportation costs over what might otherwise be reasonably expected (page 102).

[63] Saying that the railways system was consolidated by the end of the 1930's can be an exaggeration, since Colombia had few and disperse railroads tracks compared with other countries, even countries with the same level of development.

explained by the fact that rice is produced is various regions of the country (mainly in Bolivar (north), Tolima (center) and Meta (center-south)).

The second approach to examine whether there was commodity price equalization across regions is to estimate the rate of price convergence among pairs of cities. To this end, we follow M. Slaughter (1995) who estimates the commodity price convergence that was induced by the antebellum transportation revolution in the United States. The relation between prices in region A and B can be written as $P_B = (1+c_{ad})\, P_A$, where c_{ad} is the percentage ad-valorem transportation costs, and $P_A < P_B$. P_B/P_A goes toward one when transportation costs approaches to zero. This relation is estimated in terms of the log-linear regression specification: $ln(P_B/P_A)_{it} = \alpha_i + \beta t + \varepsilon_{it.}$ If $\beta < 0$ the series converges, if $\beta > 0$ the series diverges. To estimate the equation, Slaughter constructs price ratios for each chosen commodity in each city.[64] The ratios should be initially greater than one so that convergence means that the ratios decline towards one. He finds a strong convergence in each commodity ratio.[65] Then, he concludes that transportation revolution strongly integrated product markets because it sharply cut interregional transportation cost by building canals and railroads.[66]

We examine convergence among seven cities in Colombia. The cities represent six main regions within the country. The central region is represented with Bogotá, the west central with Medellín and Manizales, the north with Barranquilla, the east with Bucaramanga, the west pacific with Cali, and the south with Pasto. We chose these cities because besides that they represent the major regions of the country; they have the larger time series coverage for the commodity prices. The commodity price sample was reduced to *panela*, potatoes, corn, rice, sugar and salt. We drop from the sample plantains and red beans because the time series for these goods are too sporadic, i.e. these series do not have continuos coverage across cities for the study sample. In total we construct twenty-one price ratios for each commodity. As we mention above, the ratios are

[64] He estimated commodity price convergence among six cities: Boston, New York, Philadelphia, Charleston, New Orleans and Cincinnati.

[65] Slaughter (1995) also assumed specific transportation costs then the relation between prices in region A and region B is given by $P_B = P_A + c_s$, where c_s is the dollar specific transportation costs and again $P_A < P_B$. Since the transportation revolution lowered c_s then $(P_B - P_A)$ approaches to zero when c_s tends to zero. He constructed price differences for each commodity in the six cities in the way that price differences should be initially greater than zero. The econometric model to be estimated is of the form $(P_B - P_A)_{it} = A{*}exp(\beta t \varepsilon_{it})$. In log-linear regression specification the equation became $ln(P_B - P_A)_{it} = \alpha_i + \beta t + \varepsilon_{it}$. For each price difference he used OLS to estimate β. He found strong convergence, since almost all the price differences converges towards zero.

[66] See Matthew Slaughter (1995), page 1.

constructed to be initially greater than one, so convergence is met when the ratios decline towards one.[67]

Tables 10 to 15 summarize the results for the convergence estimation between pairs of cities, and graph 16 plots the actual and estimated price ratios. We estimate convergence rates (β) first for the entire period 1928-1990, and then for the 1950-1990 sub-period, when major developments in highways infrastructure took place.

Table 10 reports the result for the potato price series. Potato prices are lower in Bogotá and Pasto, which are located in the main regions that produce this good. For the first period, only eight price ratios converge towards one; two ratios diverges; and the coefficient of the other eleven price ratios are not statistically significant. The magnitude of the estimated convergence rate for all the eight price ratios that converge is very small. In fact, the range for the estimated convergence rates varies from –0.0075 to –0.0020. Taking for example the larger rate (Cali/Manizales), the results indicate that this price ratio converged towards one at a rate of 0.75%. This means that the price ratio in 1990 had fallen to about 63% of its 1928 value; and the half–life of convergence is about 92 years. Looking the ratios, the results suggest that in general geographical proximity explain the convergence. It is the case of ratios such as Bucaramanga/Bogotá, Cali/Bogotá, Medellín/Barranquilla, Cali/Manizales, Cali/Medellín, and Manizales/Medellín. Surprisingly, we did not find convergence between Manizales/Bogotá and Medellín/Bogotá. It is important to highlight that none of the ratios that include Pasto converge towards one. This means that there exists a segmented market for this commodity.

The results for the sub-sample 1950-1990 are quite different. First, the rates of convergence are, in general, larger than the rate for the entire period. In fact, the range for the estimated convergence rates varies from –0.0011 to –0.0032. To compare the results, we take for instance the Barranquilla/Bogota ratio. For the entire period, the rate of convergence is –0.0045. This means that the price gap between the two cities vanishes 0.45% in one year, and the half-life of convergence is about 150 years. While the results for the 1950-1990 sub-sample indicate that the gap between the prices vanishes 1.1% per year, and the half-life of convergence is about 61 years. Two more results are also important. First, all the price ratios that include Barranquilla, except for Barranquilla/Pasto, tend towards one. This result means that after the fifties the potato price of Barranquilla tended to be equal to the potato price in other cities, as a result of

[67] See Matthew Slaughter (1995), page 11.

improvements in the transportation network. Second, the potato price of Pasto diverges from the potato price of all the cities. This result can be an evidence of market segmentation for this good.

Table 11 presents the results for the *panela* ratios. For the entire period twelve ratios converge to one; two ratios diverge; and seven are not statistically different from zero. In general, the rate of convergence for the *panela* price is faster than for the potato price. The convergence rates lie between –0.016 and –0.0021.The faster convergences are between Bogotá and Bucaramanga, and Bogotá and Cali, which are cities with good transportation networks. In those cities, price ratios converged towards one at a rate of 1.5% per year. That is a price ratio in 1990 fell to about 41% of its 1934 level; and the half-life of convergence is about 46 years. The price dispersion between Manizales and Bogotá, and the lack of price convergence between Manizales and Medellín are two surprising results given their close geographical location. Again, the price in Pasto, which is the most remote city within the sample, does not converge towards the price of the other regions. For the 1950-1990 sub-sample, price six ratios tend to diverge in spite of their closer location. It is the case of Manizales/Medellin, Bogotá/Manizales, Bogotá/Medellín.

Table 12 summarizes the results for rice ratios. Twelve ratios converge towards one. However, the rate of convergence is slower than for the *panela* prices. The magnitude of the rates is between –0.0077 and –0.0021. The results of the sub-sample differ from the results of the entire period mainly in the fact that during the 1950-1990 Bucaramanga did not converge towards the price of the others cities. Table 13 presents the results for corn. Eleven price ratios between pair of cities converge but at very slow rate. In fact, the rate values are between –0.012 and –0.002. A puzzling result is the convergence between the prices of Pasto and Barranquilla since these cities are located in the extreme part of the country. For the period 1950-1990, it is important to highlight that the price of Bogota diverges at a rate near to 1% per year from the prices in Manizales, Medellín and Pasto.

Table 14 presents the results for the price of salt convergence between pairs of cities. Again the evidence for the entire sample suggests that Pasto is not integrated with the market of other regions. However, for the 1950-1990 period the price from Pasto tends to converge towards the price of Cali, Manizales and Medellín. Finally, table 15 shows the results for sugar. For the entire period, there are eleven ratios that converge to zero, but at very slow rate, even slower than the rate of convergence for the others commodities. In this case the largest rate of convergence is –0.0046. For the sub-sample the rates of convergence are slower, and there are only seven price ratios that converge. This evidence suggests that nationwide the markets for this good are not integrated.

Finally, in the traditional empirical literature of economic growth, the convergence hypothesis is tested based on cross-section methods. In particular, the existence of convergence is supported by the negative correlation between countries' initial per capita income and its rate of growth[68]. Alternatively, Bernard and Durlauf (1991 and 1995) and Jordi Suriñach et al. (1995) suggest the use of time series techniques such as unit root and cointegration analysis for testing convergence. In particular, Bernard and Durlauf (1995) implement this approach to test convergence of the per capita output across advance industrialized countries. Convergence is defined when each country has identical long-run trends. Consequently, this definition leads to the use of cointegration theory to establish long run equilibrium relationships. Using annual time series of log real output per capita for fifteen industrialized countries they found no evidence of convergence across countries[69]. In the same way, Jordi Suriñach et al. (1995) estimates the convergence of commodities price among five Spanish regions (*Comunidades Autónomas*)[70]. The results of such study suggest that there is no evidence of price convergence[71].

The relationship between an agricultural price in two regions, can be expressed as[72]:

$$P_{ikt} = A_i P_{jkt}^{\beta_i} e^{\varepsilon_{it}} \qquad (5)$$

where: i and j denote region, k indexes commodity, t indexes time, and $A_i = \exp\{\mu_i\}$ includes the deterministic components. Taking logs (5) becomes

$$\ln P_{ikt} = \mu_i + \beta_i \ln P_{jkt} + \varepsilon_{it} \qquad (6)$$

where β_i represents the variation of region i due to changes in region j.

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[68] See Chapters 1 and 2 and Barro-Sala I Martin (1995)

[69] For details on definitions, tests, and results see Bernard and Durlauf (1991 and 1995).

[70] To estimate commodity price convergence among regions they used the monthly food's consumer price index of five *Comunidades Autonómas:* Andalucía, Aragón, Cantabria, Cataluña, and Extremadura from 1978 to 1992. They also used cointegration techniques to estimate the convergence of the employment levels among regions in Spain.

[71] The main difference between the two studies is that J. Suriñach et al.(1995) tests convergence of the food's consumer price index between each region (*Comunidad*) and the average national magnitude and not the convergence across regions. Conversely, Bernard and Durlauf (1991, 1995) test the convergence of the per capita output across regions (countries).

[72] This specification follows closely J. Suriñach et al. (1995) except that they established the relation between the regional series and the national series, not among regions as we say above.

Equation (6) represents the linear equilibrium relationship when the series are cointegrated. Therefore, prices have common trends and they can not move independently from each other[73], that is, there exists of a common evolution in the series' long run behavior[74], and markets are geographically integrated. However, cointegration is not sufficient to determine convergence. According to Suriñach et al. (1995) the magnitude and sign of β_i and μ_i will help to know if there is a convergence or divergence in the prices among the regions[75]. To keep a constant equilibrium relationship it is necessary that β_i be equal to one. If this is the case, price changes in region *j* will cause a proportional variation in region *i's* prices. Second, μ_i will measure inter-regional price difference if $\beta_i = 1$[76]. We assume that μ_i represents the transportation costs that explains price's differences between two regions[77]. In sum, to achieve convergence it is necessary that $\beta_i = 1$, and μ_i goes to zero[78].

To test for common trend and convergence the analysis relies on the Johansen cointegration technique. This procedure besides testing for common trend also allows to testing for restrictions on the parameters[79].

Table 16 shows the results from the Augmented Dickey-Fuller test[80]. The test results suggest that none of the cities reject the null hypothesis of a unit root in prices. Therefore, price

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[73] R. Harris (1995) stated that *"The economic interpretation of cointegration is that two (or more) series are linked to form an equilibrium relationship spanning the long run, then even though the series themselves may contain stochastic trends (i.e., be non-stationary) they will nevertheless move closely together over time and the difference between them will be stable (i.e., stationary)"* (page 22).

[74] In the case of per capita output Bernard and Durlauf (1991) stated that *" If log per capita output in countries i and j contain a stochastic trend, then long run growth in $Y_{i,t}$ and $Y_{j,t}$ is determined by a common factor if $Y_{i,t}$ and $Y_{j,t}$ are cointegrated, i.e. there exists a constant α such that $Y_{i,t} = \mu + \alpha Y_{j,t} + \nu_{ij,t}$, where $\nu_{ij,t}$ is stationary in levels"*, (page 5).

[75] Cointegration is required to guarantee a long run convergence process, see Suriñach et al. (1995).

[76] In general, μ_i measures the equilibrium proportion between the variables corrected by the elasticity (β), see Suriñach et al. (1995).

[77] Of course, transportation cost is not the only cause that make agricultural prices among region differ. However, we assume here that it is the main cause.

[78] Alternatively, Bernard and Durlauf (1991) used unit root to test stochastic convergence in per capita output. They stated that: "*log per capita output in country i converges to log per capita output in country j if $Y_{i,t}$ and $Y_{j,t}$ have stochastic trends and if $Y_{i,t} = Y_{j,t} + \nu_{ij,t}$, where $\nu_{ij,t}$ is stationary in levels*". .

[79] This procedure has the advantages such as: i) it provides alternative means of testing for unit root on each variable, ii) estimates all the cointegration vectors without imposing the restriction of the existence of only one, and iii) allows endogenous variables in the cointegration relationship because its specification came from a VAR model. For a good explanation of the Johansen procedure see J. Suriñach et al. (1995), R. Harris (1995), W. Enders (1995), W. Charemza et al. (1997), and of course the original paper of S. Johansen (1988).

[80] The number of lags was chosen according to the Akaike Information Criteria (AIC).

series are non-stationary. The next step is to perform the cointegration analysis because the series have a unit root. The exercise is divided in two: i) tests for cointegration among pairs of cities, and ii) tests for cointegration between each city and the nation. Tables 17a to 17f summarize the results from the Johansen's cointegration procedure for pairs of cities[81]. The first (17a) reports the results for the potato price series. The results suggest that there exist a common trend in the price of potatoes between pair of cities. In particular, bivariate cointegration relationships are found for Bogotá, Medellín, Cali and Manizales, cities located in the west and central part of the country, while the remote cities, Barranquilla and Pasto, are only cointegrated with their closer neighbor. For instance, Pasto is only cointegrated with Cali and Manizales, and Barranquilla is with Medellín. Thus the result suggests that geographical proximity explain cointegration relationships[82]. The evidence also suggest that nationwide the markets are not integrated On the other hand, determine convergence column (9) and (11) present the likelihood ratio statistic (with its p-value) for the null hypothesis of $\beta=1$ and $\mu=0$, respectively. In most cases, the unitary price elasticity of potato between pair of cities is not rejected. However, the deterministic term, μ, is statistically different from zero[83].

Table 17b reports the cointegration results for the *panela's* price series. Two outcomes are important to highlight. First, all cities are cointegrated, except Bucaramanga and Pasto. Meaning that there are two segmented markets for this commodity. Second, the convergence hypothesis fails for all the bivariate relationships.

[81] Three methodological aspects are important to mention. First, the HQ and SC information criteria are used to determine the appropriate number of lag (p). Second, although the results are only presented for the trace statistic, the results from the maximal-eigenvalue statistic lead to the same conclusions. Third, to determine which deterministic components include in the short and long run model the procedure proposed by Johansen based on the Pantula principle is used (See Hansen and Juselius, 1995). There are three possible ways to specify the model. First, the intercept is restricted the cointegrating space (Model 2 in CATS). Second, the intercept is in the cointegrating space and the model allows for linear trend in the data but is assumed that there are no trends in the cointegrating relations (model 3 in CATS). Third, it is the same than model 3 but a linear trend in the cointegration vector is allowed (model 4 in CATS). The procedure consists in estimate the three models and the results are organized from the most restrictive alternative (model 2) trough to the least restrictive alternative (model 4). Then, compare the trace statistic with its critical value from the most restrictive model to least and stop only when for the first time the null hypothesis is accepted (See Hansen and Juselius, 1995, and R. Harris, 1995). In our estimations the results from this procedure are in almost all the cases in favor of model 3. Therefore, all tables present the results from model 3, except in the case that we indicate the contrary.

[82] Similarly, Bernard and Durlauf (1991) found that proximity and colonial ties can explain cointegration relationships of the rate of growth among advance industrialized economies.

[83] Therefore, there is not convergence. We only found convergence for the case Bogotá-Cali.

Table 17c reports the cointegration results for rice price series. In this case, 10 pairs of cities are cointegrated. Again the convergence hypothesis is rejected excepting for the pair Barranquilla-Manizales. The results for salt prices are illustrated in Table 17d. In this case there is not cointegration for any pairs of cities. Table 17e describes the result for corn. In particular, 9 cointegration relationships between pairs of cities are found, and convergence is found for three pairs of cities: Bucaramanga-Cali, Bucaramanga-Manizales and Manizales-Medellin. Last, Table 17f presents the results for sugar. Cointegration is found in 10 pairs of cities, and convergence is found for three cases.

In sum, common trends are important for potato, *panela* and sugar. But, there is little evidence to support the convergence hypothesis across cities.

The results from this section indicate that market integration in Colombia has been limited and is still bound by the lack of adequate transportation networks. Therefore, transportation costs have high weight in explaining price difference of the same commodity across cities. In addition, the results suggest that there exist a group of cities, in particular the three larger cities (Bogotá, Cali, and Medellín) whose commodity prices have converged in the long run. This is associated with that fact that the transportation system, in particular highways, was developed mainly to join these markets and promote economic development in these regions. However, prices converge at very slow rate, making the pace of market integration also very slow.

5 Conclusion

Railroads did not play an overwhelming role in the Colombian economy, in contrast to other Latin American countries with similar pre-rail transportation system such as Brazil and Mexico. The social savings estimation indicates that the savings spanned by the development of the railroad network were considerably larger in Brazil and in Mexico than in Colombia. In addition, we found that railroads caused expansions in coffee exports, but the magnitude of these effects were lower than those suggested in the literature. Finally, the lack of an appropriate transportation infrastructure explains the dispersion in prices across regions in the country due to high transportation costs. This suggests that even highways did not help draw the country together.

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6. Tables

Table 1: Elasticities Results from Alternative Specifications of Demand in Colombia.

A. Price Elasticities of Demand for Freight Services (ton-km) and Railroad Track Elasticities: Summary

Period	Elasticities with respect to	**Price Assumed Exogenous**				**Price Assumed Endogenous**			
		Constant Elasticity		Non Constant Elasticity		Constant Elasticity		Non Constant Elasticity	
		pooled	fixed	pooled	fixed	pooled	fixed	pooled	fixed
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1914-1980	rate (real $)	-0.7944	-0.8087	-0.7301	-0.7794	-0.9377	-0.9660	-0.6688	-0.7039
	tracks(km)	1.4128	1.5901	1.3844	1.5944	1.3473	1.6628	1.3127	1.1975
1914-1930	rate (real $)	-1.3020	-0.4434	-1.2250	-0.8479	-1.5252	-0.5337	-1.0273	-0.9097
	tracks(km)	0.7217	1.3104	1.2092	1.5807	0.4137	1.0899	1.1960	0.8614
1931-1954	rate (real $)	-0.4672	-0.1775	-0.7964	-0.4964	-0.5530	-0.3777	-0.8087	-0.5117
	tracks(km)	1.5163	0.5836	1.3865	1.6530	1.5066	0.4731	1.1985	0.7353
1955-1980	rate (real $)	-1.0272	-0.9538	-0.8039	-0.7885	-1.5360	-1.4292	-0.7592	-1.1451
	tracks(km)	2.1499	2.1677	1.6497	1.7459	1.1704	1.9971	1.5029	1.5939

B. Price Elasticities of Demand for Passenger Services (in pass.-km) and Railroad Track Elasticities: Summary

Period	Elasticities with respect to	**Price Assumed Exogenous**				**Price Assumed Endogenous**			
		Constant Elasticity		Non Constant Elasticity		Constant Elasticity		Non Constant Elasticity	
		pooled	fixed	pooled	fixed	pooled	fixed	pooled	fixed
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1914-1980	fare (real $)	-1.1963	-0.5813	-1.3293	-0.8490	-1.3182	-0.6587	-1.5295	-1.0681
	tracks(km)	1.3632	0.6886	1.3204	0.6327	1.3019	0.7221	1.3804	0.5404
1914-1930	fare (real $)	-1.0660	-0.5818	-1.3197	-0.4313	-1.0807	-0.5875	-1.3168	-0.6117
	tracks(km)	0.9106	1.2729	1.5224	0.7475	0.8119	1.1016	1.1579	0.6169
1931-1954	fare (real $)	-1.5001	-0.6711	-0.7344	-0.9121	-1.5930	-0.8814	-1.5251	-0.9380
	tracks(km)	1.5474	0.5104	1.4511	0.7197	1.5256	0.5896	1.3777	0.5537
1955-1980	fare (real $)	-0.1788	-0.4491	-0.3683	-0.1359	-0.4765	-0.8201	-0.4184	-0.5021
	tracks(km)	0.9029	1.0958	1.3834	0.6870	0.9061	1.1984	1.3605	0.6466

Source: computed.

Table 2: Transportation Rates: Chosen years by mode of transportation

Years	Mode of Transportation	Observations	Freight Rates current pesos	Passenger Fares current pesos	Sources
Average 1845-1930	Mules		0.416 ton-km		William McGreevey (1975)
Average 1905-1929	Railroad		0.15 ton-km		William McGreevey (1975)
1924	Magdalena River		0.0175 ton-km ascent 0.01 ton-km descent	0.062 passenger-km ascent express 0.041 passenger-km descent express 0.045 passenger-km ascent ordinary 0.035 passenger-km descent ordinary	Ministry of Public Works Memoirs, 1924
1927	Human Porters Mules Animal-drawn carts Railroad Magdalena River		1 ton-km 0.4 ton-km 0.2 ton-km 0.05 ton-km 0.024 ton-km ascent 0.0135 ton-km descent	0.0806 passenger-km ascent express 0.0533 passenger-km descent express 0.0585 passenger-km ascent ordinary 0.0455 passenger-km descent ordinary	Ministry of Public Works Memoirs, 1927
1930-31	Magdalena River		0.026 ton-km ascent 0.012 ton-km descent	0.0823 passenger-km ascent express 0.0589 passenger-km descent express 0.0648 passenger-km ascent ordinary 0.0502 passenger-km descent ordinary	Alfredo Ortega, 1932
	Railroad (1931) Highway	 Boyaca Line-Trucks Cambao Line-Trucks Pacho Line-Trucks Boyaca Line-Bus	0.071 ton-km 0.15 ton-km 0.135 ton-km 0.15 ton-km	0.0111 passenger-km 0.02 passenger-km 0.02 passenger-km 0.02 passenger-km 0.03 passenger-km (average)	Ministry of Public Works Memoirs, 1931
1936	Highway Railroad	Bogota-Villavicencio (125Km.) 1/	0.12 ton-km 0.051 ton-km	0.016 passenger-km 0.0091 passenger-km	Ministry of Public Works Memoirs, 1936
1938	Highway Railroad	Armenia-Ibague (100 Km.)	0.0653 ton-km 0.055 ton-km	0.03 passenger-km direct trip 0.025 passenger-km turist 0.015 passenger-km 3rd class 0.0098 passenger-km	Ministry of Public Works Memoirs, 1938
1947	Highway Railroad	Cali to the Sea Cali to the Sea	0.09 ton-km 0.07 ton-km		Annuals of Engineering, 1953
1967	*Caminos de Herradura:* (animal drawn carts) Local Road Main Highway Railroads		15 ton-km 1.2 ton-km 0.38 ton-km 0.25 ton-km	 0.082 passenger-km	Annuals of Engineering, 1966-67 Anuario General de Estadistica, 1968

1/ Before 1936 (date that the highway was opening), the transportation rate in this route (Camino de Herradura) of one ton of freight was $40.

Table 3:Social Savings Estimations on Railroad Freight Service in Colombia, 1927

Alternative mode of transportation: Mules	
a) Total Freight Services in ton-km 1/	191 million ton-km
b) Railroad Rate	$0.05
c) Mules transportation rates	$0.40
d) a*b	$9.55 million
e) a*c	$76.4 million
f) Social Savings1	$66.85 million
g) GDP	$850 million
h) Social Savings1 / GDP (%)	**7.86%**
Alternative mode of transportation: Animal-drawn carts	
a) Total Freight Services in ton-km 1/	191 million ton-km
b) Railroad Rate	$0.05
c) Animal-drawn wagon rate	$0.20
d) a*b	$9.55 million
e) a*c	$38.2 million
f) Social Savings2	$28.65 million
g) GDP	$850 million
h) Social Savings2/ GDP (%)	**3.37%**
Adjusted Social Savings by price elasticity of demand equal to -0.5	
Social Savings1	$27.57 millions
Social Savings1/ GDP (%)	**4.11%**
Social Savings2	$16.42 millions
Social Savings2/ GDP (%)	**2.25%**

1/ Excludes Livestock; Source: Computed

Social Savings International comparisons:
1. Assuming: e=0
Fishlow: 4% GDP ante-bellum USA, 1859
Fogel: 8.9% GDP at the very most, USA 1890
Metzer: 4.5% GDP Tsarist Russia, 1907
Gomez Mendoza: 19.2% GDP Spain, 1912
Coatsworth: 24%-38.5% GDP Mexico, 1910
Summerhill: 4.5% GDP Brazil, 1887
Summerhill: 22% GDP Brazil, 1913
McGreevey: 3.2% GDP Colombia, 1924 (coffee railroads)

2. Assuming: e=-0.5
Coatsworth: 14.9%-16.6% GDP Mexico, 1910
Summerhill: 11.2% GDP Brazil, 1913

Table 4: Kilometers of Railroads Utilized in Moving Coffee

Years	Total Railroad Km (a)	Railroads utilized in moving coffee km (b)	(b) / (a) (%)
1898	593	423	71.33
1914	1,143	919	80.40
1922	1,571	1,382	87.97
1933	2,892	1,943	67.19
1937	3,060	1,928	63.01
1949	3,426	2,246	65.56

Source: Beyer, Robert (1947) for 1898,1914,1922
Own calculations for 1933, 1937 and 1949.

Table 5: Augmented Dickey-Fuller Test for Coffee Exports and Railroad Tracks: 1905-1955

	Log of Coffee Exports (60 k. bags)	Log of Railroad tracks (km)
Coefficient of dependent variable lag one period: $g_{1.}$	-0.4849	-0.1402
(t-statistic)	(-3.81)	(-3.84)
Constant Coefficient: a_0	3.1042	0.9716
(t-statistic)	(3.95)	(4.70)
Time trend Coefficient: a_1	0.0251	0.0019
(t-statistic)	(3.37)	(1.35)
Chosen lag length of dependent variable: p	0	2
Ljung -Box Q-statistic: L(Q)	L(11) = 9.4581	L(11)=5.2776
Probability Value	0.58	0.917
Lagrange multiplier test for up to fourth order residual correlation LM(4)	1.2125	0.3309
Probability Value	0.3198	0.8553
Jarque-Bera Normality Test	0.2924	4.56
Probability Value	0.8639	0.1022

Note: The Mackinnon 5% critical values for rejection of the null hypothesis of unit root is -3.5088
Source: Computed

Table 5.a: Augmented Dickey-Fuller Test for Coffee Exports and Kilometers of Highways: 1936-1990

	Log of Coffee Exports (60 k. bags)	Log of National Highways (km)
Coefficient of dependent variable lag one period: $g_{1.}$	-0.5872	-0.4271
(t-statistic)	(-4.43)	(-4.36)
Constant Coefficient: a_0	4.8191	3.914
(t-statistic)	(4.43)	(4.35)
Time trend Coefficient: a_1	0.0111	0.0083
(t-statistic)	(4.21)	(4.41)
Chosen lag length of dependent variable: p	0	2
Ljung -Box Q-statistic: L(Q)	L(13) = 8.92	L(13)=2.254
Probability Value	0.779	0.9999
Lagrange multiplier test for up to fourth order residual correlation LM(4)	0.613	0.9563
Probability Value	0.655	0.4406
Jarque-Bera Normality Test	3.8651	410.96
Probability Value	0.1448	0.0

Note: The Mackinnon 5% critical values for rejection of the null hypothesis of unit root is -3.4919
Source: Computed

Table 6:Granger Causality Test for Coffee Exports and Railroad Tracks: 1905-1955

Null Hypothesis:	p	F-stat	P-value
Log of railroad tracks does not Granger Cause log of coffee exports	2	6.2061	0.0044
Log of coffee exports does not Granger Cause log of railroad tracks	2	4.0402	0.0251

Source: Computed

Table 6.1: Granger Causality Test for Coffee Exports and Kilometers of Highways: 1936-1990

Null Hypothesis:	p	F-stat	P-value
Log of national highway length does not Granger Cause log of coffee exports	2	8.5015	0.0007
Log of coffee exports does not Granger Cause log of national highway length	2	2.5758	0.0862

Source: Computed

Table 7: Results from the Variance Decomposition-Railroads Tracks and Coffee

1. Variance decomposition of Railroads Tracks

Period	S.E.	Tracks	Coffee
1	0.04531	100.00	0.00
2	0.05734	98.30	1.70
3	0.06584	94.70	5.30
4	0.07240	91.31	8.69
5	0.07787	88.15	11.85
6	0.08250	85.51	14.49
7	0.08648	83.32	16.68
8	0.08992	81.54	18.46
9	0.09292	80.07	19.93
10	0.09555	78.87	21.13

Source: Computed

2. Variance decomposition of Coffee

Period	S.E.	Tracks	Coffee
1	0.13900	0.00	100.00
2	0.14558	2.37	97.63
3	0.15997	4.82	95.18
4	0.16629	7.36	92.64
5	0.17301	9.76	90.24
6	0.17803	11.93	88.07
7	0.18260	13.83	86.17
8	0.18651	15.46	84.54
9	0.18998	16.87	83.13
10	0.19302	18.07	81.93

Source: Computed

Table 8: Results from the Variance Decomposition-Highways and Coffee

1. Variance decomposition of Highways

Period	S.E.	Highways	Coffee
1	0.05436	100.00	0.00
2	0.06604	97.30	2.70
3	0.07780	95.27	4.73
4	0.08817	92.67	7.33
5	0.09715	90.42	9.58
6	0.10481	88.65	11.35
7	0.11132	87.30	12.70
8	0.11684	86.26	13.74
9	0.12155	85.46	14.54
10	0.12558	84.83	15.17

Source: Computed

2. Variance decomposition of Coffee

Period	S.E.	Highways	Coffee
1	0.12957	0.00	100.00
2	0.16758	12.90	87.10
3	0.18280	17.05	82.95
4	0.19081	19.79	80.21
5	0.19576	21.75	78.25
6	0.19926	23.27	76.73
7	0.20196	24.49	75.51
8	0.20416	25.50	74.50
9	0.20600	26.35	73.65
10	0.20758	27.08	72.92

Source: Computed

Table 8.1: Results from the Variance Decomposition-Highways plus Railroads and Coffee

1. **Variance decomposition of Highways plus Railroads**

Period	S.E.	Highways plus railroads	Coffee
1	0.04624	100.00	0.00
2	0.06051	97.05	2.95
3	0.07027	93.11	6.89
4	0.07788	89.51	10.49
5	0.08410	86.56	13.44
6	0.08928	84.23	15.77
7	0.09366	82.42	17.58
8	0.09740	80.99	19.01
9	0.10061	79.86	20.14
10	0.10337	78.95	21.05

Source: Computed

2. **Variance decomposition of Coffee**

Period	S.E.	Highways plus railroads	Coffee
1	0.12977	0.00	100.00
2	0.18604	11.90	88.10
3	0.19001	13.29	86.71
4	0.19275	14.46	85.54
5	0.19485	15.45	84.55
6	0.19656	16.30	83.70
7	0.19800	17.02	82.98
8	0.20030	18.19	81.81
9	0.20206	19.07	80.93
10	0.20448	20.25	79.75

Source: Computed

Table 9: Inter-Regional Price Dispersion in Colombia1/: Coefficient of Variation for some Agricultural Price

Years	*Panela*	Potatoe	Corn	Rice	Sugar	Salt	Plantains	Red Beans
1858	.	.	.	0.223	0.485	.	.	.
1879	.	.	.	0.440	.	.	.	.
1928	0.620	0.408	0.213	0.250	.	0.340	.	0.533
1929	0.561	0.362	0.203	0.210	.	0.321	.	.
1930	0.505	0.323	0.201	0.177	.	0.306	.	.
1931	0.454	0.293	0.206	0.155	.	0.294	.	.
1932	0.413	0.276	0.216	0.148	.	0.286	.	.
1933	0.379	0.263	0.215	0.148	0.238	0.269	0.368	0.301
1934	0.312	0.244	.	0.176	0.192	0.218	0.371	0.252
1935	0.262	0.230	0.162	0.122	0.090	0.202	0.431	0.255
1936	0.315	0.287	0.160	0.098	0.095	0.186	0.492	0.258
1937	0.227	0.255	0.149	0.093	0.104	0.191	0.376	0.261
1938	0.181	0.235	0.147	0.088	0.079	0.174	0.312	.
1939	0.157	0.223	0.168	0.092	0.062	0.166	0.264	.
1940	0.166	0.223	0.205	0.103	0.060	0.167	0.244	0.229
1941	0.168	0.212	0.180	0.143	0.053	0.195	0.297	0.225
1942	0.234	0.233	0.168	0.143	0.119	.	.	0.263
1943	0.184	0.216	0.189	0.121	0.079	0.177	.	.
1944	0.152	0.169	0.110	0.102	0.123	0.182	.	.
1945	0.163	0.161	0.200	0.116	0.038	0.177	.	.
1946	0.243	0.196	0.203	0.131	0.086	0.226	.	.
1947	.	.	0.109	0.097	0.129	0.144	0.289	.
1948	0.274	0.205	0.116	0.077	0.054	0.105	0.297	.
1949	0.234	0.135	0.167	0.120	0.055	0.183	0.251	.
1950	0.173	0.146	0.168	0.100	0.075	0.101	0.216	.
1951	0.226	0.145	0.242	0.158	0.067	0.151	.	.
1952	0.151	0.142	0.231	0.126	0.108	0.136	.	.
1953	0.149	0.162	0.128	0.083	0.121	0.118	.	.
1954	0.157	0.108	0.119	0.102	0.117	0.101	.	.

Table 9: Inter-Regional Price Dispersion in Colombia1/: Coefficient of Variation for some Agricultural Price (continued).

Years	*Panela*	Potatoe	Corn	Rice	Sugar	Salt	Plantains	Red Beans
1955	0.152	0.161	.	0.073	.	0.138	0.279	0.206
1956	0.196	0.155	0.145	0.085	.	0.145	0.306	0.195
1957	0.201	0.144	0.142	0.055	0.090	0.127	.	0.205
1958	0.164	0.130	0.093	0.085	0.102	0.144	0.260	0.155
1959	0.136	0.167	0.075	0.077	0.094	0.126	0.291	0.202
1960	0.175	0.154	0.066	0.073	0.101	0.143	0.214	0.223
1961	0.199	0.166	0.099	0.075	0.091	0.171	.	0.299
1962	0.097	0.214	0.074	0.067	0.107	0.118	0.203	0.272
1963	0.152	0.156	0.102	0.066	0.122	0.147	.	0.239
1964	0.097	0.235	0.080	0.056	0.102	0.152	0.255	0.232
1965	0.126	0.174	0.147	0.101	0.090	0.123	0.272	0.217
1966	0.124	0.180	0.088	0.090	0.087	0.142	0.198	0.282
1967	0.106	0.195	0.092	0.057	0.106	0.238	0.199	0.236
1968	0.130	0.222	0.095	0.051	0.094	0.192	0.266	0.212
1969	0.113	0.124	0.082	0.078	0.109	0.174	0.202	0.230
1970	0.122	0.133	0.084	0.110	0.108	0.162	.	0.261
1971	0.124	0.182	0.101	0.141	0.146	0.248	.	0.282
1972	0.134	0.175	0.110	.	0.152	0.211	.	0.226
1973	0.127	0.226	0.129	.	0.143	0.137	0.240	0.196
1974	0.114	0.184	0.106	0.153	.	0.177	0.175	0.233
1975	0.150	0.237	0.123	0.147	.	0.123	0.325	0.185
1976	0.126	0.240	0.117	0.143	0.135	0.127	0.149	0.252
1977	0.124	0.200	0.146	.	0.146	0.213	0.253	0.216
1978	0.132	0.223	0.172	0.136	0.144	0.122	0.203	0.198
1979	0.156	0.162	0.160	0.086	0.106	0.134	0.193	.
1980	0.144	0.181	0.173	0.097	0.095	0.156	0.247	.
1981	0.103	0.249	0.174	0.081	0.084	0.119	0.217	0.209
1982	0.103	0.168	0.151	0.110	0.074	0.079	0.260	0.245
1983	0.085	0.176	0.179	0.079	0.052	0.077	0.250	.
1984	0.092	0.196	0.207	0.060	0.045	0.054	0.239	0.231
1985	0.108	0.124	0.185	0.048	0.051	0.062	0.234	0.218
1986	0.115	0.130	0.159	0.060	0.037	0.074	0.224	0.275
1987	0.101	0.127	0.102	0.060	0.038	.	0.188	0.200
1988	0.119	0.124	0.087	0.065	0.047	.	0.197	0.220
1989	0.175	0.131	.	0.064	0.068	.	0.241	0.182
1990	0.169	0.131	.	0.037	0.045	.	0.240	0.169

1/ Prices are from Bogotá, Barranquilla, Bucaramanga, Cali, Cartagena, Cucuta, Manizales, Medellín, Neiva, Pasto, Pereira and Villavicencio.
Source: Computed. The prices were taken from the Anuario General de Estadistica de Colombia, several years and Anuario Estadistico del Ministerio de Agricultura de Colombia.
The data of 1879 is taken from Urrutia et al. (1970), the price of rice is for two cities: Medellin and Bogota
The data of 1858 is taken from Urrutia et al. (1970), the prices of sugar and rice are for two cities: Bogota and Cartagena

Table 10: Commodity price convergence across cities: Potatoes, 1928-1990

Cities' Price Ratios $\ln(P_B/P_A)$	Convergence Rate (β)	R^2	Number Observation
Barranquilla/Bogota	-0.0045 (0.0008)***	0.3389	61
Bucaramanga/Bogota	-0.00203 (0.0008)***	0.0942	61
Cali/Bogota	-0.0067 (0.0013)***	0.3304	61
Manizales/Bogota	-0.0014 (0.0011)	0.0232	61
Medellin/Bogota	0.00053 (0.0008)	0.0066	61
Bogota/Pasto	0.00068 (0.0011)	0.0059	61
Bucaramanga/Barranquilla	0.0022 (0.0009)**	0.0812	61
Cali/Barranquilla	-0.0005 (0.0011)	0.0038	61
Manizales/Barranquilla	0.0028 (0.0012)**	0.0812	61
Medellin/Barranquilla	-0.00343 (0.0011)***	0.1376	61
Barranquilla/Pasto	-0.00166 (0.0015)	0.0224	61
Cali/Bucaramanga	-0.005 (0.0011)***	0.2917	61
Bucaramanga/Manizales	-0.0006 (0.0008)	0.0097	61
Bucaramanga/Medellin	0.0008 (0.0012)	0.0087	61
Bucaramanga/Pasto	-0.0009 (0.0015)	0.0061	61
Cali/Manizales	-0.0075 (0.0008)***	0.5931	61
Cali/Medellin	-0.00745 (0.0016)***	0.2551	61
Cali/Pasto	-0.00081 (0.0015)	0.0055	61
Manizales/Medellin	-0.00354 (0.0015)**	0.08875	61
Manizales/Pasto	-0.0007 (0.0014)	0.0041	61
Medellin/Pasto	0.0017 (0.0015)	0.01959	61

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed

Table 10: Commodity price convergence across cities: Potatoes, 1950-1990 (Cont.)

Cities' Price Ratios ln (P_B/P_A)	Convergence Rate (β)	R^2	Number Observation
Barranquilla/Bogota	-0.0113 (0.0009)***	0.8039	40
Bucaramanga/Bogota	0.0041 (0.0012)***	0.2365	40
Cali/Bogota	-0.0079 (0.0020)***	0.2875	40
Manizales/Bogota	-0.0053 (0.0012)***	0.3353	40
Medellin/Bogota	-0.0024 (0.0016)	0.0555	40
Bogota/Pasto	0.0099 (0.0019)***	0.4338	40
Bucaramanga/Barranquilla	-0.0072 (0.0012)**	0.481	40
Cali/Barranquilla	-0.0032 (0.0019)*	0.0691	40
Manizales/Barranquilla	-0.0059 (0.0014)***	0.2957	40
Medellin/Barranquilla	-0.008 (0.0017)***	0.3468	40
Barranquilla/Pasto	0.0014 (0.0021)	0.0126	40
Cali/Bucaramanga	-0.004 (0.0018)***	0.1121	40
Bucaramanga/Manizales	-0.0012 (0.0014)	0.0223	40
Bucaramanga/Medellin	0.0007 (0.0020)	0.0039	40
Bucaramanga/Pasto	0.0086 (0.0021)***	0.2946	40
Cali/Manizales	-0.0043 (0.0015)***	0.1742	40
Cali/Medellin	-0.0048 (0.0030)	0.0617	40
Cali/Pasto	0.0046 (0.0013)***	0.2279	40
Manizales/Medellin	0.002 (0.0021)	0.0241	40
Manizales/Pasto	0.0074*** (0.0016)	0.3348	40
Medellin/Pasto	0.0094 (0.0030)***	0.2019	40

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 11: Commodity price convergence across cities: *Panela*, 1934-1990

Cities' Price Ratios $\ln(P_B/P_A)$	**Convergence Rate (β)**	R^2	**Number Observation**
Barranquilla/Bogota	-0.0001 (0.0016)	0.0001	56
Bogota/Bucaramanga	-0.0162 (0.0012)***	0.7654	56
Bogota/Cali	-0.0152 (0.0011)***	0.7807	56
Manizales/Bogota	0.0053 (0.0011)***	0.2812	56
Bogota/Medellin	-0.01002 (0.0011)***	0.6265	56
Bogota/Pasto	-0.00212 (0.0025)	0.0131	56
Barranquilla/Bucaramanga	-0.0097 (0.0015)***	0.4519	56
Barranquilla/Cali	-0.01015 (0.0012)***	0.5748	56
Barranquilla/Manizales	-0.0023 (0.0008)**	0.1249	56
Barranquilla/Medellin	-0.005 (0.0013)***	0.2227	56
Barranquilla/Pasto	0.0032 (0.0023)	0.0322	56
Bucaramanga/Cali	-0.0005 (0.0013)	0.0027	56
Manizales/Bucaramanga	-0.0047 (0.0016)***	0.1393	56
Medellin/Bucaramanga	-0.00455 (0.0011)***	0.2189	56
Pasto/Bucaramanga	-0.01104 (0.0019)***	0.3621	56
Manizales/Cali	-0.0061 (0.0007)***	0.5887	56
Medellin/Cali	-0.006 (0.0010)***	0.3982	56
Cali/Pasto	-0.0097 (0.0014)	0.4502	56
Manizales/Medellin	-0.0016 (0.0010)	0.0453	56
Manizales/Pasto	0.0025 (0.0017)	0.0446	56
Medellin/Pasto	0.0044 (0.0016)***	0.1263	56

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed

Table 11: Commodity price convergence across cities: *Panela*, 1950-1990 (Cont.)

Cities' Price Ratios ln (P_B/P_A)	Convergence Rate (β)	R^2	Number Observation
Barranquilla/Bogota	0.0085 (0.0017)***	0.4123	40
Bogota/Bucaramanga	-0.0085 (0.0012)***	0.4632	40
Bogota/Cali	-0.02 (0.0016)***	0.8008	40
Manizales/Bogota	0.01226 (0.0018)***	0.5494	40
Bogota/Medellin	0.01037 (0.0018)***	0.4467	40
Bogota/Pasto	-0.01324 (0.0023)	0.469	40
Barranquilla/Bucaramanga	0.0006 (0.0011)	0.0079	40
Barranquilla/Cali	-0.01093 (0.0009)***	0.764	40
Barranquilla/Manizales	-0.0051 (0.0011)**	0.3672	40
Barranquilla/Medellin	-0.0025 (0.0013)**	0.0857	40
Barranquilla/Pasto	-0.0035 (0.0022)	0.0608	40
Bucaramanga/Cali	-0.0115 (0.0013)***	0.6693	40
Manizales/Bucaramanga	0.0056 (0.0015)***	0.2888	40
Medellin/Bucaramanga	0.0017 (0.0014)	0.0372	40
Pasto/Bucaramanga	-0.003 (0.0018)***	0.078	40
Manizales/Cali	-0.0058 (0.0008)***	0.5555	40
Medellin/Cali	-0.0077 (0.0010)***	0.605	40
Cali/Pasto	0.0074 (0.0021)***	0.2607	40
Manizales/Medellin	0.0025*** (0.0011)	0.1183	40
Manizales/Pasto	0.0015 (0.0020)	0.01566	40
Medellin/Pasto	0.0008 (0.0019)	0.0052	40

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 12: Commodity price convergence across cities: Rice, 1928-1990

Cities' Price Ratios ln (P_B/P_A)	Convergence Rate (b)	R^2	Number Observation
Bogota/Barranquilla	-0.0067 (0.0011)***	0.3574	63
Bucaramanga/Bogota	-0.0011 (0.0009)	0.0229	63
Bogota/Cali	-0.0052 (0.0007)	0.4511	63
Bogota/Manizales	-0.003 (0.0008)***	0.168	63
Bogota/Medellin	-0.0021 (0.0008)***	0.1012	63
Bogota/Pasto	-0.0002 (0.0007)	0.0012	63
Bucaramanga/Barranquilla	-0.0077 (0.0012)***	0.3961	63
Cali/Barranquilla	-0.00147 (0.001)	0.0374	63
Manizales/Barranquilla	-0.0037 (0.0009)***	0.2304	63
Medellin/Barranquilla	-0.0045 (0.0008)***	0.3473	63
Pasto/Barranquilla	-0.0064 (0.0110)	0.0302	63
Bucaramanga/Cali	-0.0063 (0.0010)***	0.3741	63
Bucaramanga/Manizales	-0.0041 (0.0012)***	0.1654	63
Bucaramanga/Medellin	-0.0032 (0.0009)***	0.1607	63
Bucaramanga/Pasto	-0.0013 (0.0009)	0.0306	63
Manizales/Cali	-0.0022 (0.0004)***	0.3075	63
Medellin/Cali	-0.00307 (0.0006)***	0.3087	63
Pasto/Cali	-0.005 (0.0010)***	0.2879	63
Medellin/Manizales	-0.0008 (0.0006)	0.0273	63
Pasto/Manizales	-0.0017 (0.0012)	0.0983	63
Medellin/Pasto	0.0019 (0.0008)**	0.0741	63

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 12:Commodity price convergence across cities: Rice, 1950-1990 (Cont.)

Cities' Price Ratios ln (P_B/P_A)	Convergence Rate (β)	R^2	Number Observation
Bogota/Barranquilla	-0.0014 (0.0010)	0.0522	40
Bucaramanga/Bogota	0.0037 (0.0018)*	0.0989	40
Bogota/Cali	0.0016 (0.0010)	0.0877	40
Bogota/Manizales	-0.0037 (0.0007)***	0.3861	40
Bogota/Medellin	-0.002 (0.0005)***	0.2968	40
Bogota/Pasto	-0.0026 (0.0011)	0.1066	40
Bucaramanga/Barranquilla	-0.0051 (0.0014)***	0.2445	40
Cali/Barranquilla	-0.003 (0.0015)**	0.0998	40
Manizales/Barranquilla	-0.0051 (0.0015)***	0.2257	40
Medellin/Barranquilla	-0.0035 (0.0011)***	0.1847	40
Pasto/Barranquilla	-0.0011 (0.0013)	0.0175	40
Bucaramanga/Cali	0.0021 (0.0020)	0.0255	40
Bucaramanga/Manizales	0.0001 (0.0022)	0.001	40
Bucaramanga/Medellin	0.0016 (0.0018)	0.0207	40
Bucaramanga/Pasto	-0.0063 (0.0013)***	0.3513	40
Manizales/Cali	-0.0021 (0.0005)***	0.2598	40
Medellin/Cali	-0.0004 (0.0006)	0.0136	40
Pasto/Cali	-0.00417 (0.0014)	0.1875	40
Medellin/Manizales	-0.0016 (0.0005)***	0.2024	40
Pasto/Manizales	-0.0063 (0.0013)	0.3785	40
Medellin/Pasto	-0.0046 (0.0011)***	0.3155	40

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 13: Commodity price convergence across cities: Corn, 1928-1988

Cities' Price Ratios $\ln(P_B/P_A)$	Convergence Rate (β)	R^2	Number Observation
Bogota/Barranquilla	-0.0019 (0.0014)	0.0337	61
Bogota/Bucaramanga	0.0047 (0.0012)***	0.2212	56
Bogota/Cali	-0.00617 (0.0013)***	0.2871	61
Manizales/Bogota	-0.008 (0.0001)***	0.4205	61
Bogota/Medellin	0.0037 (0.0013)***	0.1263	61
Bogota/Pasto	0.0045 (0.0012)***	0.1944	56
Bucaramanga/Barranquilla	-0.01053 (0.0009)***	0.6922	56
Cali/Barranquilla	-0.00897 (0.0011)***	0.5069	61
Manizales/Barranquilla	-0.01038 (0.0011)***	0.6168	61
Medellin/Barranquilla	-0.01228 (0.0009)***	0.7611	61
Pasto/Barranquilla	-0.0106 (0.0012)***	0.5711	56
Bucaramanga/Cali	-0.0014 (0.0010)	0.0341	56
Bucaramanga/Manizales	-0.0015 (0.0012)	0.0272	56
Bucaramanga/Medellin	-0.0016 (0.0008)**	0.0708	56
Bucaramanga/Pasto	-0.00059 (0.0012)	0.0047	56
Manizales/Cali	-0.0014 (0.0010)	0.0265	61
Cali/Medellin	-0.00259 (0.0010)**	0.0872	61
Cali/Pasto	-0.002 (0.0015)	0.0369	56
Medellin/Manizales	-0.004 (0.0013)***	0.1422	61
Manizales/Pasto	-0.0024 (0.0015)	0.0596	56
Medellin/Pasto	-0.0024 (0.0009)***	0.0741	56

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 13: Commodity price convergence across cities: Corn, 1950-1988 (Cont.)

Cities' Price Ratios $\ln (P_B/P_A)$	Convergence Rate (β)	R^2	Number Observation
Bogota/Barranquilla	0.0012 (0.0025)	0.0059	40
Bogota/Bucaramanga	-0.011 (0.0019)***	0.4607	40
Bogota/Cali	-0.0154 (0.0020)***	0.603	40
Manizales/Bogota	0.01317 (0.0021)***	0.5113	40
Bogota/Medellin	0.0107 (0.0020)***	0.4369	40
Bogota/Pasto	0.0091 (0.0018)***	0.4148	40
Bucaramanga/Barranquilla	-0.0098 (0.0014)***	0.543	40
Cali/Barranquilla	-0.01249 (0.0014)***	0.6694	40
Manizales/Barranquilla	-0.01095 (0.0017)***	0.5289	40
Medellin/Barranquilla	-0.0095 (0.0015)***	0.5044	40
Pasto/Barranquilla	-0.0095 (0.0018)***	0.4098	40
Bucaramanga/Cali	-0.0042 (0.0012)***	0.2452	40
Bucaramanga/Manizales	-0.0018 (0.0015)	0.0366	40
Bucaramanga/Medellin	0.00013 (0.0012)	0.0003	40
Bucaramanga/Pasto	-0.0003 (0.0018)	0.0007	40
Manizales/Cali	0.002 (0.0013)	0.091	40
Cali/Medellin	-0.0042 (0.0010)***	0.312	40
Cali/Pasto	-0.0042 (0.0015)	0.1741	40
Medellin/Manizales	-0.0018 (0.0005)***	0.2848	40
Manizales/Pasto	-0.0026 (0.0018)	0.0613	40
Medellin/Pasto	-0.0002 (0.0020)	0.0003	40

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 14: Commodity price convergence across cities: Salt, 1928-1988

Cities' Price Ratios $\ln (P_B/P_A)$	Convergence Rate (b)	R^2	Number Observation
Bogota/Barranquilla	-0.0061 (0.0016)***	0.1985	56
Bucaramanga/Bogota	-0.0036 (0.0014)***	0.1063	56
Bogota/Cali	-0.0024 (0.0010)**	0.0791	59
Manizales/Bogota	0.00014 (0.0011)	0.003	56
Bogota/Medellin	-0.0031 (0.0030)	0.0867	56
Bogota/Pasto	-0.0008 (0.0020)	0.0031	56
Bucaramanga/Barranquilla	-0.0097 (0.0017)***	0.3527	56
Cali/Barranquilla	-0.0086 (0.0015)***	0.3417	56
Manizales/Barranquilla	-0.0059 (0.0013)***	0.2736	56
Medellin/Barranquilla	-0.0092 (0.0014)***	0.4287	56
Pasto/Barranquilla	-0.0025 (0.0021)	0.0268	56
Bucaramanga/Cali	-0.0011 (0.0010)	0.0212	56
Bucaramanga/Manizales	-0.0037 (0.0013)***	0.1206	56
Bucaramanga/Medellin	-0.00053 (0.0011)	0.0039	56
Pasto/Bucaramanga	0.0027 (0.0017)	0.0626	56
Cali/Manizales	-0.0026 (0.0010)***	0.0921	56
Cali/Medellin	0.0006 (0.0010)	0.0062	56
Pasto/Cali	0.0016 (0.0016)	0.0168	56
Medellin/Manizales	-0.00323 (0.0009)***	0.1683	56
Pasto/Manizales	-0.001 (0.001)	0.0059	56
Pasto/Medellin	0.0022 (0.0018)	0.0231	56

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 14: Commodity price convergence across cities: Salt, 1950-1988 (Cont.)

Cities' Price Ratios ln (P_B/P_A)	Convergence Rate (β)	R^2	Number Observation
Bogota/Barranquilla	-0.0029 (0.0036)	0.0196	40
Bucaramanga/Bogota	-0.0079 (0.0020)***	0.3105	40
Bogota/Cali	-0.0004 (0.0020)	0.0012	40
Manizales/Bogota	0.00132 (0.0022)	0.0086	40
Bogota/Medellin	-0.0018 (0.0020)	0.0234	40
Bogota/Pasto	-0.0089 (0.0032)	0.1761	40
Bucaramanga/Barranquilla	-0.0045 (0.0026)*	0.0768	40
Cali/Barranquilla	0.00299 (0.0032)	0.0244	40
Manizales/Barranquilla	-0.0021 (0.0029)	0.0146	40
Medellin/Barranquilla	-0.0016 (0.0026)	0.01044	40
Pasto/Barranquilla	0.0055 (0.0024)**	0.1245	40
Bucaramanga/Cali	-0.0075 (0.0013)***	0.4699	40
Bucaramanga/Manizales	-0.0066 (0.0018)***	0.2613	40
Bucaramanga/Medellin	-0.0061 (0.0009)***	0.5492	40
Pasto/Bucaramanga	0.0008 (0.0024)	0.0039	40
Cali/Manizales	0.0008 (0.0017)	0.0071	40
Cali/Medellin	0.0014 (0.0011)	0.0475	40
Pasto/Cali	-0.0093 (0.0026)***	0.2745	40
Medellin/Manizales	-0.0005 (0.0017)	0.0027	40
Pasto/Manizales	-0.0081 (0.0022)***	0.2797	40
Pasto/Medellin	-0.0078 (0.0025)***	0.2209	40

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 15:Commodity price convergence across cities: Sugar, 1933-1990

Cities' Price Ratios ln (P_B/P_A)	Convergence Rate (b)	R^2	Number Observation
Bogota/Barranquilla	-0.0026 (0.0005)***	0.374	57
Bucaramanga/Bogota	-0.0007 (0.0005)	0.0418	57
Bogota/Cali	0.0007 (0.0006)	0.0204	57
Manizales/Bogota	-0.001 (0.0006)	0.0424	57
Bogota/Medellin	-0.003 (0.0007)***	0.2523	57
Bogota/Pasto	-0.00118 (0.0008)	0.03702	57
Bucaramanga/Barranquilla	-0.00375 (0.0005)***	0.5466	57
Cali/Barranquilla	0.0009 (0.0008)	0.0314	57
Manizales/Barranquilla	0.0015 (0.0007)**	0.073	57
Medellin/Barranquilla	0.0003 (0.0006)	0.0005	57
Pasto/Barranquilla	-0.0046 (0.0010)***	0.2881	57
Bucaramanga/Cali	-0.0009 (0.0006)	0.0379	57
Bucaramanga/Manizales	-0.0019 (0.0006)***	0.1431	57
Bucaramanga/Medellin	-0.0044 (0.0007)***	0.4424	57
Pasto/Bucaramanga	-0.0008 (0.0008)	0.0187	57
Cali/Manizales	-0.0012 (0.0007)*	0.0565	57
Cali/Medellin	-0.0037 (0.0009)***	0.2221	57
Pasto/Cali	-0.0009 (0.0010)	0.0162	57
Medellin/Manizales	-0.0022 (0.0009)***	0.095	57
Manizales/Pasto	-0.00268 (0.0009)***	0.1276	57
Medellin/Pasto	-0.0042 (0.0009)***	0.2687	57

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table 15:Commodity price convergence across cities: Sugar, 1950-1988 (Cont.)

Cities' Price Ratios ln (P_B/P_A)	Convergence Rate (β)	R^2	Number Observation
Bogota/Barranquilla	-0.0012 (0.0008)	0.0584	40
Bucaramanga/Bogota	0.0009 (0.0007)	0.0479	40
Bogota/Cali	-0.00217 (0.0007)***	0.2448	40
Manizales/Bogota	-0.0034 (0.0011)***	0.2109	40
Bogota/Medellin	-0.0017 (0.0012)	0.0483	40
Bogota/Pasto	-0.0014 (0.0012)	0.0349	40
Bucaramanga/Barranquilla	-0.0022 (0.0006)***	0.2754	40
Cali/Barranquilla	-0.0014 (0.0008)	0.05454	40
Manizales/Barranquilla	-0.0025 (0.0007)**	0.2587	40
Medellin/Barranquilla	-0.0004 (0.0009)	0.0048	40
Pasto/Barranquilla	0.0004 (0.0015)	0.0021	40
Bucaramanga/Cali	-0.0035 (0.0009)***	0.3066	40
Bucaramanga/Manizales	-0.0044 (0.0012)***	0.2706	40
Bucaramanga/Medellin	-0.0026 (0.0010)***	0.1452	40
Pasto/Bucaramanga	-0.0023 (0.0014)*	0.0848	40
Cali/Manizales	0.0013 (0.0009)	0.0479	40
Cali/Medellin	-0.0012 (0.0010)	0.0371	40
Pasto/Cali	0.0003 (0.0011)	0.0014	40
Medellin/Manizales	-0.0017 (0.0013)	0.0434	40
Manizales/Pasto	-0.0013 (0.0015)	0.0206	40
Medellin/Pasto	0.0024 (0.0012)	0.0011	40

Note: Standard Deviation in parenthesis, * significant at 10%, ** significant at 5%, *** significant at 1%.
Source: Computed.

Table .16

Augmented Dickey-Fuller Unit Root Test for the logarithm of Potato's Price in different cities of Colombia: 1928-1990

	Log Potato Price Barranquilla	Log Potato Price Bogota	Log Potato Price Bucaramanga	Log Potato Price Cali	Log Potato Price Manizales	Log Potato Price Medellin	Log Potato Price Pasto
Coefficient of dependent variable lag one period: γ_1 (t-statistic)	-0.0481 (-0.82)	-0.0601 (-1.11)	-0.0911 (-1.57)	-0.0648 (-1.32)	-0.1315 (-2.13)	-0.0981 (-1.35)	-0.0802 (-1.27)
Constant Coefficient: α_0 (t-statistic)	-0.1657 (-0.81)	-0.2277 (-1.12)	-0.3709 (-1.69)	-0.2772 (-1.61)	-0.5191 (-2.16)	-0.3469 (-1.27)	0.0122 (0.04)
Time trend Coefficient: α_1 (t-statistic)	0.0114 (1.85)	0.0124 (1.93)	0.0162 (2.38)	0.0124 (2.27)	0.0198 (2.70)	0.0168 (1.95)	0.0046 (0.59)
Chosen lag length of dependent variable: p	1	1	1	1	1	2	3
Ljung-Box Q-statistic: L(Q) Probability Value	L(15) = 20.78 0.144	L(15)=15.87 0.392	L(15)=11.79 0.695	L(15)=15.96 0.384	L(15)=11.21 0.738	L(15)=14.85 0.462	L(15)=9.17 0.868
L-M test for up to fourth order residual correlation Probability Value	1.6721 0.1701	1.4523 0.2298	0.9921 0.4199	0.9056 0.4671	0.8078 0.5253	1.1729 0.3337	0.6294 0.6437
Jarque-Bera Normality Test Probability Value	0.3631 0.8339	0.5105 0.7747	2.6241 0.2692	5.2448 0.0541	17.0057 0	3.572 0.1676	1.966 0.3741

Augmented Dickey-Fuller Unit Root Test for the logarithm of *Panela's* Price in different cities of Colombia: 1928-1990

	Log *Panela* Price Barranquilla	Log *Panela* Price Bogota	Log *Panela* Price Bucaramanga	Log *Panela* Price Cali 1/	Log *Panela* Price Manizales	Log *Panela* Price Medellin	Log *Panela* Price Pasto
Coefficient of dependent variable lag one period: γ_1 (t-statistic)	-0.1067 (-2.85)	-0.1671 (-2.94)	-0.1244 (-1.48)	-0.1283 (-2.71)	-0.0554 (-0.95)	-0.1445 (-3.16)	-0.0881 (-0.97)
Constant Coefficient: α_0 (t-statistic)	-0.3861 (-3.18)	-0.5422 (-2.84)	-0.4656 (-1.33)	-0.4928 (-2.12)	-0.2255 (-0.98)	-0.5483 (-3.88)	-0.2594 (-0.85)
Time trend Coefficient: α_1 (t-statistic)	0.0168 (3.94)	0.0221 (3.38)	0.0212 (1.93)	0.0202 (2.66)	0.0139 (1.92)	0.0216 (4.46)	0.0145 (1.49)
Chosen lag length of dependent variable: p	1	1	3	1	3	1	2
Ljung-Box Q-statistic: L(Q) Probability Value	L(15) = 20.14 0.167	L(15)=25.42 0.063	L(15)=8.41 0.907	L(15)=20.05 0.128	L(15)=16.93 0.323	L(15)=10.07 0.815	L(15)=13.59 0.557
L-M test for up to fourth order residual correlation Probability Value	1.8905 0.1251	2.1815 0.083	2.594 0.051	2.2513 0.066	3.1034 0.084	0.8724 0.4863	1.321 0.2653
Jarque-Bera Normality Test Probability Value	5.216 0.0627	5.811 0.0541	2.104 0.3491	19.12 0	0.885 0.6423	38.1 0	58.5 0

1/ In this serie we found that the residuals were heteroskedastics. To correct for this problem we use the White Heteroskedasticity-Consistent Standard Errors & Variance

Augmented Dickey-Fuller Unit Root Test for the logarithm of Corn's Price in different cities of Colombia: 1928-1990

	Log Corn Price Barranquilla	Log Corn Price Bogota	Log Corn Price Bucaramanga	Log Corn Price Cali	Log Corn Price Manizales	Log Corn Price Medellin	Log Corn Price Pasto
Coefficient of dependent variable lag one period: γ_1 (t-statistic)	-0.1654 (-3.11)	-0.1087 (-2.46)	-0.0634 (-0.74)	-0.1215 (-2.45)	-0.1281 (-2.20)	-0.0926 (-1.80)	-0.0534 (-0.67)
Constant Coefficient: α_0 (t-statistic)	-0.7304 (-3.11)	-0.4275 (-2.45)	-0.1819 (-0.48)	-0.4712 (-2.47)	-0.5202 (-2.24)	-0.3386 (-1.69)	-0.1706 (-0.48)
Time trend Coefficient: α_1 (t-statistic)	0.0289 (3.97)	0.0179 (3.14)	0.0137 (1.21)	0.0187 (3.11)	0.0217 (2.99)	0.0148 (2.33)	0.0104 (0.99)
Chosen lag length of dependent variable: p	2	1	2	1	2	1	1
Ljung-Box Q-statistic: L(Q) Probability Value	L(15) = 12.55 0.636	L(15)=16.35 0.359	L(15)=16.62 0.342	L(15)=8.19 0.916	L(15)=14.28 0.504	L(15)=20.123 0.167	L(15)=13.34 0.576
L-M test for up to fourth order residual correlation Probability Value	0.556 0.695	1.464 0.2262	1.1198 0.3593	0.9825 0.4716	0.7489 0.564	1.4445 0.2323	1.4602 0.2297
Jarque-Bera Normality Test Probability Value	1.0671 0.5865	5.784 0.0653	0.6336 0.7357	6.0313 0.058	18.44 0	3.1603 0.2059	1.7569 0.4154

Note: The Mackinnon 5% critical values for rejection of the null hypothesis of unit root is -3.4836

Table 16 (continued)

Augmented Dickey-Fuller Unit Root Test for the logarithm of Salt's Price in different cities of Colombia: 1928-1990

	Log Salt Price Barranquilla	Log Salt Price Bogota	Log Salt Price Bucaramanga	Log Salt Price Cali	Log Salt Price Manizales	Log Salt Price Medellin	Log Salt Price in Pasto
Coefficient of dependent variable lag one period: γ_1	-0.0308	-0.01492	-0.0238	-0.0184	-0.0255	-0.0145	-0.414
(t-statistic)	(-0.91)	(-0.49)	(-0.99)	(-0.72)	(-0.78)	(-0.37)	(-1.48)
Constant Coefficient: α_0	-0.1267	-0.0907	-0.1541	-0.1217	-0.1221	-0.1235	-0.2173
(t-statistic)	(-0.99)	(-0.80)	(-1.78)	(-1.35)	(-1.04)	(-0.88)	(-2.15)
Time trend Coefficient: α_1	0.0071	0.0061	0.0077	0.0069	0.0071	0.0088	0.0095
(t-statistic)	(1.98)	(2.00)	(3.26)	(2.75)	(2.11)	(2.24)	(3.37)
Chosen lag length of dependent variable: p	1	1	1	1	1	1	1
Ljung -Box Q-statistic: L(Q)	L(15) = 15.63	L(15)=16.01	L(15)=10.715	L(15)=20.33	L(15)=13.55	L(15)=7.4196	L(15)=11.04
Probability Value	0.407	0.382	0.773	0.159	0.56	0.945	0.749
L-M test for up to fourth order residual correlation	1.8548	0.5493	0.4427	0.9793	0.8876	0.7939	0.5393
Probability Value	0.1327	0.7	0.777	0.427	0.478	0.5354	0.7075
Jarque-Bera Normality Test	29.51	45.9	32.7	16.19	43.26	35.7	45
Probability Value	0	0	0	0	0	0	0

Augmented Dickey-Fuller Unit Root Test for the logarithm of Rice Price in different cities of Colombia: 1928-1990

	Log Rice Price Barranquilla	Log Rice Price Bogota	Log Rice Price Bucaramanga	Log Rice Price Cali	Log Rice Price Manizales	Log Rice Price Medellin	Log Rice Price Pasto
Coefficient of dependent variable lag one period: γ_1	-0.0445	-0.0238	-0.0658	-0.0665	-0.0681	-0.0654	-0.0174
(t-statistic)	(-0.99)	(-0.54)	(-1.60)	(-1.42)	(-1.35)	(-1.52)	(-0.52)
Constant Coefficient: α_0	-0.0853	-0.0666	-1.996	-0.1713	-0.1612	-0.1676	-0.0449
(t-statistic)	(-0.64)	(-0.53)	(-1.68)	(-1.24)	(-1.13)	(-1.41)	(-0.48)
Time trend Coefficient: α_1	0.0076	0.0078	0.0112	0.0107	0.0105	0.0106	0.0054
(t-statistic)	(1.45)	(1.62)	(2.44)	(1.97)	(1.84)	(2.19)	(1.48)
Chosen lag length of dependent variable: p	1	2	1	1	1	1	1
Ljung -Box Q-statistic: L(Q)	L(15) = 11.86	L(15)=10.39	L(15)=7.22	L(15)=12.43	L(15)=11.58	L(15)=16.52	L(15)=10.008
Probability Value	0.689	0.794	0.951	0.646	0.71	0.282	0.819
L-M test for up to fourth order residual correlation	0.4733	0.8044	0.7815	0.7345	1.063	1.485	0.7108
Probability Value	0.7021	0.528	0.542	0.5694	0.3838	0.2191	0.5884
Jarque-Bera Normality Test	10.11	5.211	13.39	12.94	54.13	9.1808	26.91
Probability Value	0.0063	0.0641	0.0014	0.0015	0	0.015	0

Augmented Dickey-Fuller Unit Root Test for the logarithm of Sugar Price in different cities of Colombia: 1928-1990

	Log Sugar Price in Barranquilla	Log Sugar Price in Bogota	Log Sugar Price in Bucaramanga	Log Sugar Price in Cali	Log Sugar Price in Manizales	Log Sugar Price in Medellin	Log Sugar Price in Pasto
Coefficient of dependent variable lag one period: γ_1	-0.0107	-0.0089	-0.022	-0.0194	-0.0117	-0.0067	-0.007
(t-statistic)	(-0.26)	(-0.25)	(-0.48)	(-0.53)	(-0.28)	(-0.17)	(-0.18)
Constant Coefficient: α_0	-0.0337	-0.0339	-0.042	-0.098	-0.0391	-0.0213	-0.028
(t-statistic)	(-0.21)	(-0.25)	(-0.31)	(-0.68)	(-0.23)	(-0.14)	(-0.19)
Time trend Coefficient: α_1	0.0055	0.0046	0.0059	0.0069	0.004	0.0057	0.0052
(t-statistic)	(1.07)	(1.08)	(1.10)	(1.65)	(0.85)	(1.17)	(1.12)
Chosen lag length of dependent variable: p	2	1	1	1	2	2	1
Ljung -Box Q-statistic: L(Q)	L(15) = 21.79	L(15)=20.86	L(15)=19.96	L(15)=18.26	L(15)=24.21	L(15)=20.28	L(15)=28.13
Probability Value	0.113	0.1052	0.13	0.195	0.012	0.161	0.014
L-M test for up to fourth order residual correlation	1.046	1.1087	1.69	1.222	1.1349	0.798	0.9391
Probability Value	0.3935	0.3633	0.17	0.3138	0.3513	0.5326	0.441
Jarque-Bera Normality Test	5.296	42	20	49.08	1.0372	31.44	3.88
Probability Value	0.072	0	0	0	0.595	0	0.1435

Note: The Mackinnon 5% critical values for rejection of the null hypothesis of unit root is -3.4836

Table .16 (continued)

Augmented Dickey-Fuller Unit Root Test for the logarithm of Potato's Average National Price in Colombia excluding the respective city: 1928-1990

	Log Potato Price National Average excluding Barranquilla	Log Potato Price National Average excluding Bogota	Log Potato Price National Average excluding Bucaramanga	Log Potato Price National Average excluding Cali	Log Potato Price National Average excluding Manizales	Log Potato Price National Average excluding Medellin	Log Potato Price National Average excluding Pasto	Log Potato Price National Average
Coefficient of dependent variable lag one period: γ_1	-0.0678	-0.0682	-0.06435	-0.0683	-0.0629	-0.0619	-0.0342	-0.0683
(t-statistic)	(-1.49)	(-1.45)	(-1.42)	(-1.47)	(-1.39)	(-1.38)	(-0.52)	(-1.45)
Constant Coefficient: α_0	-0.2659	-0.2582	-0.2495	-0.2616	-0.2448	-0.2439	-0.1362	-0.2575
(t-statistic)	(-1.62)	(-1.58)	(-1.54)	(-1.57)	(-1.51)	(-1.52)	(-0.52)	(-1.57)
Time trend Coefficient: α_1	0.0121	0.0118	0.0116	0.0119	0.0115	0.0114	0.0091	0.0119
(t-statistic)	(2.32)	(2.28)	(2.24)	(2.26)	(2.22)	(2.24)	(1.21)	(2.27)
Chosen lag length of dependent variable: p	1	1	1	1	1	1	2	1
Ljung-Box Q-statistic: L(Q)	L(15) = 20.21	L(15)=19.87	L(15)=20.95	L(15)=20.36	L(15)=21.74	L(15)=20.31	L(15)=23.36	L(15)=21.13
Probability Value	0.164	0.177	0.138	0.141	0.115	0.161	0.077	0.133
L-M test for up to fourth order residual correlation	1.6223	1.6094	1.7427	1.8786	1.8044	0.7429	2.74	1.79
Probability Value	0.1816	0.1849	0.1537	0.1272	0.1411	0.3922	0.037	0.1439
Jarque-Bera Normality Test	5.5927	5.2321	7.044	7.1291	5.798	9.098	2.6717	5.29
Probability Value	0.0586	0.073	0.0295	0.0283	0.0551	0.012	0.2929	[illegible]

Augmented Dickey-Fuller Unit Root Test for the logarithm of *Panela's* Price in different cities of Colombia: 1928-1990

	Log *Panela* Price National Average excluding Barranquilla	Log *Panela* Price National Average excluding Bogota	Log *Panela* Price National Average excluding Bucaramanga	Log *Panela* Price National Average excluding Cali	Log *Panela* Price National Average excluding Manizales	Log *Panela* Price National Average excluding Medellin	Log *Panela* Price National Average excluding Pasto	Log *Panela* Price National Average
Coefficient of dependent variable lag one period: γ_1	-0.1042	-0.1009	-0.1003	-0.1039	-0.1057	-0.1034	-0.1135	-0.1041
(t-statistic)	(-1.88)	(-1.95)	(-1.95)	(-2.00)	(-2.01)	(-1.99)	(-2.16)	(-1.98)
Constant Coefficient: α_0	-0.3902	-0.3834	-0.3761	-0.3897	-0.3973	-0.3895	-0.4254	-0.3913
(t-statistic)	(-1.83)	(-1.94)	(-1.94)	(-1.99)	(-1.99)	(-1.99)	(-2.13)	(-1.97)
Time trend Coefficient: α_1	0.0164	0.0161	0.0158	0.0162	0.0164	0.0162	0.0173	0.0163
(t-statistic)	(2.29)	(2.51)	(2.52)	(2.60)	(2.54)	(2.54)	(2.67)	(2.53)
Chosen lag length of dependent variable: p	1	1	1	1	1	1	1	[illegible]
Ljung-Box Q-statistic: L(Q)	L(15) = 15.68	L(15)=15.63	L(15)=16.88	L(15)=15.67	L(15)=15.409	L(15)=17.213	L(15)=16.06	L(15)=16.51
Probability Value	0.404	0.407	0.328	0.404	0.422	0.306	0.378	0.349
L-M test for up to fourth order residual correlation	1.912	1.8925	1.922	1.8216	1.817	2.062	2.176	1.6226
Probability Value	0.1218	0.1253	0.1202	0.1384	0.1392	0.0989	0.0843	0.1587
Jarque-Bera Normality Test	15.016	10.73	17.33	13.08	18.73	10.22	28.98	17.36
Probability Value	0	0.005	0	0	0	0.006	0	0

(*) In this serie we found that the residuals were heteroskedastics. To correct for this problem we use the White Heteroskedasticity-Consistent Standard Errors & Variance

Augmented Dickey-Fuller Unit Root Test for the logarithm of Corn's Price in different cities of Colombia: 1928-1990

	Log Corn Price National Average excluding Barranquilla	Log Corn Price National Average excluding Bogota	Log Corn Price National Average excluding Bucaramanga	Log Corn Price National Average excluding Cali	Log Corn Price National Average excluding Manizales	Log Corn Price National Average excluding Medellin	Log Corn Price National Average excluding Pasto	Log Corn Price National Average
Coefficient of dependent variable lag one period: γ_1	-0.1009	-0.1069	-0.0985	-0.1021	-0.1008	-0.1098	-0.1023	-0.1033
(t-statistic)	(-2.05)	(-2.14)	(-2.05)	(-2.09)	(-2.05)	(-2.28)	(-2.09)	(-2.11)
Constant Coefficient: α_0	-0.4152	-0.4441	-0.4085	-0.4228	-0.4157	-0.4606	-0.4234	-0.4287
(t-statistic)	(-1.98)	(-2.07)	(-1.99)	(-2.02)	(-1.97)	(-2.21)	(-2.02)	(-2.05)
Time trend Coefficient: α_1	0.0177	0.0186	0.0174	0.0179	0.0178	0.0191	0.0182	0.0182
(t-statistic)	(2.72)	(2.82)	(2.73)	(2.76)	(2.74)	(2.95)	(2.79)	(2.81)
Chosen lag length of dependent variable: p	2	2	2	2	2	2	2	2
Ljung-Box Q-statistic: L(Q)	L(15) = 17.92	L(15)=16.71	L(15)=16.87	L(15)=18.94	L(15)=16.28	L(15)=18.01	L(15)=18.88	L(15)=17.77
Probability Value	0.267	0.337	0.326	0.216	0.364	0.262	0.219	0.275
L-M test for up to fourth order residual correlation	0.4012	0.7279	0.7722	1.313	0.7359	0.7982	0.8802	0.8045
Probability Value	0.6715	0.5772	0.5485	0.2782	0.5719	0.5321	0.4827	0.5282
Jarque-Bera Normality Test	4.215	4.1583	3.0402	3.3566	2.673	3.4288	3.1598	3.2262
Probability Value	0.1215	0.125	0.2187	0.1866	0.2627	0.1801	0.2059	0.1992

Note: The Mackinnon 5% critical values for rejection of the null hypothesis of unit root is -3.4838

Table 16 (continued)

Augmented Dickey-Fuller Unit Root Test for the logarithm of Salt's Average National Price in Colombia excluding the respective city: 1928-1990

	Log Salt Price National Average excluding Barranquilla	Log Salt Price National Average excluding Bogota	Log Salt Price National Average excluding Bucaramanga	Log Salt Price National Average excluding Cali	Log Salt Price National Average excluding Manizales	Log Salt Price National Average excluding Medellin	Log Salt Price National Average excluding Pasto	Log Salt Price National Average
Coefficient of dependent variable lag one period: γ_1	-0.0181	-0.0193	-0.0174	-0.0186	-0.0182	-0.0185	-0.0161	-0.0179
(t-statistic)	(-0.83)	(-0.87)	(-0.78)	(-0.83)	(-0.85)	(-0.85)	(-0.72)	(-0.82)
Constant Coefficient: α_0	-0.1156	-0.1184	-0.1084	-0.1142	-0.1153	-0.1156	-0.1031	-0.1128
(t-statistic)	(-1.44)	(-1.45)	(-1.32)	(-1.38)	(-1.44)	(-1.45)	(-1.26)	(-1.39)
Time trend Coefficient: α_1	0.0067	0.0068	0.0065	0.0067	0.0067	0.0068	0.0064	0.0067
(t-statistic)	(3.05)	(3.01)	(2.88)	(2.94)	(3.06)	(3.06)	(2.82)	(2.97)
Chosen lag length of dependent variable: p	1	1	1	1	1	1	1	1
Ljung-Box Q-statistic: L(Q)	L(15) = 8.123	L(15)=6.547	L(15)=7.56	L(15)=7.25	L(15)=7.77	L(15)=7.612	L(15)=6.74	L(15)=7.36
Probability Value	0.919	0.969	0.94	0.95	0.932	0.938	0.965	0.947
L-M test for up to fourth order residual correlation	0.7006	0.4257	0.4785	0.452	0.664	0.553	0.3895	0.4437
Probability Value	0.595	0.789	0.7513	0.77	0.616	0.697	0.8152	0.7763
Jarque-Bera Normality Test	64.05	64.28	64	69.56	75.1	57.3	57.73	64
Probability Value	0	0	0	0	0	0	0	0

Augmented Dickey-Fuller Unit Root Test for the logarithm of *Panela's* Price in different cities of Colombia: 1928-1990

	Log Rice Price National Average excluding Barranquilla	Log Rice Price National Average excluding Bogota	Log Rice Price National Average excluding Bucaramanga	Log Rice Price National Average excluding Cali	Log Rice Price National Average excluding Manizales	Log Rice Price National Average excluding Medellin	Log Rice Price National Average excluding Pasto	Log Rice Price National Average
Coefficient of dependent variable lag one period: γ_1	-0.0179	-0.0154	-0.0124	-0.0168	-0.0173	-0.0162	-0.0190	-0.0158
(t-statistic)	(-0.41)	(-0.34)	(-0.28)	(-0.37)	(-0.40)	(-0.36)	(-0.43)	(-0.35)
Constant Coefficient: α_0	-0.0344	-0.0221	-0.0122	-0.0282	-0.0311	-0.0264	-0.035	-0.1027
(t-statistic)	(-0.29)	(-0.16)	(-0.09)	(-0.21)	(-0.23)	(-0.20)	(-0.28)	(-0.76)
Time trend Coefficient: α_1	0.0065	0.0061	0.0058	0.0062	0.0063	0.0062	0.0066	0.0062
(t-statistic)	(1.30)	(1.17)	(1.15)	(1.25)	(1.27)	(1.23)	(1.26)	(1.22)
Chosen lag length of dependent variable: p	2	2	2	2	2	2	2	2
Ljung-Box Q-statistic: L(Q)	L(15) = 8.93	L(15)=8.57	L(15)=9.39	L(15)=8.52	L(15)=9.137	L(15)=9.253	L(15)=9.43	L(15)=9.18
Probability Value	0.381	0.899	0.856	0.901	0.87	0.864	0.855	0.868
L-M test for up to fourth order residual correlation	0.5195	0.4709	0.4075	0.4731	0.5899	0.4307	0.4944	0.4927
Probability Value	0.7216	0.7571	0.8023	0.7552	0.6714	0.7857	0.7398	0.741
Jarque-Bera Normality Test	9.672	10.907	10.6	11.103	7.3278	10.962	9.158	10.23
Probability Value	0.008	0.005	0.005	0.004	0.02	0.004	0.011	0.006

1/ In this serie we found that the residuals were heteroskedastics. To correct for this problem we use the White Heteroskedasticity-Consistent Standard Errors & Variance

Augmented Dickey-Fuller Unit Root Test for the logarithm of Corn's Price in different cities of Colombia: 1928-1990

	Log Sugar Price National Average excluding Barranquilla	Log Sugar Price National Average excluding Bogota	Log Sugar Price National Average excluding Bucaramanga	Log Sugar Price National Average excluding Cali	Log Sugar Price National Average excluding Manizales	Log Sugar Price National Average excluding Medellin	Log Sugar Price National Average excluding Pasto	Log Sugar Price National Average
Coefficient of dependent variable lag one period: γ_1	-0.0113	-0.0126	-0.0117	-0.0111	-0.0134	-0.0111	-0.0141	-0.012
(t-statistic)	(-0.34)	(-0.38)	(-0.36)	(-0.34)	(-0.41)	(-0.34)	(-0.43)	(-0.37)
Constant Coefficient: α_0	-0.0486	-0.047	-0.051	-0.0452	-0.0577	-0.0471	-0.059	-0.0507
(t-statistic)	(-0.38)	(-0.39)	(-0.39)	(-0.35)	(-0.44)	(-0.37)	(-0.46)	(-0.40)
Time trend Coefficient: α_1	0.0051	0.0051	0.0051	0.0049	0.0053	0.0049	0.0053	0.0051
(t-statistic)	(1.61)	(1.62)	(1.62)	(1.58)	(1.64)	(1.58)	(1.31)	(1.26)
Chosen lag length of dependent variable: p	1	1	1	1	1	1	1	1
Ljung-Box Q-statistic: L(Q)	L(15) = 24.03	L(15)=23.42	L(15)=24.19	L(15)=23.81	L(15)=22.18	L(15)=23.75	L(15)=22.48	L(15)=24.01
Probability Value	0.064	0.076	0.062	0.068	0.075	0.069	0.049	0.065
L-M test for up to fourth order residual correlation	1.688	1.8184	1.7302	1.8339	1.7999	1.6833	2.146	1.7314
Probability Value	0.1682	0.1407	0.1587	0.1377	0.1443	0.1739	0.089	0.1481
Jarque-Bera Normality Test	16.13	12.88	18.22	11.79	15.78	11.58	16.49	14.72
Probability Value	0	0.002	0	0.003	0	0.0034	0	0

Note: The Mackinnon 5% critical values for rejection of the null hypothesis of unit root is -3.4836

Table 17a

Cointegration results: Johansen's Maximum Likelihood Procedure for the Potato's Price Series (in logs)

Case 1: Cointegration of potato's price serie in Bogota with potato's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1.Barranquilla	r=0	r=1	2	0.2588	17.9*	15.41	CI, r=1	0.987	0.32	-0.1069	67.17
	r=1	r=2	2	0.0257	1.43	3.76		(0.024)	p=0.57	(0.015)	p=0.0
2. Bucaramanga	r=0	r=1	2	0.2769	22.75*	15.41	CI, r=1	0.978	3.09	0.126	74.71
	r=1	r=2	2	0.0595	3.62	3.76		(0.014)	p=0.09	(0.014)	p=0.0
3. Cali	r=0	r=1	1	0.2771	20.02*	15.41	CI, r=1	0.968	3..5	0.013	0.2911
	r=1	r=2	1	0.0038	0.23	3.76		(0.035)	p=0.07	(0.025)	p=0.58
4. Manizales	r=0	r=1	3	0.2672	21.64*	15.41	CI, r=1	0.956	4.29	0.1674	46.86
	r=1	r=2	3	0.0544	3.3	3.76		(0.018)	p=0.04	(0.022)	p=0.0
5. Medellin	r=0	r=1	2	0.2525	21.19*	15.41	CI, r=1	1.122	11.75	-0.0573	3.86
	r=1	r=2	2	0.0603	3.73	3.76		(0.072)	p=0.0	(0.029)	p=0.046
6. Pasto	r=0	r=1	1	0.1498	13.34	15.41	NCI, r=0				
	r=1	r=2	1	0.0549	3.44	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 2: Cointegration of potato's price serie in Barranquilla with potato's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Bucaramanga	r=0	r=1	1	0.2603	25.47*	15.41	r=n				
	r=1	r=2	1	0.1095	7.07*	3.76					
2. Cali	r=0	r=1	1	0.132	8.75	15.41	NCI, r=0				
	r=1	r=2	1	0.0145	0.082	3.76					
3. Manizales	r=0	r=1	2	0.2453	24.94*	15.41	r=n				
	r=1	r=2	2	0.1318	8.34*	3.76					
4. Medellin	r=0	r=1	1	0.203	16.64*	15.41	CI, r=1	1.05	1.68	0.087	20.63
	r=1	r=2	1	0.044	2.8	3.76		(0.049)	p=0.2	(0.019)	p=0.0
5. Pasto	r=0	r=1	1	0.1547	14.23	15.41	NCI, r=0				
	r=1	r=2	1	0.0784	4.65*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 3: Cointegration of potato's price serie in Bucaramanga with potato's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Cali	r=0	r=1	1	0.2067	14.21	15.41	NCI, r=0				
	r=1	r=2	1	0.0013	0.08	3.76					
2. Manizales	r=0	r=1	3	0.3028	25.18*	15.41	r=n				
	r=1	r=2	3	0.0639	3.89*	3.76					
3. Medellin	r=0	r=1	1	0.2833	21.20*	15.41	CI, r=1	1.079	8.06	-0.1579	38.65
	r=1	r=2	1	0.0144	0.88	3.76		(0.032)	p=0.0	(0.025)	p=0.0
4. Pasto	r=0	r=1	3	0.1645	15.18	15.41	NCI, r=0				
	r=1	r=2	3	0.0746	4.58*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 4: Cointegration of potato's price serie in Cali with potato's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Manizales	r=0	r=1	1	0.2214	16.04*	15.41	CI, r=1	1.043	1.34	0.1239	46.81
	r=1	r=2	1	0.0125	0.77	3.76		(0.051)	p=0.25	(0.018)	p=0.0
2. Medellin	r=0	r=1	2	0.2717	19.05*	15.41	CI, r=1	1.144	6.9	-0.1054	65.01
	r=1	r=2	2	0.0004	0.03	3.76		(0.032)	p=0.0	(0.022)	p=0.0
3. Pasto	r=0	r=1	3	0.2005	16.67*	15.41	CI, r=1	1.072	2.52	0.3554	139.7
	r=1	r=2	3	0.0571	3.47	3.76		(0.046)	p=0.11	(0.042)	p=0.0

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 5: Cointegration of potato's price serie in Manizales with potato's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Medellin	r=0	r=1	3	0.3493	26.24*	15.41	CI, r=1	1.08	6.51	-0.2	45.17
	r=1	r=2	3	0.0149	0.89	3.76		(0.020)	p=0.0	(0.027)	p=0.0
2. Pasto	r=0	r=1	3	0.2045	16.81*	15.41	CI, r=1	1.05	2.16	0.2379	69.08
	r=1	r=2	3	0.0546	3.31	3.76		(0.029)	p=0.14	(0.028)	p=0.0

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 6: Cointegration of potato's price serie in Medellin with potato's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Pasto	r=0	r=1	3	0.1354	9.83*	15.41	NCI, r=0				
	r=1	r=2	3	0.0209	1.24	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Cointegration results: Johansen's Maximum Likelihood Procedure for the *Panela*'s Price Series (in logs)

Case 1: Cointegration of *panela's* price serie in Bogota with *panela's* price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Barranquilla	r=0	r=1	1	0.2206	15.55*	15.41	CI, r=1	0.914	6.75	-0.1189	30.82
	r=1	r=2	1	0.0058	0.35	3.76		(0.036)	p=0.01	(0.021)	p=0.0
2. Bucaram.	r=0	r=1	1	0.28	24.41	25.32	NCI, r=0 1/				
	r=1	r=2	1	0.0692	4.37	12.25					
3. Cali	r=0	r=1	1	0.2916	23.14*	15.41	CI, r=1	0.884	16.4	0.1525	99.22
	r=1	r=2	1	0.0339	2.11	3.76		(0.008)	p=0.0	(0.015)	p=0.0
4. Manizales	r=0	r=1	1	0.2516	22.58*	15.41	r=n				
	r=1	r=2	1	0.077	4.91*	3.76					
5. Medellin	r=0	r=1	2	0.2525	21.19*	15.41	CI, r=1	1.122	11.75	-0.0573	3.86
	r=1	r=2	2	0.0603	3.73	3.76		(0.072)	p=0.0	(0.029)	p=0.046
6. Pasto	r=0	r=1	1	0.1812	14.54	15.41	NCI, r=0				
	r=1	r=2	1	0.0377	2.35	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in cointegration space

Case 2: Cointegration of *panela's* price serie in Barranquilla with *panela's* price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Bucaramanga	r=0	r=1	3	0.2	14.55	15.41	NCI, r=0				
	r=1	r=2	3	0.0233	1.39	3.76					
2. Cali	r=0	r=1	1	0.2461	18.06*	15.41	CI, r=1	0.966	0.6	0.2974	94.19
	r=1	r=2	1	0.0135	0.83	3.76		(0.036)	p=0.44	(0.031)	p=0.0
3. Manizales	r=0	r=1	1	0.2359	19.31*	15.41	CI, r=1	0.978	0.81	0.1731	22.95
	r=1	r=2	1	0.0464	2.9	3.76		(0.020)	p=0.37	(0.024)	p=0.0
4. Medellin	r=0	r=1	2	0.2051	16.87*	15.41	CI, r=1	1.021	0.21	0.1525	23.97
	r=1	r=2	2	0.0504	3.1	3.76		(0.042)	p=0.65	(0.033)	p=0.0
5. Pasto	r=0	r=1	1	0.2523	20.01*	15.41	CI, r=1	1.032	0.66	0.3066	49.9
	r=1	r=2	1	0.0366	2.28	3.76		(0.038)	p=0.42	(0.047)	p=0.0

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 3: Cointegration of *panela's* price serie in Bucaramanga with *panela's* price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Cali	r=0	r=1	1	0.0893	7.31	15.41	NCI, r=0				
	r=1	r=2	1	0.026	1.61	3.76					
2. Manizales	r=0	r=1	2	0.2364	24.38	25.32	NCI, r=0 1/				
	r=1	r=2	2	0.1277	8.2	12.25					
3. Medellin	r=0	r=1	1	0.1235	12.35	15.41	NCI, r=0				
	r=1	r=2	1	0.0682	4.31	3.76					
4. Pasto	r=0	r=1	1	0.1196	10.16	15.41	NCI, r=0				
	r=1	r=2	1	0.0385	2.4	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in cointegration space

Case 4: Cointegration of *panela's* price serie in Cali with *panela's* price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Manizales	r=0	r=1	3	0.3899	32.66*	15.41	CI, r=1	0.997	0.02	-0.1039	13.97
	r=1	r=2	3	0.0578	3.51	3.76		(0.022)	p=0.89	(0.031)	p=0.0
2. Medellin	r=0	r=1	2	0.248	20.19*	15.41	CI, r=1	1.009	0.18	-0.1149	63.68
	r=1	r=2	2	0.0501	3.09	3.76		(0.017)	p=0.67	(0.016)	p=0.0
3. Pasto	r=0	r=1	1	0.1665	13.3*	15.41	NCI, r=0				
	r=1	r=2	1	0.0353	2.19	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 5: Cointegration of *panela's* price serie in Manizales with *panela's* price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Medellin	r=0	r=1	1	0.1773	13.89	15.41	NCI, r=0				
	r=1	r=2	1	0.032	1.99	3.76					
2. Pasto	r=0	r=1	1	0.1882	16.01*	15.41	CI, r=1	1.06	2.08	0.1345	882
	r=1	r=2	1	0.0525	3.29	3.76		(0.042)	p=0.15	(0.038)	p=0.0

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 6: Cointegration of *panela's* price serie in Medellin with *panela's* price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Pasto	r=0	r=1	2	0.1249	13.83	15.41	NCI, r=0				
	r=1	r=2	2	0.0926	5.83*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Cointegration results: Johansen's Maximum Likelihood Procedure for the Rice Price Series (in logs)

Case 1: Cointegration of rice's price serie in Bogota with rice's price serie in:

Cities	H_0	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Barranquilla	r=0	r=1	2	0.3863	31.75*	15.41	CI, r=1	1.077	7.58	-0.028	3.85
	r=1	r=2	2	0.04	2.45	3.76		(0.038)	p=0.01	(0.015)	p=0.049
2. Bucaram.	r=0	r=1	1	0.2258	18.48*	15.41	CI, r=1	0.943	5.23	0.1757	41.7
	r=1	r=2	1	0.0459	2.87	3.76		(0.028)	p=0.02	(0.027)	p=0.0
3. Cali	r=0	r=1	1	0.2705	23.3	25.32	NCI, r=0 1/				
	r=1	r=2	1	0.0644	4.06	12.25					
4. Manizales	r=0	r=1	1	0.1982	16.51*	15.41	CI, r=1	1.07	4.64	-0.061	11.86
	r=1	r=2	1	0.0485	3.03	3.76		(0.045)	p=0.03	(0.017)	p=0.0
5. Medellin	r=0	r=1	1	0.1634	14.97	15.41	NCI, r=0				
	r=1	r=2	1	0.0648	4.09*	3.76					
6. Pasto	r=0	r=1	2	0.2437	25.84*	15.41	r=n				
	r=1	r=2	2	0.1345	8.81*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in cointegration space

Case 2: Cointegration of rice's price serie in Barranquilla with rice's price serie in:

Cities	H_0	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Bucaramanga	r=0	r=1	1	0.4289	34.57*	15.41	CI, r=1	0.986	0.58	0.093	9.69
	r=1	r=2	1	0.0065	0.4	3.76		(0.019)	p=0.45	(0.031)	p=0.0
2. Cali	r=0	r=1	2	0.3279	25.64*	15.41	CI, r=1	0.925	13.12	0.079	7.64
	r=1	r=2	2	0.0296	1.8	3.76		(0.028)	p=0.00	(0.033)	p=0.006
3. Manizales	r=0	r=1	2	0.2667	21.75*	15.41	CI, r=1	0.962	2.68	-0.009	1.02
	r=1	r=2	2	0.051	3.14	3.76		(0.026)	p=0.1	(0.016)	p=0.30
4. Medellin	r=0	r=1	1	0.3515	28.84*	15.41	CI, r=1	1.0004	0	-0.0816	13.31
	r=1	r=2	1	0.039	2.42	3.76		(0.012)	p=0.98	(0.011)	p=0.0
5. Pasto	r=0	r=1	1	0.3159	24.11*	15.41	CI, r=1	0.921	5.24	-0.1031	18.2
	r=1	r=2	1	0.0155	0.95	3.76		(0.050)	p=0.02	(0.037)	p=0.0

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 3: Cointegration of rice's price serie in Bucaramanga with rice's price serie in:

Cities	H_0	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Cali	r=0	r=1	2	0.1854	18.53*	15.41	r=n				
	r=1	r=2	2	0.0985	6.22*	3.76					
2. Manizales	r=0	r=1	1	0.24	20.70*	15.41	CI, r=1	1.05	3.16	-0.1762	27.92
	r=1	r=2	1	0.0451	2.82	3.76		(0.032)	p=0.08	(0.029)	p=0.0
3. Medellin	r=0	r=1	2	0.2238	17.67*	15.41	CI, r=1	1.065	5.08	-0.2322	51.22
	r=1	r=2	2	0.0403	2.47	3.76		(0.036)	p=0.02	(0.042)	p=0.0
4. Pasto	r=0	r=1	2	0.2173	23.35*	15.41	r=n				
	r=1	r=2	2	0.1343	8.65*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated.

Case 4: Cointegration of rice's price serie in Cali with rice's price serie in:

Cities	H_0	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Manizales	r=0	r=1	2	0.3204	29.21*	15.41	r=n				
	r=1	r=2	2	0.0956	6.03*	3.76					
2. Medellin	r=0	r=1	1	0.1748	14.37	15.41	NCI, r=0				
	r=1	r=2	1	0.054	3.22	3.76					
3. Pasto	r=0	r=1	1	0.2955	34.22*	25.32	r=n 1/				
	r=1	r=2	1	0.19	12.85*	12.25					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in cointegration space

Case 5: Cointegration of rice's price serie in Manizales with rice price serie in:

Cities	H_0	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Medellin	r=0	r=1	2	0.2605	28.44*	15.41	r=n				
	r=1	r=2	2	0.1582	10.33*	3.76					
2. Pasto	r=0	r=1	1	0.2689	32.61*	25.32	r=n 1/				
	r=1	r=2	1	0.1986	13.51*	12.25					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in cointegration space

Case 6: Cointegration of rice price serie in Medellin with rice price serie in:

Cities	H_0	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_0: \beta=1$	μ	$\chi^2(1)$ $H_0: \mu=0$
1. Pasto	r=0	r=1	1	0.3349	37.56*	25.32	r=n 1/				
	r=1	r=2	1	0.1877	12.68*	12.25					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated, 1/ Trend included in the cointegrating space

Table .17d

Cointegration results: Johansen's Maximum Likelihood Procedure for the Salt Price Series (in logs)

Case 1: Cointegration of salt's price serie in Bogota with salt's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Barranquilla	r=0	r=1	1	0.1776	13.36	15.41	NCI, r=0				
	r=1	r=2	1	0.0381	2.22	3.76					
2. Bucaram.	r=0	r=1	2	0.1398	11.53	15.41	NCI, r=0				
	r=1	r=2	2	0.0539	3.1	3.76					
3. Cali	r=0	r=1	1	0.2042	24.20*	15.41	r=n				
	r=1	r=2	1	0.1781	11.18*	3.76					
4. Manizales	r=0	r=1	2	0.1774	14.11	15.41	NCI, r=0				
	r=1	r=2	2	0.0552	3.18	3.76					
5. Medellin	r=0	r=1	1	0.1685	20.52*	15.41	r=n				
	r=1	r=2	1	0.1609	10.00*	3.76					
6. Pasto	r=0	r=1	1	0.1883	19.19*	15.41	r=n				
	r=1	r=2	1	0.1201	7.29*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 2: Cointegration of salt's price serie in Barranquilla with salt's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Bucaramanga	r=0	r=1	1	0.2851	2178*	15.41	CI, r=1	0.805	7.98	-0.076	7.84
	r=1	r=2	1	0.0455	2.65	3.76		(0.095)	p=0.0	(0.037)	p=0.01
2. Cali	r=0	r=1	1	0.2301	20.00*	15.41	r=n				
	r=1	r=2	1	0.0855	5.09*	3.76					
3. Manizales	r=0	r=1	2	0.172	15.30	15.41	NCI, r=0				
	r=1	r=2	2	0.0819	4.48*	3.76					
4. Medellin	r=0	r=1	1	0.209	14.95	15.41	NCI, r=0				
	r=1	r=2	1	0.0273	1.58	3.76					
5. Pasto	r=0	r=1	3	0.1833	15.20	15.41	NCI, r=0				
	r=1	r=2	3	0.0716	4.09	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 3: Cointegration of salt's price serie in Bucaramanga with salt's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Cali	r=0	r=1	2	0.1552	15.07	15.41	NCI, r=0				
	r=1	r=2	2	0.0955	5.62*	3.76					
2. Manizales	r=0	r=1	2	0.1674	14.71	15.41	NCI, r=0				
	r=1	r=2	2	0.0764	4.45	3.76					
3. Medellin	r=0	r=1	2	0.1691	14.36	15.41	NCI, r=0				
	r=1	r=2	2	0.0731	4.17	3.76					
4. Pasto	r=0	r=1	2	0.1565	12.46	15.41	NCI, r=0				
	r=1	r=2	2	0.0510	2.93	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 4: Cointegration of salt's price serie in Cali with salt's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Manizales	r=0	r=1	1	0.3347	31.12*	15.41	r=n				
	r=1	r=2	1	0.1292	7.89*	3.76					
2. Medellin	r=0	r=1	2	0.2208	22.25*	15.41	r=n				
	r=1	r=2	2	0.1374	8.28*	3.76					
3. Pasto	r=0	r=1	1	0.1941	20.36*	15.41	r=n				
	r=1	r=2	1	0.1319	8.06*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 5: Cointegration of salt's price serie in Manizales with salt price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Medellin	r=0	r=1	3	0.215	15.92*	15.41	CI, r=1	0.900	6.11	-0.099	11.95
	r=1	r=2	3	0.0463	2.61	3.76		(0.058)	p=0.01	(0.026)	p=0.0
2. Pasto	r=0	r=1	1	0.1962	20.14*	15.41	r=n				
	r=1	r=2	1	0.1261	7.68*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 6: Cointegration of salt price serie in Medellin with salt price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Pasto	r=0	r=1	1	0.1962	20.14*	15.41	r=n				
	r=1	r=2	1	0.1291	7.68*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Table 17e

Cointegration results: Johansen's Maximum Likelihood Procedure for the Corn Price Series (in logs)

Case 1: Cointegration of corn's price serie in Bogota with corn's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1.Barranquilla	r=0	r=1	2	0.1677	14.43	15.41	NCI, r=0				
	r=1	r=2	2	0.0713	4.14	3.76					
2. Bucaram.	r=0	r=1	1	0.4161	34.83*	25.32	CI, r=1 1/	1.352	15.53	1.495	21.38
	r=1	r=2	1	0.1235	6.86	12.25		(0.085)	p=0.0	(0.205)	p=0.0
3. Cali	r=0	r=1	1	0.3608	33.42*	25.32	CI, r=1 1/	1.447	12.03	1.88	32.8
	r=1	r=2	1	0.1298	7.93	12.25		(0.015)	p=0.0	(0.47)	p=0.0
4. Manizales	r=0	r=1	1	0.2333	18.85*	15.41	CI, r=1	0.999	0.00	0.0728	7.35
	r=1	r=2	1	0.0576	3.44	3.76		(0.025)	p=0.99	(0.033)	p=0.0
5. Medellin	r=0	r=1	2	0.24	18.76*	15.41	CI, r=1	1.122	11.21	0.075	13.92
	r=1	r=2	2	0.0588	3.39	3.76		(0.039)	p=0.0	(0.021)	p=0.0
6. Pasto	r=0	r=1	2	0.2227	20.63*	15.41	r=n				
	r=1	r=2	2	0.1416	7.79*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated, 1/ Trend included in the cointegrating space

Case 2: Cointegration of cornt's price serie in Barranquilla with corn's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Bucaramanga	r=0	r=1	2	0.1382	13.07	15.41	NCI, r=0				
	r=1	r=2	2	0.1019	5.48	3.76					
2. Cali	r=0	r=1	3	0.1768	15.01	15.41	NCI, r=0				
	r=1	r=2	3	0.0753	4.30*	3.76					
3. Manizales	r=0	r=1	2	0.1228	11.94	15.41	NCI, r=0				
	r=1	r=2	2	0.0788	4.60	3.76					
4. Medellin	r=0	r=1	1	0.2526	19.88*	15.41	CI, r=1	1.135	11.77	-0.0899	12.85
	r=1	r=2	1	0.058	3.29	3.76		(0.031)	p=0.0	(0.025)	p=0.0
5. Pasto	r=0	r=1	2	0.2962	24.74	25.32	NCI, r=0 1/				
	r=1	r=2	2	0.1253	6.82	12.25					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated, 1/ Trend included in the cointegrating space

Case 3: Cointegration of corn's price serie in Bucaramanga with corn's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Cali	r=0	r=1	1	0.3582	26.56*	15.41	CI, r=1	1.007	0.43	-0.021	2.11
	r=1	r=2	1	0.0651	3.5	3.76		(0.009)	p=0.51	(0.016)	p=0.146
2. Manizales	r=0	r=1	1	0.4533	34.46*	15.41	CI, r=1	1.019	3.55	-0.0008	0.038
	r=1	r=2	1	0.0572	3.08	3.76		(0.008)	p=0.06	(0.002)	p=0.844
3. Medellin	r=0	r=1	1	0.5803	50.4*	25.32	CI, r=1 1/	0.926	7.68	-0.4331	7.96
	r=1	r=2	1	0.0962	5.26	12.25		(0.024)	p=0.01	(0.16)	p=0.0
4. Pasto	r=0	r=1	2	0.1211	10.13	15.41	NCI, r=0				
	r=1	r=2	2	0.0748	3.81	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated, 1/ Trend included in the cointegrating space

Case 4: Cointegration of corn's price serie in Cali with corn's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Manizales	r=0	r=1	2	0.2902	32.10*	25.32	r=n 1/				
	r=1	r=2	2	0.2059	12.91*	12.25					
2. Medellin	r=0	r=1	1	0.2411	19.61*	15.41	r=n				
	r=1	r=2	1	0.0658	3.88*	3.76					
3. Pasto	r=0	r=1	1	0.4032	31.07*	15.41	r=n				
	r=1	r=2	1	0.0781	4.23*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated, 1/ Trend included in the cointegrating space

Case 5: Cointegration of cornt's price serie in Manizales with corn price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Medellin	r=0	r=1	2	0.3326	25.86*	15.41	CI, r=1	1.034	2.93	-0.0012	0.0103
	r=1	r=2	2	0.0558	3.22	3.76		(0.020)	p=0.09	(0.014)	p=0.91
2. Pasto	r=0	r=1	1	0.1962	49.12*	15.41	r=n				
	r=1	r=2	1	0.1261	5.08*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Case 6: Cointegration of corn price serie in Medellin with corn price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Pasto	r=0	r=1	2	0.1612	13.29	15.41	NCI, r=0				
	r=1	r=2	2	0.0911	4.68*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated

Table 17f

Cointegration results: Johansen's Maximum Likelihood Procedure for the Sugar Price Series (in logs)

Case 1: Cointegration of corn's price serie in Bogota with sugar's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1.Barranquilla	r=0	r=1	1	0.2175	16.91*	15.41	CI, r=1	1.016	0.64	-0.0352	5.07
	r=1	r=2	1	0.0656	3.66	3.76		(0.017)	p=0.42	(0.017)	p=0.04
2. Bucaram.	r=0	r=1	1	0.3599	31.70*	15.41	r=n				
	r=1	r=2	1	0.1315	7.62*	3.76					
3. Cali	r=0	r=1	1	0.1639	15.59*	15.41	r=n				
	r=1	r=2	1	0.1087	6.1*	3.73					
4. Manizales	r=0	r=1	2	0.174	13.27	15.41	NCI, r=0				
	r=1	r=2	2	0.062	3.33	3.76					
5. Medellin	r=0	r=1	1	0.3034	29.17*	25.32	CI, r=1 1/	1.161	9.87	0.5611	28.024
	r=1	r=2	1	0.1637	9.65	12.25		(0.042)	p=0.0	(0.064)	p=0.0
6. Pasto	r=0	r=1	1	0.1761	14.97	15.41	NCI, r=0				
	r=1	r=2	1	0.1003	5.28*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in the cointegrating space

Case 2: Cointegration of sugar's price serie in Barranquilla with sugar's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Bucaramanga	r=0	r=1	1	0.1795	14.82	15.41	NCI, r=0				
	r=1	r=2	1	0.0738	4.14*	3.76					
2. Cali	r=0	r=1	1	0.2459	18.38*	15.41	CI, r=1	0.957	2.45	0.1447	74.95
	r=1	r=2	1	0.0564	3.14	3.76		(0.036)	p=0.12	(0.014)	p=0.0
3. Manizales	r=0	r=1	3	0.1861	13.64	15.41	NCI, r=0				
	r=1	r=2	3	0.0549	2.94	3.76					
4. Medellin	r=0	r=1	1	0.2848	27.50*	25.32	CI, r=1 1/	1.077	3.81	0.2837	10.85
	r=1	r=2	1	0.1598	9.4	12.25		(0.037)	p=0.05	(0.081)	p=0.0
5. Pasto	r=0	r=1	1	0.2361	18.33*	15.41	r=n				
	r=1	r=2	1	0.0861	4.59*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in the cointegrating space

Case 3: Cointegration of sugar's price serie in Bucaramanga with sugar's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Cali	r=0	r=1	2	0.2897	30.21*	25.32	CI, r=1 1/	0.918	0.43	-0.0821	1.64
	r=1	r=2	2	0.1871	11.39	12.25		(0.019)	p=0.51	(0.068)	p=0.20
2. Manizales	r=0	r=1	1	0.4533	34.46*	25.32	CI, r=1 1/	1.019	3.55	-0.0008	0.038
	r=1	r=2	1	0.0572	3.06	12.25		(0.008)	p=0.06	(0.002)	p=0.844
3. Medellin	r=0	r=1	1	0.3813	35.77*	25.32	CI, r=1 1/	1.108	9.06	0.485	42.59
	r=1	r=2	1	0.1666	9.84	12.25		(0.032)	p=0.[illegible]	(0.07)	p=0.0
4. Pasto	r=0	r=1	3	0.1804	14.4	15.41	NCI, r=0				
	r=1	r=2	3	0.0852	4.45*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in the cointegrating space

Case 4: Cointegration of sugar's price serie in Cali with sugar's price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Manizales	r=0	r=1	2	0.4041	37.44*	25.32	CI, r=1 1/	1.02	0.88	0.074	1.16
	r=1	r=2	2	0.172	10.00	12.25		(0.018)	p=0.35	(0.062)	p=0.28
2. Medellin	r=0	r=1	2	0.2324	23.55	25.32	NCI 1/				
	r=1	r=2	2	0.1645	9.53	12.25					
3. Pasto	r=0	r=1	3	0.2417	23.69*	15.41	r=n				
	r=1	r=2	3	0.1638	9.3*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in the cointegrating space

Case 5: Cointegration of sugar's price serie in Manizales with sugar price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Medellin	r=0	r=1	1	0.3251	31.41*	25.32	CI, r=1 1/	1.185	10.72	0.555	34.32
	r=1	r=2	1	0.1718	10.18	12.25		(0.041)	p=0.0	(0.079)	p=0.0
2. Pasto	r=0	r=1	1	0.4062	38.38*	15.41	r=n				
	r=1	r=2	1	0.1727	10.24*	3.76					

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in the cointegrating space

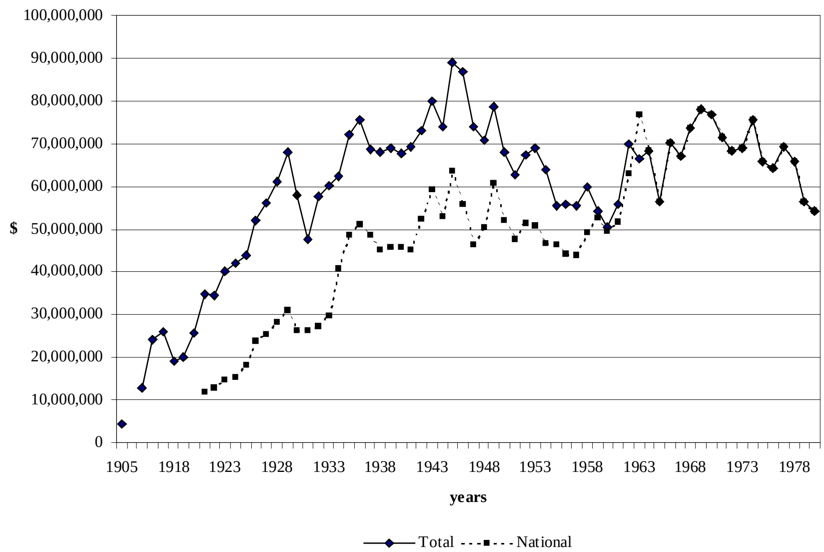
Case 6: Cointegration of sugar price serie in Medellin with sugar price serie in:

Cities	H_o	H_a	VAR(p)	Eigen Value (λ)	Trace Statistic	5% critical value	Conclusion	β	$\chi^2(1)$ $H_o: \beta=1$	μ	$\chi^2(1)$ $H_o: \mu=0$
1. Pasto	r=0	r=1	1	0.4208	41.51*	25.32	CI, r=1, 1/	0.879	11.24	-0.4849	21.26
	r=1	r=2	1	0.1996	12.02	12.25		(0.027)	p=0.0	(0.11)	p=0.0

Note: standard deviation in parenthesis, CI: cointegrated, NCI: No cointegrated. 1/ Trend included in the cointegrating space

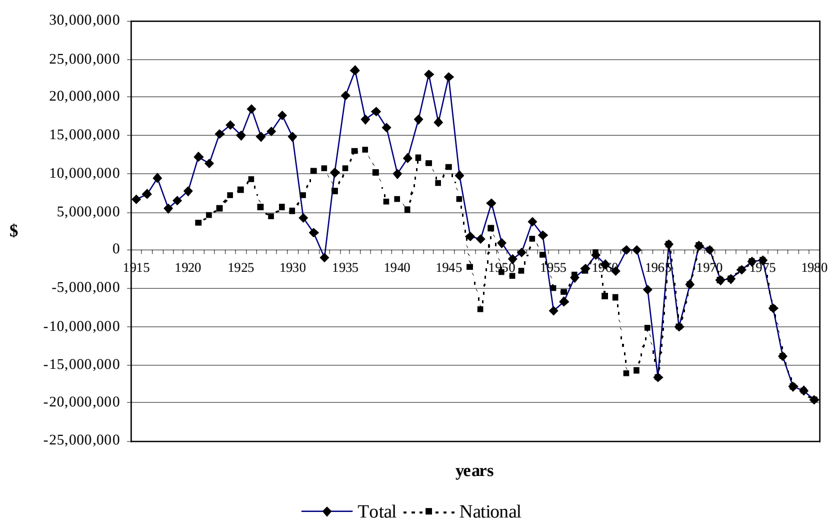
7 Graphs

Graph 1: Railroads Operating Revenues (pesos 1950)



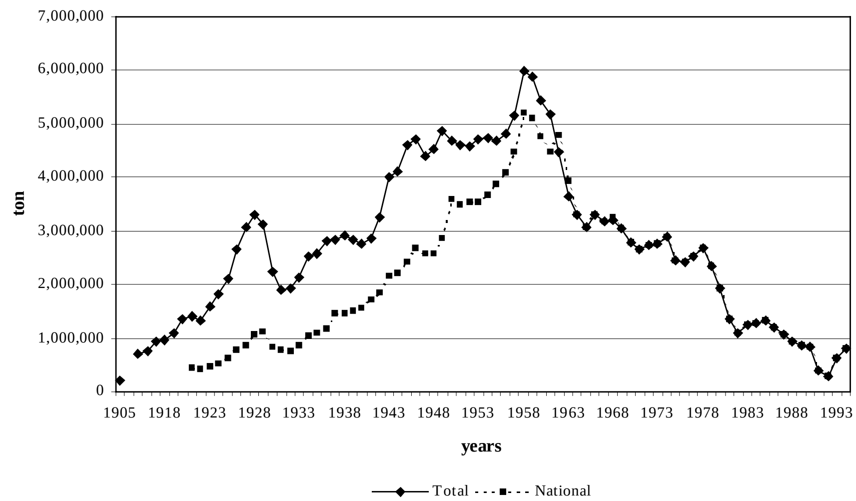
Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 1a:Net Operating Revenues (pesos 1950)



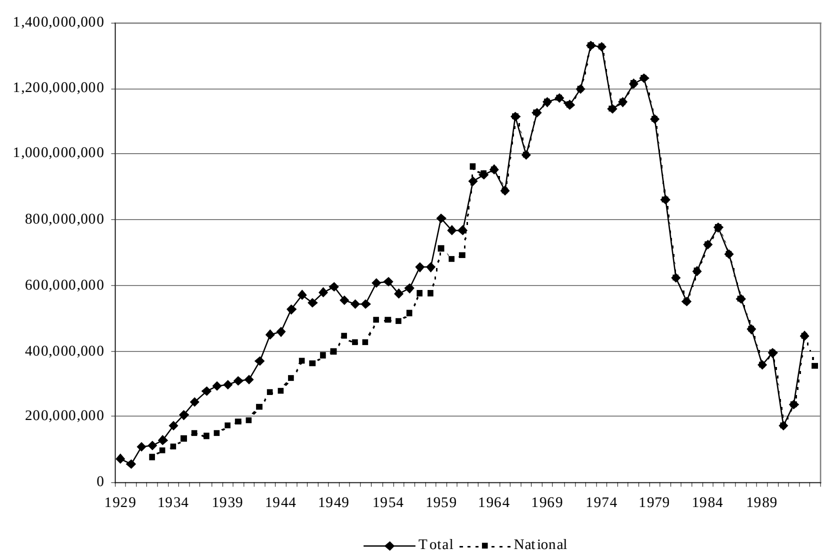
Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 2: Railroads Freight



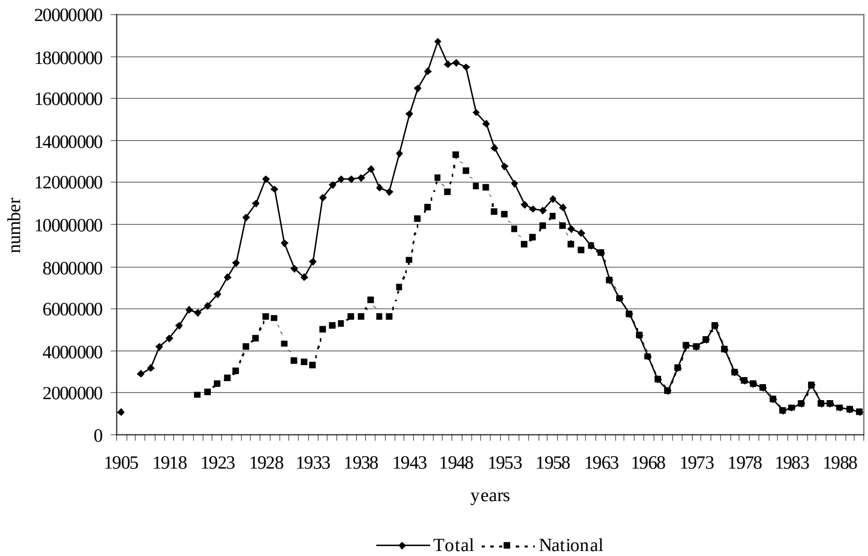
Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 2a: Railroads Freight Ton-Km



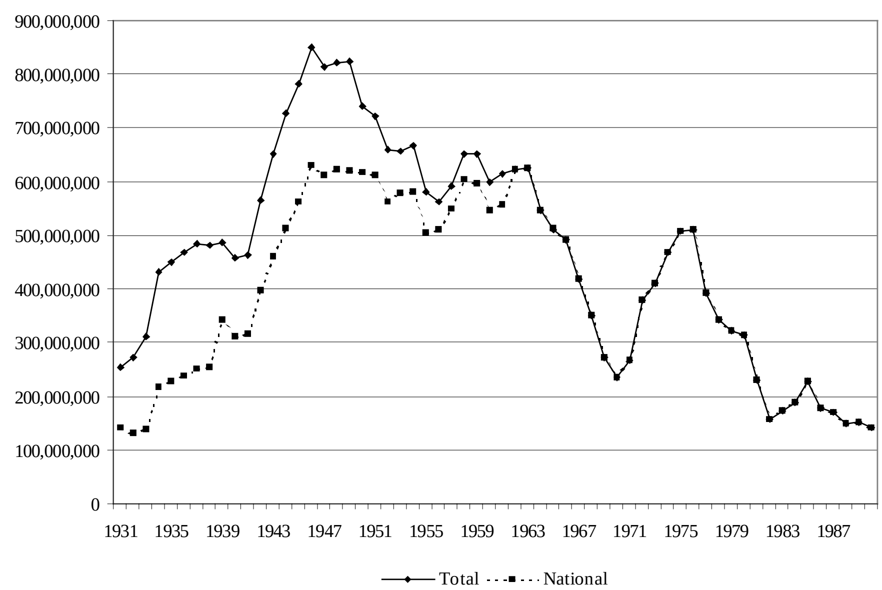
Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 3: Railroad Passengers



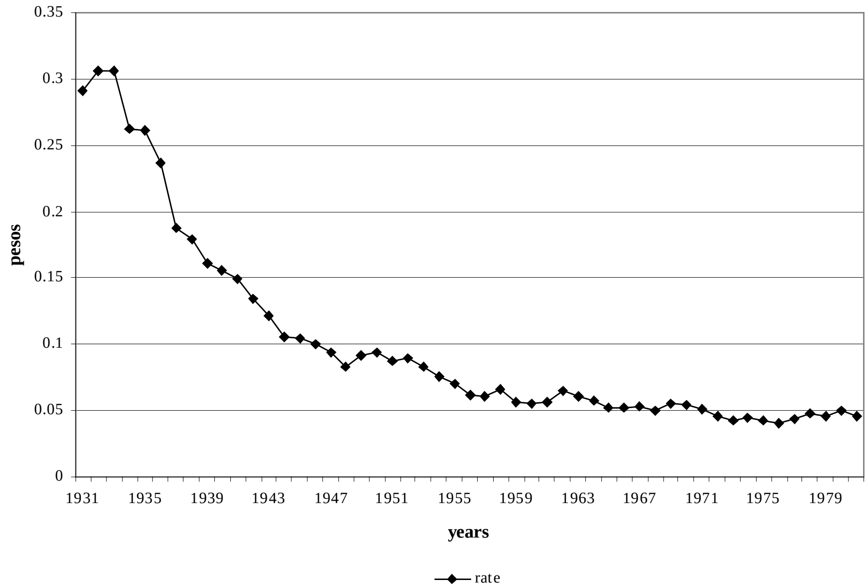
Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 3a: Railroad Passenger Km



Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 4: Railroads Rates per Ton-Km (constant pesos 1950)

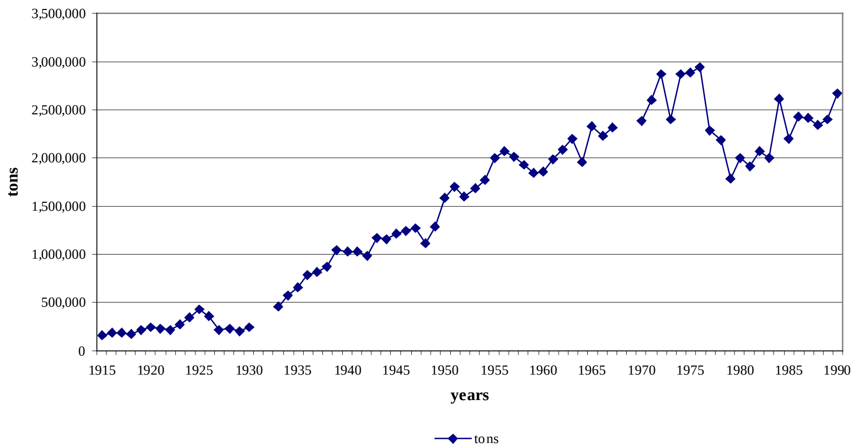


Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 4a: Railroads Fare per Passenger-Km (constant pesos 1950)

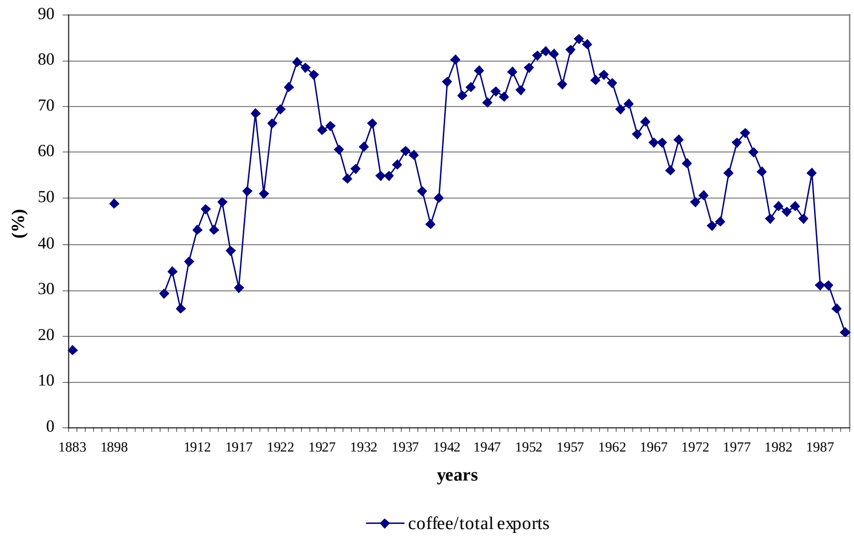
Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 5: Magdalena River: Tons of Freight



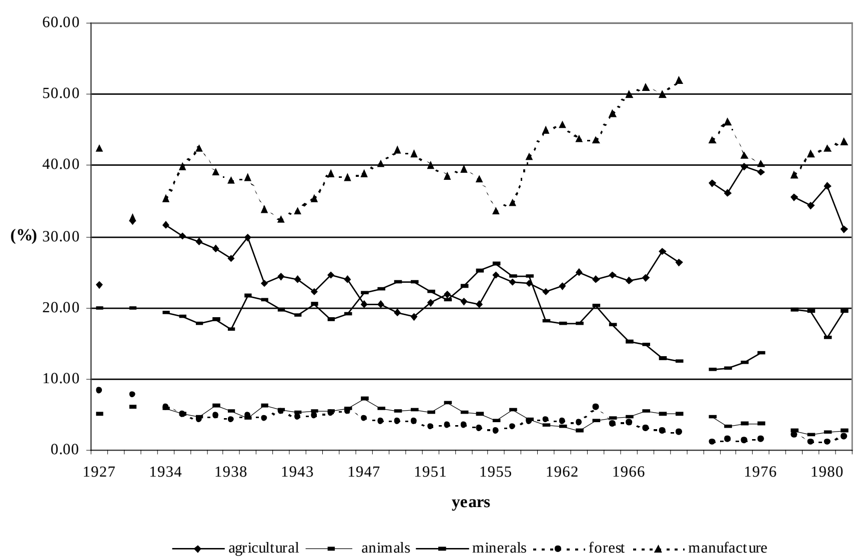
Source: Maria Teresa Ramirez, On Infrastructure and Economic Growth, UIUC dissertation, Chapter 3.

Graph 6: Value of Coffee Exports / Value of Total Exports



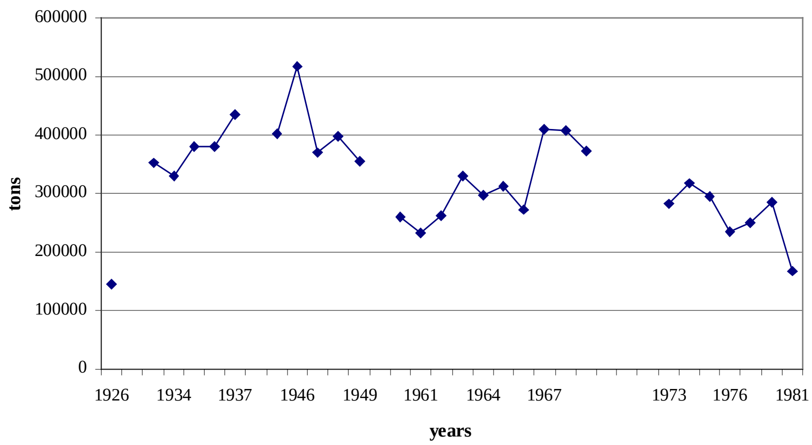
Source: M.T. Ramírez 1999, and Ocampo (1984)

Graph 7: Railroads Type of Freight (% total freight)



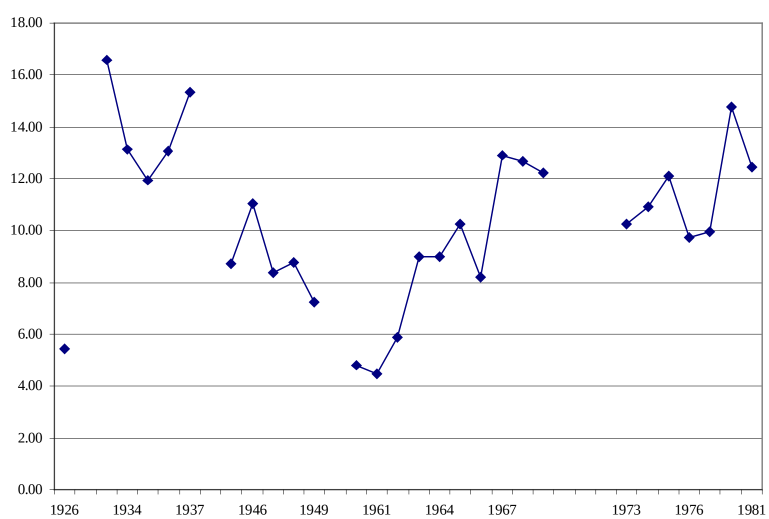
Source: Computed based on data from:
Anuario General de Estadistica de Colombia, several years
Memorias del Ministerio de Obras Publicas y transporte several years
Anuario de Transporte y Comunicaciones several years
Los Ferrocarriles en Cifras, several years

Graph 8: Quantity of Coffee Shipped by Railroads



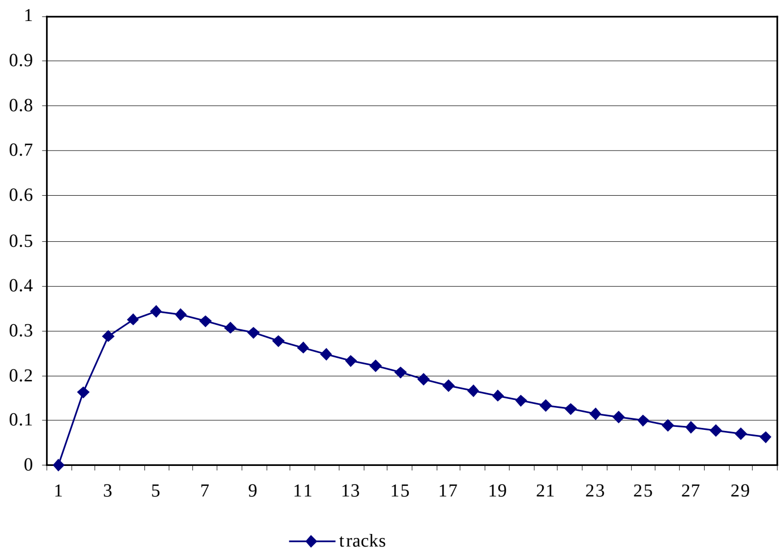
Source: Anuario General de Estadistica de Colombia, several years.

Graph 8a: Coffee (quantity) Share in Total freight shipped by railroad



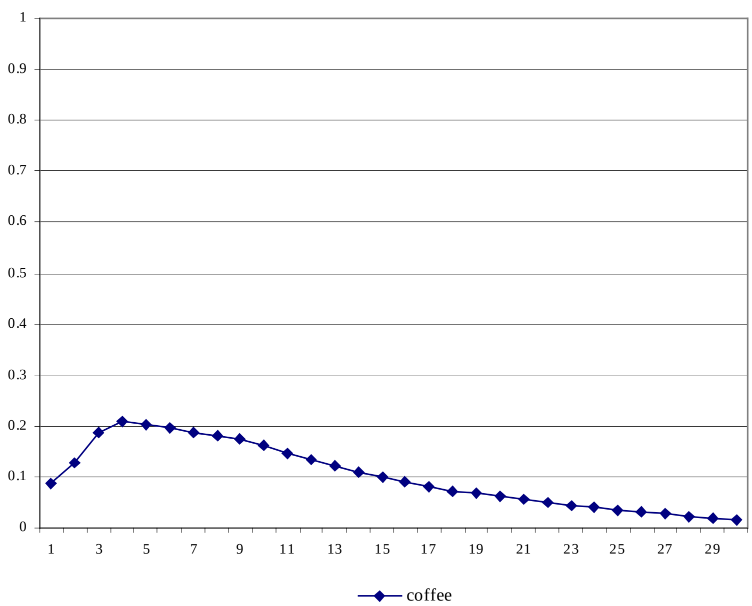
Source, Anuario General de Estadistica de Colombia, several years
Memorias del Ministerio de Obras Publicas y transporte several years
Anuario de Transporte y Comunicaciones several years
Los Ferrocarriles en Cifras, several years

Graph 9: Response of Railroads to a shock in Coffee



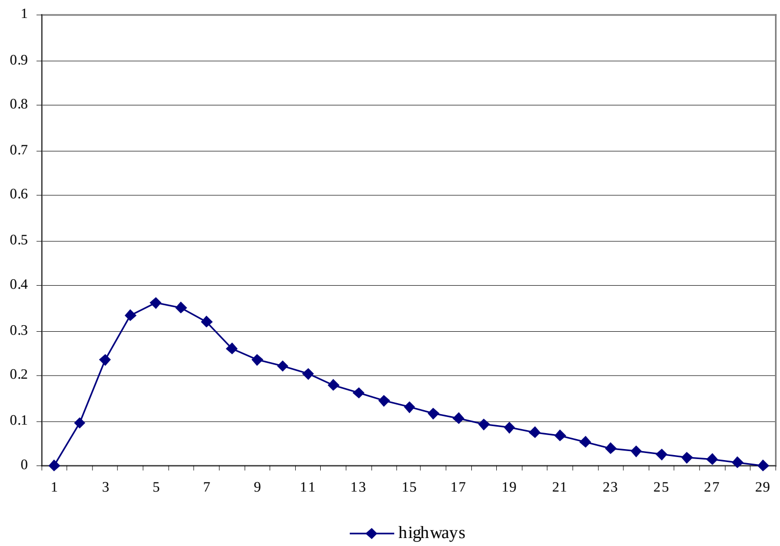
Source: Computed.

Graph 10: Response of Coffee to Shock in Railroads



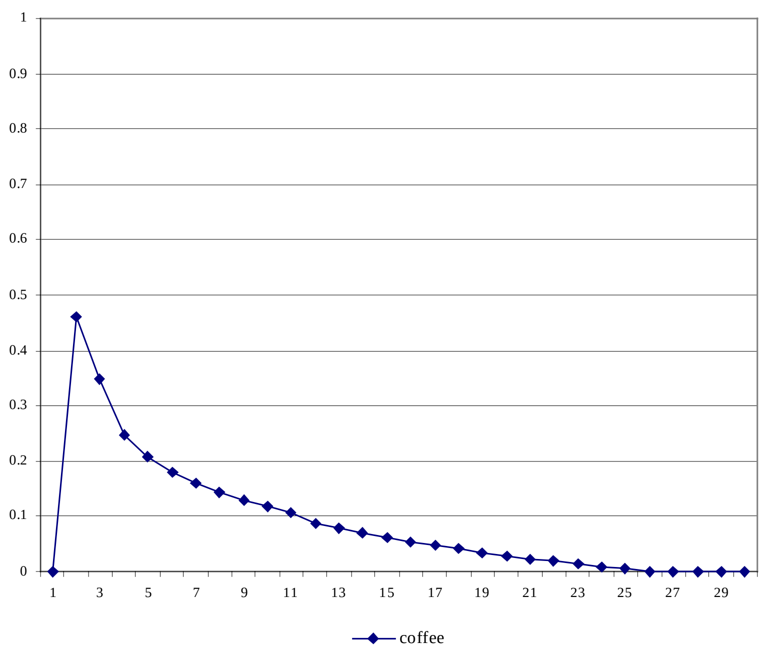
Source: Computed.

Graph 11: Response of Highways to a shock in Coffee



Source: Computed.

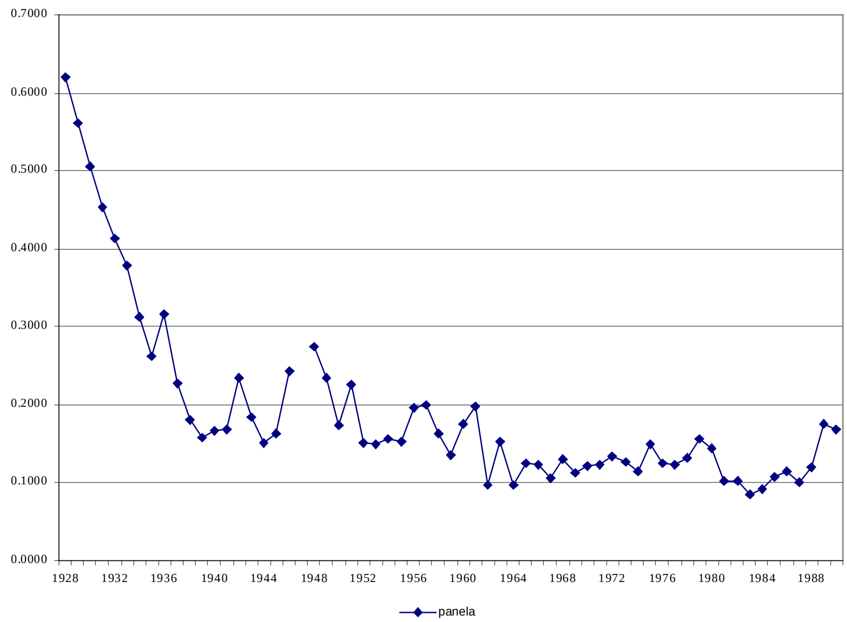
Graph 12: Response of Coffee to a shock in Highways



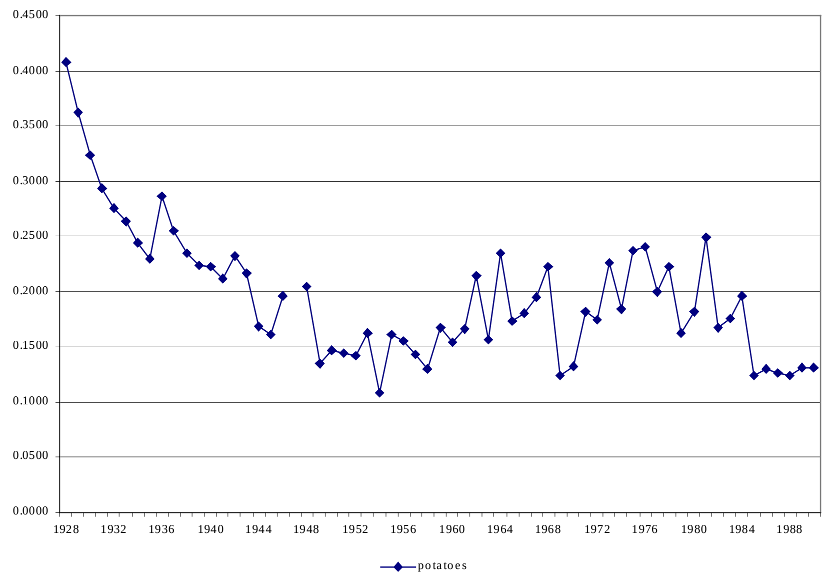
Source: Computed.

Graph 15: Coefficient of Variation-Commodity Price

1. *Panela* Price

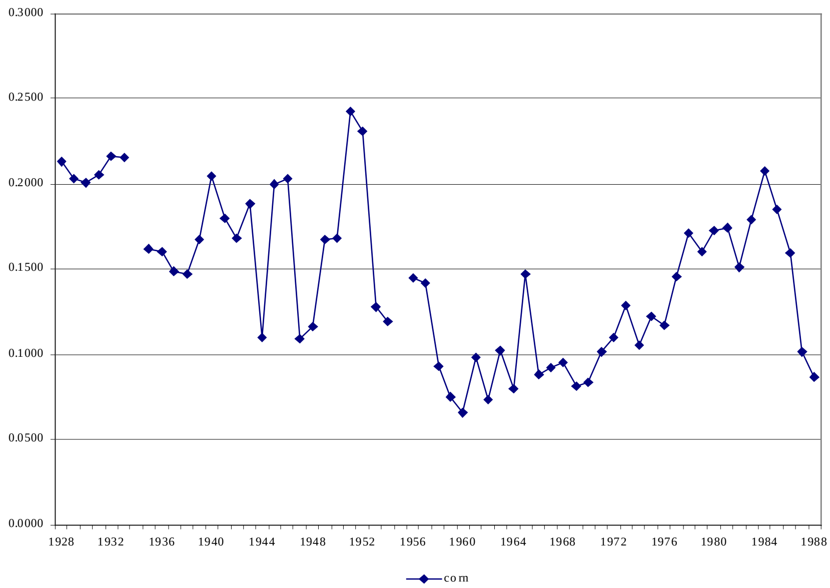


2. Potato Price

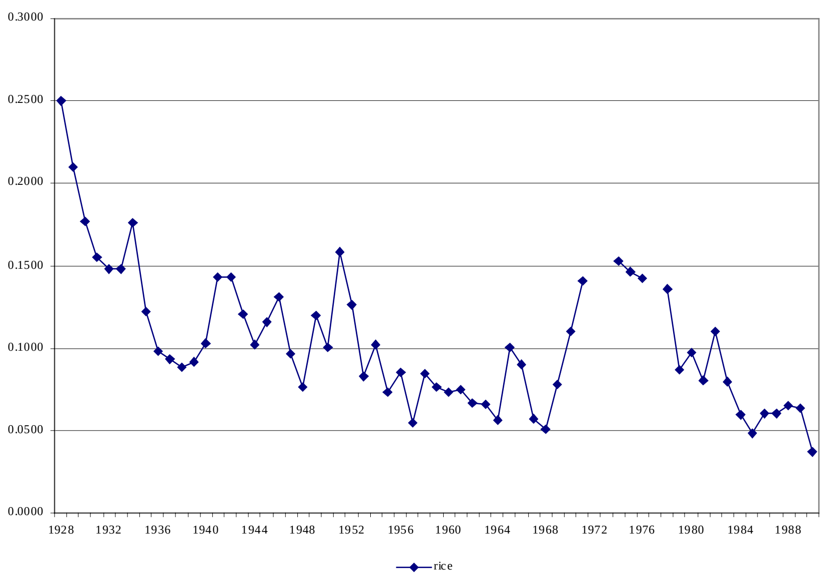


Graph 4.15: Coefficient of Variation-Commodity Price (continued)

3. Corn Price

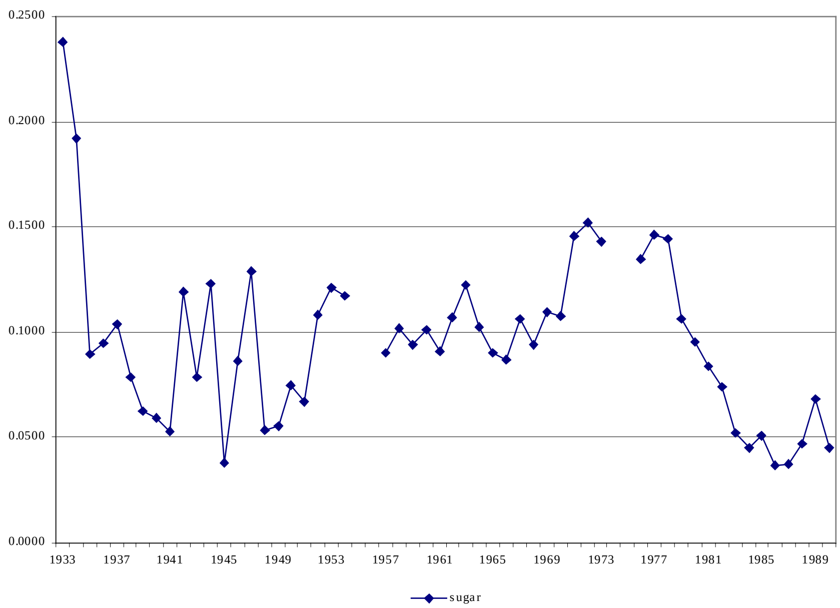


4. Rice Price

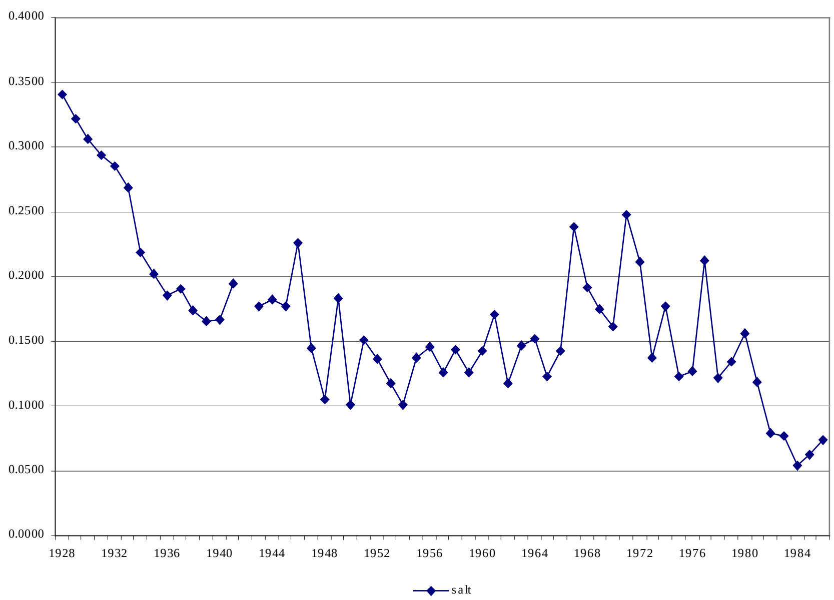


Graph 15: Coefficient of Variation-Commodity Price (continued)

5. Sugar Price

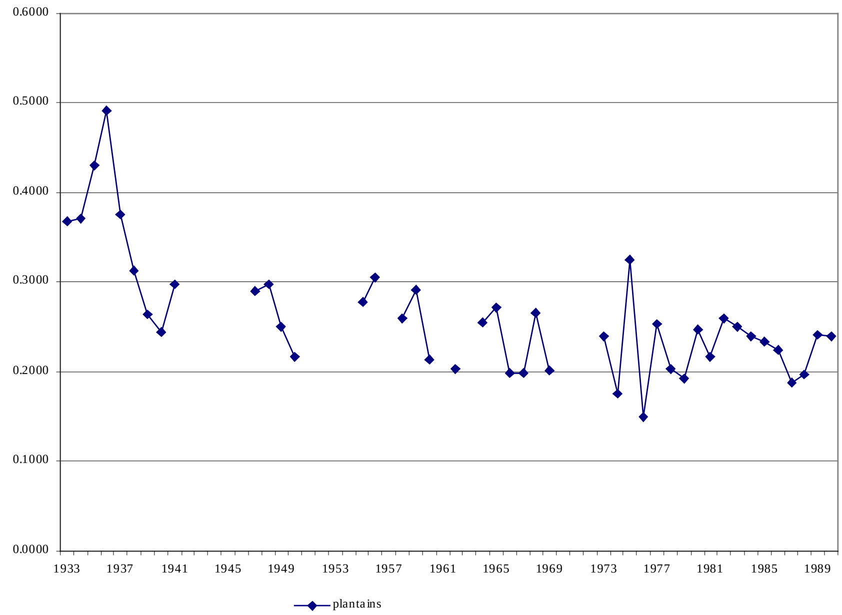


6. Salt Price

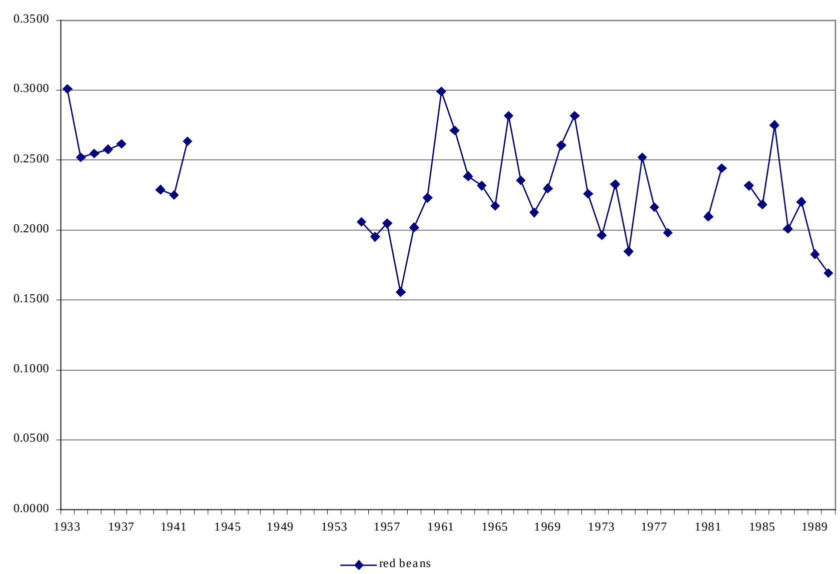


Graph 15: Coefficient of Variation-Commodity Price (continued)

7. Plantains Price



8. Red Beans Price



Source: Table 9