ECONOMETRIC MODEL FOR CEMENT DEMAND AND SUPPLY IN BOLIVIA

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CONTENT

ABSTRACT

This document introduce the obtained results of the econometric estimation of cement demand and supply in Bolivia considered as a simultaneous equations model, based on two equations, one for the demand and another for the supply. The objective of this study is to quantify the forces that affect the cement market in the period understood among the years 1994 up to 2003.

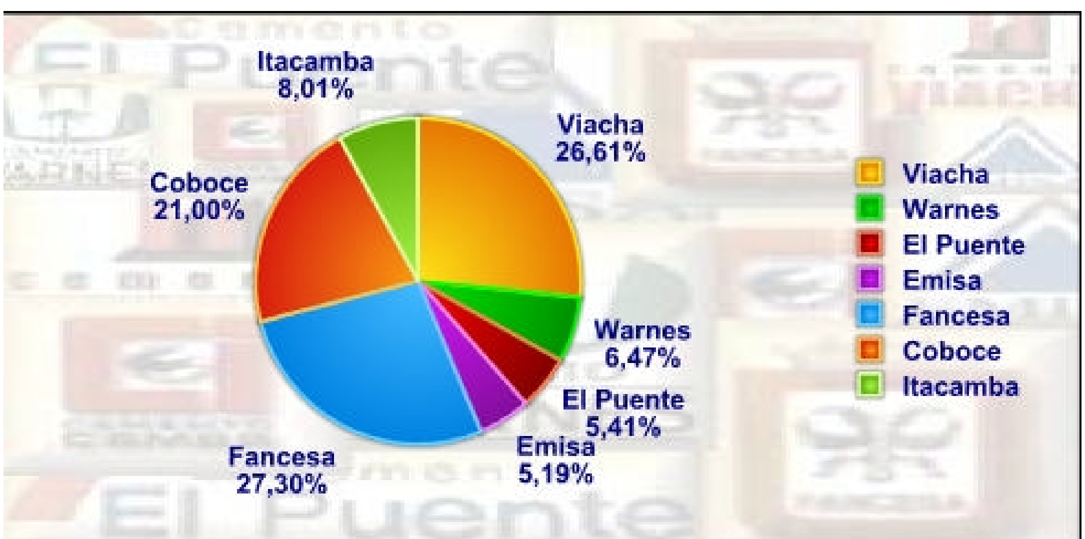
Five models of simultaneous equations were considered, which are based on the respective linear functions of cement demand and supply to be able to explain the coefficients associated to the variables in form of elasticities. The estimates were made following the classic methodology of econometrics with the respective statistical validation, being carried out the individual and groupal validation of the coefficients associated to each variable indicating the statistic significance of the same ones.

1. INTRODUCTION

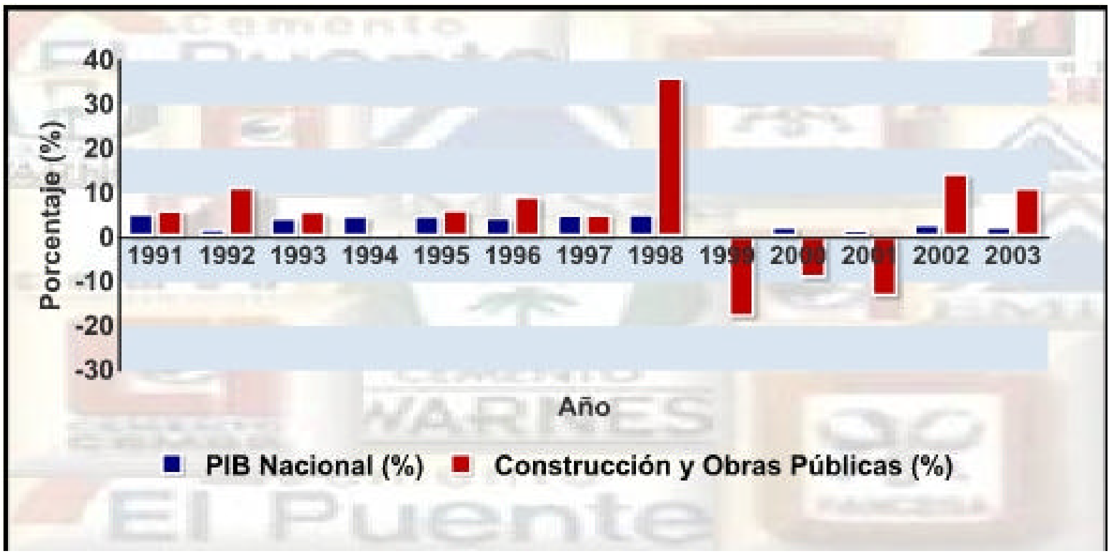
Cement is an indicator of supreme importance to reflect the economic situation of a country. The cement demand and supply in Bolivia are variable and subject to several factors, according to Armando Gumucio is considered that the item of the construction of highways making use of the rigid pavement uses in the country in a direct way from 2.000 to 2.500 people and easily of 30.000 at 40.000 in an indirect way.

2. SECTOR ANALYSIS

Cement market in Bolivia is provided at the moment by cement plants located along the national territory. SOBOCE group associates the plants of Viacha (La Paz), Warnes (Santa Cruz), Cepsa (Tarija) and Emisa (Oruro), likewise the individual participation of Fancesa (Sucre), Itacamba (Santa Cruz) and Coboce (Cochabamba). The percentage participation referred to cement sales in TM (Metric Tons) of each plant for the years understood between 1994 and 2003 is reflected in the graph:

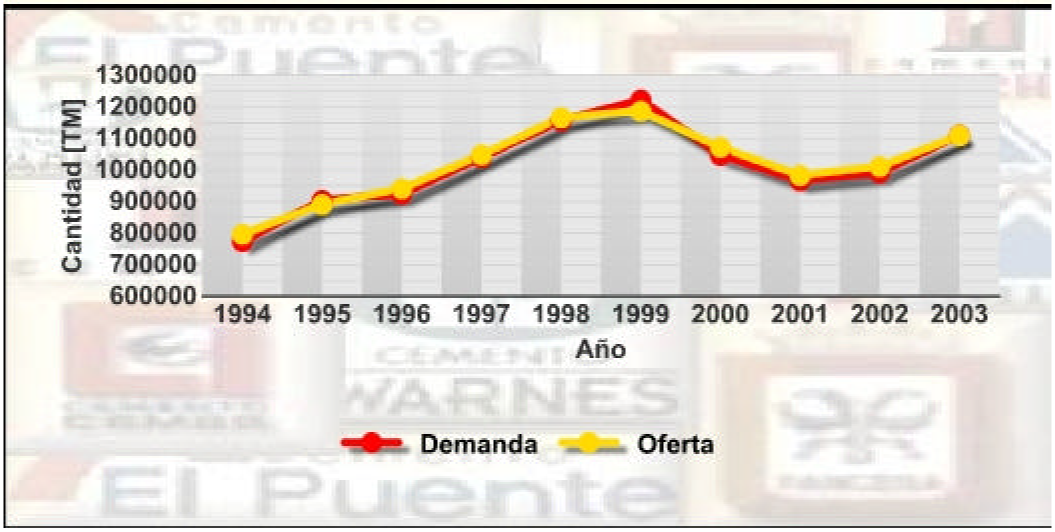


Fancesa (Sucre) leads the percentage participation in Bolivia (27.3%) followed very closely by Viacha (La Paz) (26.61%), in third comparative place it is observed Coboce (Cochabamba) (21.0%) followed by Warnes (6.47%), El Puente (5.41%) and lastly Emisa (5.19%). The percentage variation of the national GDP and the sector of the Construction and Public Works are reflected in the following graph:



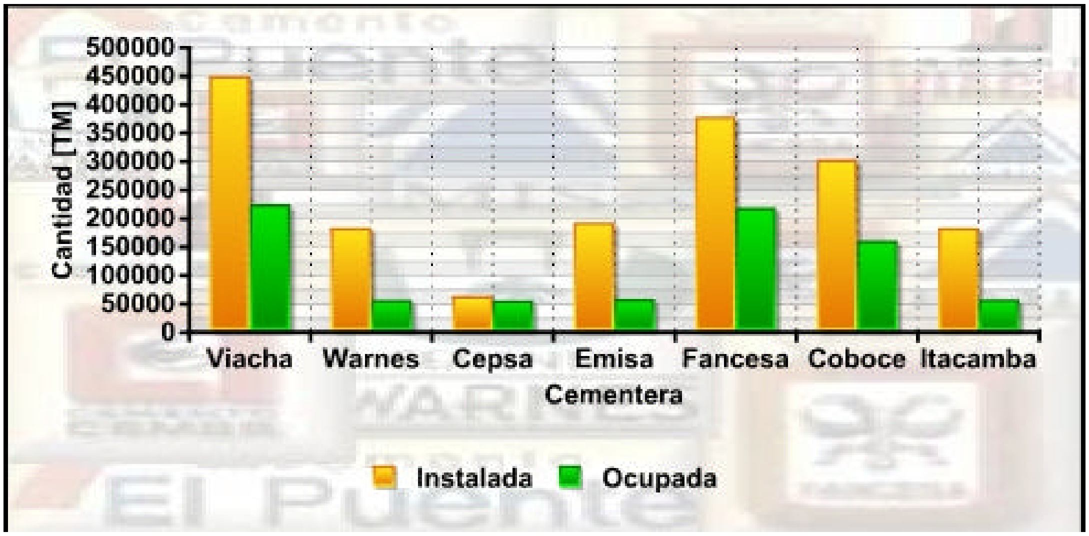
The clear effect of the economic crisis is evidenced in these indicators, being appreciated a negative variation for 1999 due to the severe economic crisis that affected the country in that period of time, for the later years a light recovery is observed.

The following graph indicates the evolution of the cement demand and supply at national level:

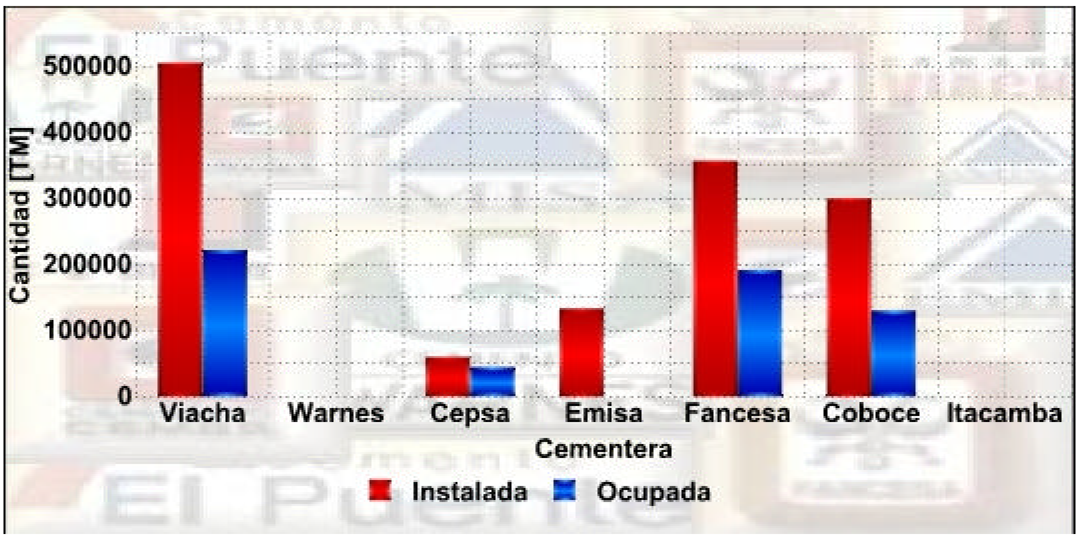


The graph shows the almost parallel evolution of the cement demand and supply in Bolivia reflecting a maximum in the demand and supply in 1999 taking place a gradual decrease in later years as clear indicator of the economic crisis in which Bolivia was involved. In 2001 a light increment is observed from now on.

The following graph indicates the installed and occupied capacities in Bolivia:



It’s necessary to stand out that the iddle capacity in general is approximately between the range of 29 and 87%. It is necessary to make notice that CEPSA, is the only one that worked close to 100% of its capacity in production, in the same way its capacity in clinker production it overcame to the other ones. The productive capacity of Clinker/year in Metric Tons appreciates it in the following graph:



VIACHA and FANCESA have lead the clinker production.

3. MODEL DEVELOPMENT

It’s assumed the interdependence of the cement demand and supply being considered both inside a system of simultaneous equations being added the equilibrium condition. Based on bibliography, surveys to branch professionals and in common sense, 5 tentative models were formulated dedicated to explain the behavior of the variables that affect the demand and supply to be able to understand their evolution.

Due to their particular characteristics and after the respective identifications the next step is estimate the same ones using the TSLS method for each one (over-identificated). Likewise the prices and quantities of equilibrium are obtained for every year.

The variables included in the cement demand equation (DC_t) (TM) are:

- Cement Price (PC_t)($us/50 kg bag)
- National GDP per capita (PIB_t) ($us/hab)
- Construction National GDP per capita ($PIBC_t$) ($us/hab)
- Cost ratio Construction (ICC_t)
- Telluric Motion (MT_t) *
- Built Roads Length (LCC_t) (thousands of Km)
- Gross Fixed Capital Formation ($FBCC_t$) (thousands of Bs.)

For cement supply (OC_t)(TM):

- Cement Price (PC_t)($us/50 kg bag)
- Lagged Cement Price (PC_{t-1}) ($us/50 kg bag)
- Inputs Production ratio (IP_t)
- Public Investment in Infrastructure ($IPEI_t$) (millions $us)
- Installed Capacity (CI_t) (TM)
- Quality Certificates (CC_t) *

* Dummy variables.

Both equations adopt the lineal form after the application of natural logarithms (ln):

$$DC_t = a_0 + a_1 PC_t + a_2 PIB_t + a_3 PIBC_t + a_4 ICC_t + a_5 MT_t + a_6 LCC_t + a_7 FBCC_t + u_t$$

$$OC_t = b_0 + b_1 PC_t + b_2 PC_{t-1} + b_3 IP_t + b_4 IPEI_t + b_5 CI_t + b_6 CC_t + v_t$$

4. RESULTS

Assuming the market equilibrium is obtained the price and the quantity of equilibrium. The results of the estimation using TSLS for the period 1994 at 2003 making use of E-Views v1.1c are:

Coefficients estimation for Demand
Final Model

Variable	Coefficients
PC_t	-0.556109
PIB_t	1.224399
$PIBC_t$	0.135011
ICC_t	-2.073488
MT_t	-0.1307276
LCC_t	5.178661
$FBCC_t$	0.4772060
R^2	0.931856
F	3.907066

Coefficients estimation for Supply

Final Model

Variable	Coefficients
PC_t	0.06302695
PC_{t-1}	0.16221071
IP_t	0.0784555
$IPEI_t$	-0.686210
CI_t	0.38163385
CC_t	0.00285663
R^2	0.984003
F	30.75632

BEST MODEL SELECTION

For the selection of the pattern that explains in a better way the behavior of the cement demand and supply in Bolivia was considered:

1. The sign concordance obtained in the estimation compared with *a priori* expectations for each coefficient related with their respective variable.

2. The value of R^2 (R-squared) that measures the adjustment kindness for each equation. While higher it is this coefficient in the regression, in a better way it will explain the behavior of the dependent variable.

3. The individual statistic for each coefficient indicating statistically if they are significant and therefore they deserve to be present in each equation.

4. The value of *F* statistic, which indicates if jointly all the considered variables are statistically significant to be included in their respective equation.

=> The R^2 calculated for the last model is the highest in comparison to the rest (not presented in this summary). The *a priori* signs are the expected ones for each coefficient associated to the respective variable with the exception of variable (IPEIt), with a negative sign contrarily to the expectation. Explained, possibly, to the final use that the invested mount by the government in infrastructure, the reality is different considering the data. The signs and the magnitudes of the rest of the variables are reasonable and they are agree with the expectations.

- It was for almost the entirety of the coefficients the presence of a high colineality, reflected in the non-statistical significance of the parameters that however for prediction terms they are not a problem.

- The F statistic rejects the null hypothesis that affirms that the coefficients included in the model are similar or equal to zero.

PRICE AND EQUILIBRIUM QUANTITY

The prices and equilibrium quantities are detailed in the following chart:

Year	Equilibrium Price [$us/bag]	Equilibrium Amount [TM]
1994	3.67	796974
1995	4.32	900914
1996	5.32	916208
1997	4.24	1057562
1998	4.89	1164185
1999	4.56	1178601
2000	4.56	1065134
2001	4.51	980404
2002	4.95	1032325
2003	4.87	1126219

5. CONCLUSIONS

The main conclusion in this work is that the cement in Bolivia is ruled under the classic laws of demand and supply. Numeric values were obtained on the variables that affect jointly the cement demand and supply in Bolivia expressed in elasticities. It was found that the elasticity estimated for the price of the demand has an inelastic value of -0.55610961 in absolute value, indicating that before an increment of the cement price at national level of 1%, we hope the cement demand in Bolivia dicreases approximately in 0.56%. Another elasticity that deserves an analysis is the GDP per capita, before an increment in the GDP per national capita of 1%, we hope the cement demand in Bolivia is increased approximately in 1.22%. The elasticity of higher value estimated for the demand equation is referred to the variable Lenght of Built Roads (LCC_t) 5.178661 indicating that if is observed the increment of this variable in 1%, we wait that the cement demand at national level is increased approximately in 5.18%. The variable GDP of the Construction was added ($PIBC_t$) to measure the contribution on the cement demand being an inferior value to the GDP per capita.

In the same way for supply: The offer equation has characteristic of distributed lagged because it was added to the price left behind as explanatory variable. Considering the values of the coefficients of PC_t on the whole and PC_{t-1} (cement price in the previous period) whose values were: 0.063026956 and 0.16221071 respectively, which are known as impact multipliers or of short term, to represent the change in the half value of the cement offer after an unitary change in the cement price in the same period of time. Maintaining the change in the price at the same level of there from now on, then 0.063026956 + 0.16221071 correspond to the change in the cement offer in the following period, that is to say 0.225238. Then 0.063026956 turn out to be the short term multiplier of the supply equation, while the long term multiplier is 0.16221071. It means that before an increment of 1% in the price of the cement, the bidders will increase its production level in approximately 0.063% during the first year and 0.16% the second year. The cocients between 0.063026956 and 0.225238, in the other side 0.16221071 and 0.225238 are obtained respectively: 0.279823 and 0.720174, indicating that 27.98% of the impact on the offer of cement of an unitary change in the price feels immediately and 100% feels after having lapsed one year. Equally, it was not evidenced the dynamics existence statistically in the demand equation, when being calculated a negative value for the coefficient of the variable it Demands of Cement straggler in one period (DC_{t-1}).

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