Evaluating Radical Change in the Management Model through a Natural Experiment. Case of the Venezuelan Iron and Steel Industry

Evaluación del Cambio Radical del Modelo de Gestión mediante un Experimento Natural. Caso de la Industria Ferrosiderúrgica de Venezuela

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Abstract

This article provides scientific evidence on the impact of shifting from a capitalist to a socialist management model on a country's industry. For this purpose, a natural experiment was conducted on the results of the Venezuelan iron ore mining industry between 2003 and 2014. The experiment used the Venezuelan iron ore mining industry as the unit of study. The industry had been applying a management strategy based on what is known as state capitalism and had radically shifted to a socialist management model since 2009. The Swedish iron ore mining industry, both very similar in terms of capacity, was used as the control group. The natural experiment allowed for a reliable estimation of the causal effects on the productivity and profitability of that country's industrial sector resulting from the application of a socialist management model. The results revealed the negative impact of the implementation of a socialist management model on the Venezuelan iron ore mining industry. The research results were replicated at the business management level in the steel sector through the same natural experiment, using a steel company in Venezuela as the treatment unit and a similar steel company in Brazil as the control unit.

Keywords

Natural experiment, Management model, Socialist enterprise, Capitalist enterprise.

Resumen

El artículo aporta evidencia científica sobre el impacto que tiene en la industria de un país, el cambio de un modelo de gestión capitalista a un modelo de gestión socialista. Para tal propósito, se realizó un experimento natural sobre los resultados de la industria de minería de hierro de Venezuela, entre los años 2003 y 2014. En el experimento se tomó como unidad de tratamiento a la industria de minería de hierro de Venezuela, que venía aplicando una estrategia de gestión

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enmarcada en lo que conoce como capitalismo de estado y desde 2009 realizó un cambio radical a un modelo socialista de gestión, como grupo de control se tomó a la industria sueca de minería de hierro, ambas muy similares en términos de capacidad. El experimento natural permitió estimar con certeza los efectos causales sobre la productividad y rentabilidad del sector industrial de ese país que resultan de la aplicación de un modelo de gestión socialista. Los resultados revelaron el impacto negativo de la implementación de un modelo de gestión socialista en la industria minera de hierro venezolana. Los resultados de la investigación fueron replicados a nivel de gestión empresarial en el sector siderúrgico a través del mismo experimento natural, tomando como unidad de tratamiento una empresa del sector siderúrgico de Venezuela y como unidad de control a una empresa siderúrgica similar de Brasil.

Palabras clave

Experimento natural, Modelo de gestión, Empresa socialista, Empresa capitalista.

Introduction

Reviewing the recent history of the iron and steel industry in Venezuela, it can be divided into two periods, one before and one after, with the rise to power of a radical socioeconomic movement known as "21st-century socialism," a movement whose main vision is to establish a productive model that prioritizes the social goals of participation, equality, and poverty reduction. To this end, the government promoted the creation of social production enterprises known as socialist enterprises, which would be under the control of a new entity called workers' control. With this objective, state-owned enterprises and privately held companies that were nationalized were converted into socialist enterprises, thus becoming a means of establishing a new system of government called 21st-century socialism. For Heinz Dieterich (2014), 21st-century socialism and participatory democracy are the same term, and according to Cockshott, P., & Heinz Dieterich (2006), 21st-century socialism is based on four essential points: participatory democracy, a democratically planned economy of equivalences, a non-classist state and, therefore, the rational-ethical-aesthetic citizen. Between 2007 and 2010, more than $23 billion were invested by the Venezuelan state in the expropriation, acquisition, start-up and creation of companies that fit the paradigm of socialist development (Obuchi et al., 2014}.

Thus, beginning in 2008, Venezuela's iron and steel industry, comprised of iron ore mining, direct reduction (DRI), and steel companies, was transformed into socialist enterprises, with the goal of promoting a new economic model in the country. This represented a radical change in the strategic vision and a different management model for these companies. In this research, a management model is understood as a framework or reference system for the administration of a company or industrial sector in a country. This is a vitally important aspect because it allows for the establishment of priority variables and the guidelines that guide decision-making. More than fifteen years after implementing the new strategic vision and management model in the Venezuelan iron and steel industry, the productivity and profitability results have not been as expected. This has generated debate about the causes. Opponents of the socialist management model attribute the causes of the negative results to the model itself, while defenders attribute the negative results of socialist companies to external causes. However, the debate continues about the causes of the

disastrous results of companies in the iron and steel sector in Venezuela. Determining a single causal factor is difficult due to the variety of external factors that defenders of the socialist management model attribute to them.

On the other hand, there are no official figures, but according to "Transparency Venezuela" (2017), there are 520 state-owned companies in Venezuela, most likely all of which are socialist companies, but to date, no successful cases of these companies have been identified. In the scientific field, determining causal relationships between variables is not a trivial problem. However, at the scientific level, causality is admitted through the experimental method, a method that allows the researcher to control and separate external factors from the causal variable. Unlike exact sciences such as physics, medicine, and chemistry, among others, there are economic and ethical difficulties in applying experimental methods in economics, management, and in certain cases in engineering sciences, a field in which considerable progress has been made in recent years, especially with natural experiments.

Los experimentos naturales se han vuelto omnipresentes en las ciencias sociales (Dunning, 2012, p. 1). Este método de investigación permite a los analistas estudiar los efectos de variables difíciles de manipular experimentalmente, usando situaciones que ocurren en la vida real de manera natural, sin el control del investigador, y que se asemejan bastante a un diseño experimental clásico, lo que le permite al investigador aislar factores externos y determinar el factor causal.

The main purpose of this research is to answer the question about the impact of the socialist management model on the results of the iron ore and steel mining industry in Venezuela through a natural experiment. The research proposed the causal hypothesis that the negative management results of the Venezuelan iron and steel industry were due to the application of the socialist management model. For this purpose, the iron ore mining industry, which has been implemented with a socialist management model since 2009, was used as a sample for experimental treatment. The Swedish iron ore mining industry was used as a control group. Both are state managed in their respective countries and are very similar in terms of capacity. The results of this experiment were replicated and verified through the same natural experiment conducted with the Venezuelan steel company Sidor as the treatment unit and the Brazilian steel company CSN as the control unit. Both companies are also very similar, which gives the results obtained the attribute of external validity.

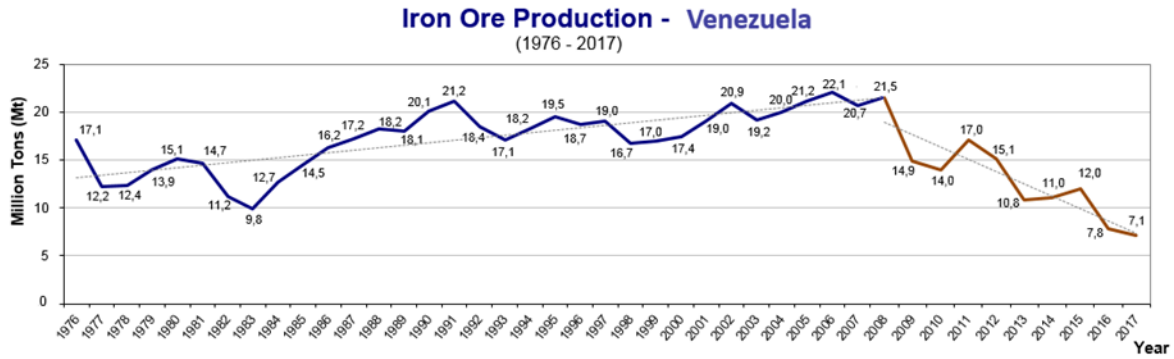
Historical Background

A review of the historical context, from 1974, the year of the nationalization of the iron ore industry, to 2008, shows that the strategic objectives proposed for the nationalization of iron ore were being met, as the national steel industry was developed downstream (increasing the production capacity of steel and reduced iron), adding value to iron ore, guaranteeing the national supply of iron ore, and exporting surpluses. Between 1975 and 2000, Venezuela consolidated its position as a major producer of direct reduced iron (DRI) worldwide, with the installation of several plants in Ciudad Guayana, Bolívar state, achieving an installed capacity of 10.1 million tons, and becoming the largest DRI producer in the world in 2000. In the period beginning in 1999, a year in which a radical change in the Venezuelan central government took place due to the assumption of power by a new

leftist political movement, iron ore production reached its peak between 2005 and 2006, with positive results until 2008. From that year on, production began to decline steadily. The year 2009 coincided with the beginning of the implementation of a new socialist management model in the Venezuelan iron and steel mining industry. This strategic shift shifted the management of companies to a new approach called "workers' control," whereby people for managerial and leadership positions were to be selected not based on professional merit but by popular election by the workers. The implementation of this plan was unique in that key positions, including the presidencies in almost all companies, were occupied by military personnel. And so, since 2009, Venezuela's iron ore mining industry has begun to be run as a socialist enterprise.

Figure 1

Iron ore production of FMO (1976 -2017)



Source: Villalva (2017)

Socialist Enterprises vs. Capitalist Enterprises

The main characteristic of a socialist enterprise is that each worker has decision-making power within the company and can participate in setting its objectives and goals. According to Añez & Melean (2011), socialist enterprises are economic entities dedicated to the production of goods or services with a high social content and where the principles of equality, cooperation, solidarity, complementarity, and reciprocity prevail.

According to El Troudi & Monedero (2006), the precursors of socialist enterprises are: "a model that seeks equality, the overcoming of the alienation produced by wage labor, the end of the separation between manual labor and intellectual labor, and worker participation in the management, ownership, and distribution of the company's surpluses." (p. 91)

Another important characteristic of socialist enterprises is their detachment from meritocracy, as it is considered a method that promotes inequality of opportunity and discrimination. Meritocracy is a system where people are promoted to positions of greater responsibility or receive rewards based on talent and effort. In return, organizations benefit from the promotion of people with the best skills to managerial and decision-making positions, which should logically lead to efficiency and productivity.

In a socialist model of business management, generally when it comes to large companies, the ownership of the means of production is usually publicly owned (state-owned enterprises), as is the case in the iron ore and steel industries in Venezuela, which involve large capital expenditures. A state-owned enterprise is one controlled and managed by the state, with the government owning the majority of the company's shares. It is the state, through central planning, that determines production, prices, and the destination of production, leaving management with very little room for decision-making in these matters. This makes them bureaucratic and generally inefficient in the face of changing market and/or environmental conditions.

On the other hand, the capitalist model of business management is characterized by free competition, the pursuit of profit, and the maximization of capital through efficiency, market adaptation, and strategic management. The market is seen as an opportunity and a place of competition between companies, where competitiveness is a fundamental aspect, driving innovation, efficiency, and productivity. Companies use strategies to continually adapt to the market, identify opportunities, and increase profits. To this end, the most capable managers are selected based on their merits. This management model considers social responsibility as an integral part of its strategy, which also seeks to generate value and benefits for society. The literature identifies two types of capitalist management. Managerial capitalism, where managers, not owners, make key decisions about the company. State capitalism, where the government plays an important role in the economy through business ownership and policies. State capitalism has different interpretations, and it is sometimes interpreted as a different form of capitalism, closer to the socialist model. Therefore, it is important to clarify that for the purposes of this research, state capitalism is part of the capitalist management model.

However, all companies, whether capitalist or socialist, must face the same market challenges, which are often unpredictable and volatile, and according to Borgucci (2012):

> The socialist manager faces, in general terms, the same dilemmas as a manager in the capitalist economy, but has fewer tools to minimize the negative effects of decisions arising from central planning and according to this author, this limitation lies in the lack of the tool of market-based economic calculation, the separation between ends set by political criteria and means; and the impossibility of making adjustments according to changes in the economic environment. (p. 183)

Methodology

Natural experiments

The word experiment is used in a quite precise sense to mean an investigation where the system under study is under the control of the investigator. This means that the individuals or material investigated, the nature of the treatments or manipulations under study and the measurement procedures used are all selected, in their important features at least, by the investigator (Cox & Reid, 2000), (Morgan & Winship, 2007). Experiments guide theoretical development by providing a

means for pinpointing the effects of institutional rules, preference configurations, and other contextual factors that might be difficult to assess using other forms of inference (Druckman et al., 2012).

In a natural experiment, unlike a traditional random experiment, the researcher does not artificially manipulate the control and experimental variables of interest, but these are influenced by the nature of the phenomenon or by factors beyond the control of the researchers, in such a way that the researcher limits himself to observing and analyzing a situation where the variables present a behavior very similar to a classic experiment, makes it possible to determine the causal relationship between variables. For this reason, researchers face a major challenge in identifying situations in which natural experiments occur (Dunning, 2012). Good natural experiments are studies in which there is a transparent exogenous source of variation in the explanatory variables that determine the treatment assignment (Meyer, 1995, p. 1). In a natural-experiment evaluation, the analyst makes use of the differences in outcomes between a treatment group and a control group, just as in a classical experiment, but treatment status is determined by nature (Card & Krueger, 1995, p. 22). The design used by a researcher to evaluate a natural experiment will largely depend on the type of data that is available. A widely used method to identify causal effects of any phenomenon through a natural experiment is the Difference in Differences (DiD).

The term "natural experiment" became popular in economics after research conducted by Card & Krueger (1994, 1995) on the effects of raising the minimum wage in New Jersey, USA, in 1992. In their research, they refuted the economic thesis that raising the minimum wage would reduce employment. This surprising result (contrary to theory) was instrumental in introducing economists to the concept of a natural experiment (Mary Morgan, 2023, p. 352). Since then, the identification of causal effects through this method has gained increasing attention in economics and management sciences in recent years, to the point that three of its main protagonists, David Card, Joshua Angrist and Guido Imbens, won the Nobel Prize in economic research related to the causal relationships between variables through natural experiments.

Differences in Differences Method

The Difference-in-Difference (DiD) approach is a research design for estimating causal effects. DiD is a quasi-experimental method that makes use of longitudinal data before and after the intervention of the treatment and control units to obtain an appropriate counterfactual and estimate causal effect. The method has an intuitive appeal and has been widely used in economics, public policy, health research, management, and other fields (Fredriksson & Magalhães, 2019, p. 519). DiD estimates the effect of a specific treatment by comparing the changes in the results over time between a treatment group and a control group, in this way it measures the effect (δ) that a dependent variable (Y_{it}) has on a treatment, in a period before and after.

DiD is used in conjunction with a natural experiment in which nature performs the randomization instead of the researcher. The application of the DiD method requires data on the results before

and after both the group that receives the treatment and the group that does not receive it. To calculate the DiD, proceed as follows:

- Calculate the difference between the means, before and after in the result (Y_{it}) for the treated group ($\bar{Y}_{t2}$-$\bar{Y}_{t1}$).
- Calculate the difference between the means, before and after in the result (Y_{it}) for the control group ($\bar{Y}_{c2}$-$\bar{Y}_{c1}$)
- Calculate the difference between the treated group outcome difference ($\bar{Y}_{t2}$-$\bar{Y}_{t1}$) and the control group difference ($\bar{Y}_{c2}$-$\bar{Y}_{c1}$). This is the difference in differences: (DID)=($\bar{Y}_{t2}$-$\bar{Y}_{t1}$) - ($\bar{Y}_{c2}$-$\bar{Y}_{c1}$)

Figure 2 shows an explanatory graph of the Differences in Difference estimation method of δ from values before, and after the dependent variable Y_{it}. In equation 1, the way to calculate the effect δ of the treatment on the variable Y_{it}; and in Table 1 a summary of the calculation of DID.

Figure 2

Difference-in-Difference estimation, graphical explanation

$$\delta_{DD}=\bar{Y}_{t2}-[\bar{Y}_{t1}+(\bar{Y}_{c2}-\bar{Y}_{c1})]=(\bar{Y}_{t2}-\bar{Y}_{t1})-(\bar{Y}_{c2}-\bar{Y}_{c1}) \qquad (1)$$

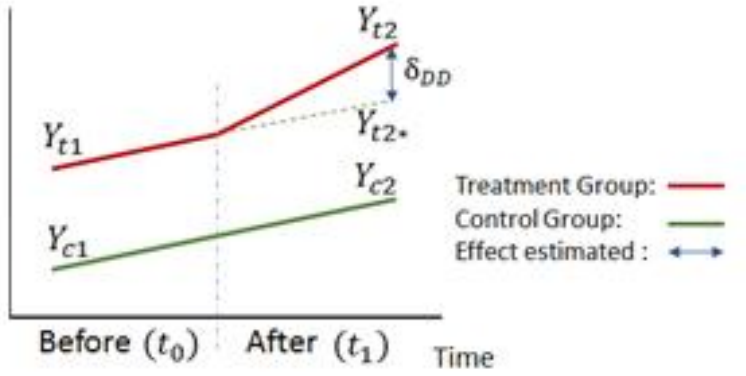


Table 1

Summary of the calculation of DID

	Control (c)	Tratamient (t)	Contrafactual	DID (δ_{DD})
Pre-Tratamient (t_0)	$\bar{Y}_{c1}$	$\bar{Y}_{t1}$	$\bar{Y}_{t1}$	
Post-Tratamient (t_1)	$\bar{Y}_{c2}$	$\bar{Y}_{t2}$	$\bar{Y}_{t1}+(\bar{Y}_{c2}-\bar{Y}_{c1})$	$\bar{Y}_{t2}-[\bar{Y}_{t1}+(\bar{Y}_{c2}-\bar{Y}_{c1})]$

This Difference-in-Difference method can be modeled using the following regression:
$Y_{it} = \beta_1 + \beta_2 * P + \beta_3 * T + \delta * (P * T) + e_{it}$ (2)

where

$\bar{Y}_{C1} = \beta_1$ (Control before)

$\bar{Y}_{C2} = \beta_1 + \beta_2$ (treatment before)

$\bar{Y}_{t1} = \beta_1 + \beta_3$ (Control after)

$\bar{Y}_{t2*} = \beta_1 + \beta_2 + \beta_3$ (Counter-Factual)

$\bar{Y}_{t2} = \beta_1 + \beta_2 + \beta_3 + \delta$ (Treatment after)

In equation 2, δ provides us with a measure of the impact or interaction of the program/treatment (P) as a function of time T, it is a dichotomous variable that reflects a measurement taken before and after, and this linear regression gives us allows to determine the statistical significance of the value of β_1 represents the mean value of the dependent variable of the individuals in the control group, before the program, that is, when both the value of the treatment variable P and the time T are zero, that is when the program has not been carried out and we are at the initial moment.

When designing an experiment, researchers must consider how extraneous variables can threaten the internal and external validity of an experiment. Internal validity is the extent to which an experiment can establish the causal relationship between the independent variable and the outcome variable. The Differences in Differences method makes it possible to eliminate the strange causal effects that each group has on the result and to compare the results before and after applying the treatment intertemporally. External validity is the extent to which the causal relationship obtained from an experiment can be generalized to other settings, which is usually verified by replicating the experiment.

Difference-in-Difference Assumptions

The DiD method relies on meeting three key assumptions to validly interpret the treatment effect. The main assumption that the DiD must meet is that the treatment and control groups exhibit parallel trends in the outcomes (parallel trend assumption). This implies that, in the absence of treatment, the difference between the treatment and control groups remains constant over time. The DiD method can reflect causal estimates as long as the parallel trend assumption is met (Lechner, 2011). This assumption validates the absence of concurrent (or simultaneous) changes that affect the variable of interest differently in the treatment and control groups. To verify this assumption, visual inspection of the trend graphs is very useful, as there is no statistical test that verifies it. Another way to test the parallel trend assumption is by specifying the linear regression equation 2, where the coefficient β2 is not statistically significant if the parallel trend assumption is met. A third way to test the assumption of equal trends would be to conduct what is known as a placebo test. For this test, a second difference-in-differences estimate is made using a "sham" treatment group—that is, a group that, to the researcher's knowledge, has not been affected by the

program (Gertler et al., 2017). Failure to comply with the parallel trend assumption will result in a biased estimate of the causal effect. Another important assumption is the Stable Value Assumption of Unitary Treatment, which implies that there should be no spillover effects between the treatment and control groups, since, in such a case, the treatment effect would not be identified (Duflo et al., 2008). This also implies that the composition of the intervention and comparison groups is stable for repeated cross-sectional designs. Finally, it is assumed that the treatment is unrelated to the outcome at baseline.

Results and discussion

Observations and Data

For the study, countries with medium-sized, state-owned iron ore mining industries were selected, thereby avoiding the effect of economies of scale associated with large companies. The medium-sized, state-owned segment of the global iron ore mining industry is extremely small. There are many countries with medium-sized iron ore mining industries worldwide, but very few are state-owned. Among them are Venezuela (FMO), Sweden (LKAB), India (NMDC), and Algeria (SNIN). However, even if these are state-owned companies, they have been considered successful in their operations, except Venezuela. On the other hand, there are also Chinese companies, which do not publish audited data, and no information is available about them.

The observations for the natural experiment on the impact of socialist management on the iron ore mining industry were taken from 2003 to 2014. Since 2014, Venezuela has stopped publishing audited reports on the results of its iron ore mining industry. However, this period allows valid inferences to be made through DiD regarding the causal relationships that the application of a socialist management model has on management results. There were no events within the companies other than the treatment, nor were there relevant external variables during the observations before and after the application of the socialist model, which could provide alternative explanations for the outcome. In fact, the before and after observations in the treated company took place in a context with the same economic and political tendency of the central government. Both the treatment unit and the control unit are state-owned iron ore mining activities in both Venezuela and Sweden, with similar characteristics in terms of productive capacity.

When analyzing or conducting a study in any industrial sector, it is important to keep in mind its characteristics. In the case of the global iron ore mining industry, we can say that it is a capital-intensive business, with a low added-value product, standardized operations (exploration, extraction, milling, processing, transportation), where economies of scale operate, and it is highly technical, where all companies have access to the most advanced technologies that supplier companies in open competition offer for sale to mining countries. Where large mining companies in Australia and Brazil (Vale, Rio Tinto, BHP, Fortescue), due to economies of scale, tend to be more efficient, productive, and profitable than the medium-sized mining segment in South Africa, Chile, Canada, Sweden, Venezuela, even Brazil and Australia itself. Therefore, it is obvious in comparative studies to conduct them within each segment to avoid bias. In this research, the units

of analysis are located within the same segment: medium-scale iron ore mining and owned by the state.

The selected indicators: production (Q), installed capacity utilization (UCI), and operating margin (OM), are indicators commonly reported in annual earnings reports. The data were collected through 2014, firstly because it is sufficient for the DiD analysis; and secondly because the Socialist leadership did not publish its annual earnings reports after 2014.

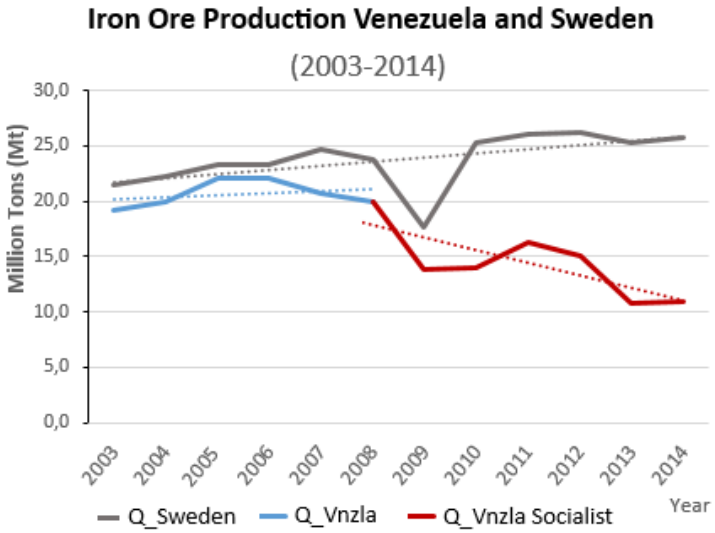
Installed capacity utilization (UCI) is a productivity indicator that measures the relationship between actual production and installed capacity. Installed capacity is the production potential or maximum production volume that a company can achieve in each period, considering all the resources available to it in terms of equipment, facilities, human resources, technology, etc. The operating margin determines the percentage of profit obtained from sales after deducting the costs associated with the production of the goods or the provision of the service and administrative and sales expenses. The operating margin (OM) indicator shows the company's profitability and is the ratio of operating profit (revenue - operating cost) to revenue.

MO = operating profit / revenue (3)

Figures 3, 4, and 5 show the evolution of the production performance indicators, installed capacity utilization, and operating margin for the iron ore mining industry in both Venezuela and Sweden. The parallel trend assumption is quite acceptable, and at first glance, it is evident that the treatment unit shows a change in trend in 2008, the year in which socialist management was implemented. The statistical validity of the assumption of parallel trends was verified by the statistically non-significant β2 coefficient in Table 3.

Figure 3

Venezuela and Sweden iron ore production trends



Source: By the author with data from MPPIM (2010), MPPI (2014) and LKAB (s/f/).

Figure 4

Trends in the use of the installed iron ore production capacity of Venezuela and Sweden. Source: By the author with data from MPPIM (2010), MPPI (2014) and LKAB (s/f/)

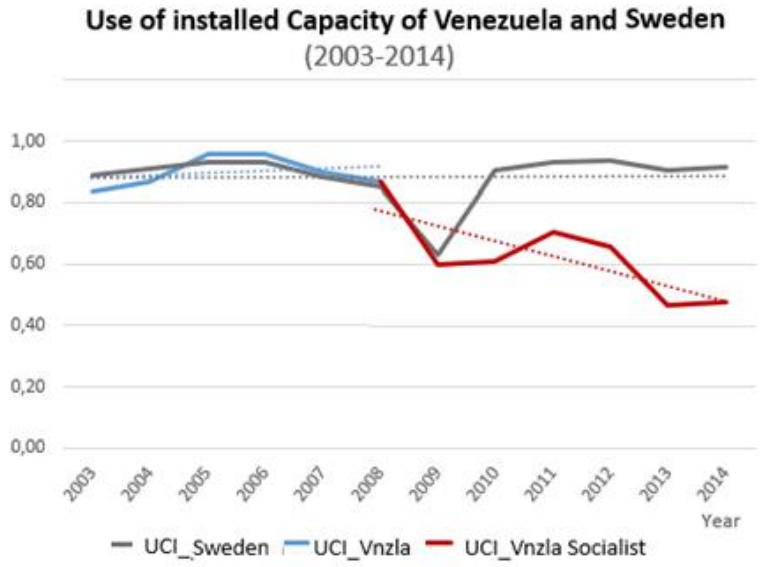
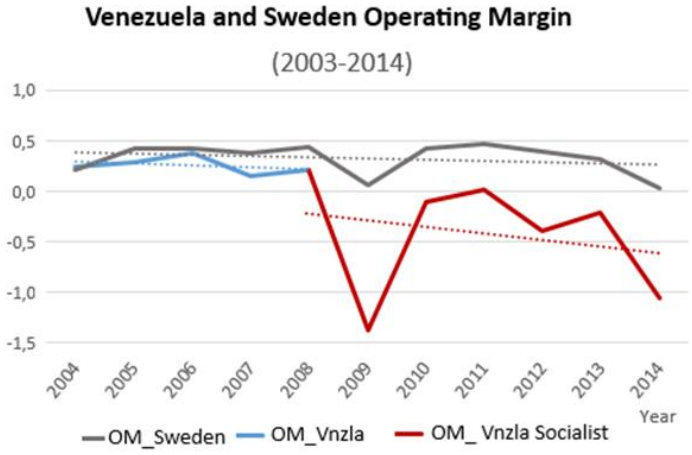


Figure 5

Venezuela and Sweden Operating Margin Trends. Source: By the author with data from MPPIM (2010), MPPI (2014) and LKAB (s/f/)



Impact of the Socialist Management Model

Table 2 shows the results of applying the DiD method to the before-and-after data for the Venezuelan industry as the treatment unit and the Swedish industry as the control unit. The difference in difference δ for production is -8.43 Mt, for installed capacity utilization is -0.74, and for the operating margin is -0.28. These are statistically significant according to the results of the linear regression models presented in Table 3. In Appendix 1, the replication of the Natural Experiment with Another Control Unit is shown; to verify the robustness of the results, Venezuela (FMO Mining Company) was used as the treatment unit and India (NMDC Mining Company) as the control unit.

Three methods were used to verify the robustness of the results. First, DiD analyses were performed with different definitions of the treatment variable associated with efficiency, productivity, and profitability. Second, another alternative analysis method, linear regression, was used. Third, the experiment was replicated with another control unit, using the same treatment unit. The same results were obtained in all the methods used.

The negative impact of the change in the management model of the Venezuelan iron ore mining industry to a socialist management model is evident. Far from the positive results expected by the precursors of the socialist management model, the trends show a sustained deterioration in the indicators selected for evaluation.

Table 2

DID results of Q, MO and ICU of Venezuela and Sweden

	Control (LKAB)	Tratamient (FMO)	Contra-factual	DID
Q_Fe-Pre	23,13	20,68	20,68	
	(0,47)	(0,49)		
Q_Fe-Post	24,38	13,50	21,93	
	(1,35)	(0,90)		
Q_Fe-Dif	1,25	-7,18		-8,43
MO_Fe-Pre	0,34	0,27	0,27	
	(0,05)	(0,03)		
MO_Fe-Post	0,28	-0,52	0,22	
	(0,08)	(0,23)		
MO_Fe-Dif	-0,05	-0,80		-0,74
UCI-Pre	0,90	0,90	0,90	
	(0,01)	(0,02)		
UCI-Post	0,87	0,59	0,87	
	(0,05)	(0,04)		
UCI-Dif	-0,03	-0,31		-0,28

Note: Standard errors are shown in parentheses.

Table 3

Results of the linear regression models of Q, MO and ICU of Venezuela and Sweden

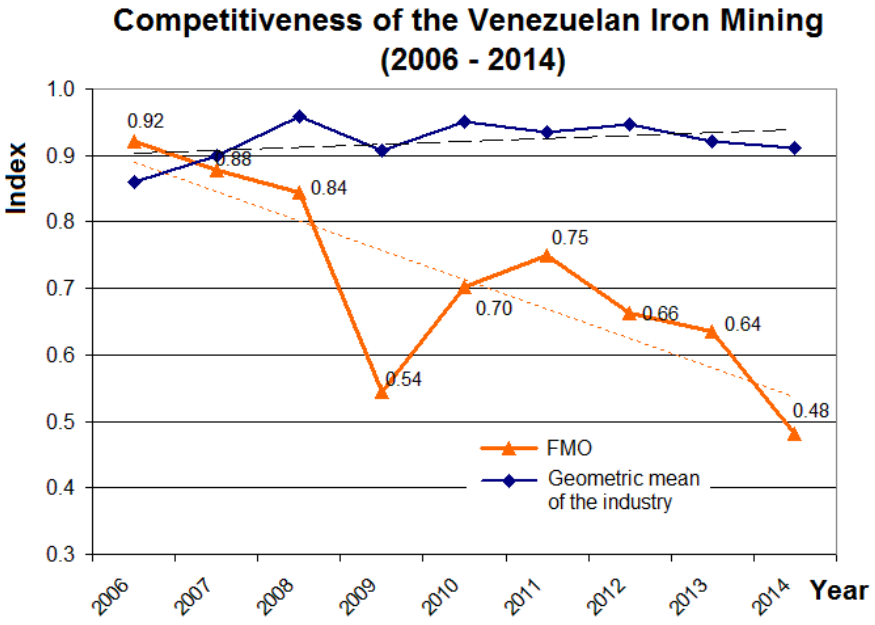
Model	β_1 _cons	β_2 Post	β_3 Soc	δ Soc_Post
Q_Fe	2,31	1,25	-2,45	-8,43
	(0,000)	(0,326)	(0,062)	(0,000)
MO_Fe	0,336	-0,053	-0,062	-0,743
	(0,015)	(0,771)	(0,730)	(0,008)
UCI_Fe	0,899	-0,029	0,000	-0,284
	(0,000)	(0,553)	(0,999)	(0,000)

Note: Statistical significance levels are shown in parentheses.

The results of this study confirm those of previous studies on the competitiveness of Venezuela's iron ore mining industry. Figure 6 shows the dramatic decline in the competitiveness of the Venezuelan iron ore mining industry, as found in another previous study. According to that study, prior to 2008, the competitive level of the Venezuelan iron ore mining industry was above the global industry average; after the implementation of the socialist management model starting in 2009, it declined sharply.

Figure 6

Competitiveness of the Venezuelan Iron Mining (2006 -2014)



Source: Villalva (2018)

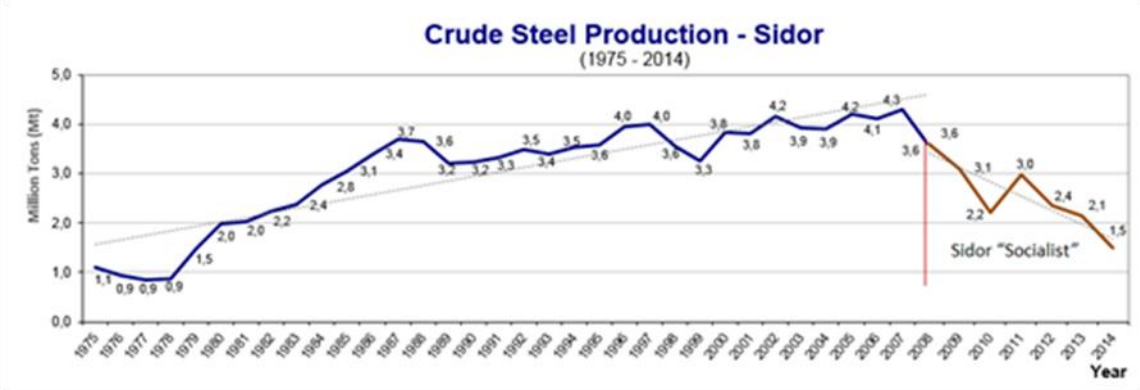
Reproducibility of the Experiment

Experimental reproducibility refers to the possibility of obtaining consistent results when replicating a study with a different data set following the same experimental design, which allows for verifying the validity of the findings from the first experiment. To verify the reproducibility of the experiment, data from "Siderúrgica del Orinoco" (Sidor), a Venezuelan state-owned steel company located in the Guayana region, in the southeast of the country, were used. This company had been privatized during Rafael Caldera's second administration in 1997 and returned to the Venezuelan state in 2008.

Figure 7 shows Sidor's production curve between 1975 and 2014. The same socialist management approach applied to Venezuela's iron ore mining industry was applied to the Venezuelan steel company Sidor, and the "Compañía Siderúrgica Nacional" (CSN, 2025) of Brazil, a company with similar characteristics to Sidor, was used as the control unit. The indicators used were the same and for the same period as the previous experiment: production (Q), use of installed capacity (UCI) and operating margin (MO), reported annually by the government through the Ministry of Industries.

Figure 7

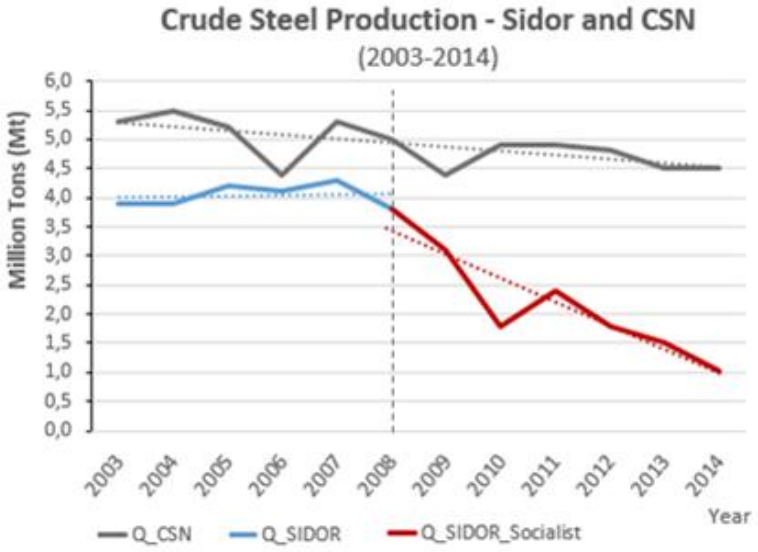
Crude steel production of Sidor (1975 -2017). Source: Villalva (2017)



Figures 8, 9, and 10 show the evolution of the production performance indicators, installed capacity utilization, and operating margin for Sidor and CSN. The parallel trend assumption is quite acceptable, and at first glance, it is evident that the company in question, Sidor, shows a change in trend starting in 2009, the year the socialist management model was implemented.

Figure 8

Sidor and CSN crude steel production trends



Source: By the author with data from MPPIM (2010), MPPI (2014) and CSN (s.f.)

Figure 9

Trends in the use of the installed crude steel production capacity of Sidor and CSN. Source: By the author with data from MPPIM (2010), MPPI (2014) and CSN (2025)

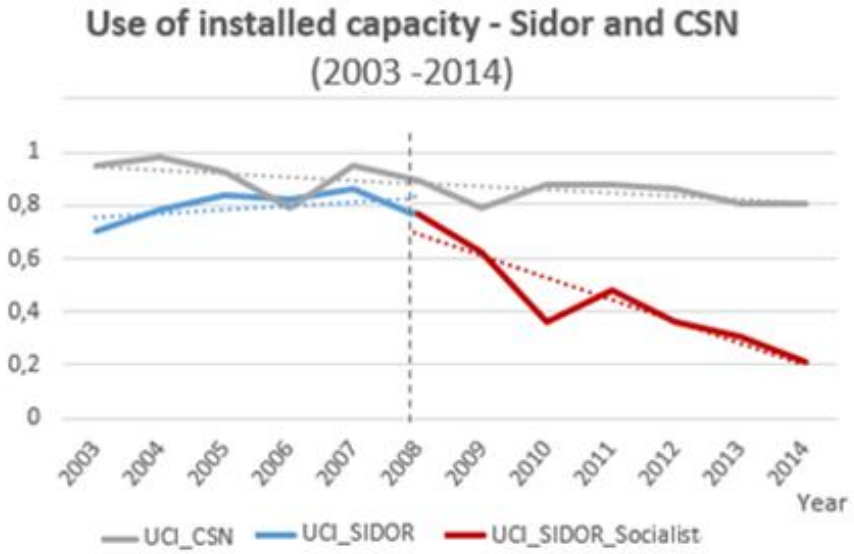
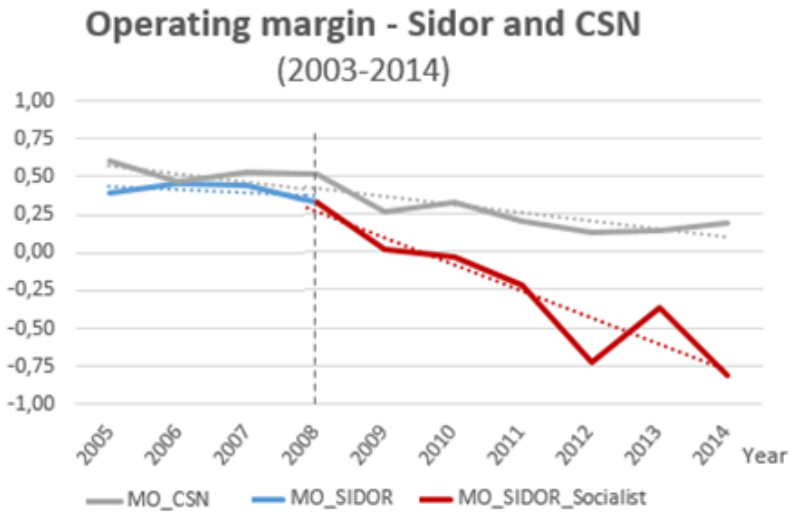


Figure 10

Sidor and CSN Operating Margin Trends



Source: By the author with data from MPPIM (2010), MPPI (2014) and CSN (2'25)

Table 4 shows the results of applying the Difference-in-Differences method to the before-and-after data for Sidor, the treatment unit, and CSN, the control unit. The difference-in-differences δ for production is -1.64 Mt, installed capacity utilization is -0.44, and the operating margin is -0.32. These are statistically significant according to the results of the linear regression models presented in Table 5. These results confirm the results obtained in the first experiment, on the negative impact of socialist management on the company, confirm the reproducibility of the experiment, and the validity of the findings from the first experiment.

Table 4

DID results of Q, MO and ICU of Sidor and CSN

	Control (CSN)	Tratamient (SIDOR)	Contra-factual	DID
Q_Pre	5,12	4,03	4,08	
	(0,16)	(0,08)		
Q_ Post	5,12	4,03	4,08	
	(0,09)	(0,29)		
Q_Dif	-0,45	-2,09		-1,64
MO_ Pre	0,53	0,40	0,40	
	(0,03)	(0,03)		
MO_ Pre	0,21	-0,36	0,08	
	(0,03)	(0,14)		
MO_ Pre Dif	-0,32	-0,76		-0,44
MO_ Pre	0,92	0,79	0,80	
	(0,03)	(0,02)		
MO_ Post	0,83	0,39	0,71	
	(0,02)	(0,06)		
MO_ Dif	-0,08	-0,41		-0,32

Note: Standard errors are shown in parentheses.

Table 5

Results of the linear regression models of Q, MO, and ICU of Sidor an CSN

Steel Model	β_1 _cons	β_2 Post	β_3 Soc	δ Soc_Post
Q	5,117	-0,450	-1,083	-1,643
	(0,000)	(0,089)	(0,000)	(0,000)
MO	0,527	-0,320	-0,124	-0,439
	(0,000)	(0,026)	(0,402)	(0,031)
UCI	0,915	-0,082	-0,122	-0,323
	(0,000)	(0,119)	(0,025)	(0,000)

Note: Statistical significance levels are shown in parentheses.

Conclusions

This article examines the impact of the transition from a capitalist management model to a socialist management model on an industrial sector. This model places greater emphasis on social aspects and is based on the participation of the working class in control and decision-making.

A natural experiment was used, with the Venezuelan iron ore mining industry as the treatment unit (to which the socialist management model is applied) and the Swedish iron ore mining industry as the control unit, which does not receive the treatment. The Difference-in-Differences method was used to estimate the causal effects of applying this socialist management model. The following indicators were used as outcome variables: Q, UCI, and MO.

The research used a scientifically accepted procedure to demonstrate causality between the variables studied. The results revealed the negative impact of the implementation of a socialist management model on the Venezuelan iron ore mining industry, an industry that until then had enjoyed economically sustainable mining management.

The results of the experiment were confirmed by replicating the experiment with another data set, using the Venezuelan steel company Sidor as the treatment unit and the Brazilian company CSN as the control unit.

The robustness of the results was verified using three methods: (1) DiD analysis with three different definitions of the treatment variable. (2) Use of another alternative analysis method, linear regression. and (3) The experiment was replicated with another control unit, using the same treatment unit.

The results obtained from this research on the application of the socialist model to the management of an industrial sector contradict the expectations established by the precursors of this management model and represent compelling evidence of the economic unsustainability of a socialist management model.

It has been demonstrated that through natural experiments, causality in the results of changes in strategic vision, management, strategies, policies, organizational processes, etc., in companies, industries, and countries can be reliably assessed.

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Appendix

Replication of the Natural Experiment with Another Control Unit. Venezuelan Treatment Unit (FMO Mining Company) and Indian Control Unit (NMDC Mining Company).

Figure A1

Venezuela (FMO) and India (NMDC) iron ore production trends

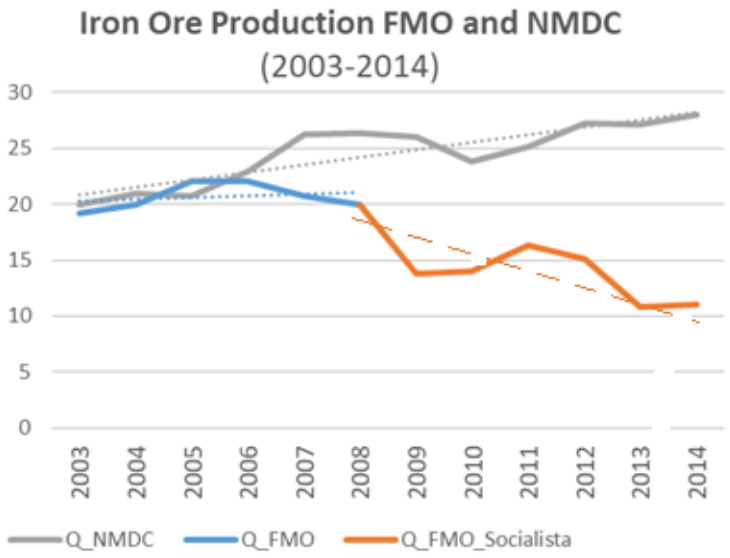

Figure A2

Trends in the use of the installed iron ore production capacity of Venezuela (FMO) and India (NMDC)

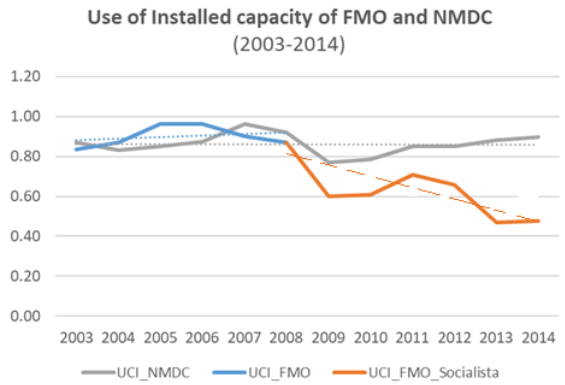

Figure A3

Venezuela (FMO) and India (NMDC) Operating Margin Trends

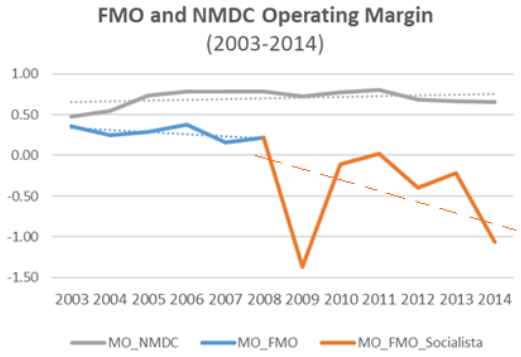

Table A1.
DID results of Q, MO and ICU of Venezuela (FMO) and India (NMDC)

	Control (NMDC)	Tratamient (FMO)	Contra-factual	DID
Q_Fe-Pre	20.44	20,68	0.25	
Q_Fe-Post	26.99	13,50	13.49	
Q_Fe-Dif	6.55	-7,18		-13.73
MO_Fe-Pre	0,69	0,27	-0,41	
MO_Fe-Post	0,72	-0,52	-1.24	
MO_Fe-Dif	0,03	-0,80		-0,82
UCI-Pre	0,88	0,90	0,02	
UCI-Post	0,84	0,59	-0,25	
UCI-Dif	-0,04	-0,31		-0,27

Table A2
Results of the linear regression models of Q, MO and ICU of Venezuela (FMO) and India (NMDC)

Model	β_1 _cons	β_2 Post	β_3 Soc	δ Soc_Post
Q_Fe	20.4	6.55	0.25	-13.7
	(0,000)	(0,000)	(0,831)	(0,000)
MO_Fe	0,6865	0,029	-0,413	-0,825
	(0,000)	(0,864)	(0,025)	(0,003)
UCI_Fe	0,884	-0,045	0,0157	-0,267
	(0,000)	(0,245)	(0,681)	(0,000)

Note: Statistical significance levels are shown in parentheses.