PRODUCTIVE EFFICIENCY IN THE BANKING INDUSTRY

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Abstract

The goal of this paper is to estimate the productive efficiency of Argentine banks. For this purpose, panel data of the universe of banks under the supervision of the Central Bank of the Republic of Argentina (BCRA) has been collected. In order to build the bank´s indicators, we used a database of 66 institutions, with annual information for the period 2009-2013. The sources of information were both the BCRA´s web site (www.bcra.gov.ar), and the Buenos Aires Stock Exchange´s web site (www.bolsar.com). It has been selected an efficiency indicator ranging between 0 and 1, meaning the lowest and highest level of efficiency, respectively. The concept of efficiency used here is a relative one, because it considers a Bank´s performance in relation to the behavior of the best players in the industry, being the latter the base of the industry benchmark or frontier. The results show that the mean efficiency of Argentine banks is 0,8277 in the specific period under consideration. The comparison with the results of other studies relating efficiency and competitive pressure, didn´t allow us to infer that the Argentine banking industry experienced in the period a high level of competition.

Keywords: Productive Efficiency, Banking Industry, BCRA

1. INTRODUCTION

The goal of this paper is to estimate the productive efficiency of banks in Argentina. For this purpose, panel data of the universe of banks under the supervision of the Central Bank of the Republic of Argentina (BCRA[5]) has been gathered. In order to build the bank´s indicators, a database of 66 institutions was used, with annual information for the period 2009-2013. The sources of information were both the BCRA´s web site (www.bcra.gov.ar), and the Buenos Aires Stock Exchange´s web site (www.bolsar.com).

The paper is organized as follows. In section 2, the efficiency concept is developed. In section 3, the theoretical causes of productive inefficiency are analyzed. In section 4, the formal features of the econometric model used to estimate the bank´s efficiency are exposed. In section 5, the empirical evidence of the banking sector in Argentina is shown, incorporating average estimates of bank´s efficiency. In section 6 and 7, the conclusions and the references are included, respectively.

2. DEFINITIONS OF EFFICIENCY

The conventional theory of the firm distinguishes between at least two classes of efficiency: price and technical efficiency. Price efficiency refers to the selection of an optimal combination of inputs, given the prices of factors, while technical efficiency refers to the maximum output attainable for the available factors.

According to Carlsson (1974), price efficiency exists if the marginal product of every factor employed in the production is the same for all alternative uses. In a profit-maximizing firm, the optimal combination of inputs is chosen in a way that their marginal product equal relative prices. The level and price of the production are set in the point where cost and marginal revenue match, for a given demand function. According to this, every profit maximizing firm is price efficient. If the firm faces a negative-sloped demand, the price will be higher than its marginal cost. As long as other firms don´t get into the industry and the excess profits be removed, all firms in the industry can still be considered price efficient, but still remains allocative inefficiency from the consumers' perspective: as long as price be higher than marginal cost, the consumer´s welfare might be increased if more resources are invested to the production of goods. Price efficiency can be considered a kind of allocative efficiency, which refers to the allocation of resources within the firms.

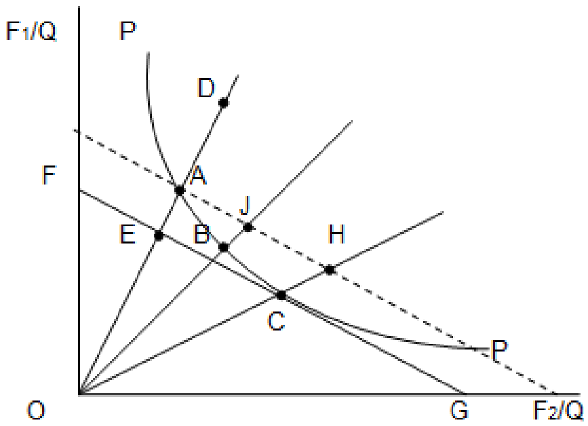
Technical efficiency is usually assumed in the conventional production function, which establishes the maximum output attainable from a given combination of inputs. The difference between price and technical efficiency is illustrated in the Figure 1. The Production function is represented with a unit isoquant, PP, with two inputs, and assuming constant returns to scale. Firms A, B, and C are all on the isoquant, which implies that for each level of production they employ the minimum level of inputs; so that, they are technically efficient. On the other hand, firm D is using more of the two inputs for the same level of production, so it is technically inefficient. If we now introduce a price line FG representing the relative prices of factors, assuming

[5] BCRA are the initials for Banco Central de la República Argentina in spanish, or Central Bank of the Republic of Argentina, in English.

that is the same for the four firms, we find that A and B are price inefficient, while C is efficient: its cost per unit of output is smaller because it uses a more convenient combination of inputs than A or B. If we set F_1 = capital and F_2 = labor, it could be argued that A and B are using too capital-intensive techniques given the relative prices of factors.

One measure of technical efficiency introduced by Farrell (1957) is the ratio OA/OD for the plant D. It can be observed that this ratio is always ≤ 1. The price efficiency associated with the OE combination of factors is OE/OA. The economic or "total" efficiency of plant D is given with the ratio (OA/OD) x (OE/OA) = OE/OD, which is the product of technical and price efficiency. It can be noted that the price line FG represents the total expenditure for one unit of product in the case of the most efficient combination of factors. Every price line above FG represents a bigger average expenditure per unit of product. The economic efficiency of plant D is then the ratio of the average production cost at C to the average production cost in D.

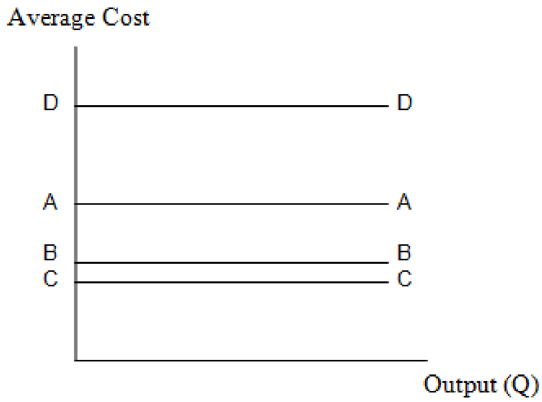
Figure 1. Unit isoquant



Let´s analyze now price and technical inefficiency in the context of an average cost curve (see Fig. 2). Considering that the unit isoquant in Fig. 1 assumes constant returns to scale and that the price line FG represents the minimum cost per unit of product, we can draw the average cost curve for firm C as the straight line CC. Every point A, B and D in the Fig. 1 are related with the upper average cost curves, represented by AA, BB and DD in the Fig. 2. The CC curve is usually denominated the industry average cost curve. It can be observed that it is impossible to distinguish on the average cost curve AA, the points A and H in the Fig. 1. Even though A is technically efficient and price inefficient, and H is technically inefficient and price efficient, both have the same cost curve AA. On the other hand, the point J is technically and price inefficient, but it is on AA too.

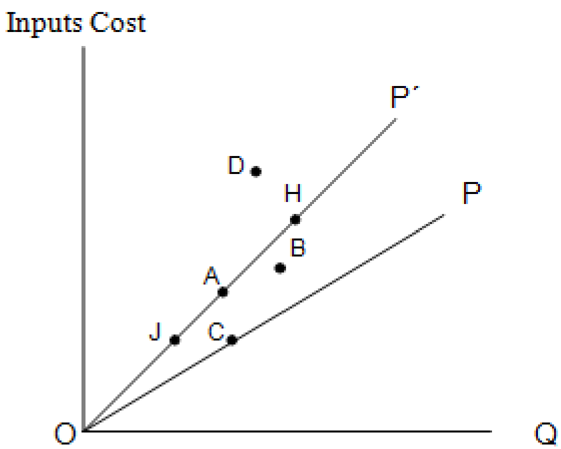
In Fig. 3, the average cost curves are transformed into total cost curves. Still assuming constant returns to scale, OP is a straight line that represents the total cost function of firm C. Firms A, H and J are in a different total cost function OP´, which highlights the fact that for a given production level they experience higher costs than the efficient firm C. Firm A is still technically efficient and price inefficient, while H is technically inefficient and price inefficient.

Figure 2. Average cost curves



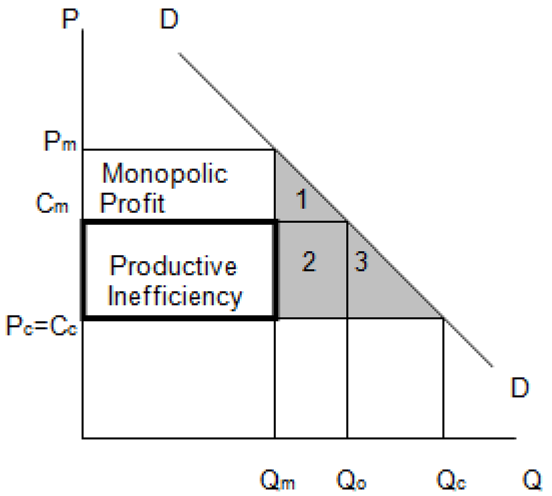
The cost function OP in Fig. 3 is usually denominated the frontier cost function of the industry, which describes the most efficient technology in the sector. This cost function is built with the most technically and price efficient firms. Firms above the frontier could be technically or price inefficient, or both. If we couldn´t know a priori whether these points are technically or price inefficient, it can be difficult to distinguish between these two aspects of inefficiency. However, we could say that these points are related to firms that exhibit productive inefficiency or "X-inefficiency", using in the latter case the terminology introduced by Leibenstein (1966).

Figure 3. Total cost curves



In order to perform an integral analysis and highlight the differences between the concepts of efficiency used in the literature, we can examine Fig. 4. According to our previous definition of allocative inefficiency as originated due to any difference between price and marginal cost, we could conclude that the existence of a monopoly, in any degree, implies an inefficient allocation of resources. If we could measure the difference between price and marginal cost for every firm in the economy, times the related quantity of output, assumed known the elasticity of the demand, we could obtain a measure of the cost for the economy of the existing allocative inefficiency. This cost is equivalent to the loss of the consumer surplus, represented by the area 1 in Fig. 4. In this chart is assumed that the marginal cost is equal to average cost, and the latter is constant for the relevant range. The loss of the consumer surplus is then one aspect of the allocative inefficiency. However, it can be observed that the allocative inefficiency defined by area 1 assumes that firms operate in the same industry average cost or, alternatively, the frontier average cost function. Accordingly, the consumer´s welfare loss measured in this way could underestimate the actual loss, if the observed marginal cost (or average cost assuming constant returns to scale) in a monopolist industry, Cm, exceeded the level of cost Cc that a firm (hypothetic) in perfect competition would have in the same industry. If this were the case, in order to arrive to the total loss welfare, we should add to the area 1, the areas 2 and 3 of the Fig. 4. Besides, the thick border rectangle represents inefficiency in production.

Figure 4. The monopoly inefficiency



3. THEORETICAL CAUSES OF PRODUCTIVE INEFFICIENCY

In an ideal perfect competition world, where all firms are profit maximizers, where information is perfect and costless, and where changes in technology are costless and instantaneous, there would not be room for inefficiency neither for the short nor the long run. Every firm would produce the optimal product mix using an optimal combination of factors, achieving the maximum output for given resources. There are a lot of ways in which reality departs from this ideal situation. All economists agree that the absence of perfect competition causes inefficiency because the lack of competitive pressure allows firms to survive in the long run. The presence of competition is an empirical matter, not theoric. But the reason for inefficiency depends on whether firms maximize profits or not and on the meaning of “profit maximization”: trying to maximize, or success in maximizing. Failure in trying to maximize profits has an “ex ante” or motivational sense, while unsuccessful actions that pursue to maximize are called ex post failures.

When there is no competitive pressure, firms are free to pursue other goals different from profits maximizing, affecting adversely the allocation of resources and efficiency in the long run. Managers could follow their own goals, after achieving some minimum level of profits, or could try to maximize some utility function that doesn´t include profits, with the condition of the survival of the company, but limited by other factors. Profits could be some of the arguments in the target function, but others could be expenditures on staff and managerial compensations, the growth rate of the firm or sales income. Motivational failure could also result from the separation of ownership and control of the firm, due to differences in the target functions of managers and stockholders.

Another source of inefficiency comes from lack of information and uncertainty about the true production function. One of the reasons is the imperfections in inputs markets. As Leibenstein pointed out, labor contracts are incomplete, because the employer doesn´t know with certainty workers’ capabilities and there are no exact specifications of each job. Moreover, there are inputs not merchandised in the market, or when they are, they are not available in the same way for all firms. Examples of these are managerial skills, technical knowledge and rights on patents. Accordingly, each firm could face a different set of production factors, and so that, a different production function. Of course, what really matters is the concept of relative efficiency, or each firm´s efficiency compared to existing and applied technology in the industry. A profit-maximizing firm could be efficient regarding its own production function, given its resources and environment, but inefficient concerning the industry production function. This is because other firms could have different assets (particularly those not merchandised in markets) and thus could reach a different production function. Any firm could be on the frontier, if it pays the costs of accessing the information and makes the adjustments in the production process.

The presence of uncertainty could affect also the average use of physical assets and the size of the firm, turning planning and budgeting more difficult due to the uncertainty about the price of output, the behavior of competitors, changes in raw material prices, and other costs.

4. THE MODEL

The estimation of the productive efficiency of a bank requires an industry frontier production function where it belongs.

A stochastic frontier production function was independently proposed by Aigner, Lovell and Schmidt (1977) and Meeusen and van den Broeck (1977). The original specification involved a production function specified for cross-sectional data which had an an error term with two components, one to account for random effects and another to account for technical inefficiency.

For this paper it has been selected a stochastic frontier production function for unbalanced panel data proposed by Battese and Coelly (1992), which considers the existence of firm effects distributed as normal truncated random variables, which allowed to vary systematically along time. The model can be expressed as follows:

$$Y_{it} = x_{it}\beta + (V_{it} - U_{it}),\ i = 1,\dots,N;\ t = 1,\dots,T \qquad (1)$$

Where Y_{it} is the production of the i-th bank in the t-th time period; x_{it} is a kx1 vector of input quantities of the i-th bank in the t-th time period; β is a vector of unknown parameters; the V_{it} are random variables distributed independently and identically as normal with mean 0 and constant variance, $N(0, \sigma_v^2)$, an independent of the

$$U_{it} = (U_i \exp(-\eta(t-T)))$$

Where the U_{it} are no negative random variables that express inefficiency in production, and assumed to be independently and identically truncated in 0 of distribution $N(\mu,\sigma_U^2)$; and η is a parameter to be estimated.

We utilize the parameterization of Battese and Corra (1977) who replace σ_V^2 and σ_U^2 with $\sigma^2=\sigma_V^2+\sigma_U^2$ and $\gamma=\sigma_U^2/(\sigma_V^2+\sigma_U^2)$. This is done with the calculation of the maximum likelihood estimates in mind. The parameter, γ, must lie between 0 and 1 and thus this range can be searched to provide a good starting value for use in an iterative maximization process such as the Davidon-Fletcher-Powell (DFP) algorithm. The log-likelihood function of this model is presented in the appendix in Battese and Coelli (1992).

The ratio of the observed output for the i-th bank in a given period, in relation to the potential product defined by the frontier production function, given the vector inputs x_{it}, is used to define the efficiency of the i-th bank in period t:

$$EF_{it} = (x_{it}\beta - U_{it})/(x_{it}\beta) \qquad (2)$$

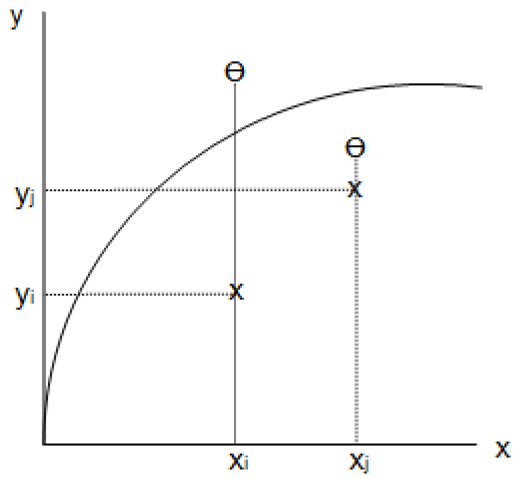
This coefficient is an output oriented Farrell measure of technical efficiency, which takes a value between 0 and 1, and expresses the magnitude of the output for the i-th bank regarding the output that could be produced by an efficient bank using the same inputs vector.

If the production function takes the Cobb-Douglas form[6], this measure will change to:

$$EF_{it} = \exp(x_{it}\beta - U_{it})/\exp(x_{it}\beta) = \exp(-U_{it}) \qquad (3)$$

The main features of the stochastic frontier model are illustrated in Figure 5 with only one input, and in this case assuming diminishing returns to scale. The input is represented in the horizontal axis and the output in the vertical axis. The figure shows the production and inputs observed for two banks, i and j. Bank i uses the input level x_i to produce the output, y_i. The observed input-output value is shown in the point marked with an x above the value of x_i. The value of the production in the stochastic frontier, $y_i^* = \exp(x_i\beta + v_i)$, is marked with the point Θ above the production function because the random error, v_i, is positive. Similarly the bank j uses the input level, x_j, and produce output, y_j. However, the frontier production, $y_j^* = \exp(x_j\beta + v_j)$, is below the production function because the random error is negative. Of course, the stochastic production levels are not observables, because the random errors, v_i y v_j, are not observables. However, the deterministic part of the stochastic frontier model is located between the stochastic frontier output. The observed production levels might be higher than the deterministic part of the frontier, if the random errors are bigger than the inefficiency effects. (for ex.: $y_i > \exp(x_i\beta)$ if $v_i > u_i$).

Figure 5. The stochastic frontier production



5. EMPIRICAL EVIDENCE

The database contains information of the 66 argentine banks regulated by the BCRA, from year 2009 to year 2013.

For the estimation of the frontier production function is selected the Cobb-Douglas version of the model cited en section 4., with the following features:

$$LN(Y_{it}) = LN(x_{1it})\beta_1 + LN(x_{2it})\beta_2 + (V_{it} - U_{it}),\quad i = 1,\dots,N;\ t = 1,\dots,T \qquad (4)$$

Where i ranges from 1 to 66 (quantity of firms); t ranges from 1 to 5 (year 2009 to 2013); Y_{it} are financial and services income of the i-th bank in the t-th year; $x1_{1it}$ are financial expenditures of the i-th bank in the t-th year; $x2_{1it}$ are operational and services expenses of the i-th bank in the t-th year.

It has been used for this purpose the software Stata/SE 8.0. The results from estimating the frontier function are exposed in the Table 1.

The individual coefficients of each bank are not shown for space reasons. In the Table° 2 are shown the statistical descriptors of the efficiency coefficients and in the Figure 6 the histogram of frequencies. For these purposes, the statistical software SPSS has been used.

In light of these findings, we think that it would be fruitful to compare these results with other efficiency studies. Button and Weyman-Jones (1992) examined nine efficiency research papers, which were clearly described by their authors regarding the level of competitive pressure in each industry. Besides, all of them reported the mean, minimum and standard deviation of the efficiency indicators. We should expect to find that when the competitive pressure was attenuated, mean efficiency is low, minimum efficiency is low, and the spread of efficiency among the firms is high. The high level of mean and minimum efficiency would be consistent with the features of a perfectly competitive market, where there is little product differentiation, there

[6] In this case the variables will be inserted in logs in the equation.

are many players and the information about technology is available for everyone. In this type of markets, participants are price-takers, so that the costs of every firm should be close to the industry minimum cost, because otherwise they would suffer losses and sooner or later would be pushed to leave the market. On the other hand, a low standard deviation could be the consequence of the absence of market power protecting the firm members from the pressure for being efficient. If this is the case, we could expect a lower spectrum or dispersion of behavioral patterns.

Table 1. Estimates of the frontier function

Variable	*Coef. (β)*	*Std. Err.*	*Z*	*P>|z|*	*[95% Conf. Interval]*	
lnEgreFin	.2922009	.0406428	7.19	0.000	.2125425	.3718592
LnGastos (C)	.6728967	.0508536	13.23	0.000	.5732254	.772568
_cons	1.452589	.2723506	5.33	0.000	.9187919	1.986387

Table 2. Statistical descriptors

			Statistic	Std. Error
Eficiencia	Mean		,827707	6,03E-03
	95% Confidence Interval for Mean	Lower Bound	,815847	
		Upper Bound	,839566	
	5% Trimmed Mean		,839913	
	Median		,851317	
	Variance		1,174E-02	
	Std. Deviation		,108340	
	Minimum		,0678	
	Maximum		,9382	
	Range		,8703	
	Interquartile Range		7,79E-02	
	Skewness		-5,385	,136
	Kurtosis		35,414	,271

Figure 6. Histogram of efficiency indicators

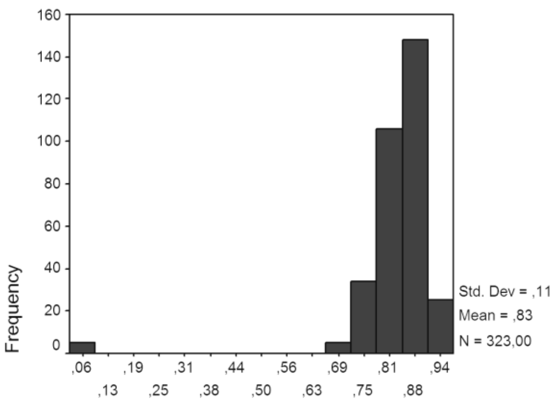


Table 3 summarizes the critical information of the nine studies mentioned in the previous paragraph, indicating with 0 and 1, high and low level of competitive pressure of each industry´s sample, respectively. Moreover, we add as study N° 10, the values obtained in the present paper for the banking industry in Argentina. On purpose, initially we leave the binary code about competition as a query. In order to verify the relationship introduced in the preceding paragraph, Button and Weyman-Jones calculated the correlation between the efficiency measures and the competitive pressure code. The results are shown in the Table 4, under the title "Correlation 9 studies". They conclude that the signs of the correlation coefficients are logical according to the efficiency theory, because on average, those industries with lower competitive pressure show a lower mean and minimum efficiency and a higher standard deviation, compared with those industries with higher competitive pressure.

Table 3. Efficiency indicators

Study	*Efficiency*			*Competitive Pressure*
	Mean	*Minimum*	*Deviation*	
1	0,65	0,18	0,18	0
2	0,79	-	-	0
3	0,7	0,6	0,05	0
4	0,896	0,628	0,08	0
5	0,771	0,408	0,13	0
6	0,71	0,329	0,18	1
7	0,906	0,618	0,144	1
8	0,609	0,175	0,149	1
9	0,973	0,84	0,046	0
10	0,827	0,69	0,108	¿?

Note: Study N° 10 elaborated by the author with sample data

Source: Studies 1 to 9 collected by Button y Weyman-Jones (1992)

The negative correlation for the mean efficiency, for example, indicates that when the competitive pressure code gets its highest value (1 = low competitive pressure), the mean efficiency is lower. In order to test if the Argentine banking industry shows results according to a high level of competition, we could try completing with 0 the binary code. If this were true, the correlations recalculated - including the study N° 10 - should keep the same sign, and the absolute values should increase. This is what happens with the mean and minimum efficiency, but not for the standard deviation, which keeps that same absolute value. The results are shown in the Table 4 under the title "Correlation 10 studies". Our broad conclusion is that, considering the mean and minimum efficiency, there is some suggestion that the Argentine financial system exhibit some reasonable level of competitive pressure. However, this result could not be verified using the standard deviation measure.

Table 4. Correlations between competitive pressure and efficiency

Efficiency Indicator	*Correlation 9 studies*	*Correlation 10 studies*
Mean	-0,22	-0,24
Deviation	0,57	0,57
Minimum	-0,34	-0,39

Source: Studies collected by Button and Weyman-Jones (1992) and own elaboration with sample data

6. CONCLUSIONS

The goal of this paper is to estimate the productive efficiency of Argentine banks. For this purpose, panel data of the universe of banks under the supervision of the Central Bank of the Republic of Argentina (BCRA) has been collected. In order to build the bank´s indicators, we used a database of 66 institutions, with annual information for the period 2009-2013. The sources of information were both the BCRA´s web site (www.bcra.gov.ar), and the Buenos Aires Stock Exchange´s web site (www.bolsar.com). It has been selected an efficiency indicator ranging between 0 and 1, meaning the lowest and highest level of efficiency, respectively. The concept of efficiency used here is a relative one, because it considers a Bank´s performance in relation to the behavior of the best players in the industry, being the latter the base of the industry benchmark or frontier. The results show that the mean efficiency of Argentine banks is 0,8277 in the specific period under consideration. The comparison with the results of other studies relating efficiency and competitive pressure, didn´t allow us to infer that the Argentine banking industry experienced in the period a high level of competition.

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