The Failure of Risk Management for Non-Financial Companies in the Context of the Financial Crisis: Lessons from Aracruz Celulose and Hedging with Derivatives.

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Abstract

The main contribution of the paper is to present hard evidence on risk exposure, hedging strategies, and agency problems resulting in speculation with derivatives, by focusing on the case of Aracruz Celulose. It highlights the failure of risk management systems in non-financial firms in the face of extreme events like the financial crisis of 2008. The company posted financial losses of U$2.1 billion due to currency derivatives trading in the third quarter of 2008. We show how the company's real hedge position deviated from its optimal hedge as a result of the speculation with OTC derivatives, permitted by weak governance structures that failed in preventing hubris and mistakes in risk management.

Keywords: hedging; fx exposure; derivatives; foreign-currency; risk exposure, agency theory.

Introduction

The financial crisis brought billions of losses due to derivatives trading as part of hedging strategies for non-financial companies in many countries (Dodd (2009) suggests that losses totaled around U$500 billion for non-financial companies during the 2008-2009 period). This paper aims to shed light on this topic by focusing on the hedging policy of a Brazilian company that lost over U$2 billion due to exchange rate movements resulting from the financial crisis of 2008. In particular, we show how the company deviated from the optimal hedge early in 2008 by the use of "innovative" derivatives. We contribute to the literature in two ways: fist by describing in detail, with an unusually rich dataset, the hedging policies of Aracruz; and then by presenting an empirical analysis of the case, relating the downfall of the company with the indirect effects of the financial crisis. We build on previous case studies such as Brown (2001) to show how companies can indeed speculate on derivatives, even if inadvertently, and we try to provide an explanation for a class of non-financial companies that suffered heavy financial losses following direct and indirect events from the financial crisis.

Most studies on this topic can be divided in two types: what managers did right that should be emulated and what they did wrong that should not be repeated. One relevant case in the hedging literature is the collapse of Metallgesellschaft (MG). This seminal case falls on the "should not be repeated" kind and provides many insights into risk analysis involving hedging strategies that use derivatives. Although many papers have analyzed this case (see, e.g., Culp and Miller (1995); Edwards and Canter (1995); Krapels (2001)) doubts still remain on the validity of the company's strategy, with some authors claiming the company's strategy was sound, while others defend the view that it

inappropriately increased the overall risk of the company. In any case, the literature on the MG case alone provides enough lessons to prevent managers from undertaking strategies that would increase the overall risk of companies through hedging with derivatives. In the present case, Aracruz Celulose posted losses of U$2.13 billion in derivatives in the last quarter of 2008. These losses were 3.7 times greater than the EBIT in 2007 and represented 30% of Aracruz's market capitalization if we consider the value of the company in the end of the second quarter of 2008. The company's collapse was marked by a stock plunge of more than 90% in 3 months, and only ended when Aracruz was acquired by another cellulose producer in 2009.

We try to verify if the strategy developed by Aracruz was sound and derive the effects of the financial crisis on the company's position. We try to explain Aracruz's financial strategy to understand if hidden risks were the real culprit in the collapse of the company or if managers led the company to a situation of such increased leverage that its downfall was inevitable. We appeal to Bodnar and Marston (2001) model of foreign exchange risk exposure. The main idea is to derive the optimal hedge of the company during the 1999-2008 period, and compare the optimal hedge with the effective one that was used to hedge the company's exchange rate risk, using agency theory to provide a rationale for the departure of the optimal to the realized hedge. We also try to explain why the company suffered heavy losses due to rapid exchange rate movements following the turmoil in financial markets in August and September of 2008.

The first section presents a brief literature review to contextualize the Aracruz case in the empirical foreign-exchange hedging literature. The second section introduces the stylized facts surrounding the case, placing the company's downfall in the context of the

ambient financial crisis as well as similar cases from around the world. The third section deals with the formal models and presents results for the optimal and effective hedging of Aracruz for the period 1999-2008. Finally, the fourth section summarizes the case and offers comments on implications for future research.

1. Hedging Exchange-Rate Risk with Derivatives

The theoretical literature on hedging exchange-rate risk for firms that face currency exposure is well established, with the main result being that using the optimal hedging ratio for financial hedging strategies increases firm value. Even when simple hedging of the expected output may not be the optimal risk management strategy (Brown and Toft 2002), some level of hedging does enhance value through exchange-rate risk minimization.

In the case of empirical research, we find a wide range of results. Thus, Geczy, Minton and Schrand (1997) present a seminal discussion on the main reasons for firms with exchange-rate exposure to use derivatives for hedging currency risk. They divide the incentives for hedging into three: capital market imperfections; the exposure to foreign exchange-rate risk; and the costs of implementing a derivatives strategy. Allayannis and Ofek (2001) measure the incentive to hedge in firms with currency exposure in the US. They conclude (p. 273) that the use of foreign currency derivatives is positively associated with companies' market value and that, on average, firms that face currency risk and use currency derivatives have a 4.87% higher value than firms that do not use currency derivatives. Fok, Carroll and Chiou (1997) find that hedging reduces financial

distress for US companies. However, Judge (2006) shows that in the UK hedging actually increases the potential financial distress of companies that employ such strategies. Another alternative result is that of Guay and Kothari (2003), which find that financial derivatives are not an economically important component of corporate risk management, while Aabo (2006) demonstrates that foreign debt is a sensible alternative to currency derivatives in managing exchange rate exposure to risk.

Table 1 below summarizes other significant empirical results regarding the using of foreign-currency derivatives by firms exposed to exchange-rate risks.

PLEASE INSERT TABLE 1 HERE.

The main idea here is to complement these studies by focusing on a single company with specific needs in hedging exchange-rate risk. Two particularly important outcomes from Table 1 include: Bartram (2008), who suggests "that managers of nonfinancial firms with operations exposed to foreign exchange rate risk take savvy actions to reduce exposure to a level too low to allow its detection empirically" (p.1508); and Adam and Fernando (2006), who argue that cash flow gains from derivatives trading increase shareholder value. We try to show what happens when managers are not as savvy as in Bartram (2008) and that cash flow gains from derivative trading may give incentives for excessive financial exposure to derivatives.

2. The case of Aracruz Celulose.

2.1 Stylized Facts.

Many companies in emerging and developed markets lost billions of dollars in derivatives in the wake of the financial crisis. Although precise numbers are difficult to come by due to disclosure issues, Dodd (2009) estimates that for 12 countries that include Poland and economies of Asia and Latin America the financial crisis affected possibly 50,000 firms, with derivatives losses totaling roughly $530 billion. Kamil, Sutton and Walker (2009) present a small subsample of companies in Mexico (6 companies) with total losses of U$4.7 billion (with an average loss of 23% of total assets) and 3 companies in Brazil with total losses of U$5.5 billion - and an average loss of 46% of total assets. Table 2 below shows some examples from losses in developed and developing countries. It is important to notice that these examples are far from exhaustive, because most non-listed companies did not disclose their losses and, in some cases, as in India, the government is still trying to make listed companies disclose their losses.

PLEASE INSERT TABLE 2 HERE

The case of Aracruz is similar to other companies - it first announced in September of 2008 that it had heavy losses due to currency derivatives and, in October 3rd, announced total losses of U$1.95 billion, later amended to U$2.1 billion. In the

meantime, the stock plunged from an average of R$12 throughout 2008 to less than R$1.5 later in October. In November 2008 Brazilian stockholders sued Aracruz's former CFO, while some American stockholders (the company is traded in the US market through American Depositary Receipts – ADRs) joined in a class action against the Board.

In 2008, Aracruz Celulose was the biggest world producer of bleached eucalyptus pulp, with 26% of the world market, market capitalization of U$7.1 billion (July 8th, 2008) and net revenue of U$1.42 billion. Aracruz was a single product manufacturer, with steady growth in terms of revenue, output capacity and profits throughout the 1999-2007 period. It also had a 'BBB' flat rating by Moody's, S&P and Fitch, possessing investment grade since November of 2005. It was self-sufficient in wood with a total of 593,000 hectares, self-sufficient in electricity, and had a private port terminal which shipped 85% of its total output. It also had three production sites with an annual capacity of 3.3 million tons (ARACRUZ, 2008). It was also the only company in the celluloses sector to be part of the Dow Jones Sustainability Index. More than 95% of the company's revenue came from exports. Table 3 presents the main competitors of Aracruz in the world market.

PLEASE INSERT TABLE 3 HERE.

The company was also more profitable than its peers, as Table 4 shows.

PLEASE INSERT TABLE 4 HERE.

Other than delivering a historical average of 50% EBITDA margin, stylized facts on Aracruz were: first Brazilian company listed at NYSE (1992) under level III in the American Depository Receipt Program; first Brazilian company to publish its audited financial statements in English each quarter; its financial policy was approved by the Board and accessible on the company's website; and it won the Instituto Brasileiro de Governanca Corporativa (Brazilian Institute of Corporate Governance) award in the innovation category (ARACRUZ, 2008). By all measures Aracruz was regarded as a solid company with good growth prospects and sizable market power .

3. Optimal and Effective Hedge for Aracruz.

3.1. The Model

Here we use Bodnar and Marston (2001) to derive Aracruz's optimal hedge ratio during the 1999-2008 period. The model has the main advantages of being simple and easy to apply to financial data, and a sensitive analysis shows that the result is robust in the face of changes in the parameters.

The main hypotheses of the model are:

- The value of a firm can be expressed in terms of a stream of present and future cash flows;
- Net investment of the firm is equal to zero;
- Cash flows are expected to be constant from year to year.

From these simple assumptions, Bodnar and Marston (2001) derive the foreign exchange exposure as proportional to the derivative of current profits with respect to the exchange rate. The general result is (for its derivation, see the original paper):

$$\delta = h_1 + (h_1 - h_2)\left(\frac{1}{r} - 1\right) \qquad (1)$$

in which the general exposure of the firm (δ) is a function of:

h_1 = foreign currency-denominated revenue as a percent of total revenue;

h_2 = foreign currency-denominated costs as a percent of total costs;

r = profits as a percent of total revenues.

The model is flexible enough to allow for three cases, a pure exporter, a pure importer, and a multinational firm which sells both domestically and abroad.

Translating (1) to real data is easy to do: because the idea is to relate the ideal hedge to variations in the EBIT, the optimal hedge (*h*) that completely eliminates the exchange rate risk:

$$h = EBIT * (-\delta) \qquad (2)$$

This in variation terms is equal to:

$$\Delta h = EBIT * (-\delta) * \Delta e \qquad (3)$$

In which Δe is the variation in the exchange rate, measured in percentage points. The model does not cover quantity risk, in which the quantity of foreign currency exposure is

uncertain due to the fact that the firm sells its product abroad, but it does not know how much it will sell or even at what price. So the model has some serious limitations: there is no competition or uncertainty, which leads to very stylized assessments of risk exposure. As a result, it does not have a great prediction capability, losing its value as a reference to companies planning their hedges. However, we can surpass these drawbacks by using this model not as a predictor, but an *ex-post* check if the effective hedge was successful or not. Following this rationale we use the ex-post EBIT as the main measure for the determination of the hedge ratio. We are concerned not with the company's best strategy, but with a rational hedging choice by the company's managers. If we can show, by using a sensitive analysis and verifying whether the type of hedge was appropriate, that the strategy used by the company was not adequate, it is not necessary to extend the model to a more comprehensive one.

The possible differences found between the effective and the optimal hedge could be a result of revenue uncertainty. However, a sensitive analysis can show us how much of the deviation is attributable to this uncertainty.

3.2 Optimal Hedge

The necessary data for measuring the optimal hedge *h* in (2) are: foreign currency revenue in relation to total revenue – h_1; foreign currency costs in relation to total costs – h_2; profits in relation to total revenues (here *EBIT/Total Revenues*) - *r*. Both h_1 and *r* are directly derived from financial reports, but there is no reported data on h_2. Information on h_2 comes from Investor Relations at the company, and was corroborated

by interviews with hedge fund managers at a major Brazilian investment bank who regularly track the company. The common view is that h_2 is close to 25% in the period analyzed. We use this number and a sensitivity analysis shows that for even large changes in h_2 results remain unchanged. For the period 1999-2008, data are presented in Table 5 (in absolute values), and the optimal hedge (in US$mil) is the multiplication of $-\delta$ and the EBIT (in US$ mil).

PLEASE INSERT TABLE 5 HERE.

Table 5 shows an increasing pattern in the optimal hedge position of Aracruz, with a particular jump to a δ *of* 5.15 in 2008. All changes in δ are due primarily to changes in *r,* because h_1 is stable throughout the period (and, of course, h_2 is fixed by assumption). Since EBIT and revenue increase significantly in the period 1999-2008, the optimal hedge position, in U$ terms, significantly increases, from less than U$0.5 billion in 1999 to U$1,8 billion in 2008. This alone should have provided managers with strong incentives to procure more hedging for Aracruz. Below we show how the company reacted to the increasing need for hedging.

3.3. Effective Hedge

The real hedging position of Aracruz is composed of three components: liabilities in foreign currency; net assets in foreign currency; and the position in derivatives (the

amount effectively being hedged instead of a simple marking to market). Here we assume, following Aabo (2006), that foreign debt is an alternative to the use of currency derivatives. Aracruz assumes a short position in derivatives to hedge against a fall in the local currency, and the real short position of the company is then the sum of short-term liabilities in foreign currency plus the derivatives net position (notional values) minus net assets in foreign currency. The real hedging position for the company (h^*) is therefore:

$$h^* = Liabilities + Derivatives - Assets \qquad (4)$$

For the purpose of determining h^* data came from the financial reports of the company during the 1999-2008 period, with the value of the foreign currency used being the value of the Dollar against the Brazilian currency, Real, on the last day of each period.

The company used six different kinds of derivatives during the 1999-2008 period to hedge its position, two were standardized contracts and the others OTC derivatives. The two standardized derivatives were: standard future contracts at the Brazilian Mercantile Exchange (Bolsa de Mercadorias e Futuros - BM&F) - in use in 2002 and during 2005 to 2007 and Currency cupons, 2002 and 2003; and.

The four OTC derivatives were non deliverable forwards (NDF), 1999 to 2002, conventional swaps, in 1999, 2007 and 2008, an exotic swap with monthly settlements and a structured derivative called sell target forward, which we credit with the company's downfall. Both were used in 2008, and the sell target forward doesn't show in end of the year data because it did not exist before 2008 and all the positions regarding this derivative were settled before the end of the year.

The sell target forward is a structured derivative composed of the combination of a short position in a NDF coupled with a short position in exchange-rate options. The premium received from these options enables the company to obtain better FX rates than the market. The contract is valid for a year with monthly settlements that bring the value of the whole contract to the present. This is important because that is the source of the major financial hurdle implicit in the contract. Dealing with this derivative, for Aracruz, is the equivalent of selling twelve calls with sucessive montlhy strike dates, and also twelve NDFs. Because the contract constitutes a combination of calls and NDFs, there is no limit to how much the company can lose, but there is a limit for the losses of the counterparty.

An illustration should enlighten the potential losses of this derivative for the company. Suppose that the actual exchange rate is R$1,60 per dollar, the strike price is R$1,65 per US$1, the notional value is U$15 million, and that at the end of the first month the exchange rate jumps to R$2 per dollar (granted, a big jump in the exchange-rate, but this is smaller than the one that happened in the financial crisis). The total losses for the company is determined by:

$$l = n2t(X - S) \qquad (5),$$

And the percentage loss in US$ (Δp) in n due to changes in S is:

$$\Delta p = \frac{2t(X - S) * 100}{S} \qquad (6),$$

In which l is the amount of losses, n is the notional value of the contract, X is the strike exchange-rate, S the actual exchange-rate, and t the number of months left in the

contract. For the illustrative example, *I* =15*[2*12*(1,65-2)] = –R$126 million or –U$63 million at the new exchange-rate. There is no maximum loss for the contract, but a local currency devaluation of 50% exposes the company to a potential loss of 8 times the notional value of the contract[1]. The risk trade-off was clearly deleterious for the company as the financial risk of this product was much bigger than the risk from operations that the company was trying to hedge.

Table 6 shows the short positions in derivatives and the pattern of hedging for the company in the 1999-2007 period, using the notional values of the derivatives.

PLEASE INSERT TABLE 6 HERE

Table 6 shows that before 2008 the company incurred, in hedged positions, at most U$1.4 billion, in line with values of the optimal hedge (*h*). However, in 2008 the total spikes to U$6.3 billion, and that is for the end of year data, after the company realized losses in derivatives trading that impacted the liabilities, as can be seen in figure 1:

PLEASE INSERT FIGURE 1 HERE

[1] The result of the following equation is 800% : $\Delta p = \frac{2*12*(X-1.5X)*100}{1.5X}$

Figure 1 shows that the company started to pursue hedging strategies more vigorously in 2003 by incurring growing liabilities in foreign currency. After 2005 there is a growing trend in the use of derivatives. We can see that for 2008 the financial burden of Sell Target Forwards is distributed through a large increase in liabilities, as well as short positions in derivatives. Comparing the annual optimal hedge (*h*) with the annual realized hedge (*h**) yields:

PLEASE INSERT FIGURE 2 HERE.

Figure 2 shows how the company followed a hedge strategy that is broadly consistent with the *ex-post* optimal hedge until 2005. In 2006 and 2007 the company actually hedged less than the optimal hedge, either by underestimating the EBIT or by a simple measurement error. In 2008, however, the real hedge position increases to U$6,3 billion, out of line with *h*. This increase, however, does not reflect the highest exposition of the company in 2008. Because of the crisis the company disclosed information regarding quarterly exposition to derivatives. Table 7 provides quarterly exposures for the company, by applying (4) to quarterly data and using notional values for derivatives, in which positive values means short position:

PLEASE INSERT TABLE 7 HERE

Table 7 shows the poor timing of the company in using OTC derivatives to hedge its position, with h^* jumping from approximately U$1 billion to U$7 billion in the second trimester of 2008. Aracruz exposure grew considerably in the months preceding the crisis, and spiked just before the crisis hit. The result, predictably, was a massive restructuring of the company's hedging position, the sell-off of its sell target forward position, and the doubling of its liabilities in foreign-currency. In the beginning of 2009 the company was still exposed to exchange-rate risk due to the trading of sell target forwards for more maturing swaps. The financial burden, however, resulted in the company being acquired by its smaller competitor, Votorantim Papel e Celulose (VCP), by approximately U$3 billion in early 2009. The resulting company changed its name to Fibria and is traded in the New York Exchange.

3.4 The Impact of the Financial Crisis.

One pressing question is how to relate the events that led to Aracruz's downfall with the financial crisis that began in 2007 but picked up steam in 2008. A major lesson from the crisis is that systemic risk was seriously underestimated throughout the entire financial system. However, less explored is the link between the crisis and non-financial companies. We argue that even if works like Bartram (2008) are generally right - that managers do make savvy decisions regarding hedging strategies - there is still an underestimation of the number of companies pursuing badly designed hedging strategies, either by intent or by mistake. The main reason such strategies do not cause

more financial havoc for non-financial companies is that for the effect to be large enough there are two necessary conditions: the underlying risk has to be sufficiently large and/or misunderstood; and the market should move swiftly enough so that managers cannot react in time. Most badly designed risk strategies can be mitigated, but the original feature of the financial crisis was to constrain reaction by managers on their hedging positions.

In the present case, the catalyst for losses, as previously observed, was the rapid depreciation of the Real, jumpstarted by the contagion of the crisis to the Brazilian financial markets. The chronology of the depreciation follows precisely the turmoil in the world financial markets. The company first publicly announced its losses on October 3rd, 2008, stating that it was trying to close its position in derivatives. Below, in figure 3, we present the daily exchange rate from the preceding 26 business days before the announcement with the changes in the American S&P Index. The cumulative depreciation is 23%, or 0.85% daily, while the S&P Index lost more than 18% in the same period.

PLEASE INSERT FIGURE 3 HERE.

The trend before the crisis was of a continuous currency appreciation, and this rapid reversion resulted in the huge losses experienced by Aracruz. No other macroeconomic shock could have conceivably made the Brazilian currency depreciate 23% in a month,

especially in a scenario in which the country was the recipient of copious amounts of foreign capital. Since early 2010 the appreciation process has returned, with the Real returning to its pre-level crisis in mid-2011. The financial crisis unveiled many badly designed strategies in financial and non-financial companies, either directly or indirectly. In the present context the linkage between the crisis and Aracruz's downfall is indirect, but we argue that other than an extreme event like the financial crisis the company could have survived. If there was only a simple mistake in computing risks, any market movement that would make the company incur in losses would not result in such hefty losses as the company experienced in 2008.

3.5. Agency Theory and Aracruz

There is no simple explanation for why the company hedged its position as it did in the months preceding the financial crisis. Explanations in the Brazilian media at the time included incompetence, bad faith, greed, and bad luck. Of course, "bad faith" and "bad luck" are hardly explanations at all. But, if we appeal to finance theory, we can reframe the explanation using the data above in terms of agency theory.

There is a clear agency problem in the hedging of Aracruz, and that is due to the financial gains for the company during the period. It was common knowledge to market players that in the period preceding the financial crisis of 2008 the Brazilian currency was in a process of appreciation due to significant influxes of external capital through financial and commercial channels. Specifically, carry-trade caused an influx of external capital of over U$70 billion in 2007 and was on pace to increase by 50% in 2008,

totaling over U$100 billion in new short-term capital before the crisis hit. Agents expected that the Brazilian currency would continue to rise against the dollar, continuing the process that begun in 2003. Figure 3 shows the US/R exchange rate during the 2003-2007 period, showing patterns in the expectation of exchange-rate movements for 1-month, 6-months, and 12-months horizons, plus the effective exchange rate.

PLEASE INSERT FIGURE 4 HERE.

The main pattern in the figure is that both expectations and effective exchange-rate presents an almost constant decline throughout the period of 2003-2008, followed by sharp depreciation when the crisis hit. Expectations regarding exchange-rate movements may have played an important role in the decision to over-hedge.

As noted by Gay, Nam and Turac (2003), when a firm faces a relevant quantity risk, the optimal hedge should be nonlinear and a function of the correlation between the exchange rate and the quantity risk. When price and quantity risk are negatively correlated, Brown and Toft (2002) shows that a long position in put options is often superior to selling forward contracts. They also concluded that firms with positive correlation typically benefit from selling options.

This correlation was clearly negative for Aracruz during the financial crisis, when sales declined at the same time that the exchange rate increased. As a result, the optimal hedge for Aracruz would be a long position in a put option. Instead, management

decided to hold a short position in a call option, by acquiring sell-target forwards contracts. A sensitive analysis also corroborates the conclusion that the company was speculating with derivatives (we omit the results for brevity). Even supposing that in 2008 Aracruz's revenue and EBIT followed the trend observed from 1999 to 2007, the effective hedge would be three times the optimal hedge. Coupled with the speculative strategy there was probably an error involved in computing the true risks of sell-target forwards.

In any case, the error in the strategy cost the company dearly, showcasing yet again that, as in the case of Metallgesellschaft, proper risk computing is essential to any kind of hedging. Allayannis and Ofek (2001) show that companies generally do not speculate with currency derivatives, but maybe *hubris* could explain the excessive risk-taking by the management of Aracruz. Li and Tang (2010) summarizes the literature on *hubris* and excessive risk-taking by presenting three reasons for it: overestimation of management problem-solving capabilities; overestimation of the firm's resource endowments; and underestimation of the uncertainties the firm is facing.

The data on the present case make a strong argument for at least an underestimation of the uncertainties that Aracruz was facing, and, thus, demonstrates that *hubris* have played an important role in excessive risk taking behavior by Aracruz's managers.

Regarding agency theory, we can focus our analysis in two potential sources of agency problems: corporate governance and remuneration schemes.

In spite of being regarded as a solid company, the corporate governance structure related to risk management was inappropriate. As we can see in the financial

statements in the end of 2007, the treasury department of Aracruz was responsible for proposing and executing the risk management strategy. This department was subordinated to the Chief Financial Officer and was also responsible for evaluating the effectiveness of any risk management strategy. This structure allowed too much discretion for the CFO and could not prevent a hedging strategy from hubris and mistakes in calculating the risks of sell target forwards.

In order to amend these failures in corporate governance, after the fact Aracruz decided to rearrange its governance structure. In the end of 2008, the company created a new control and risk management area, which was independent of the existing financial area and would monitor financial and operational risks. Managers also approved in 2009 an investment and financial risk policy, which made a lot of constraints to hedging strategies, such as prohibiting leverage and structured financial transactions with built-in derivatives.

Regarding the remuneration scheme, following the distinction by Eisenhardt (1989) between behavior-oriented (e.g., salaries and hierarchical governance) or outcome-oriented (e.g., commissions and stock options) we can see that in the case of Aracruz the remuneration scheme followed the latter, as managers' compensation was based on the performance of share prices during three years. In terms of a general remuneration scheme, correct incentives were given to the executives, with a focus that was not only short-term based.

There are many implications from this case to future risk management issues in non-financial firms. That companies are still dabbling in excessive risk through derivatives is

no surprise in itself, but the broadness of losses is staggering and future managers need to put in place governance structures that do not allow for excessive risk-taking.

4. Final Comments.

The idea that companies are efficient in using currency derivatives finds ample evidence in the literature. The main goal of this paper was to provide hard evidence on mismanagement of risk strategies that were only revealed by turmoil in financial markets due to the financial crisis. We go beyond just showing how Aracruz speculated with derivatives in 2008, contrasting with a good track performance in achieving the optimal hedge since 1999. We use the model developed by Bodnar and Marston (2001) to show that the company's real hedge position deviated from its optimal ratio and agency theory to explain why it happened.

The speculation with call options happened because of the weak governance structures related to risk management that failed in preventing hubris and mistakes in computing the financial risk of OTC derivatives.

This case is important because it is hard to find explicit evidence of agency problems resulting in speculation with derivatives, and in the present case this is coupled with significant financial losses from unexpected exchange rates movements following the financial crisis of 2008.

Future lines of research should explore this and other cases of mismanagement of hedging with derivatives to provide more information on how firms really operate their

hedging positions. An important question concerns the sources of derivatives losses for companies around the world. Was overhedging also a problem for other companies? Also, cross-section analyses of companies which posted losses in derivatives could identify which governance mechanisms were ineffective in preventing excessive risk exposures.

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Tables

Table 1 – Empirical results in the usage of Foreign-Currency Derivatives.

	Sample	Period	Some Results
Carter, Pantzalis and Simkins (2003)	620 U.S. Mining and manufacturing firms	1996	Among the results, authors show that financial and operational hedge can reduce foreign exchange exposure even if companies are asymmetrically exposed to states of weak and strong dollar.
Adam and Fernando (2006)	92 US gold firms	1989-1999	Cash flow gains from derivatives transactions have increased shareholder value
Bali, Hume and Martell (2007)	1190 firms; simultaneous consideration to currency (FX), interest rate (IR), and commodity (CM) derivatives.	2001-2005	Hedging with derivatives is only significantly related to commodity risk exposure during most years of the study, and to a more limited degree to interest rate exposure. The implications are that hedging with derivatives is not always important to a firm's rate of return and is linked to other nonfinancial and economic factors.
Bartram (2008)	Case study of a multinational firm.	1996-1999	The analysis illustrates that the insignificance of foreign exchange rate exposures of comprehensive performance measures such as total cash flow can be explained by hedging at the firm level. The results of the paper suggest that managers of nonfinancial firms with operations exposed to foreign exchange rate risk take savvy actions to reduce exposure to a level too low to allow its detection empirically.
Clark and Judge (2008)	366 UK Firms with FC exposure	1995	Authors show that leverage variables are significantly related to the FC hedging decision for firms that use FC debt either in isolation or in combination with FC derivatives but not for firms that only use FC derivatives.
Clark and Judge (2009)	412 UK Firms	1995	There is no hedging premium associated with foreign currency debt hedging, except when combined with foreign currency derivatives. Taken individually, FC swaps generate more value than short-term derivatives.
Schiozer and Saito (2009)	Nonfinancial Firms with ADRs from Argentina, Brazil, Chile, and Mexico	2001-2004	Authors' evidence indicates that derivatives held for hedging purposes can yield cash flows of the same order of magnitude of capital expenditures, operational earnings, and financial expense, unlike what was previously found by Guay and Kothari (2003) for U.S. firms.
Ben Khediri and Folus (2010)	French firms	?	Authors find, from the univariate analysis, that the derivative users have lower firm value (as proxied by Tobin's *Q*) than the nonusers.
Fabling and Grimes (2010)	Circa 10.000 New Zealand Firms	1997-2007	Authors find that hedging ratios for exporters' Australian dollar exposures vary systematically as the exchange rate departs from historical averages; this behaviour is more marked for larger relative to smaller exporters.
Hutson and Stevenson (2010)	3788 firms from 23 developed countries	1984-2003	Authors show that the more open the economy, the more exposed are its firms to exchange rate movements. They also find a strong inverse relation between a firm's exchange exposure and the extent of creditor protection in the country in which it is based. This is consistent with managers acting to reduce the likelihood of financial distress in countries where bankruptcy costs are high, and it underlines the importance of institutional incentives in encouraging value-enhancing risk management activities.

Table 2 – Losses with FX or Exotic Derivatives – Non-Financial Firms – US$ million - 2008

Country	US$ million	Country	US$ million
Mexico		**Korea**	
Comerci	2,200	Win4Net	3660
Cemex	911	GM Daewoo	1100
Gruma	852	Hwankwang	2100
Vitro	358	**China**	
Alfa	194	China Cosco	577
GISSA	161	Air China	450
Brazil		**Japan**	
Sadia	2400	Saizeriya	170
Aracruz Celulose	2100	Ariake	93
Grupo Votorantim	1000	**Australia**	
Hong Kong		APN Property	116
Citic Pacific	2400	Westfield	1300

Sources: IMF (2009); Dodd (2009); Reuters; Various websites.

Table 3 – Main Celluloses Pulp Producers by Output Capacity and Country of Origin - 2009

Company	Country of Origin	Capacity (tons/year)
Aracruz	Brazil	3,310,000
APRIL	Indonesia	2,280,000
VCP	Brazil	1,825,000
Suzano	Brazil	1,765,000
ENCE	Spain	1,380,000
APP	Indonesia	1,350,000
Cenibra	Brazil	1,200,000
CMPC	Chile	1,160,000
Botnia	Finland / Uruguay	1,100,000
Arauco	Chile	790,000

Source: Hawkings Wright (2009)

Table 4 –Aracruz EBITDA Margin.

EBITDA Margin 1997-2007(%)	Minimum	Average	Maximum
Aracruz	40.3	50.1	56.4
International Peers	12.2	16.0	19.2

Source: ARACRUZ (2008)

Table 5 – Optimal Hedge for Aracruz in the 1999-2008 period.

Year	Profits (r)	Revenue (h1)	Costs (h2)	Optimal hedge (δ)	EBIT (US$ '000)	Optimal Hedge (US$ '000)
1999	37.73%	94.64%	25.00%	2.10	225,462	472,539
2000	45.66%	94.84%	25.00%	1.78	340,517	605,933
2001	28.88%	96.12%	25.00%	2.71	177,413	481,165
2002	27.88%	97.61%	25.00%	2.85	172,289	491,733
2003	36.37%	96.14%	25.00%	2.21	422,542	932,130
2004	31.33%	95.00%	25.00%	2.48	456,401	1,133,804
2005	27.33%	95.95%	25.00%	2.85	441,924	1,257,604
2006	24.50%	95.97%	25.00%	3.15	502,452	1,581,256
2007	23.24%	93.61%	25.00%	3.20	570,978	1,828,438
2008	13.87%	92.92%	25.00%	5.15	245,415	1,263,054

Source: Financial Statements, elaborated by the author.

Table 6 – Effective Hedge done by Aracruz Celulose – 1999-2008 – US$ thousands.

Year	Futures	NDF	Currency Cupons	Swaps	Exotic Derivatives	Liabilities - Assets	*h**
1999	0	24,148	0	41,439	0	536,501	602,088
2000	0	2,864	0	0	0	298,185	301,049
2001	0	13,058	0	0	0	481,267	494,325
2002	128,500	30,000	15,849	0	0	436,243	610,592
2003	0	0	67,666	0	0	937,097	1,004,763
2004	3,000	0	0	0	0	992,006	995,006
2005	500,000	0	0	0	0	850,754	1,350,754
2006	289,000	0	0	0	0	637,458	926,458
2007	150,000	0	0	334,115	0	558,970	1,043,085
2008	0	0	0	215,000	3,600,000	2,513,626	6,328,626

Source: Financial Statements, elaborated by the author.

Table 7 – Effective Hedge done by Aracruz Celulose – 4Q07-4Q08 – US$ '000.

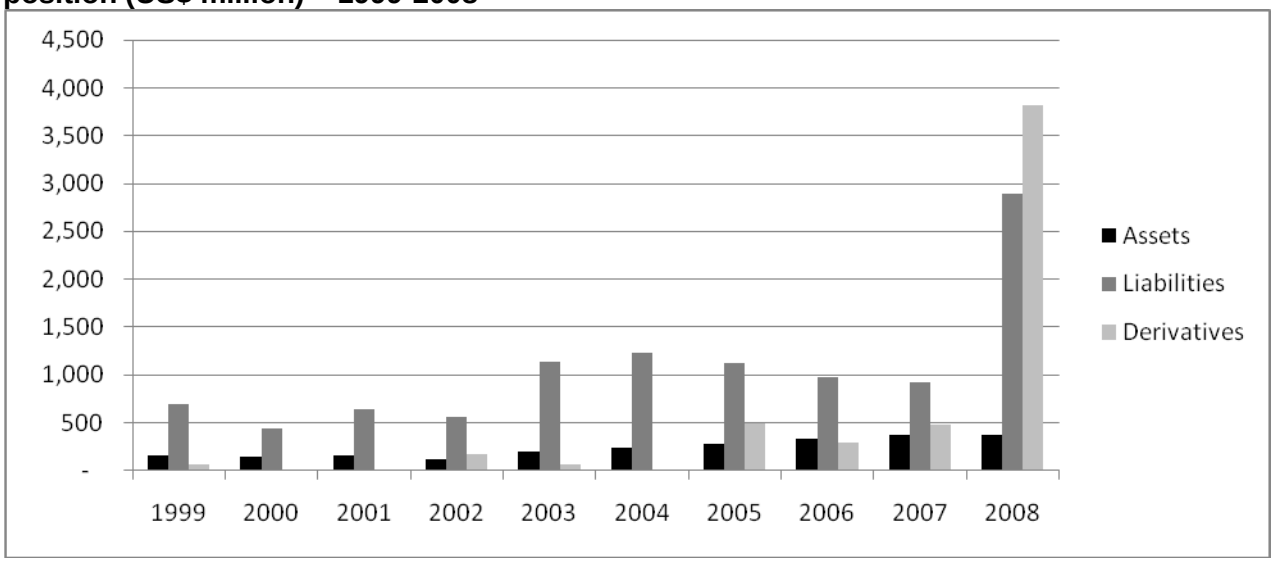
Quarter	Liabilities	Assets	Exc-traded Derivatives	Sell Target Forward	Exotic Swap	Other OTC derivatives	Real Hedge (*h**)
4/2007	929,131	370,160	150,000	0	0	334,115	1,043,085
1/2008	929,201	402,502	270,000	0	0	345,837	1,142,537
2/2008	1,109,795	451,442	0	5,280,000	600,000	559,480	7,097,833
3/2008	1,578,190	417,930	-538,000	8,640,000	2,400,000	305,059	11,967,320
4/2008	2,888,466	374,840	0	0	3,600,000	215,000	6,328,626

Source: Financial Statements, elaborated by the author. Real hedge given by

$$h^* = Liabilities + Derivatives - Assets$$

Figures

Figure 1 – Aracruz Foreign Currency Liabilities and Assets, and Derivatives Short position (US$ million) – 1999-2008



Source: Financial Statements, elaborated by the author.

Figure 2 – Aracruz Optimal and Real Hedge (US$ million) – 1999-2008

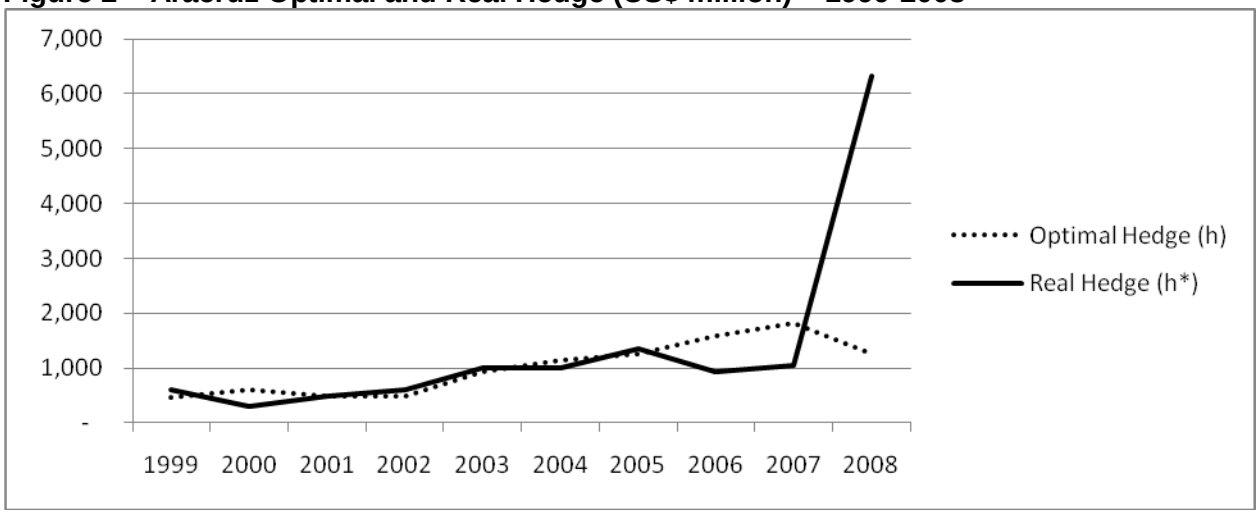
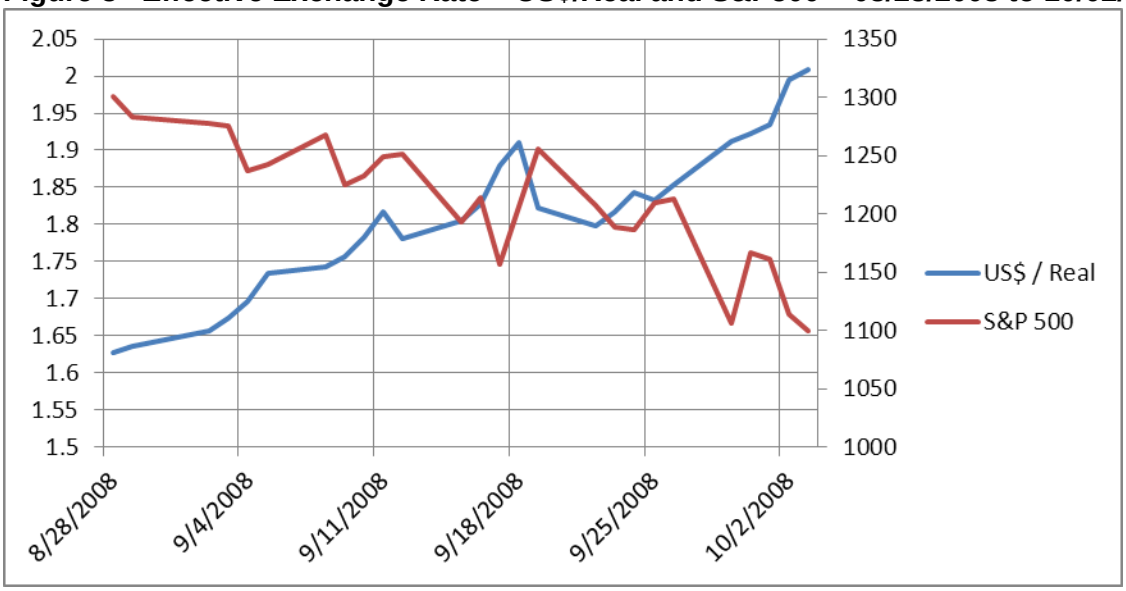


Figure 3 –Effective Exchange Rate – US$/Real and S&P500 – 08/28/2008 to 10/02/2008



Source: Brazilian Central Bank, 2010.

Figure 4 – Expectation (1,6,12 months) and Effective Exchange Rate – US$/R$ – 2003-2008

Source: Brazilian Central Bank, 2010.