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Default Recovery Values and Implied Default Probabilities Estimations: Evidence from the Argentinean Crisis

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Default Recovery Values and Implied Default Probabilities Estimations: Evidence from the Argentinean Crisis, December 2001.

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Abstract

This paper estimates both the default recovery values and the risk-neutral default probabilities embedded in the argentine sovereign bond prices during the crisis of December 2001. It is applied the model presented by J. Merrick Jr. (2001). On December 24th, a stand-in president announced the country's insolvency. It arises from the estimations that from October 19th to that time, the default recovery values descended from USD 40.9 for each USD 100 face value to USD 20.8 whereas the default probabilities registered an increase from 13.3% to 45.5%. Thus, both determinants become relevant in explaining the downward trend of the average bond prices, falling from USD 58.3 to USD 26.5. Comparing estimated and market recovery values it emerges that, bond market prices were overvalued by USD 4.7 on average, which amounts to 21.7%.Then, the estimations are compared with those generated by Merrick (2001) for Argentina and Russia during August 1998. Assuming an Argentinean debt haircut set it at 70% of the promised face value and an estimated average recovery value which amounts to USD 21.7, Argentina would have overcome its default paying a country risk premium of around 1960 basic points. This result after debt restructuring would fully justify a substantial haircut over the face value, the bond temporal term structures and interest rate coupons.

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JEL classification: G12, G15

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1 Introduction

Over the last thirty years, the theory of pricing credit risk has been put forward in order to measure corporate debt. Even if similar approaches should be applied for the calculation of sovereign risk, it becomes essential to point out the differences between risky corporate debt and risky sovereign debt as well as their consequences in valuing assets.[1]

For instance, emerging country sovereign bonds are issued in countries such as the United States of America and the United Kingdom, under completely different legal jurisdiction and capacity of enforcement if compared with corporate bonds. Emerging countries are more stable than corporations, they are fewer in number, they have longer-term economic planning, they do not default as frequently as corporations do and they do not typically disappear. Consequently, there is considerably less empirical evidence of default on sovereign debt than on corporate debt.

As regards the theoretical background, most of the models focus on default risk adopting static assumptions, treating default recovery rates either as a constant parameter or as a stochastic variable independent of the probability of default. The connection between default recovery rates and implied default rates has traditionally been disregarded by credit risk models. Accordingly, the problem faced by portfolio managers in Argentina in 2001 was how to settle default recovery rates and the implied default probability of their portfolios, only on the grounds of the bond market prices. Worded differently, if the bond market price is a function of two unknown determinants, how to calculate both of them simultaneously and consistently?

Thus, the approaches applied by the analysts were grounded on the analysis of domestic and foreign data generated by earlier international crises, such as those of Mexico (1995), Russia (1998) and Brazil (1999). Firstly, it consisted in the analysis of the time series in relation to indicators such as peaks, trends and the volatility of domestic and foreign sovereign bond market prices. Then, a deeply approach was based on a sensitivity analysis. It considers the bond market price (or spreads) in order to calculate the implied default probability for different possible recovery values. This method entails forming conjectures about the

[1] For a survey of the literature concerning this topic, see Altman Edward, Andrea Resti and Andrea Sironi (2004), Default Recovery Rate in Credit Risk Modeling: A Review of the Literature and Empirical Evidence. Economic Notes by Banca dei Monte dei Paschi di Siena. Volume 33.

value of recovery and the size of spread by resorting to evidence provided by earlier crises.[2]

The disadvantage of this approach is that its outcomes result from different bond temporal term structures; and hence from different bond durations when compared to those of the analysed bonds. Consequently, the information provided is misleading. Moreover, the approach does not include information concerning recently issued bonds nor the particular macroeconomic conditions of the country subject to analysis. Therefore, these methods neglect highly relevant information which is later incorporated ad-hoc into the analysis.

In order to avoid these disadvantages, we have applied a model, originally presented by J. Merrick Jr. (2001), to estimate both determinants embedded in Argentinean sovereign bond prices. Knowledge of both bond price determinants —the default recovery value and the implied default probability— enables the analyst to anticipate the value of their position in case of default and assume a long or short position according to the benchmark, among other strategic decisions. As a result, the motivation of this research was based on the ambition of contributing and testing another methodology in valuing sovereign bond portfolios under financial distress as well as to provide new evidence about recovery values and implied default probabilities.

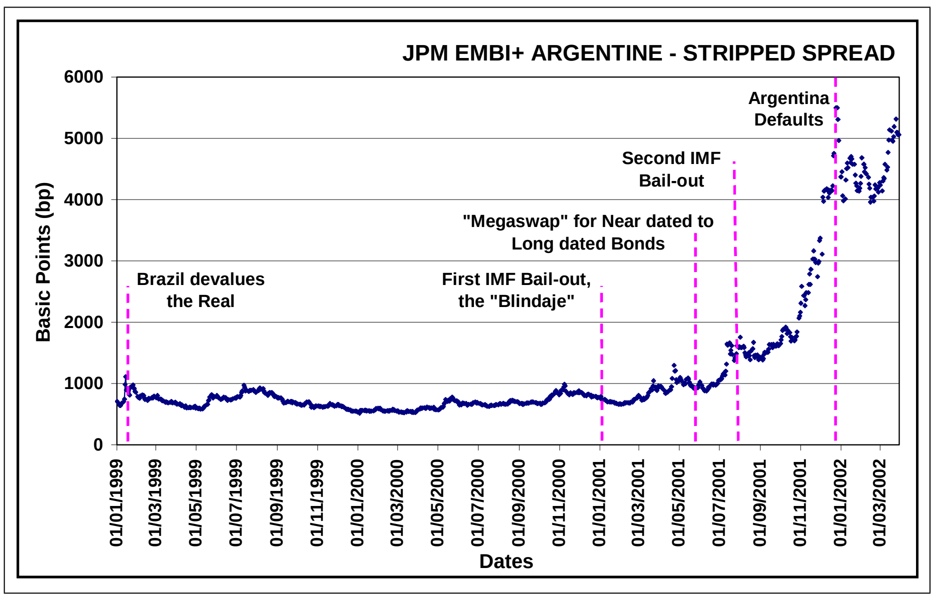
1.1 Events Preceding the Crisis: Brief Summary

Before presenting the model, it is worth looking at the most important events which caused the Argentinean crisis in December 2001. In August 1998, Russia defaulted on their public debt depriving Argentina of access to the international capital market. Five months later, Brazil devalued their currency causing Argentina's competitiveness in foreign markets to deteriorate. The economy sank into recession with twin deficits— a trade balance gap and a fiscal budget gap— which foreigners were less and less willing to finance. Argentinean economy needed to regain competitiveness and since the exchange rate could not be permitted to fall, prices and wages had to drop. In December 1999, after the general election, Mr. De la Rúa was elected to office but the new political structure was too weak to face the strong political change necessary to overcome the crisis.

[2] For an example of this approach, see Federico Sturzenegger (2000), "Defaults Episodes in 90's: Factbook, Tool-kit and Preliminary Lessons", prepared for the World Bank (page 14).

As a consequence, peso quotation edged downwards, tax revenues faltered and Argentina's debts in US dollars became harder to repay. In spite of this, Argentina refused to fold and kept raising the stakes. At the beginning of 2001, Argentina requested a USD 15 billion loan from the IMF, which was known as 'blindaje' or 'armour'. In order to buy some time, in June 2001, the country completed the notorious 'megaswap' in which near-dated securities were exchanged for longer-dated securities, higher-yielding bonds. In August 2001, Argentina received a second $8 billion bail-out. Finally, political turmoil and lack of further assistance from multilateral institutions drove Argentina into default in December 2001 (see Graph1).

Graph 1: Argentinean Sovereign-Debt Spread.
Relevant Pre-Default Events. Period: January 1999 –February 2002



This paper is divided in three sections. Section II describes the Model and the Data, Section III analyses the estimations and results and Section IV presents conclusions and a summary. Finally, the Appendix produces a detailed presentation of the estimated results and complementary macroeconomic data.

2 The Model

This section presents the pricing framework for N-period sovereign bonds, which is made up of four elements.

The first element is the bond structure, which is made up of the coupons and the principal, showing the amount of the coupon paid in period t as C_t and the amount of the principal paid on due date, in period N, as F_N.

The second component is the default recovery value which is represented with the letter R. In this analysis, R is the amount paid to the bondholder immediately after the default has been announced. It is also called recovery rate when it is expressed as a percentage of the principal. All the sovereign bonds considered in this paper have a promised principal of USD 100 face value. So, the estimation results it could be called indistinctly recovery rate or recovery value. If the fiscal authority defaults on the public debt, the following scheme takes place: the coupons are not longer paid, but the investors will receive a fixed fractional recovery of the promised principal immediately after defaulting.[3]

The third element is the adjusted risk-neutral payment probability distribution. As in Leland and Toft (1996) and Merrick (2001), the probability distribution used here is interpreted as the implied risk-neutral distribution. Henceforward, we are implicitly referring to *risk-neutral* probabilities. Now, it is defined P_t as the joint probability of no default between the moment when the bond is issued and the moment t. Moreover, denote the adjusted probability of default during the specific date $(t-1)$ to date t period as p_t. Thus, the risk-free adjusted default probability is indicated by means of p_t and is defined as: [4]

$$p_t = P_t - P_{t-1}$$

Before stating the joint probability of no default, P_t, we define the risk-neutral default probability rate, noted as δ_t. Previous researches, such as Fons (1987) and Bhanot (1998), consider a constant δ_t. Our proposal, as much as Merrick (2001), understands δ_t as an increasing linear function with respect to time, t, as it is shown in equation (1):

$$\delta_t = \alpha + \beta.\,[t] \tag{1}$$

The purpose of this function is to capture the default probability temporal term structure throughout time in a parsimonious way. This formalisation registers the fact that in a critical period, the probability

[3]The recovery value can also be defined as the expected present value of cash flows, which have been or are to be reprogrammed. For a detailed presentation, see: Recovery Rates: The Search of Meaning. High Yield. Merrill Lynch. March 2000.

[4]Alternatively, the probability of receiving a promised date t coupon payment,P_t , can be expressed as: $P_t = 1 - \sum_{s=1}^{t} p_s$.

of default is greater as the deadline of the coupons and the amortisation become closer in time.[5]

Thus, the joint probability of no default, P_t, can be defined as:

$$\begin{aligned} P_t &= (1-\delta_t)^t \\ P_t &= (1-(\alpha+\beta.\,[t]))^t \end{aligned} \tag{2}$$

In which parameters α and β are restricted so that P_t is always less than or equal to one and greater or equal to zero.

The fourth and last element is the risk-free present value discounted factor for a time t cash flow, denoted f_t. The discount rate used is the risk-free rate, since the asset risk is captured by the probabilities of each possible cash flow, as it is shown next in equation (3).

Having described the four elements, we are in a better position to state equation (1) which enables us to value a bond through the expected present value of cash flows. As it has already been suggested by Jonkhart (1979), Fons (1987) and Hurley and Jonson (1996), we state that the present value of a bond is the sum of its expected cash flows (coupons, principal and the recovery rate), multiplied or adjusted by their probability; see below equation (3):

$$V_0 = \sum_{t=1}^{N} \{P_t.f_t.C_t\} + \{P_N.f_N.F_N\} + \sum_{t=1}^{N} \{p_t.f_t.R\} \tag{3}$$

The bond's current value is viewed as the probability-weighted sum of the coupon flows, the principal and the recovery rate.

As it was aforesaid, expressing the pricing equation in these terms implies that the asset risk becomes captured by the implied default probability and its complement –the implied probability of payment. As a consequence, all possible cash flows –coupons, principal and the recovery rate– remain discounted at the risk-free rate. Otherwise, the asset risk is generally enclosed in the discounted factor.

Finally, equation (4) explicitly states the three unknown elements, R, α and β incorporated in the model:

[5] Otherwise, during crisis long-term default probabilities might be lower than the short-term conditional on the sovereign's ability to avoid the case to fall into default. This effect is not captured by this assumption.

$$V_0 = \sum_{t=1}^{N} \left\{ (1 - (\alpha + \beta . [t]))^t . f_t . C_t \right\} + \tag{4}$$
$$\left\{ \left(1 - (\alpha + \beta . [N])^N\right) . f_N . F_N \right\} +$$
$$\sum_{t=1}^{N} \left\{ \left[(1 - (\alpha + \beta . [t-1]))^{t-1} - (1 - (\alpha + \beta . [t]))^t \right] . f_t . R \right\}$$

Having established the equations, it is possible to present the model that allows for a consistent estimation of the three unknown parameters (R, α, β), which will, in turn, enable us to estimates the default recovery value and the default probability temporal term structure.

2.1 Estimation Strategy

In order to estimate the unknown parameters, firstly, it is defined the bond model value, $\hat{V}_{i,0}$, by substituting in equation (4) the three unknown parameters (R, α, β) by its estimations ($\hat{R}$, $\hat{\alpha}$, $\hat{\beta}$).

Then, consider at date $t = 0$ a cross-section of I outstanding bonds indexed by the subscript i. Now, we are able to define the sum square of residuals (SSR) at date $t = 0$ as:

$$SSR_0 = \sum_{i=1}^{I} \left(V_{i,0} - \hat{V}_{i,0} \right)^2 \tag{5}$$

where $V_{i,0}$ denote the market value of the ith bond at date $t = 0$ recalling that $\hat{V}_{i,0}$ is the estimated ith bond price.

Finally, the date $t = 0$ estimation can be achieved by getting the value for $\hat{R}$, $\hat{\alpha}$ and $\hat{\beta}$ that minimise equation (5) subject to the average cross-sectional bond pricing residual equalised to zero; expressed as

$$\left(\frac{1}{I} \right) \sum_{i=1}^{l} \left(V_{i,0} - \hat{V}_{i,0} \right) = 0 \tag{6}$$

For each day estimation in the sample it was constructed the cash flow event tree for each of the ith bonds according to equation (4). Then, initial guesses were used for the unknowns to estimate the parameters. Subsequently, this exercise was repeated for each day of the analysed period.

A Solver was employed to minimise square residuals -equation (5)- on condition that the average sum of errors is equalised to zero -equation (6). It applies the Generalised Gradients Method to estimate the unknown elements.[6]

Notice that the estimations were computed using an algorithm of non-linear optimisation subject to non-linear constraints. So, it does not guarantee that the results are the global solution. However, experimentations with alternative initial guesses conduct to the same results. The Appendix includes an example that shows the estimated results based on the market price structure of October 1st 2001. The data and results concerning the fourth quarter 2001 are shown in a Table.

It have been selected the five most representative bonds of the economy –i.e., the bonds which have been most actively traded in the short, medium, and long term. So, the model as a whole is formalised through the statement of five equations; it means $i = 1, ...5$. From these five bonds we obtain the default recovery rate and the default probability temporal term structure, which are the most representative determinants of the economy for a given market price structure at each moment in time. For the model to be consistent, it is assumed that the bonds have a cross-default clause— which is a realistic assumption in the case of Argentina. This assumption implies that there is a representative default recovery value for the economy as a whole.

2.2 The Data

For the period subject to analysis –October 2001-December 2001– we have considered 5 Global Bonds, denominated Eurobonds, at a fixed rate, with semestrial coupons and amortisation at finish. These characteristics are specified below:

Table 1: Sample of US-Dollar denominated Eurobonds

Name	**Issue Date**	**Maturity Date**	**Yearly Interest Rate**
Arg. 03	20-Dec-1993	20-Dec-2003	08.375 %
Arg. 06	09-Oct-1996	09-Oct-2006	11.000 %
Arg. 10	15-Mar-2000	15-Mar-2010	11.375 %
Arg. 17	30-Jan-1997	30-Oct-2017	11.375 %
Arg. 27	19-Sep-1997	19-Sep-2027	09.758 %

[6] In this paper, we have used the Solver included in Microsoft Office Package.

These bonds are not guaranteed. They have a cross-default clause and they were issued under the jurisdiction of English Courts in London. This analysis was carried out considering the daily prices supplied by the Secretary of Finances of the National Ministry of Economy from the Argentine Republic.

Figure 1a shows the average daily prices for the bonds which have been described as representative of the economy for the period we are analysing. Figure 1b, in turn, specifies the same series considering each of the bonds individually.

Figure 1a : Average Bond Market Prices

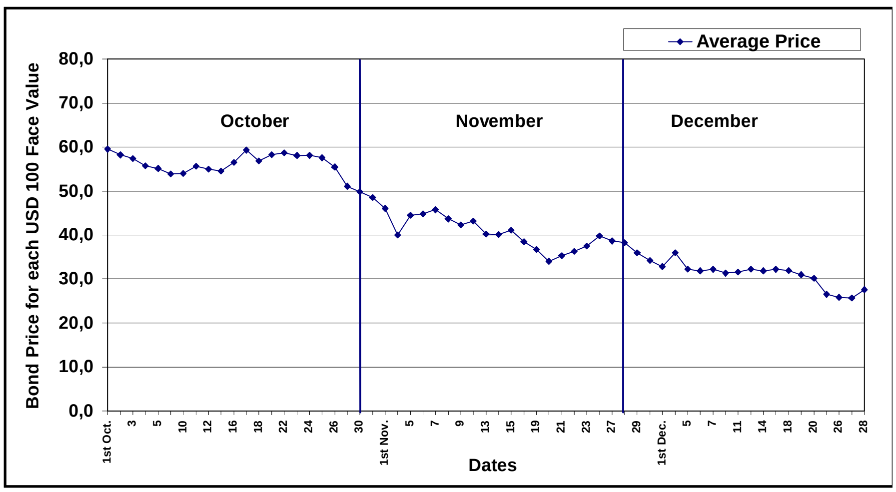
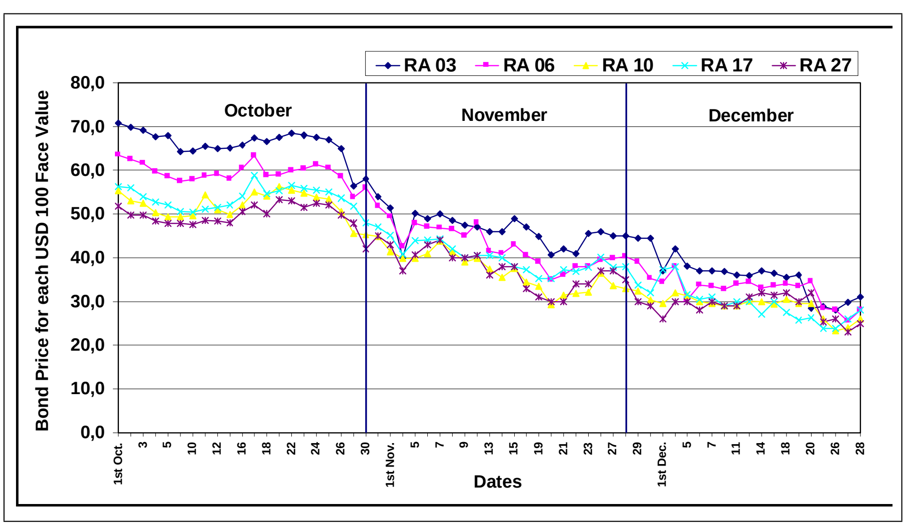


Figure 1b : Individual Bond Market Prices



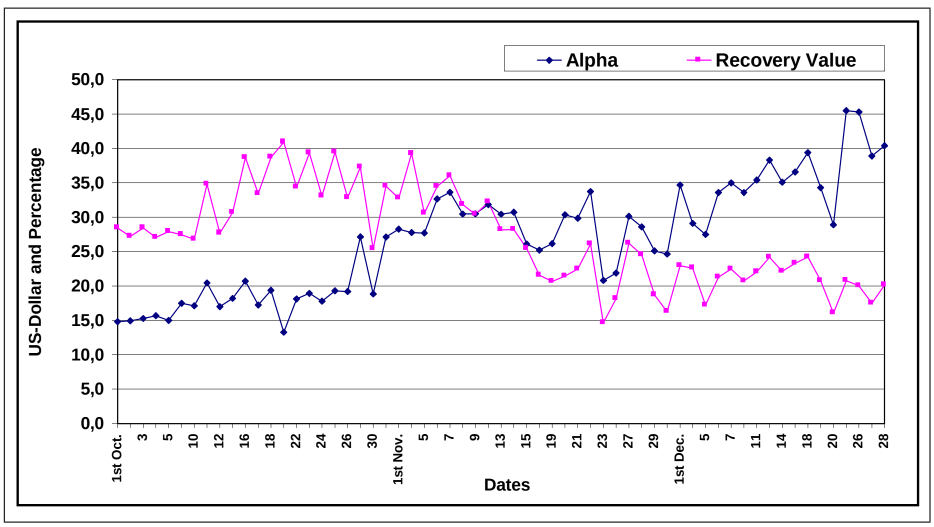
3 Estimation Results

This section deals with the model estimations concerning the aforementioned Eurobonds for the case of the Argentinean domestic crisis. It will be focused on the fourth quarter 2001.

It is worth noticing that the *Base* Default Probability is denoted in the model by means of parameter Alfa (α) and it defines the current default probability. The estimations regarding parameter Beta (β), which is employed to calculate the default probability temporal term structure, shows an increasing linear trend with respect to time as it was defined. However, we will not analyse the estimations of the Betas and the changes in the steepness of the temporal term structure.[7]

In what follows, both the default recovery values and base default probabilities estimations are presented in Figure 2a:

Figure 2a: Estimated Default Recovery Values and Base Default Probabilities.



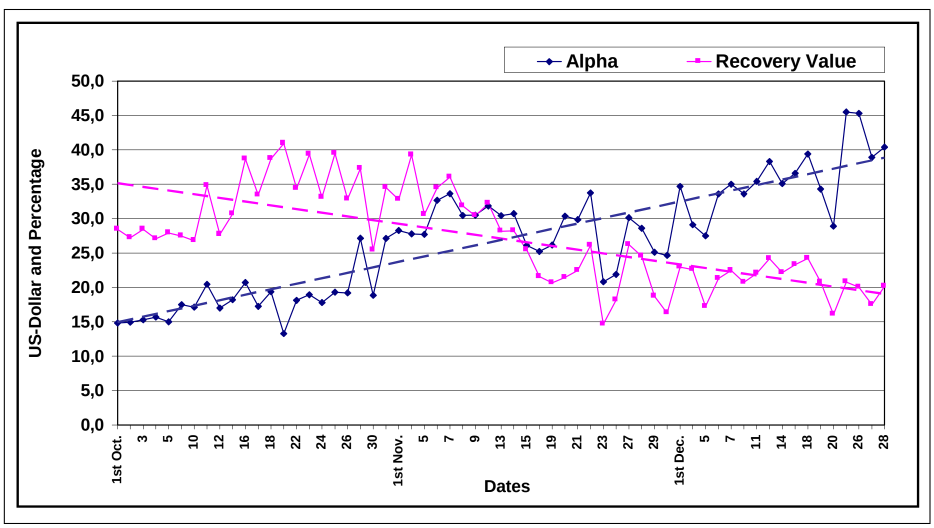
As it is depicted in Figure 1a, between October 1st and December 28th 2001, the average bond market value reflected a downward trend, falling from USD 59.5 to USD 27.6 for each USD 100 face value. Simultaneously, as it is depicted by Figure 2a, the default recovery value have descended from USD 28.5 to USD 20.1 reaching its maximum level, USD 40.9, on October 19th and its minimum, USD 14.6, on November

[7]Regarding the shape of the default probability temporal term structure, another approach is presented in more detailed way by Andritzky, J. R. (2004).

23rd. Conversely, the base default probability registered an increase from 14.8% to 40.4% reaching its maximum level, 45.5%, on December 21st and its minimum, 13.3%, on October 19th.

Notice that on October 19th the estimations show the maximum recovery rate, USD 40.9, and its minimum base default probability, 13.3%. On the other hand, on December 21st the base default probability registered its maximum level, 45.5%, while the default recovery value is one of the lowest in the sample, USD 20.8. Thus, both embedded determinants become relevant in explaining bond price volatility while they seem to follow a negative correlation but long periods have to be considered; for instance one and half month –equivalent to 30 observations. Figure 2b shows the estimation results depicting linear trend lines.

Figure 2b: Estimated Recovery Values and Default Probabilities with linear trendlines



As it can be seen in Figures 2, the period October 1st -October 10th shows that both curves are stable and that the default recovery rate registers a downward trend whereas the Default Probability reveals an upward trend, both being coherent with a drop in bond prices. It must be observed that both determinants show a moderate gradient which corresponds to the trend intensity registered by market prices; see Figures 1. Subsequently, the opposite phenomenon is registered from October 11th to October 19th. Thus, the Model presented is capable of assessing slight oscillations in market prices.

However, for some short periods (two weeks which equal 10 observations) the estimations register a positive correlation between recovery rates and base default probabilities. A negative relationship is accomplished if we take a longer period so that statistic errors can be compensated for.

Considering the period extending from October 19th to December 21st, along which bond prices registered a downward trend, it is possible to observe that default recovery values start at USD 40.9 for each USD 100 face value to descend reaching USD 20.8 whereas base default probability starts at 13.3% and reaches 45.5%.

To sum up, the increase in prices was accompanied by an increase in default recovery rates and a fall of implied default probabilities. Conversely, the reduction in prices was accompanied by a drop in default recovery rates and an increase in implied default probabilities. See below Figures 3.

Figure 3: Default Recovery Values and Base Default Probabilities with Trendline. From October 19th to December 21st
Figure 3a: Linear Trendline

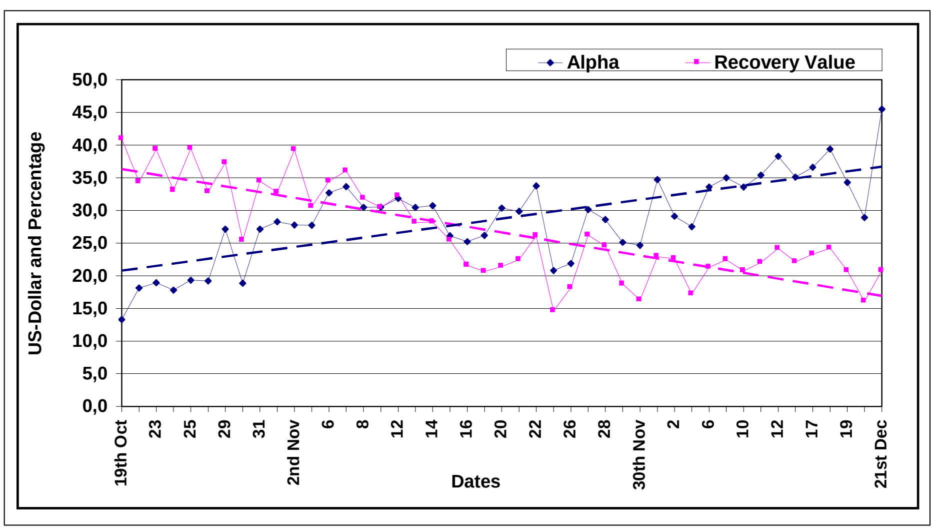
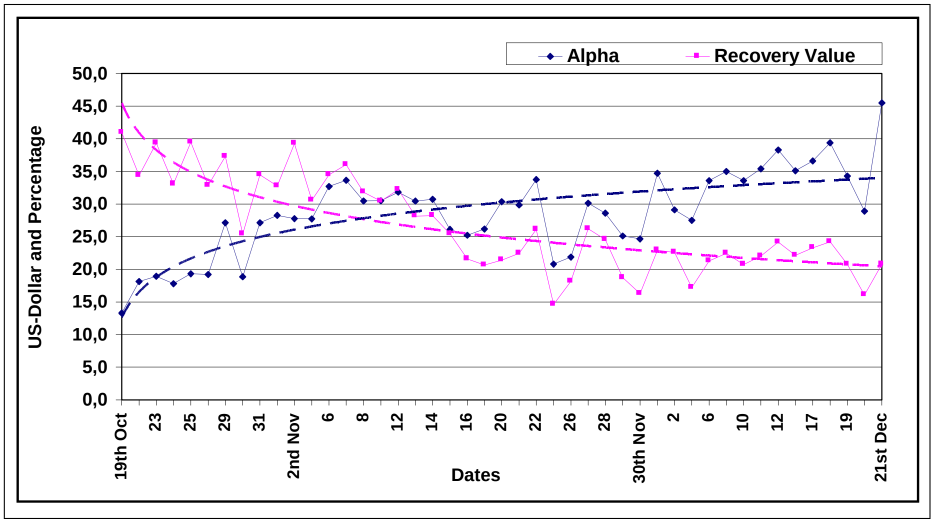


Figure 3b: Logarithmic Trendline

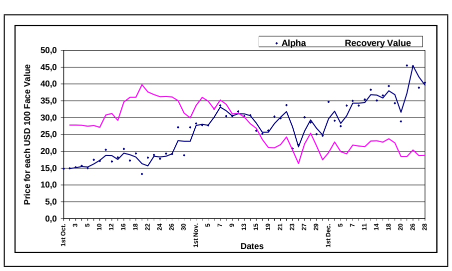


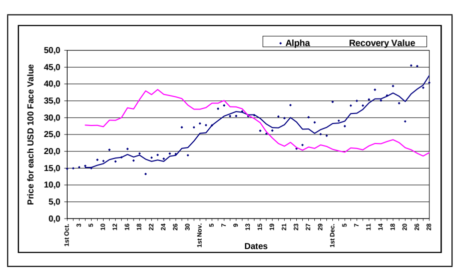
Regarding the standard deviation of the estimations, they are due to the fact that for some estimation the square residuals are low (one digit) whereas for others estimations the square residuals range from 15 to 30. See in the Appendix Table A1 of input data and estimation results. The cases in which residuals are close to zero (and, so the estimations are very accurately) the Solver has found a combination of estimated parameters (and, so estimated bond prices) which exactly reproduce the yield-duration market curve. See in the Appendix the Solver Results Sample for October 1st.

But just with qualitative purposes, it has been plotted the series considering a two period and four period moving average to obtain a more stable series which can average out the statistic errors. See below Figure 4a and 4b.

Figure 4: Default Recovery Values and
Base Default Probabilities with Trendline

Figure 4a: Two moving average Figure 4b: Four moving average





As a corollary,the information provided by the model enables the individualisation of the parameters ruling over market prices. The results obtained show that for long periods (e.g. a two-month period), the model produces results which are consistent along the time.

3.1 Interpretation of Results

For a proper interpretation of the data, it is important to situate the model in the environment registered at the time. Here is presented a brief chronicle of the events leading to the crisis: on December 20th, the Minister of Economy and the President, Dr. Fernando De La Rúa, submit their resignation. On December 21st, the president of the Senate, Dr. Ramón Puerta, takes over provisionally for a 48-hour period. On December 23rd, Dr. Adolfo Rodríguez Saa is appointed as President. On December 24th, he announces the country's insolvency before the National Congress.

Market information produced, between December 10th and December 28th, before and after the officially announcement of the default is presented in the following Table:

Table 2: Estimated Parameters before and after Defaulting

Date	RA 03	RA 06	RA 10	RA 17	RA 27	Average Price	Recovery Value
10 Dec	36.8	32.8	29.0	29.0	29.0	31.32	20.73
11 Dec	36.0	34.0	29.0	30.0	29.0	31.60	22.04
12 Dec	35.9	34.4	30.1	30.0	31.0	32.28	24.16
14 Dec	37.0	33.1	30.0	27.1	32.0	31.84	22.15
17 Dec	37.0	33.6	29.4	30.0	31.5	32.20	23.30
18 Dec	35.5	34.0	30.5	27.5	32.0	31.90	24.21
19 Dec	36.1	33.4	29.5	25.8	30.0	30.96	20.77
20 Dec	28.5	34.5	29.5	26.3	32.0	30.16	16.08
21 Dec	28.9	28.5	26.0	23.9	25.3	26.52	20.79
26 Dec	28.0	28.0	23.3	23.9	26.0	25.84	20.01
27 Dec	29.8	25.5	24.0	26.0	23.0	25.66	17.50
28 Dec	31.0	28.0	26.0	28.0	25.0	27.60	20.15

On December 20th, the Minister of Economy and the President, Dr. Fernando De La Rúa, submit their resignation. On December 23rd, Dr. Adolfo Rodríguez Saa, is appointed as President. On December 24th, he announces the country's insolvency before the National Congress. Actually, Argentina defaulted on December 20th.

These data show that the bond market prices adjusted falling from USD 30.16 for each USD 100 face value to USD 26.52 on December 21st –the following day after the resignation of the Minister of Economy and the President–, instead of producing the adjustment on December 26th –after the officially announcement of the default. At that time, market price reduction reached 11.7% overnight. Then, the prices kept decreasing until they stabilised at USD 20 in March 2002. Thus, this section is assuming that Argentina really defaulted in the night of December 20th 2001.

As regards of the default recovery values evidenced between December 10th and December 28th, these are good estimations given that they present small square residuals, except for that registered on December 20th. It should be obseved that estimations recorded on December 20th registered a square residuals of three digits. Consequently, in order to obtain a better approximation to this value, we will take the average value of the default recovery values in the pre-default period; it means between December 10th and December 19th . This average value amounts to USD 22.48.[8]

So, the relevant data and estimation results before and after market the adjustment are summarised as follows:

Pre-default Period: from Dec. 10th to Dec. 20th		
Data	**Maximum - Minimum**	**Average**
Average Price	USD 30.2 - USD 32.3	USD 31.5
Recovery Value (1)	USD 20.7 - USD 24.2	USD 21.7

Post-default Period: from Dec. 21th to Dec. 28th		
Data	**Maximum - Minimum**	**Average**
Average Price (2)	USD 25.8 - USD 27.6	USD 26.4
Recovery Value	USD 20.8 - USD 17.5	USD 19.6

The average market prices registered as of December 21st — the date as of the market considers that Argentina defaulted— are considered as the default recovery values validated by the market. Recall that the recovery value is the amount paid to the bondholder immediately after defaulting. So, if the fiscal authority unexpectedly defaults in period t, the bond market value will be equal to the recovery value implicit in the last market value before defaulting. As a result, this paper compares market prices registered in the post-default period (it means, the actual recovery values) with the default recovery value estimated in the

[8]Given that the market price on December 20th registers USD 30.2, less than the prices registered between December 10th and December 19th (USD 31.0 - USD 32.3), the Default Recovery Value implicit in that price should be marginally smaller to USD 22.48 but in no case close to USD 16.08.

pre-default period (it means, the estimated default recovery values). It results that:

Data	Maximum - Minimum	Average
The difference: (2) – (1)	USD 5.1 - USD 3.4	USD 4,7

So, as from the model's estimations, the argentine sovereign bonds were overvalued at USD 4.7 on average (in a range of USD 5.1 and USD 3.4); that is, by 21.7%. So, it would have been correct to adopt a short position and buy again when the market evidenced the model's estimations; that is when the assets were quoted at average values of USD 21.7 (in a range of USD 20.7 and USD 24.2) as it happened as of May 2002.

3.2 Empirical Evidence: What to learn about?

Comparing the estimation results with those of Merrick's, it appears that the default recovery values registered in Russia, before their currency devaluation and the announcement of default, were very similar to those of Argentina in 2001 facing the same scenario. On average, these values were USD 27.3 and USD 21.5, respectively. Under these circumstances, both countries registered a country risk premium which ranged from 5000 basic points to 6000 basic points. Nevertheless, during the Russian crisis, in 1998, Argentina preserved a significantly superior level of recovery, if compared with Russia in August 1998 or Argentina in December 2001. In the context of the Russian crisis, Argentina registered a country risk premium which ranged from 600 basic points to 750 basic points and a USD 51.2 average recovery value. This approximately doubled the value registered by Russian and Argentinean sovereign bonds in the scenario of local crisis. Sovereign bonds from emerging countries facing unstable macroeconomic conditions suffer a significant reduction in their recovery value which amounts to approximately 50% when compared with the bonds issued in countries facing stable macroeconomic fundamentals and a stable currency value, as was the case in Argentina in August 1998. The following Table summarises the data:

Average Estimated Recovery Values		
Crisis	Russia	Argentina
August 1998	USD 27,3	USD 51,2
December 2001		USD 21,7

The model allows us to evaluate investor's perception about macroeconomic conditions and its prospect by decomposing bond market prices in the both determinants. Moreover, the model's estimations allow to analyses the extent to which a local or foreign crisis may undermine the macroeconomic fundamentals. See below some macroeconomic data after the crisis:

Country	Exchange Rate* (and Variation)			
	Before Devaluation	After Devaluation		
		A Month After	An Year After	Two Years After
Russia 1998	6.29	16.06 (155,3%)	17.00 (293,5%)	27.77 (72,9%)
Argentine 2001	1.00	2.15 (115,0%)	3.37 (237,0%)	2.95 (195,0%)
Argentine 1998	1.00	1.00 (0,0%)	1.00 (0,0%)	1.00 (0,0%)
*Local Currency to US Dollar				

3.3 The Argentinean Debt Haircut: An Assessment

Assuming a 70% haircut over the Argentinean debt and considering the estimated recovery value through the model of USD 21.7, Argentina could have overcome its default paying a country risk premium of around 1960 basic points –assuming a 2% risk-free interest rate and preserving the currently bond structure– whereas Russia did it paying 1000 basic point (see Figure A1). Thus, Argentinean restructured bonds will have a 21.6% average annual rate of return. The following Table summarises the input data and the results:

Set of Assumption		Results	
Estimated Recovery Rate	USD 21,7	Average Annual Rate of Return	21,6%
Debt Haircut	70%		
Bond's Term Structure	Constant		
Risk-free Rate	2%	Country Risk Spread	1.960 bp

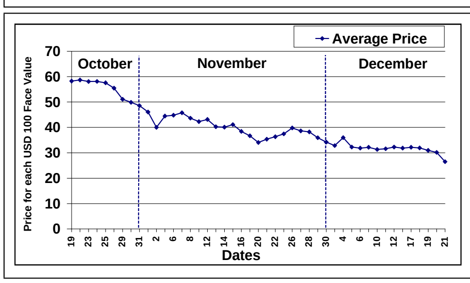
Such a high country risk premium after debt restructuring, calls for a debt haircut consistent in the long-term. In other words, a haircut that applies not only to face value but also to the temporal term structure and the interest rate coupons should be fully justified.

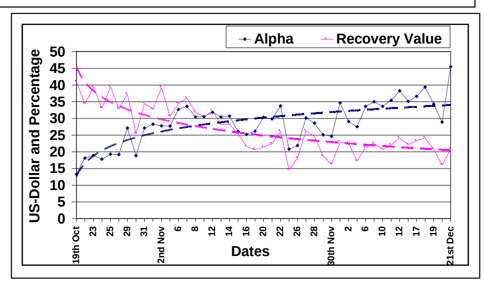
Finally, after a three-year period of restructuring, creditors accepted the Argentinean offer taking a 70% loss, twice the average haircut in recent sovereign defaults. In other debt restructuring processes, creditors had to accept either a cut in the principal, a lengthening of maturity or a reduction in interest payments. Argentina has achieved all three offering a 42-year bond. Only two days after the negotiation process had ended, the Minister of Economy, Roberto Lavagna, announced that the provisional take-up was 76%. After the swap the Argentinean debt amounts to 80% of GDP remaining higher than the 52% debt ran by its neighbour, Brazil. But the interest burden on Argentinean debts is considerably lighter and the maturity schedule is more flexible.

4 Conclusion and Summary

The input data and the main findings for the pre-defaulted period are sum up in the following Table and Graphics:

Argentina 2001: Pre-Default Period			
		Oct. 19th	Dec. 21st
Input Data	Bond Market Price	USD 58,3	USD 45,5
Estimation	Default Recovery Value	USD 40,9	USD 20,8
Results	Base Default Probability	13,30%	45,50%





Extending this research to test the contagion effect over the Brazilian economy, it should be noticed that in the months preceding and following Argentine default, the average price level was never inferior to USD 85 for each USD 100 face value. In the week extending from October 2nd to October 10th 2001, bond prices stood at USD 80 on average, whereas the average default recovery rate was USD 67.9 and the base default probability 1.45%. It appears that almost 100% of the volatility affecting Brazilian bond prices can be explained in terms of the default recovery rate volatility, whereas the base default probability remains close to zero. Brazilian bond prices have never reached the low level registered in Argentina or Russia, in December 2001 and August 1998, respectively.

Notice that when sovereign bonds prices are deeply stressed, the model is particularly relevant in explaining bond price trends by means of both implicit determinants.

Moreover, as of the model's estimations, bond market prices after defaulting were overvaluated. The Average Market Recovery Value immediately after defaulting was 21.7% higher than the Average Estimated Recovery; the difference amounted USD 4,7. Value. See the Table below:

Description	Value
Average *Market* Recovery Value	USD 26,4
Average *Estimated* Recovery Value	USD 21,7
The Difference	USD 4,7

Besides, new empirical evidence is generated to understand international financial crisis and the sovereign risk of default. Finally, according to the debt haircut assessment, a significant haircut covering a cut over the principal, a lengthening of maturity schedules and a reduction in the payment of interest should be considered as a fair renegotiating result.

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6 Appendix

Table A1: Data and Results

The bigger Square Residuals which could still be optimised are emphasised in bold type.

Date	RA 03	RA 06	RA 10	RA 17	RA 27	Average Prices	Alpha	Recovery Values	(SSR)
1st Oct.	70,8	63,5	55,3	56,3	51,8	59,5	14,82	28,45	1,92
2	69,8	62,5	53,0	56,0	49,8	58,2	14,95	27,21	1,83
3	69,1	61,6	52,5	54,0	49,8	57,4	15,28	28,45	1,95
4	67,6	59,6	50,3	52,7	48,4	55,7	15,68	27,07	0,38
5	67,9	58,6	49,3	52,1	47,8	55,1	15,00	27,92	0,95
9	64,3	57,5	49,3	50,5	47,8	53,9	17,50	27,47	2,34
10	64,4	57,9	49,6	50,4	47,6	54,0	17,12	26,80	3,69
11	65,5	58,7	54,3	51,1	48,5	55,6	20,46	34,79	**33,78**
12	64,9	59,1	51,0	51,5	48,4	55,0	16,99	27,71	5,04
15	65,0	58,0	49,9	52,0	48,0	54,6	18,21	30,68	2,86
16	65,7	60,4	52,0	54,1	50,5	56,5	20,70	38,65	**15,48**
17	67,4	63,3	55,0	58,8	52,0	59,3	17,25	33,42	7,90
18	66,5	58,8	54,1	54,6	50,1	56,8	19,37	38,71	**19,09**
19	67,5	59,0	56,2	55,3	53,3	58,3	13,28	40,94	**20,40**
22	68,5	59,9	55,5	56,5	53,0	58,7	18,12	34,38	7,39
23	68,0	60,3	54,8	55,8	51,5	58,1	18,93	39,35	**15,65**
24	67,5	61,3	53,8	55,5	52,5	58,1	17,79	33,09	1,42
25	67,0	60,5	53,4	55,0	52,0	57,6	19,31	39,48	**11,03**
26	64,9	58,5	50,6	53,6	49,8	55,5	19,20	32,85	0,97
29	56,4	53,8	45,5	51,8	47,9	51,1	27,14	37,29	6,71
30	58,0	56,0	45,3	48,0	42,0	49,9	18,84	25,42	**25,91**
31st Oct.	54,0	51,8	44,9	47,0	45,0	48,5	27,12	34,50	8,47
1st Nov.	51,4	49,4	41,4	45,1	43,0	46,1	28,27	32,77	7,79
2	40,0	42,5	39,8	40,8	37,0	40,0	27,77	39,27	**15,18**
5	50,2	47,8	39,8	43,9	40,7	44,5	27,72	30,59	8,56
6	49,0	47,0	41,0	44,0	43,0	44,8	32,68	34,48	3,49
7	50,0	46,8	43,8	44,3	44,0	45,8	33,64	36,03	5,38
8	48,5	46,5	41,3	42,0	40,0	43,7	30,47	31,83	**12,69**
9	47,5	45,0	39,0	40,0	40,0	42,3	30,51	30,42	9,23
12	47,0	48,0	39,8	40,5	40,5	43,2	31,84	32,21	**27,06**
13	46,0	41,4	37,4	40,5	36,0	40,3	30,44	28,17	6,82
14	46,0	41,0	35,5	40,0	38,0	40,1	30,73	28,22	0,35
15	49,0	43,0	37,5	38,0	38,0	41,1	26,11	25,45	6,76
16	47,0	40,5	34,4	37,3	33,0	38,4	25,22	21,59	5,65
19	44,8	39,0	33,4	35,3	31,0	36,7	26,16	20,66	**10,63**
20	40,6	35,0	29,3	35,3	30,0	34,0	30,35	21,43	6,38
21	42,0	36,0	31,4	37,3	30,0	35,3	29,86	22,46	**15,08**
22	41,0	38,0	31,9	36,8	34,0	36,3	33,74	26,11	2,81
23	45,5	38,0	32,1	37,8	34,0	37,5	20,81	14,63	**40,56**
26	46,0	39,4	36,5	40,1	37,0	39,8	21,89	18,16	**56,97**
27	45,0	39,8	33,6	37,8	37,0	38,6	30,13	26,21	1,33
28	45,0	40,2	32,9	38,0	35,0	38,2	28,60	24,55	2,70
29	44,5	39,0	32,4	33,8	30,0	35,9	25,10	18,71	**12,84**
30th Nov.	44,5	35,3	30,3	32,0	29,0	34,2	24,64	16,28	3,94

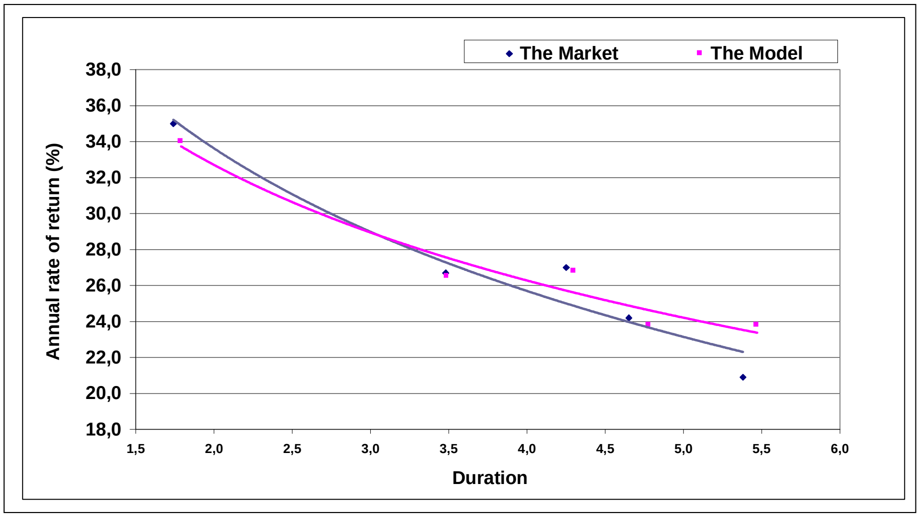
Date	RA 03	RA 06	RA 10	RA 17	RA 27	Average Prices	Alpha	Recovery Values	(SSR)
1st Dec.	37,0	34,4	29,5	37,3	26,0	32,8	34,7	22,94	**50,24**
4	42,0	38,0	32,0	37,9	30,0	36,0	29,1	22,60	**21,92**
5	38,1	30,4	31,3	31,6	30,0	32,3	27,5	17,20	**33,65**
6	37,0	33,8	30,0	30,5	28,0	31,9	33,6	21,28	**12,15**
7	37,0	33,5	29,5	31,0	30,0	32,2	35,0	22,45	3,52
10	36,8	32,8	29,0	29,0	29,0	31,3	33,6	20,73	8,21
11	36,0	34,0	29,0	30,0	29,0	31,6	35,4	22,04	8,98
12	35,9	34,4	30,1	30,0	31,0	32,3	38,3	24,16	**10,34**
14	37,0	33,1	30,0	27,1	32,0	31,8	35,1	22,15	**28,60**
17	36,5	33,6	29,4	30,0	31,5	32,2	36,6	23,30	6,98
18	35,5	34,0	30,5	27,5	32,0	31,9	39,4	24,21	**28,80**
19	36,1	33,4	29,5	25,8	30,0	31,0	34,3	20,77	**35,52**
20	28,5	34,5	29,5	26,3	32,0	30,2	28,9	16,08	**161,81**
21st Dec.	28,9	28,5	26,0	23,9	25,3	26,5	45,5	20,79	**17,10**
26	28,0	28,0	23,3	23,9	26,0	25,8	45,3	20,01	9,41
27	29,8	25,5	24,0	26,0	23,0	25,7	38,9	17,50	5,37
28th Dec.	31,0	28,0	26,0	28,0	25,0	27,6	40,4	20,15	5,11

Solver Results Sample

The data and the results produced by the Solver for a specific day are presented in the tables. This exercise was repeated for each day in the quarter analysed. Tables and Figure Sample for October 1st 2001.

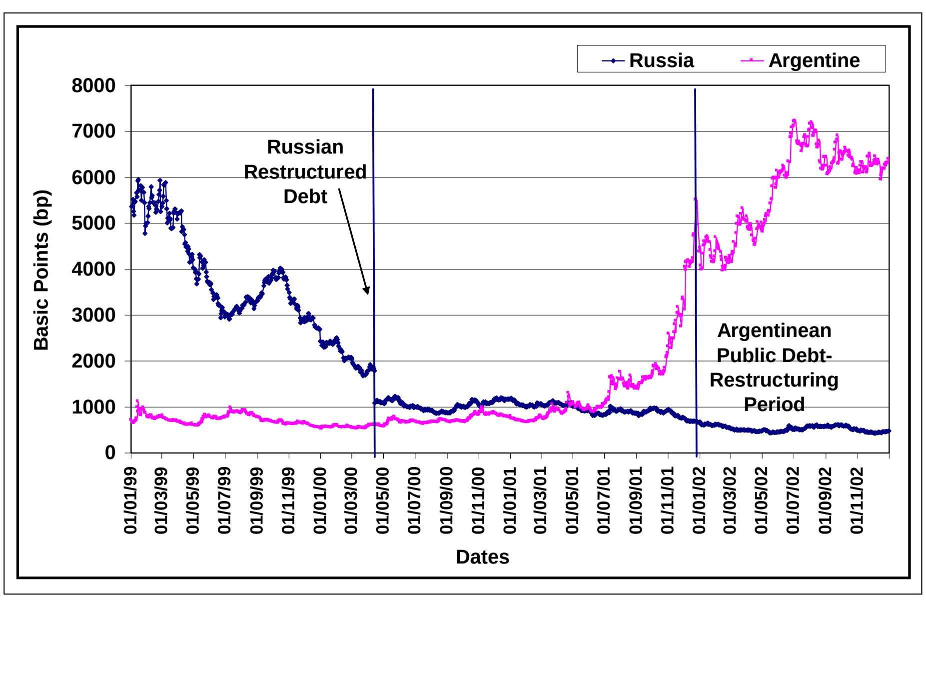
The Data			
BOND DESCRIPTION	**Market**		
	Duration	**Yield**	**Price**
Global Bond Arg. 03	1.74	35.0%	70.75
Global Bond Arg. 06	3.48	26.7%	63.5
Global Bond Arg. 10	4.25	27.0%	55.25
Global Bond Arg. 17	4.65	24.2%	56.25
Global Bond Arg. 27	5.38	20.9%	51.75

The Results						
BOND DESCRIPTION	**Model**			**Parameters**		
	Duration	**Yield**	**Price**	**Alpha**	**Beta**	**Recovery**
Global Bond Arg. 03	1.79	34.0%	70.6	0.15	0.00	28.45
Global Bond Arg. 06	3.49	26.5%	63.7			
Global Bond Arg. 10	4.30	26.8%	54.1	1.92	Minimised Equation (5)	
Global Bond Arg. 17	4.78	23.8%	56.8	0.00	Equation (6) Equalised to zero	
Global Bond Arg. 27	5.47	23.8%	52.3			



The blue logarithmic curve represents the market curve whereas the pink line represents the curve which results from the estimations produced by the model. In the figure, it is possible to visualise the degree of adjustment the model proposes in the cases of small statistic errors, which are less than 2 as this case shows. A Solver of a higher resolution would enable a level of adjustment for all price combinations.

Figure A1: Argentinean and Russian Country Risk Spread.
Period: January 1999 –December 2002



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