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Application of Call-Put Parity for modeling the value of implicit put options, granted to shareholders of "too big to fail" financial institutions at taxpayers' expense

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Purpose of the research

The key postulate put forward in this research is to try to measure the degree of the buildup of moral hazard related to implicit state guarantees for systemically important financial institutions. In that sense, the study is concerned with the "time dimension" of systemic risk [IMF 2012:8]. The benchmark considered as part of the research is the theoretical value of an implicit put option contract (on the underlying stock) held by shareholders of "too big to fail" financial intermediaries. The resulting modeling is conducted on an ex-post basis, using historical data. The main contribution of the paper is the proposition of an options-based framework for illustrating the value attribution of implicit government guarantees. In turn, it might be postulated that such a measure may be used for quantifying the extent of the buildup of moral hazard related to pledges of state support for systemic firms. Theoretical considerations account for assigning a problem-specific interpretation to one of the cornerstone relations of options literature: the so-called "Call-Put Parity". Based on the adopted methodology, an empirical example is presented to illustrate the applicability of the scheme as well as to outline its shortcomings. In conclusion, relevant issues are suggested for future refining of the concept and policy implications.

The Call-Put Parity

The original version of the Call-Put Parity of option pricing was formally developed by Stoll in 1969 and modified by Merton [Klemkosky and Resnick 1979:1141]. The equation describes a theoretical relation between the prices of predefined types of "call" and "put" options. Thanks to the concept, it is possible to estimate the missing component, given all other variables.

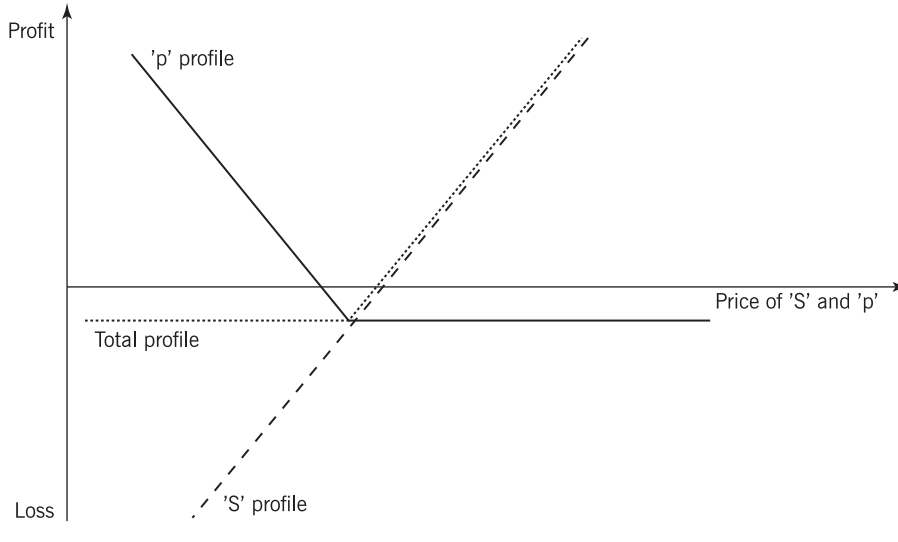
As indicated above, "Call-Put Parity" does not apply to all kinds of options. In its most basic form, the assumptions are as follows [Hull 1999:238–241]:

- Options involved are "European style" – which means that they cannot be exercised ahead of a predefined, fixed date.
- The options incorporate claims on the same asset.
- The strike price for the underlying asset must be the same in case of both – "call" and "put" options.
- The expiry date (being at the same time the exercise date) is also the same for both – "calls" and "puts".
- In the basic version – which shall be used for the research – it is assumed that the underlying asset does not yield any additional return (dividends, coupons) on top of capital gains.

As for notation, the following shall be used (based on the proposition of Hull, 1999):

c = price of a call option
p = price of a put option
X = strike price of call and put options
S = spot price of underlying assets
T = time until expiry of options (measured in years)
r = risk-free rate

EXHIBIT 1. **Profit and loss profile of a portfolio composed of "S" and "p"**



Source: own chart based on P. Cusatis, M. Thomas, Hedging instruments and risk management, McGraw-Hill Companies, New York, 2005, p.182.

Call-Put Parity recognizes the fact that it is possible to construct two portfolios exhibiting the same profit-and-loss profile with the use of cash, underlying assets and options. The value of both positions ought to be the same under frictionless [Knoll 2002:27] conditions [Tu and Chin 2004:5].

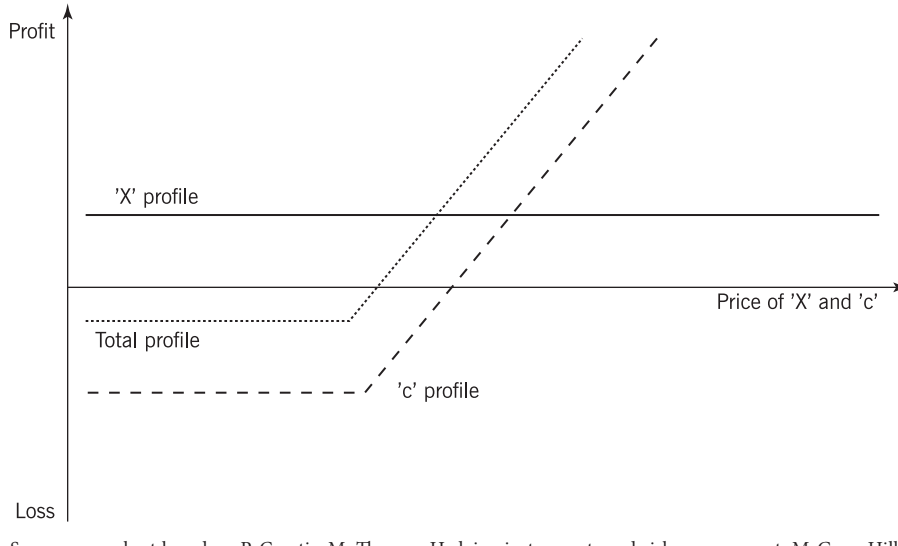
The first portfolio within the equation is composed of underlying assets (e.g. stock) and a put option on them [Hull 1999:238]:

$$(S + p) \quad [1]$$

The second portfolio includes the present value of the cash needed for exercising the call, as well as a call option on the underlying assets [Hull 1999:238]:

$$(Xe^{-rT} + c) \quad [2]$$

EXHIBIT 2. **Profit and loss profile of a portfolio composed of "X" (defined in terms of present value) and "c"**



Source: own chart based on P. Cusatis, M. Thomas, Hedging instruments and risk management, McGraw-Hill Companies, New York, 2005, p.182.

According to the logic of Call-Put Parity, the two portfolios need to be equally valued in order not to provide arbitrage opportunities. Thus [Hull 1999:238]:

$$(Xe^{-rT} + c) = (S + p) \quad [3]$$

If the equation is not fulfilled, an arbitrage profit may be achieved by selling the overvalued portfolio and buying the undervalued one. The combined investment should not be burdened with the risk of price changes, since both positions (long and short) exhibit the same profit and loss profile [Hull 1999:239–241].

Applications of Call-Put Parity encountered in literature

Call-Put Parity is an essential part of the options valuation framework. However, its application stretches beyond just the pure derivatives pricing field of interest. The logic of the concept was applied on a number of occasions.

In 2002, Knoll used the framework for outlining regulatory arbitrage opportunities, which in his opinion were made available thanks to the use of the conceptual approach of the Call-Put Parity scheme [Knoll 2002]. He argued that due to their focus on the legal form of financial deals (rather than on merit), regulations leave significant room for evasion of prudential rules. In effect, economic outcomes – similar to the ones prohibited by law – can be achieved using legally compliant methods. In the underlying cases, the act of structuring deals (which otherwise would be considered illegal) to achieve corresponding goals without violating the law was a case of arbitrage.

Hatgioannides and Karanassou used not so much the parity equation itself, but rather its options-based logic for underpinning their concept of *Warrant Economics* [Hatgioannides and Karanasou 2011:1]. According to their view, the global financial crisis of 2008–2009 was largely a culmination of a process that was marked by the adoption of asymmetric incentives in business. The approach was characterized by the increased disparities in terms of wealth distribution among economic agents. A small corporate elite boosted their claims on the payoff derived from the economic boom (call option), while limiting liability in the case of bust (put option). As evidence of the former component of the framework, the gradual surge of the importance of profits within the structure of the American gross national product was quoted. This gain came at the expense of salaries and wages, resulting in ever-greater income disproportions within society. On the other hand, the "put" part of the concept was based on obtaining implicit government guarantees by entities believed to be "too big to fail". Direct provision of taxpayer-sponsored funding in the case of institutions such as AIG, Citibank, Fortis and RBS provides practical backing for the latter thesis [Hatgioannides and Karanasou 2011:6–19]. As a result, corporate business logic assumed the privatization of profits and nationalization of losses.

Flood applied option pricing – along with Call-Put Parity – for analyzing incentives of parties involved in deposit insurance plans [Flood 1990:26]. Referring to theoretical relations between prices of various option types, he argued that by guaranteeing depositor money, insurance providers effectively write a put option on the assets of the involved bank and grant this right to shareholders of the lender. On the other hand, the guarantor

eventually ends up holding a call option on the underlying assets, should compensation be required. By the same token, Flood's remarks are applied, in the framework developed below, to the issue of government guarantees for financial institutions.

The implicit character of put options, which are granted to shareholders by creditors, may be derived from an option-based approach to company valuation, referred to as Contingent Claims Analyzis [Gapen, Gray, Lim, and Xiao 2004:7–8]. With this approach, owners of an enterprise have a junior claim on the residual value of a company. Creditors, on the other hand, are faced with topping the bill for eventual losses in case of a default. Thus the position of shareholders may be regarded as a call option, with debt holders writing a put option on the firm's assets. As a generalization, the Contingent Claims view recognizes that (with regard to valuation of an enterprise) [Gray, Merton and Bodie 2007:9]:

$$\text{assets} = \text{implicit call} + \text{default free debt} - \text{implicit put} \qquad [4]$$

Wilson applied Call-Put Parity for valuing the common stock of banks holding so-called "toxic assets" [Wilson 2010:31–35]. He analyzed the influence of the value of the put option on decisions of shareholders to dispose of problematic positions from balance sheets of financial institutions. According to the study, owners of a bank will demand a premium on top of the market value of distressed assets, due to the positive "Vega" [Ianieri 2009:238] of the "right" to place their holdings with bailout providers.

Essentially, Wilson's paper uses the same logic as the research conducted below. In contrast, however, Wilson did not directly refer to modeling of the moral hazard related to implicit government guarantees for systemically important institutions. His article concentrates on pricing distortions of toxic assets.

The concept of applying Call-Put Parity for modeling moral hazard

The main idea of the research below is based on the concept that the portfolios included in the Call-Put Parity equation can be used for presenting the positions of shareholders of "too big to fail" financial institutions, and state authorities who may eventually be faced with a bailout decision.

By the logic of the argument, at a given starting time – which could be viewed as the beginning of the option contract – officials responsible for taxpayer money have at their disposal an indefinite supply of funds, which could be used for bailing out faltering financial institutions. Specifically, the government could be expected to have at its disposal the present value of money needed to provide financial assistance to banks or other systemically significant financial intermediaries. Let us call this variable "B" – for bailout cost.

On the other hand, the decision whether to rescue a firm is largely left to the discretion of state authorities. They usually do not have a binding commitment versus private shareholders of banks; thus the character of guarantees granted to crucial market players remains implicit. Therefore, governments may be perceived as holding an option for rescuing lenders – in effect often acquiring control over the entities [Shahabian 2011:351]. Let this option be referred to as "b" – for bailout option.

At the starting point of the options contract, owners of "too big to fail" institutions are the shareholders of the underlying firms. Therefore let their stakes be marked as "E" – for equity holdings.

However, due to the fact that the involved financial intermediaries are systemically important, the owners expect the government to intervene in case of distress, in order to avoid social costs being inflicted on the rest of society. Such expectations trigger the moral hazard of implicit government guarantees. Naturally, equity holders may lose their stakes in the course of the rescue operation. Still, they will not need to face the full consequences of the fallout of their earlier investment decisions. As observed by Miller, according to the Call-Put Parity interpretation, shareholders of a company enjoy only a limited liability for the business of their firm. If at debt servicing date, the value of company's assets turns out to be lower than that of its liabilities, owners of the entity have an option of not covering the shortfall. They might hand the company over to creditors instead [Miller 1988:110]. In the case of a state-sponsored bailout, they have an option to pass control over the company to the government. Let this opportunity be marked with "g" – for giving up by shareholders.

In effect, it is possible to conclude that as far as the above logic is concerned, the positions of shareholders and state authorities concerning a systemically important financial institution may be modeled along the lines of the Call-Put Parity:

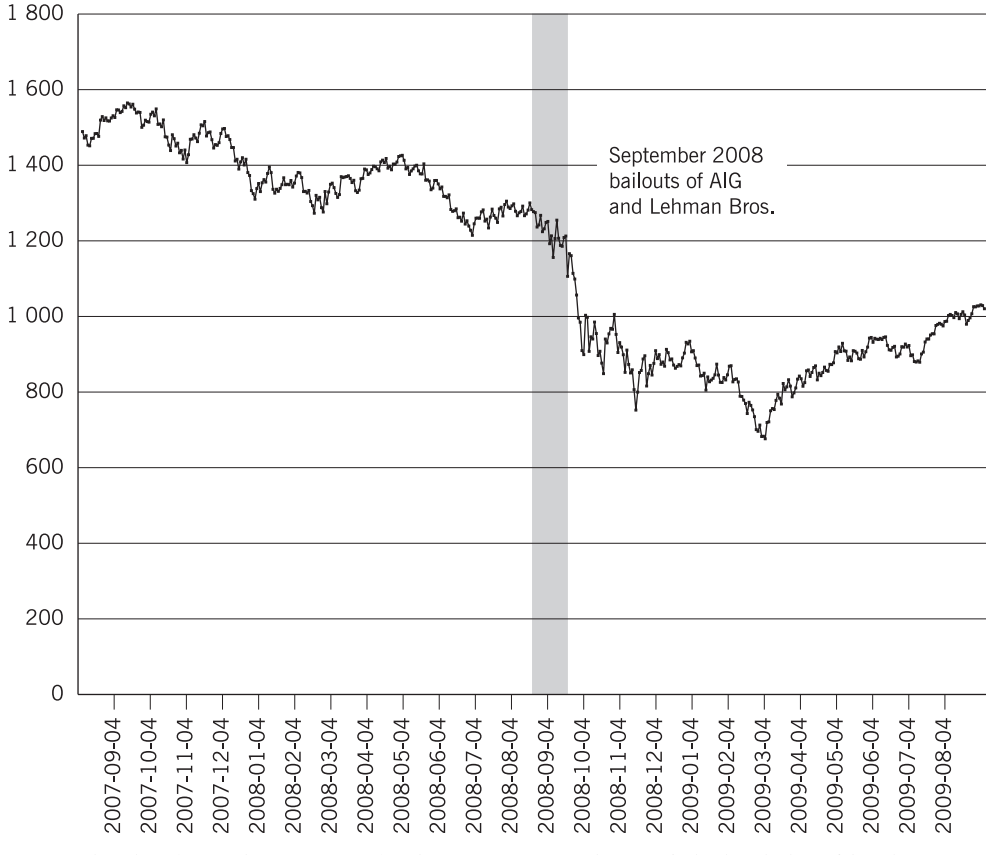
$$b + Be^{-rT} = E + g \qquad [5]$$

where:
"b" stands for "c"
"B" stands for "X"
"E" stands for "S"
"g" stands for "p"

However, a modification may be implemented in the "bailout parity" outlined above versus the original Call-Put Parity equation. It can be argued that under the conditions of a non-distressed market economy, governments should not have an incentive to acquire control over financial institutions. The reasons for such an opinion are the distorted incentives of state authorities, guided by political rather than economic principles. As Ellyott put it: "The long and sobering list of negatives leads the author to support nationalization only when it is clear that there is no other reasonable approach." [Ellyott 2009:16]. In other words, there is no general justification for governments holding a call

option on privately owned companies. Even if state officials effectively have such a right (due to the "bailout-provider-of-the-last-resort" function), the prerogative should not be perceived as an asset, as it logically should not be exercised – even in case of bailouts. Proof of the claim that aid packages for financial institutions are a result of exercising put options on behalf of shareholders (rather than of utilizing call options by governments) may be derived from the timing of such events as state-sponsored recapitalization schemes. During the 2008–2009 crisis these occurred when financial intermediaries became illiquid (or even insolvent), and – more importantly – the price of their equity exhibited a downward trend [Verret 2010].

EXHIBIT 3. **Standard & Poor's 500 index from September 2007 – August 2009 (closing prices)**



Sources: Bloomberg (accessed on 21 June 2012) and M. Fratianni, F. Marchionne, The banking bailout of the subprime crisis: size and effects, PSL Quarterly Review, vol. 63, n. 254, pp. 182–233; [http://bib03.caspur.it/ojspadis/index.php/PSLQuarterlyReview/article/download/9427/9322 (accessed on 16 June 2012), 2010, p. 201.

The deteriorated standing of market players became an incentive for state authorities to intervene. However, this was not a normal time to exercise a call option, which is used to claim ownership of well-performing investment positions, while limiting potential losses related to failures (see the upward sloping P&L profile along the axis of underlying assets' price in Exhibit 2). On the other hand, times of disruption are the ideal opportunity to take advantage of put options on distressed companies' shares. In such a scenario, the profit tends to increase with slumping equity prices. Effectively, exercising a put option may be regarded as selling assets above their current market price (see Exhibit 1), which makes sense for the seller but not for the buyer of the underlying stock. Therefore, during financial market turmoil, governments have no incentive to use their call option, but shareholders might have reasons to exercise the put.

Thus, the "b" component in the equation above (5) ought to be valued at null price, since the right to nationalization should not be sought. As a result:

$$\text{if } b = 0 \text{ then } Be^{-rT} = E + g \qquad [6]$$

As indicated earlier, the goal of this research is to try to quantify the value of implicit government guarantees and thereby to assess the extent of the buildup of the related moral hazard.

By the logic of the concept presented above, an opportunity for shareholders to give up their holdings in return for state aid, is referred to as "g". As a result, by rearranging equation (6) we get:

$$g = Be^{-rT} - E \qquad [7]$$

Empirical application of the "bailout parity"

The main obstacles to applying the "bailout parity equation" above are the constraints derived from the Call-Put Parity framework. First of all, there is the assumption that the options involved are European style. Such a notion suggests that in the case of implicit government guarantees, pledges are granted at a given time for a fixed period. Because of the very nature of informal arrangements, it is difficult to conclude when parties become subject to them. The notion seems to be reinforced by the fact that state support measures are meant to be granted to systemically important institutions. Yet, the methodology of defining which financial firms may pose systemic threats is only being developed. Thus, it is difficult to conclude when an entity becomes crucial from the systemic stability point of view – and when the implicit guarantee is effectively being granted by the state.

Because the study described below aims to present an illustration of how moral hazard within the financial industry can be explained with the use of Call-Put Parity, a Euro-

pean-style version of the equation is used for clarity of presentation. The corresponding formula for American-style options consists of an inequality, indicating the upper and the lower band of valuation [Hull 1999:242]. This approach may be methodologically more appropriate, but yields less communicative outcomes. Essentially, American-style options should be worth at least as much as European ones, plus the margin for the flexible exercise date feature. The inclusion of the upper band of valuation within the framework does not yield significant additional findings, apart from the fact that implicit bailout pledges may actually be worth more than in the European style variant (for verification please see Appendix 1 – charts of outcomes of the study for American-style options).

Furthermore, pledges of fiscal aid are usually not defined, either in terms of value or duration. Therefore, a simplifying assumption is made: that such informal insurance contracts are valid until the actual default situation occurs. It is then that pledges need to be exercised, in order to remain plausible. Naturally, after the bailout is completed, sovereigns might choose to engage in further (implicit or explicit) guarantees for the same financial institutions that have just been rescued. Such a move, however, is treated in this paper as the start of a new options contract, separate from the one that is the subject of the study. This approach is consistent with the Call-Put Parity relation, which assumes definite validity of options (the time until expiry is known and defined as "T").

Knowing the start date of the guarantee, it is possible to determine its tenor ex-post. However, it is hardly feasible to do so ahead of the approaching distress situation. This is why, in order to achieve applicability of the concept in empirical research, "dummy" dates need to be assumed. Events marking fundamental changes in financial regulation may be used as triggers for reassuring equity holders of banks about the possibility of taxpayer-sponsored support.

For the purpose of the research conducted below, it shall be presumed that the cornerstone year for triggering implicit state guarantees for systemic financial institutions in the United States was 1999. That was when the Glass-Steagall Act was abolished. The event is widely – although not unanimously [Pelaez and Pelaez 2009:3] – believed to have fostered conditions for consolidation of the financial industry [Kay 2009:23–24]. As such, the legislative shift may have been perceived as an incentive for financial conglomerates to become more systemically important through gains in the size and scope of operations. In turn, the increased significance of individual companies for the industry became vast enough to require implicit guarantees on behalf of the government. The year 1999 was also when the Gramm-Leach-Bliley Act was adopted, effectively preventing comprehensive cross-sector financial supervision in the United States [Hurley 2010:355]. Such a regulatory development could have added to the "too big to fail" problem, by making it easier for financial conglomerates to engage in difficult-to-monitor cross-selling activities of structured products. The only constraint with regard to such deals was market discipline – which now is considered a profoundly flawed prudential tool [Moss 2011:99].

The choice of start and finish dates is motivated by the fact that the study below aims to take into account "implicit" state guarantees – the kind that are anticipated by market participants, but not directly spelled out by officials. Therefore, the research period begins when economic agents could have gotten incentives to grow excessively in size, scope and economic significance – which triggered the "too big to fail" bailout pledges in the first place – and concludes once the pledge is fulfilled, and eventually is made explicit.

With reference to the above argumentation, for the purpose of the numerical example presented below, the assumed start date of implicit government guarantees will be 1 January 2000. As this was not a trading day, market data as of the close on 31 December 1999 will be applied.

The exercising time of the underlying options contracts shall account for the actual rescue triggering date, when state officials committed themselves to support the regarded institution – in this case, 16 September 2008 [Paulson 2010:223–242]. The pledge may not have been granted in full all at once, but for simplicity it shall be treated in this manner. Such an approach remains consistent with the postulated ex-post character of the study.

The assumption concerning the equal strike price for the call and put option should intuitively hold within the proposed framework. In the case of a state bailout, the provided funds account for the money that needs to be spent in order to keep an ailing financial institution afloat. Similar costs should be expected in the same situation, if the financially troubled firm was acquired by a third party. The strike price is independent of the current market value of underlying assets and can be set at any given level agreed in the options contracts. Thus, the possible disparities between the market capitalization of "insured" entities at the beginning of the options contracts and the cost of their bailouts do not constitute a methodological obstacle.

For the purpose of the empirical research conducted later, pledged funding of taxpayer-sponsored bailouts will be used to determine the strike price of options. Financial institutions that become subject to state aid may not utilize the full extent of provided facilities. Still, from the fiscal point of view, it is the ceiling of acceptable bailout costs that marks the government commitment. Thus, whether used or not, the total amount declared by the state shall be included in the calculations.

Due to the fact that implicit government guarantees are granted for long periods, one resulting modeling problem might be to agree on the risk-free rate to be applied to the time value of money. Regular options contracts most often account for expiry dates under one year. In the case of implicit pledges of state support, this time can stretch over several years, during which market-specific benchmark interest rates may fluctuate significantly. In order to align the outcome of the study with reality, the adopted methodology resorts to the original logic of Call-Put Parity. It assumes a justification of the underlying equation by means of arbitrage. The risk-free rate is an essential part of the arbitrage model, as it determines the income from cash positions, or the cost of financ-

ing of non-cash parts of the portfolios involved. Therefore, in order to grasp the rationale of the concept, the cost of funding employed needs to closely track the effective financing rate over the arbitrage period.

As part of the research, which will be based on an example from the U.S. market, a weighted average of daily effective federal funds rates will be applied over the maturity of the options contract. In turn, "The daily effective federal funds rate is a weighted average of rates on brokered trades." [The Federal Reserve, 2012]. This approach enables capture of the true cost of financing the involved arbitrage positions.

The example for the application of the "bailout parity" described above shall be computed based on the case of the failure of American International Group (AIG) in 2008. A number of features exhibited by the rescue operation undertaken by U.S. authorities make the company an ideal object for empirical studies. For once, there are reasons to believe that the insurer was saved because it was regarded as systemically important [Committee on Oversight and Government Reform 2010:131]. The notion is of the first order of importance when taking into account that the scheme described earlier is to measure the value of implicit government guarantees granted to institutions perceived as "too big to fail". Furthermore, the AIG support package included equity commitment on behalf of the authorities, leading to the practical nationalization of the financial group [Davidoff, 2011:1738]. Secondly, there is well-documented data set on the provision of U.S. state-sponsored funding for the purpose of this bailout [Sjostrum 2009]. Such detailed figures are indispensable for conducting necessary calculations. Thirdly, prior to its financial difficulties (as well as thereafter), AIG was a listed company, which makes it easy to access the historical series of data on its market capitalization – one of the inputs.

The computation procedure of the "bailout parity" equation

The grand total of funds made available to AIG by various authorities in the United States amounted to $182.5 billion. The pool was not provided all at once. The sum was a cumulation of multiple liquidity support and recapitalization programs. The timeline of events is presented below.

In order to align the total bailout sum with the computation procedure, the value of all pledged tranches shall be discounted to their present amount – as of the bailout trigger date on 16 September 2008. The discount rate used is calculated as the weight-averaged daily effective federal funds rate for the corresponding period [The Federal Reserve 2012a] – similar to the risk-free rate computed for the parity equation. As continuous compounding shall be used for underlying calculations, the discount rates need to be suitably converted [Watsham and Parramore 1997:7]. All figures are rounded up to four decimal places. The resulting value of state-sponsored financial support shall be used as the exercise price of the bailout option "B".

EXHIBIT 4. Timeline and value of AIG bailout

Date	Value of the support pledge	Description of the event
16 September 2008*	$85 billion	Revolving Credit Facility provided for AIG by the Federal Reserve
9 November 2008	$40 billion	U.S. Treasury decides to recapitalize AIG with equity, as part of the Systemically Significant Failing Institutions program
9 November 2008	–$25 billion	In response to the recapitalization, the Federal Reserve reduces the Revolving Credit Facility to $60 billion
10 November 2008	$22.5 billion	Federal Reserve Bank of New York pledges to buy a portfolio of mortgage-backed securities from AIG's subsidiaries (through Maiden Lane II LLC)
11 November 2008	$30 billion	Federal Reserve Bank of New York agrees to provide funds (though Maiden Lane III LLC) for the purpose of buying back Collateralized Debt Obligations (CDOs) from holders of Credit Default Swaps (CDS) issued by a subsidiary of AIG as insurance of the CDOs. As a result the CDO investors agree to terminate the underlying CDS.
2 March 2009	$30 billion	U.S. Treasury offers an equity facility to be drawn upon by AIG in case of necessity, in return for preferred shares.

Source: United States Government Accountability Office, Federal financial assistance. Preliminary observations on assistance provided to AIG, GAO-09-490T, testimony before the Subcommittee on Capital Markets, Insurance, and Government Sponsored Enterprises, Committee on Financial Services, House of Representatives, Washington, 2009, p. 6–8, and Committee on Oversight and Government Reform, The causes and effects of AIG bailout, Hearing before the Committee on Oversight and Government Reform, One Hundred Tenth Congress Second Session, Serial No. 110–208, U.S. Government Printing Office, Washington, 2010, p. 132.

EXHIBIT 5. Present value of pledged state support to AIG

Start date	End date	Nominal sum	Number of days in the discount period	Interest rate	Present value of the pledge on 16 Sep 2008
16 Sep 2008	16 Sep 2008	$85 billion	0	—	$85 billion
16 Sep 2008	9 Nov 2008	$15 billion*	23	1.5484 %	$14.9854 billion
16 Sep 2008	10 Nov 2008	$22.5 billion	24	1.5419 %	$22.4772 billion
16 Sep 2008	10 Nov 2008	$30 billion	24	1.5419 %	$29.9696 billion
16 Sep 2008	2 Mar 2009	$30 billion	167	0.4857 %	$29.9334 billion

* Net amount of the $40 billion recapitalization and the –$25 billion Revolving Credit Facility Reduction.

Source: own calculations.

The grand total of the above present values of bailout pledges, as of 16 September 2008 amounted to **B = $182.3656** billion.

Using the data series of the daily effective federal funds rate, the cost of financing over the maturity of the underlying implicit guaranty option may be computed – that is, for the assumed period from 1 January 2000 until 15 September 2008. The corresponding, continuously compounded equivalent rate of daily effective federal funds amounts to **r = 3.2977%**. Please note that for cash flows accessible on a given date, the overnight fed funds rate is set on the basis of the benchmark from the previous day[1]. As 1 January was not a trading day, for the purpose of computing market capitalization of AIG on the start date of the implicit government guarantee, the last closing price shall be used (31 December 1999). In effect the "E" loaded into the equation (constituting market capitalization) amounts to **E = $167.50** billion.

The time until expiry of the implicit put option contract (the period 1 January 2000 to 16 September 2008) consists of 3,181 days. Converted into an annual multiple, the variable's value is **T = 8.7151**.

Now that all necessary inputs have been estimated, we can calculate the value of the implicit put option based on the above data:

g = Be^–rT – E = 182.3656*e^–(0.032977*8.7151) – 167.50 = –30.6867 [$ billion]

Since an option cannot be priced below null [Chance and Brooks 2009:74], the conclusion is that the right of shareholders of AIG to place the financial conglomerate in the hands of the state had zero value on 1 January 2000, provided the earlier assumptions hold. In other words, the status of being "too big to fail" did not add value for shareholders.

Naturally, the framework exhibits a number of vulnerabilities. Among the possible stumbling blocks are the following:

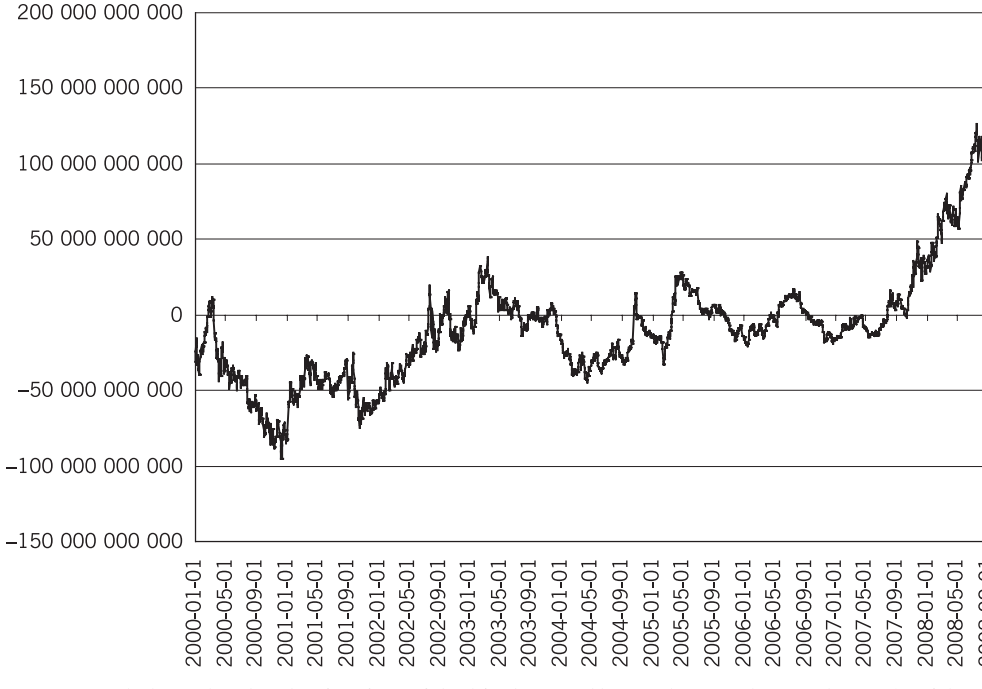
- The concept assumes that the option contract is agreed at a certain date for a fixed period, known to the counterparts – conditions which are in reality not fulfilled.
- The choice of the start and end date is arbitrary.
- It is postulated that the call option is priced at null, whereas such a right may be of use to sovereigns in times of crisis, when nationalizations might prevent the inflicting of social costs on the society [Crivelli and Staal 2009:2].
- Frictions, which gain significance under conditions of market disruption, may distort empirical outcomes of the theoretical considerations.

In order to examine the volatility of the option's value, and mitigate the defect of arbitrary choice of the beginning of the contract, it is possible to analyze the impact of the chosen start date on the estimated worth of the bailout option. This eventually means that the implicit put shall be priced over its maturity period, rather than at just one point on the timeline.

Dynamic analyzis of the "bailout parity" with regard to the "start date factor"

In order to test the dynamics of the equation with reference to the start date, it shall be assumed that each day during the period – 1 January 2000 to 15 September 2008 – could have been the beginning of the implicit option contract. Thus, the theoretical parity value of placing AIG with the U.S. Government shall be estimated over the above-mentioned period. The risk-free rate will be computed separately for each period, using the above methodology based on the effective daily federal funds rate. The valuation shall also be conducted for non-trading days, in order to allow for a continuous measurement. To provide sufficient data for uninterrupted modelling, the last closing figures are to be used in the case of non-trading days. Eventually, a series of "g" values of the put option is computed. The calculations are plotted on the chart 6.

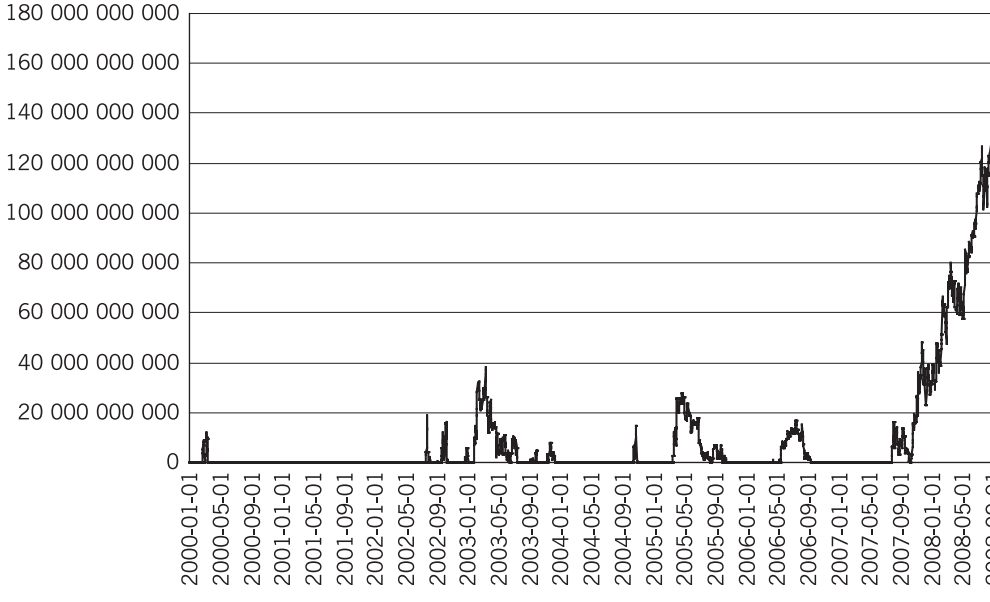
EXHIBIT 6. **Theoretical value of the put option for AIG, depending on the start date of the implicit guarantee (in U.S. dollars)**



Source: own calculations based on data for effective federal funds rate and historical AIG market capitalization (as of closing prices) from, respectively, www.federalreserve.gov accessed on 4 June 2012 and Bloomberg accessed on 12 June 2012.

As stated earlier, an option's price does not turn negative. Therefore, the next chart presents pricing of the put (rather than its theoretical value).

EXHIBIT 7. **Price of the implicit put option for AIG, depending on the start date of the implicit guarantee (in U.S. dollars)**



Source: own calculations based on data for effective federal funds rate and historical AIG market capitalization from, respectively, www.federalreserve.gov,accessed on 4 June 2012 and Bloomberg, accessed on 12 June 2012.

Findings of the dynamic "start date factor" analyzis

Based on the above exhibit, the following remarks might be made:

- The value of the implicit put option is not constantly positive over time
- The pricing of the option turned positive a number of times prior to the 2008 bailout.
- Mounting problems of AIG were reflected by the surging value of the "g" as of summer 2007 (so the implicit put gained value for shareholders in the wake of distress)

The dynamic analyzis of the modified Call-Put Parity equation, with regard to the start of the implicit put option on AIG, indicates that shareholder value attribution of government guarantee option contracts may be subject to significant variation over time. In the case of the 2008 bailout, the underlying option price tended to surge ahead of the provision of state aid. Due to this feature (if applied prospectively), the measure

may become an early-warning indicator of cumulation of distortion factors, with reference to the earlier-mentioned "time dimension" of systemic risk. Finally, not every spike in the pricing of the implicit option must yield a distress situation and trigger exercising of the put.

Suggestions for further research

The Call-Put Parity logic intuitively seems to correspond with the positions of shareholders of financial institutions and bailout decision makers faced with the "too big to fail" dilemma. That is the reason the framework was employed for the valuation of put options, which give owners of systemically important firms an opportunity to place the entities in the hands of state authorities. The outcome of empirical research – conducted on the example of the 2008 bailout of AIG – outlined that the underlying right is not value-creative to shareholders at all times (from the point of view of option pricing). As indicated above, framework constraints might affect the result. More conceptual work is required to refine the parity equation by relaxing several simplifying assumptions. Specifically, further considerations on the assumed null value of the government's call option are still warranted. The concept also ought to be tested on a greater number of bailout cases.

Policy implications

Based on an understanding of the determinants of moral hazard related to implicit state guarantees, policy responses might become better tailored for facilitating the causes of distress within the financial industry. Rather than concentrating on symptoms of systemic crises, relevant authorities may in the future be able to address the distortions of the market players' incentives structure in order to prevent the build-up of systemic imbalances. The above study is a proposition for understanding the logic of a government bailout commitment from the shareholders' perspective. The modified Call-Put Parity formula, and related findings of the empirical research, may be further used for back-testing cases of "too big to fail" bailouts. Ex-ante application of the concept might be made possible based on additional data provided by financial intermediaries as part of their "living wills" [Avgouleas, Goodhart and Schoenmaker 2010:2], especially as far as potential bailout costs are concerned. This could help make the scheme applicable for prognostic purposes.

Note

[1] For similar benchmark-setting solutions (with reference to an interest rate swap example) [Hull 1999:167]. References

References

Avgouleas E., Goodhart C., Schoenmaker D. (2010), Living wills as a catalyst for action, Duisenberg School of Finance, *DSF Policy Paper* No. 4; http://www.dsf.nl/assets/cms/File/Research/DSF%20policy%20Paper%20No%204%20Living%20wills%20as%20a%20Catalyst%20for%20Action%20Update%20May%202010.pdf (accessed on 23 Jun 2012)

Chance D.M., Brooks R. (2009), Introduction to derivatives and risk management, 8th Ed., Cengage Learning Inc.

Crivelli E., Staal K. (2009), Nationalizations and efficiency, Governance and Efficiency of Economic Systems, *Discussion Paper* No. 268; http://www.sfbtr15.de/uploads/media/268.pdf (accessed on 5 Jun 2012)

Committee on Oversight and Government Reform (2010), The causes and effects of the AIG bailout; Hearing before the Committee on Oversight and Government Reform, One Hundred Tenth Congress Second Session, Serial No. 110–208, U.S. Government Printing Office, Washington

Cusatis P., Thomas M. (2005), Hedging instruments and risk management, McGraw-Hill Companies, New York

Davidoff S.M. (2011), Uncomfortable embrace: Federal corporate ownership in the midst of the financial crisis, *Minnesota Law Review*, Vol. 95, No.5, pp.1733–1778

Ellyott D.J. (2009), Bank nationalization: What is it? Should we do it? The Brookings Institution, Washington

Flood M.D. (1990), On the use of option pricing models to analyse deposit insurance, *Federal Reserve Bank of St. Louis Review*, Vol. 72, No. 1, pp. 19–34

Fratianni M., Marchionne F. (2010), The banking bailout of the subprime crisis: size and effects, *PSL Quarterly Review*, Vol. 63, No. 254, pp.182–233; http://bib03.caspur.it/ojspadis/index.php/PSLQuarterlyReview/article/download/9427/9322 (accessed on 26 Jun 2012)

Gapen M.T., Gray D.F., Lim C.H., Xiao Y. (2004), The contingent claims approach to corporate vulnerability analysis: estimating default risk and economy-wide risk transfer, International Monetary Fund, *IMF Working Paper* WP/04/121, Washington

Gray D.F., Merton R.C., Bodie Z. (2007), Contingent claims approach to measuring and managing sovereign risk, *Journal of Investment Management*, Vol. 5. No. 4, pp.5–28

Hatgioannides J., Karanasou M. (2011), Warrant economics, call-put policy options and the fallacies of economic theory, IZA, *Discussion Paper* No. 6251, Bonn

Hull J. (1999), Kontrakty terminowe i opcje wprowadzenie, WIG-Press, Warszawa

Hurley C. (2010), Paying the price for too big to fail, *Entrepreneurial Business Law Journal*, Vol. 4:2, Columbus OH

Ianieri R. (2009), Options theory and trading, John Wiley and Sons, New Jersey

IMF Monetary and Capital Markets Department (2011), Macroprudential policy: An organizing framework, International Monetary Fund; http://www.imf.org/external/np/pp/eng/2011/031411.pdf (accessed on 13 Jun 2012)

Kay J. (2009), Narrow banking: the reform of banking regulation, Centre for the Study of Financial Innovation, London

Klemkosky R.C., Resnick B.G. (1979), Put-call parity and market efficiency, Journal of Finance, Vol. 34, Issue 5, pp. 1141–1155

Knoll M.S. (2002), Put-call parity and the law, The Law School and the Wharton School, University of Pennsylvania; https://www.law.upenn.edu/fac/mknoll/put-callparity.pdf (accessed 2 June 2012)

Miller M.H. (1988), The Modigliani-Miller propositions after thirty years, American Economic Association, *The Journal of Economic Perspectives*, Vol. 2. No. 4, pp. 99–120

Moss D.A. (2011), An ounce of prevention: financial regulation, moral hazard, and the end of "too big to fail" in: Porter R.B., Glauber R.R., Healey T.J., New directions in financial services regulation, MIT Press, London

Paulson H. (2010), On the brink. Inside the race to stop the collapse of the global financial system, Headline Businesses Plus, New York

Pelaez C.M., Pelaez C.A. (2009), Financial regulation after the global recession, Palgrave Macmillan, London

Shahabian M.R. (2011), The government as shareholder and political risk: procedural protections in the bailout, *New York University Law Review*, Vol. 86, pp. 351–385

Sjostrum Jr. W.K. (2009), The AIG bailout, *Washington and Lee Law Review*, Vol. 66, Issue 3, pp. 943–991

The Federal Reserve 2012; http://www.federalreserve.gov/releases/h15/data.htm#top (accessed 4 June 2012)

Tu A., Chin D. (2004), Mean revision tests of call-put parity for equity index options with randomization of Bayesian Gibbs sampling viewpoint: S&P500 versus DAX, National Chengchi University; http://www.finance.nsysu.edu.tw/SFM/15thSFM/14thSFM/13thSFM/12thSFM/Papers/CompletePaper/113-1426899573.pdf (accessed 13 Jun 2012)

United States Government Accountability Office (2009), Federal financial assistance. Preliminary observations on assistance provided to AIG, GAO-09-490T, testimony before the Subcommittee on Capital Markets, Insurance, and Government Sponsored Enterprises, Committee on Financial Services, House of Representatives, Washington

Verret J.W. (2010), Separation of bank and State: The bailout meets federal budget law; http://works.bepress.com/cgi/viewcontent.cgi?article=1002&context=john_verret (accessed 16 Jun 2012)

Watsham T.J., Parramore K. (1997), Quantitative methods in finance, 1st ed., Thompson Learning, Bedford

Wilson L. (2010), The put problem with buying toxic assets, *Applied Financial Economics*, Vol. 20. No. 1

Abstract

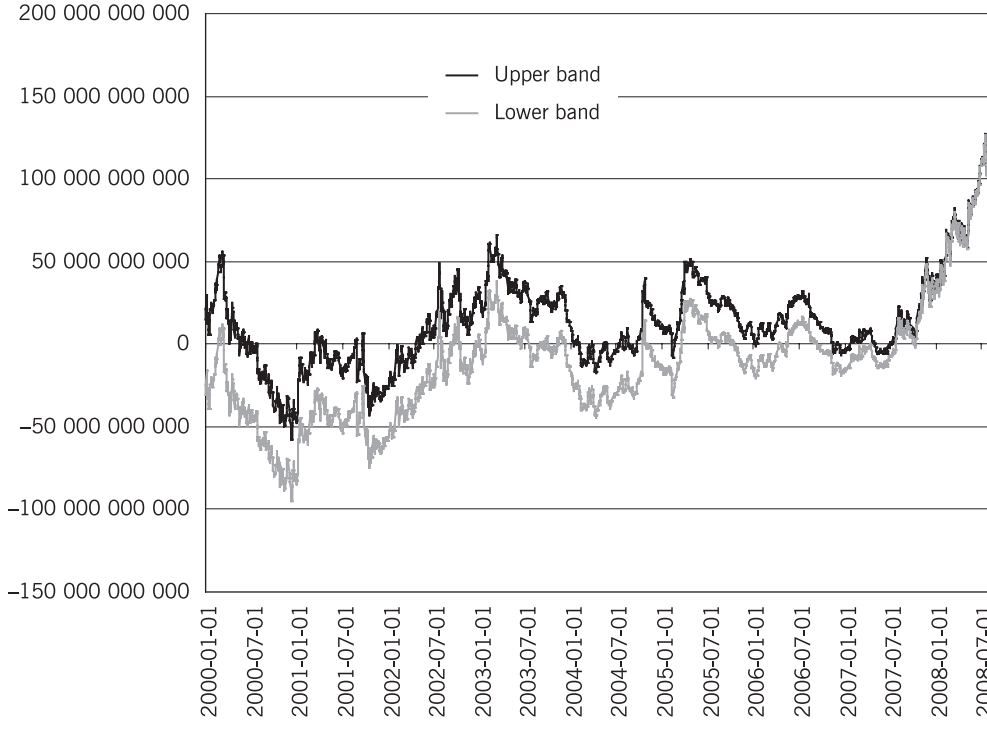
The article outlines the issue of moral hazard related to implicit state guarantees for so-called "too big to fail" financial institutions in the context of Call-Put Parity. Shareholders of the involved entities and state decision makers are presented as counterparts of an implicit put option contract. By modifying the original parity equation, a formula is developed for quantifying the value to investors of a state bailout pledge. An empirical example is presented, based on data concerning the 2008 rescue of American International Group.

The study finds that pledges of state support do not always yield value for equity holders. Furthermore, the price of the put option may become subject to significant variation over time. Finally, in the case of AIG, the underlying implicit contract significantly gained in value prior to disclosure of the company's distress.

Keywords: moral hazard, too big to fail, call-put parity, systemic risk

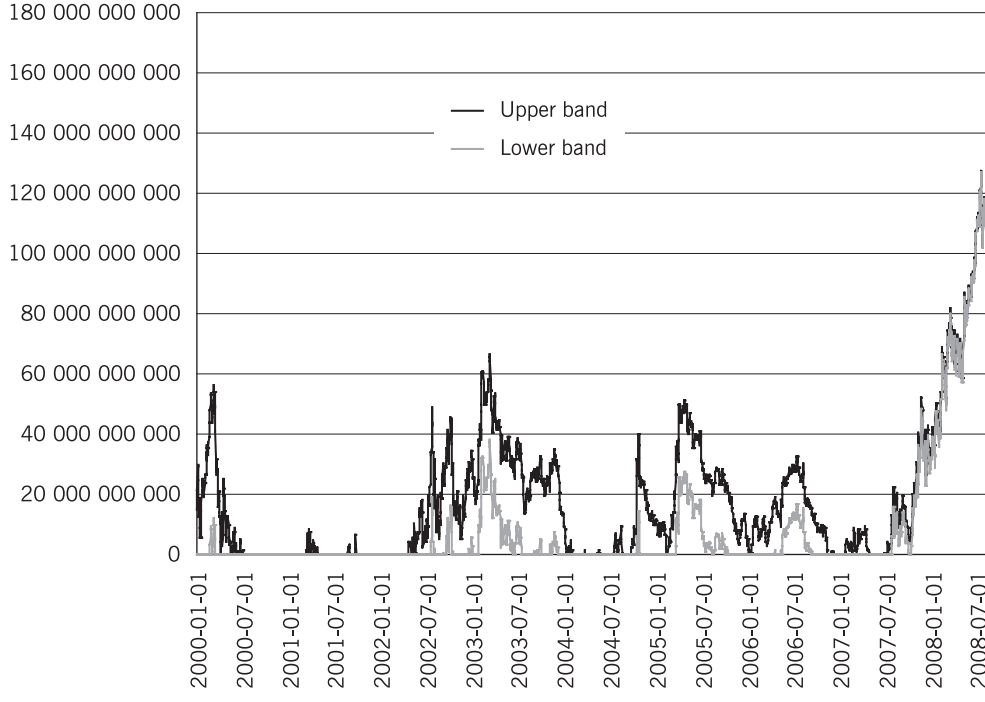
Appendix 1

EXHIBIT 8. **Theoretical value boundaries of the American-style put option for AIG, depending on the start date of the implicit guarantee (in U.S. dollars)**



Source: own calculations based on data for effective federal funds rate and historical AIG market capitalization (closing prices) from, respectively, www.federalreserve.gov (accessed 4 June 2012, and Bloomberg, accessed 12 June 2012).

EXHIBIT 9. Price boundaries of the American style implicit put option for AIG, depending on the start date of the implicit guarantee (in U.S. dollars)



Source: own calculations based on data for effective federal funds rate and historical AIG market capitalization from, respectively, www.federalreserve.gov (accessed on 4 June 2012 and Bloomberg, accessed on 12 June 2012).