
Regulatory arbitrage and model sophistication in the financial crisis

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Abstract This paper investigates the financial institutions' strategies behind the recent financial meltdown. These strategies have certain features in common. First, before 2007, they were all considered as arbitrage opportunities. Secondly, regulation loopholes and model sophistication were vital for their profitability. Thirdly, markets were unable to assume their traditional role of suppressing these opportunities, at least before the imbalance they generated had become so heavy that they collapsed under their own weight. This paper argues that any reform of the regulation of financial institutions will open the field to a new wave of financial innovations, all with the primary goal of circumventing the new regulations — something that regulators and financial institutions would do well to remember. Beside global reforms, one must look carefully at more microeconomic considerations. In this respect, auditing the performance and return on (regulatory) capital of main desks and business lines/products within financial institutions could be a practical way to track extraordinary return-on-equity, which in turn is probably the most accurate guide to knowing where the next accident will take place.

Keywords: *risk management, financial crisis, regulatory arbitrage, regulation*

INTRODUCTION

The 'no arbitrage' or 'no free lunch' assumption is the stone on which the derivatives business and more generally the whole finance industry have been founded. From the Black-Scholes and Merton frameworks for modelling equity derivatives and credit derivatives to the Heath, Jarrow and Morton models for interest rate and exchange rate derivatives, these models and frameworks all share the very same assumption that

one cannot make a sure profit from a zero-cost strategy. In other words, under the assumption of 'no arbitrage', anyone thinking they have found such a strategy is mistaken — they are actually taking on risk and will face the consequences in the near future.

This assumption has a straight corollary: should such an opportunity for arbitrage (or a free lunch) ever appear somewhere and someday, then there will always be investors who will swiftly book an

immediate profit out of it, ensuring that no arbitrage opportunity can ever last for long. In other words, the assumption of no arbitrage can be stated in a milder form: one cannot make a sure and *sustainable* profit from a zero-cost strategy.

The aim of this paper is to discuss this assumption in the light of the strategies which have exploded in banks', monolines' and insurers' balance sheets and which are at the centre of the financial wreckage of the past couple of years. Indeed, negative basis trades, conduit or credit derivative product company-based strategies, credit default swap (CDS)/financial guaranty deals, etc were once considered and sold as profitable, non-risky and incredibly cheap strategies. Any risk manager of any bank has at some point heard the fairy tale once told by front-office vendors: 'a conduit-based strategy produces a sure profit for zero-equity and, as such, has an infinite return-on-equity'.

It comes as no surprise that these strategies once seen as (quasi-)arbitrage opportunities have eventually gone bust. This is exactly what the assumption of no arbitrage says, that is, that arbitrage opportunities do not actually exist (or are only temporary), and if ever one market participant believes they have found one, it is most likely because they have failed to recognise that the strategy actually bears significant hidden risks.

In some sense, the financial crisis does not contradict the assumption of no arbitrage. More precisely, it accords to the following version of the assumption of no arbitrage, which is quite different from that stated above, and it is precisely this difference which is at the core of this paper. Indeed, the financial crisis teaches that one *can* make a sure and durable profit from a zero-cost strategy ... but *not for ever*.

Indeed, it is all about time and horizon. In the conventional statement of the assumption of no arbitrage, an arbitrage opportunity cannot last more than (say) a few days. Yet in the 'contemporary' assumption of no arbitrage, as exemplified by the current crisis, an arbitrage opportunity can last much longer than a few days — perhaps a few months or even years. In fact, it can last so long as to create a huge market imbalance which eventually crashes down in freefall.

This is the interesting point, and understanding the reasons why apparent opportunities for arbitrage lasted for so long is crucial to pave the way for a safer future in the financial world.

NO OPPORTUNITY FOR ARBITRAGE IN FINANCIAL MODELLING

The assumption of no arbitrage has the convenient feature of being economically sound and mathematically powerful. As an economic assumption, it simply states that, whatever economic agents' preferences, aversion towards risk, or subjective discount rates may be, economic agents all share some minimal rationality that should someone be presented with a positive profit at no cost and with no risk, they are expected to rush out to take advantage of it, eventually killing the opportunity as soon as markets function properly and adjust accordingly. Therefore, such an opportunity for arbitrage should either not exist in the first place or, in the event that it should appear, it should then disappear promptly.

Any pricing and hedging modelling used on any trading floor for the last 30 years has been constrained to satisfy this assumption. In other words, no one

would agree to trade derivative products on the basis of a model that failed to satisfy this assumption. Incidentally, many competing models, for example models based on non-conventional price dynamics, such as fractal or chaotic or fat-tail distribution, have long been rejected by quants and traders because of the difficulty of plugging the assumption of no arbitrage into these frameworks, even though many eminent academics have repeatedly demonstrated that market price dynamics are evolving more like fractal, chaotic or long-memory distributions, allowing black swan events to happen more easily than more conventional Gaussian-based models.

Indeed, the assumption of no arbitrage is not only an economically appealing hypothesis, it is also a highly powerful mathematical tool. All quants have at some point been illuminated by the pricing formulas derived from this assumption — formulas seemingly too elegant to be misleading. In short, the assumption of no arbitrage implies that prices can be expressed as the discounted value of the future expected cash flows generated by the asset, where the expectation is calculated with the so-called risk-neutral (or forward-neutral) probability distribution, which in some sense sums up all agents' preferences and risk aversion.

As such, the no-arbitrage pricing framework is at the heart of what International Financial Reporting Standard (IFRS) rules consider as a fair value and one may also find some explicit reference to this theory in the Basel II framework (for example, when Basel II describes how loss given default parameters should be computed when future recoveries are uncertain and bear systematic risks).

Unfortunately, this pricing framework is sometimes used as a kind of magic — it goes without saying that the theory applies only if certain other assumptions are also satisfied. In particular, the theory states that the no-arbitrage prices cannot be uncovered univocally when markets have dried up or do not exist. In short, the IFRS level 2 and level 3 types of assets — for which marked-to-market prices are not readily available — are exactly the situation where no-arbitrage mark-to-model prices should be used with great caution.

A discussion of the various pitfalls resulting from inappropriate use of the no-arbitrage framework is beyond the scope of this paper. One should keep in mind that detecting and taking advantage of arbitrage opportunities were at the core of what traders and quants were asked to do over the past two or three decades.

The story becomes highly interesting when one realises that regulatory rules, accounting rules and discrepancies between the models used by market participants appear to generate opportunities for arbitrage. Moreover, these arbitrage opportunities are of the long-lasting sort, as there are no available market mechanisms to ensure they disappear rapidly. As they last too long, they lead to an ever-growing market imbalance, culminating in a meltdown such as that which has been ongoing for the past couple of years.

REGULATORY AND MODEL ARBITRAGE IN PRACTICE

In some sense, most fees earned by the banking industry in recent years have been derived from building and exploiting arbitrage opportunities created by regulations and model loopholes. It is

no exaggeration to state that banks' corporate and investment branches were mostly dedicated to this 'arbitrage business' and in the most part bonus and compensation packages paid to traders and quants people were justified by the (apparent) positive profit and loss generated by these activities.

These arbitrage opportunities fall into different categories and eventually end up differently.

First, consider banking regulation-based arbitrage, eg the simple arbitrage strategies made possible within banking regulation. These consist of purchasing (say) some mortgage-based securities and booking them into a trading portfolio instead of a banking book. Such securities had a very significant credit risk component and could be viewed either as mortgage-like assets (thus consistent with a banking book classification) or as a trading product, as they seemed easily tradable on a day-to-day basis. As is now recognised, these markets were not so liquid, and even at the time when they were purchased and sold, it was dubious to consider such securities as trading products. Nonetheless, they were booked as trading products because trading products fall under market risk regulation; as such they were weighted lightly in comparison with the capital they would have been charged had they been booked as banking products. As a result, this strategy could show a persistent abnormally high return-on-equity. This may explain why so many proprietary trading desks in banks around the world, even in regional or retail banks whose core business was definitely not making money from proprietary trading, purchased huge loads

of asset-based securities as a recipe for boosting returns-on-equity.

Moreover, as this strategy was booked in a trading portfolio, the internal funding rate was based on the short-term interest rate even though in retrospect these assets turned out to be highly illiquid and comfortably installed in banks' balance sheets for the next few decades (except where a government-sponsored defeasance structure is set up). Had they been booked in a banking portfolio, the internal funding unit would maybe have charged a much higher long-term interest rate, which together with the higher capital charge would have considerably reduced the incentive to enter these strategies in the first place. The game played by banks between their trading and banking books is now well documented and has been explicitly cited by Basel Committee architects as a primary cause for concern in reforming market risk regulations.

In some ways, these arbitrages can also be interpreted as a form of internal arbitrage between the trading floors of the bank, with the internal funding unit on one side and the capital management unit on the other, in other words, those units responsible for funding business lines and allocating capital. In this respect, the publicly released 'Shareholder Report on UBS's Write-Downs'¹ is interesting, highlighting the way internal mispricing for funding and inappropriate regulatory capital charges can drive business lines into very dangerous waters.

The financial crisis has also shown other lasting arbitrage opportunities involving different pieces of regulation, such as the banking and insurance regulations. Although these two

regulations focus by definition on different kinds of risks, they nevertheless share some of them. Typically, credit/counterparty risks are in the scope of the two regulations but are not weighted identically in terms of capital charge, whether one is a bank or an insurer. The negative basis trades are typical examples of these multi-regulation arbitrage opportunities. These strategies consisted of purchasing credit-linked securities, say collateralised debt obligation (CDO) tranches, and simultaneously purchasing protection, namely a credit default swap, written by an insurer, typically one of the so-called monoline insurance companies.

This trading strategy had a very low contribution to market risk as any change in the CDO's value was supposed to be offset by the opposite change in the value of the protection contract. Moreover, as monolines were rated AAA, the net exposure (ie the CDO plus its CDS based protection) was almost zero and was reduced to AAA exposure, which then did not deserve a significant capital charge regarding counterparty risk. Although this strategy was supposed to bear almost no risk in the sense of the regulatory capital requirement necessary to cover it, it did, however, have a positive spread, meaning that there was a mispricing somewhere. That this arbitrage lasted for so long before explosion, ie before monolines and AIG financial products-like companies (almost) defaulted all together, proves that the usual market mechanisms did not function properly in their mission of driving out arbitrage opportunities and mispricing.

Negative basis trades are of particular interest as they illustrate how multiple regulations and different credit-risk models have combined together for the

worst. First, one may blame the gap between the models used by corporate and investment banking branches for pricing and evaluating potential CDO and CDS credit losses and, on the other hand, the models (or more precisely the absence of models) used by monolines in their symmetrical assessment of the risks embedded in the protection they sold. Therefore, negative basis trade may also be understood as an arbitrage of models built by banks at the expense of monolines as the models used in banks were definitively more sophisticated and accurate than those used in monolines. Furthermore, banks were clearly aware of this fact — simply put, sophisticated markets operate under a sort of 'law of the jungle', insomuch as anyone who fails to use state-of-the-art models will be promptly arbitrated by all other market participants.

Secondly, model arbitrage also took place between banks and rating agencies' models. The rating models used by rating agencies were either flawed or so widely publicised that they could be easily reverse-engineered, again at the expense of monolines, which used to take agencies' ratings for granted. Quants people in banks had been structuring CDOs with the explicit goal of obtaining a predefined rating target, and they were able to do so precisely because the market participants all knew the rating agencies' models. Nothing illegal or immoral there, but as no model is perfect (least of all the rating agency models), this led to a large gap between the stated rating and actual riskiness of the product, into which structured credit desks in banks entered massively.

Thirdly, banking and insurance regulations are not similar, meaning that insurance-regulated monolines did not

consider CDS the same way as the banking regulation did. In the most sophisticated deals, a so-called 'transformer' vehicle was set up for transforming financial CDS into (insurance-regulated) financial guarantees, in order to capture the best of both worlds.

Internal rate funding was not adequately priced for the same very reason as outlined at the beginning of this section: a short-term internal funding rate was charged to the desk while negative basis trades were difficult to unwind at short notice.

Arbitrage of models, arbitrage between different regulations and arbitrage within banks' internal funding systems combined to let negative basis trade deals last for too long and make them look like arbitrage opportunities.

The conduit-based industry is another example of arbitrage between multiple regulations, and here accountancy rules were deeply involved. A conduit was a special investment vehicle (SIV) to which risks related to credit-linked products such as CDOs (again) were transferred. The vehicle was refinanced by issuing short-term commercial paper sold to investors. The banks which transferred their credit risks bore a part of the special purpose vehicle's (SPV's) equity and extended a backup liquidity line to the SPV (preferably a less-than-one-year liquidity line).

Avoiding the unnecessary sordid details, one may sum up the deal in the following way: rather than having these risks in their balance sheets, banks would transfer them into the conduit; a significant share of profit generated by the conduit would then come back to them, while commercial paper investors would earn an interest income. The trick

was then to convince accountants and auditors that the risks had been genuinely transferred and therefore did not need to be consolidated in the balance sheet. This was done under the umbrella of the accounting rule which states that consolidation can be avoided if one can prove that one does not bear the majority of risks and benefits coming from the SIV. When accountants and auditors were not 'spontaneously' convinced by the demonstration provided by front offices, a little 'friendly' and warm pressure was generally sufficient to convince them that consolidation was not really a good idea . . .

At the end of the day, banks earned a positive profit out of a conduit whose regulatory capital requirement was actually zero due to the fact that the backup liquidity line was contractually fixed for less than one year (which implied zero capital charge). However, the return of this strategy stayed positive for a long time, partly because of the large-scale maturity transformation between underlying assets (CDOs) which were actually long-dated assets and liabilities made of short-dated commercial paper. The liquidity premium was the core of the profit, while there was no capital charge in the face of the subsequent liquidity risk. As a result, front offices repeatedly explained for years that this strategy had an infinite return-on-equity, in other words, it was an arbitrage opportunity. Alternatively, in the words of the Lord Turner Review: 'SIVs [Conduits] were a clear case of regulatory arbitrage'.²

What conclusion can be drawn from all these strategies involving hundreds of billions of dollars of nominal amounts of CDO-like credit structured products?

First, as thoroughly detailed in the Lord Turner Review, regulatory arbitrage or model-based strategies were not, in the long run, true arbitrage opportunities because at the very end they all collapsed and incurred such huge losses that the banking industry itself verged on total meltdown. Nevertheless, one must accept the fact that these strategies were considered as risk-free profitable strategies (ie arbitrage opportunities) for quite a long time — closer to several years than just a few days or weeks. Consequently, this teaches that these spurious arbitrage opportunities have not been driven out of financial markets in the usual way, that is, when and where conventional arbitrage opportunities emerge, market participants exploit them rapidly and market prices quickly adjust to make these opportunities unprofitable. In non-conventional arbitrage opportunities, ie those where regulations and/or models and/or internal regulations are involved, these strategies can last longer, appearing as a genuine opportunity for profitable arbitrage. Above all, precisely thanks to regulation distortion, modelling or internal regulation loopholes, these non-conventional arbitrage opportunities are not solved (and driven away) through usual market adjustments but through the ultimate collapse of the global imbalance (ie a financial crisis) they helped to generate.

WHAT NEXT?

Regulators are now working on new regulations to prevent these dangerous strategies by making them unprofitable in the first place. Following are examples of proposals expected to become formalised in the coming months:

- *Preventing internal arbitrage, in particular between trading and banking books:* As an example, the final Basel II consultation papers on market risk and incremental risk charge (IRC) propose stricter rules and heavier capital charges for credit-linked expositions in trading books, which at the very end might remove all economic incentives in the trading/booking game within banks.
- *Killing conduit-based, unconsolidated vehicles:* The Lord Turner Review emphasises the need for an ‘economic substance over form’ appreciation of risks,² which is a diplomatic call for more stringent rules when deconsolidating risks out of the balance sheet.
- *Focusing more on models’ pertinence:* Although the Lord Turner Review offers a deep investigation of models’ flaws, inconsistent underlying assumptions, misplaced reliance on sophisticated mathematics etc, it does not propose any significant regulatory change at this stage, which comes as no surprise considering the difficulty of enacting laws and rules regarding the mathematic models used by quants people around the world.
- *Improving the pertinence of fair value figures, etc.*

There is an abundant literature these days issued by academics, regulators, supervisors and central bankers which will be soon translated into formal rules. Banks should prepare to meet much higher regulatory standards in the future and those banks that fail to do so on time will not stay intact.

In addition, it is worth keeping in mind that, as usual, new regulations are focused on preventing a repeat of past failings and thus say little about any future crisis. In particular, if the underlying idea behind the discussion in

previous sections of this paper is valid, ie that a large part of banks' business is dedicated to exploit arbitrage opportunities and loopholes made available by regulations (both external and internal) and model sophistication, then one can expect a new industry to emerge among market participants (banks, funds, insurers etc) with the aim of playing on the large new field opened by regulatory innovations. Intuitively, one is inclined to think that over-regulation discourages innovation. Yet in the financial industry the opposite is true: regulation encourages (maybe perverse) financial innovation. Indeed, according to the de Larosière Group, 'over-regulation, of course, should be avoided because it slows down financial innovation and thereby undermines economic growth in the wider economy'.³ The argument is obviously sound in theory, but in the day-to-day life of financial markets, it is far from clear.

The good news is that it may bring fat fees to improve banks' financial accounts (and incidentally large bonuses to improve bankers' personal accounts), but given that future regulation will be even more complex than existing regulation, it is difficult, not to mention a little scary, to imagine what the next crisis may look like.

One does not need a crystal ball to predict that the financial innovation on which the next generation of quants people will be working will be oriented towards the following:

- Circumventing new market risk and credit risk regulation.
- Exploiting differences between Basel II and Solvency II regulations. The fact that Solvency II allows for internal economic

capital models whereas Basel II did not go that far is a great opportunity to give birth to a chimerical beast, part-insurer, part-banker, designed with the best of both worlds in mind.

- Playing with differences between renovated IFRS rules and banking/insurance regulations. The fact that the Basel II consultative papers on market risk and IRC are discussing a new concept of 'prudent valuation framework', which might not accord with the IFRS definition of fair value, opens the field for home-cooked financial accounts and prudential statements.
- Playing with hybrid capital, bond-like equity or equity-like bonds for an 'efficient' monitoring of solvency ratios and tiers, etc.

WHAT TO DO?

Past financial crises tell a pessimistic story of what could happen next: first, a new set of regulations gives birth to a new wave of financial innovations with much greater complexity; then the financial industry becomes populated with new shadow banking/insurance bodies specifically designed to take on risks (and ideally profit from them, at least for a while) in those areas where the regulation is at its weakest; finally, the whole industry eventually collapses under its own weight and the imbalance it has contributed to create.

This does not mean that regulation is counterproductive or dangerous; rather, this is simply something to bear in mind when designing sophisticated new regulations. Besides, some hope does actually exist. Indeed, banks' risk

management divisions will be reinforced thanks to what has happened over the last couple of years. In many cases, risk managers did not fail to predict what would go wrong; rather, they were not paid enough attention or given CEO-level support to deter front offices from taking excessive risks. Conflicting relations between business people and controllers is a classic story, as old as the financial industry itself, but one would hope that most banks' managers now understand that banking is about managing risks and that risk management should be at the core of any business model that aims to generate sustainable profit. In this respect, one may hope that supervisors and governance bodies will do their best to help those inside banks whose role is to ensure that risk management is in the DNA of any risk-taking business.

Turning to fundamental economics, one should recognise that regulation and specifically capital adequacy rules are a tentative way to set the 'price of risk', not from a market-driven mechanism (eg where supply and demand eventually reach an equilibrium price) but from a top-down process by which regulators define authoritatively the amount of capital required to cover risk. In this respect, future regulation will be directed to increasing the discretionary price of risk. At the end of the day, taking risk will supposedly be more expensive, meaning that financial institutions should be willing to take less risk in the first place or pay a higher price for it (eg set aside more capital on the face of it). So the story goes.

However, fundamental economics and history warn about the dangers of interfering in the price-setting mechanism at the core of any market

economy, whether these markets are dedicated to goods, services or financial instruments, the latter corresponding exactly to the 'goods' invented by economic agents for exchanging risk. Dangers linked to interference are typically those termed in the economic literature as 'inefficient allocation' of the underlying good, or 'inefficient allocation of risk' in this context. In other words, as the price of risk is not derived from a market-driven discovery mechanism, one may end up in a situation where price is either understated or overstated, which means three things:

- The mispricing of risk implies that some economic agents take too much risk while others take too little.
- The capital adequacy ratio, which is supposed to match capital requirement with the risks actually taken, loses its pertinence and lacks adequacy. Not surprisingly, any report issued after a financial accident never fails to stress the fact that current regulation 'underestimates some important risks and overestimates banks' ability to handle them' (following the lines of the de Larosi re Group, for example). Regulation is never sufficient to mitigate *all* potential risks as such a target is constantly moving. Top-down price-setting (and regulatory capital requirements are a tentative way to set the price of risk) always generates a gap between demand and supply, eg between the 'regulatory price' and the market price which would ensure equilibrium.
- Imbalance, ie disequilibrium between supply and demand for risk, emerges almost surely and thrives as soon as risks are mispriced, which at the very end

means bubbles and exuberant behaviour in financial instrument markets.

A relatively simple analogy would be to consider financial instruments as a tool to exchange risk and to equate financial markets with 'risk markets' (ie markets where risks are sold and purchased). If such analogy bears some truth, it implies again that regulation, although highly necessary, may yet have nightmarish and unwanted outcomes.

There is no straightforward solution to address the issue as a no-regulation free-banking world is certainly not an option. At the macroeconomic level, regulation should promote market-driven mechanisms and symmetrically discourage over-the-counter transactions. This is exactly what regulators are doing right now when putting pressure on market participants to establish regulated clearing houses for trading credit default swaps. As with any market-driven solution, it allows for greater transparency and standardisation, and increases the chance for the price-setting mechanism to work properly, which should eventually price risk closer to an efficient market price than the authoritative price fixed by regulators through adequacy rules.

Secondly, at the microeconomic level, supervisors (and before them, banks' top executives and board members) should pay great attention to returns and performance measures of all banking activities, and probably at the finest level of granularity. Outstanding returns are the most accurate indicators of dysfunctional markets and therefore the best predictors of future accidents. Whether one looks at proprietary trading or conduit-based or negative basis trade business before 2007, one cannot fail to

note the astonishing (sometimes infinite) returns-on-equity of these strategies. In practice, supervisors and top management should focus on desks or product lines that show extraordinary returns relative to their capital requirement and should demand appropriate explanations from business managers as to whether their outstanding performance comes from plain high value-added innovation or from internal arbitrage, external regulatory arbitrage or model sophistication.

In short, top executives should ask their budget control managers to list (say) the top ten best performers (in terms of return on capital and provided that all costs and benefits are properly taken into account), then ask these business managers/heads of desk to explain the rationale of their performance, and pass on these justifications for validation and audit to independent experts from risk, finance and internal audit divisions or even to external experts and auditors to feed board discussions. Although setting a performance auditing process implies some work to build sound measures of return-on-equity, the efforts pay dividends. In particular, performance measurement requires the comprehensive measure of capital requirement (eg capital requirement may be an aggregation of requirements coming from market risk, credit risk and operational risk regulations), cost of risk, cost of internal funding, managing costs etc, and, last but not least, these elements have to match exactly with what feeds accounting reports and, of course, contributes to remuneration calculation.

Finally, from the supervisor's point of view, one may guess that if some strategy shows incredible returns-on-equity and is

performing equally well among all market participants, then it may ring as a warning bell that some regulatory arbitrage or model wrongdoings are taking place and that corrective actions are likely to be needed.

These modest microeconomic recommendations may well appear to lack the ambition and flamboyance of other recent proposals, such as macro-prudential policy, risk-based remuneration design, cyclicity-adjusted capital requirements etc, but they surely promote safer risk-taking business at a lower cost and would provide banks' or insurers' executives, board members and supervisors with an early warning guide

to where the next accident will take place.

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