An analysis of deviations in market bubble moments and their heteroscedasticity

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Résumé: Nous émettons l’hypothèse que les bulles financières de marché sont le possible résultat de l’interaction entre les produits bénéfiques au consommateur, nommés les Biens (« Goods »), et les produits toxiques (« Bads ») qui se développent à travers trois moments qui se succèdent de manière systémique : l’attroupement (« herding »), l’essaimage (« swarming ») et la calvacade (« stampeding »), avec des déviations caractérisées par de l’hétéroscédasticité. Nous utilisons notre modèle stylisé de prédation financière, (« Consolidated Model of Financial Predation, CMFP), et les données que nous avons accumulées au cours de huit ans de recherche sur le terrain et l’étude de 30 ans d’histoire du marché américain afin d’explorer les fondements des crises financières de marché. Nous constatons que la confiance aveugle (ou le biais de positivité) et la peur de passer à côté d’une opportunité d’entrer ou sortir d’un marché ont un impact sur les décisions des investisseurs d’investir ou de se rétracter. Nous montrons comment les marchés sont orientés vers une dynamique de prédateur qui crée des gagnants et des perdants, en partie à cause de la faiblesse des réglementations les régissant. De plus, nous identifions une constante $k$ qui imprègne les comportements des marchés.

Abstract: We conjecture that market bubbles may be the results of the interplay of Goods and Bads (toxic products) which develop through three interlocking moments – herding, swarming, and stampeding, with deviations marked by heteroscedasticity. We use our stylized model of financial predation, the Consolidated Model of Financial Predation (CMFP), and data we have accumulated through in-the-field eight-year research and the study of 30 years of U.S. market history in order to explore the foundations of market crises. We find that blind trust (or the positivity bias) and of the fear to miss out on an opportunity to enter/exit a market impacts the investors’ decisions to invest or retract. We show how markets are driven towards a make-or-break predatory dynamic that creates winners and losers due in part to weak regulations and identify a constant $k$ that permeates market behaviors.

Keywords: Bads, Goods, financial predation, consolidated model of financial predation (CMFP), crisis, regulation, “badfare”

Mots clés : Produits toxiques, produits financiers, modèle consolidé de prédation financière (CMFP), crises financières, réglementations
1. INTRODUCTION

There have been countless market crises in the last centuries, including the Tulipomania in 17th century Holland, the Mississippi Bubble in France in the 18th century, the S&L fiasco in the USA in the 1980’s and the 2000’s “.com” experience (Rosier, 1987; Kindleberger, 2004; Rajan, 2010). The 2007-2009 U.S. subprime crisis provides an exemplary model of things going awry. It impacted consumers, communities, businesses and governments with dire effects (Brown, 2010). Most of those crises point to the failure of governments to control the increased toxicity of their markets (Samoa and Shoaf, 2005).

While many authors have offered their views on the causes of market crashes, few have ventured into modeling them in a systematic way.

Explanations typically encompass such ideas as:

i. The market agents’ behaviors and/or ethics: “the failure of either to behave diligently or in good faith at any point in the exchange” (Ericson and Doyle, 2003, p. 11); the tendency to indebtedness Minsky (1975); the window dressing (Neal and Wheatley, 1998); the creative accounting (non-book entry of CDO’s) (Akerlof and Shiller, 2009).

ii. The market agents’s profile: the peer pressure (Scherbina, 2013); various factors (Aguilera and Vadera, 2008); Machiavellian personalities (Christie and Geis, 1970) – cold, calculative, sneaky, and selfish).

iii. The presence of structural problems: the asymmetry in portfolio managers’ incentives (Allen and Gate (1999); the ease and speed of transactions (e.g., Internet) and the ease of access to money (Ferguson (2012); the inability of arbitrageurs to time the market (Abreu and Brunnermeier, 2003); the income inequality (Iacoviello, 2008; Roy and Kemme, 2012); the network effect (Olsen, 2012); the use of complexity, often to hide the real risks (Akerlof and Shiller, 2009; Corneil and McNamara, 2010); the changes in market conditions (employment, interest rates,
etc.) (Reinhart and Rogoff, 2008, 2009); the banks’ poor management (Jizi et al., 2014); the inadequate firms’ risk ratings, especially by the Big Three – Fitch, Moody’s, and Standard and Poor’s (Tremoulinas, 2009; Hellwig, 2009; Gayraud, 2011); the management exuberant bonuses (Graafland and van de Ven, 2011); a financial culture of Corporate psychopathology (Boddy, 2011); protected financial networks and their schemes along with poor risk management (Rajan, 2010).

iv. The government: the absence of protection or legal recourse for victims, the lack of due diligence, the lack of enforcement and punishing power, and the trend towards deregulation (Ferguson, 2012); the Federal Reserve Bank’s inability to control the money supply (Friedman and Schwartz, 1963); the government’s laissez-faire (Gayraud, 2011); the slow speed of the government response (Taylor, 2009); the unjustified tax breaks (Stiglitz, 2003); unruly deregulation (Krugman, 2009).

In regards the subprime crisis in the US1, the International Monetary Fund (IMF, 2009, Chap. 2, p. 92) has offered an explanation for it, which emphasizes the existence of spreads (stretches) and traps (more particularly, the need to refinance once the grace period of the teaser rates has expired):

“The rising home prices masked the plummeting lending standards, since the overstretched borrowers found it easy to refinance or sell the house at a profit. As the impact of rising interest rates kicked in and house prices flattened, stretched borrowers were left with no choice but to default as prepayment and refinancing options were not feasible with little or no housing equity. As defaults mounted, the feedback loop that had amplified home price growth dragged prices down, which in turn made it impossible for many overstretched borrowers to refinance to avoid default.”

Inasmuch as the above explanatory efforts have validity, they do not form a complete, well-rounded capable of explaining or predict market bubbles. To do this, a better understanding of Goods that are good for the market and of Bads (products with a certain level of toxicity) is mandatory.

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1 See also Bekaert and Hodrick for a discussion on the US subprime crisis (2012, pp. 7-9).
In this paper, we first discuss the selling of Bads, and link it to financial predatory behaviors and our stylized model of financial predation – the Consolidated Model of Financial predation (CMFP) –, including its psychological version and its notion of predatory net and traps. We briefly review the four market agents that are active in a bubbling market: consumers (investors), suppliers (investors in their own right), regulators (such as the SEC in the US) and predators (who, inevitably, exist in combination with prey). We then delve into details into the three moments of market crises, supporting our analysis with in-the-field research and US market data ranging from 1971 to 2013. We show that these three moments present various levels of heteroscedascity of their standard deviations and that the distribution of the population during these moments responds to the constant $k$, a constant that pertains to the CMFP. We examine the Action and resting potentials of market crises and show how different payoff strategies explain a market’s three critical crisis moments.

Finally, we conclude by showing that the marketing and selling of Bads generates a “badfare” economy that the market agents must control and annihilate.

2. THE SELLING OF “BADS”

The 1977 US Community Reinvestment Act (CRA) allowed banks to grant credits to clients that would have hardly qualified for loans and mortgages. In the years leading to the 2007-2009 subprime crisis, this philosophical stand continued to grow with the mid 1990’s Glass-Stegall Act revision. In essence, the low income and illiterate citizens as well as other less favored individuals such as the disabled and older people were considered prime candidates for a free economy that encouraged spending and home ownership (Tremoulinas, 2009; Gayraud, 2011).

Over the years, the house mortgage industry grew to billions of US dollars, with the 2000-2008 period being infested with predatory mortgages. These predatory mortgages used teaser tactics such as adjustable-rate loans and teaser rates (as low as 1% over one or two
years) in order to attract would-be homeowners (Frame et al., 2008 p. 2-3). The subprime industry eventually explained 53% of all foreclosures during the critical period.

2.1 Financial predatory behaviors

The term “predatory mortgages” is well chosen. Predatory behaviors during the 2007-2009 crisis existed with both consumers (those house buyers who hid critical information that would have disqualified them) and sellers (Cowen, 2008).

Historically, the term “predation” has not been a mere figure of speech (see Tokic, 2014). Indeed, people readily adopt a predator or prey position (Carney et al., 2010). It has been used in association with predatory marketing (e.g., the 1890’s Sherman Antitrust Act, the Act to Prevent Predatory Marketing Practices against Minors; the 1993 Court case of Brooke Group Ltd. Vs. Williamson Tobacco Corp.; the 2009 Mortgage Reform and Anti-Predatory Lending Act; see also Ordover and Willig, 1981, p. 9) by which prices are set below costs in order to drive out competition.

The US SEC recognizes predation and discusses it in its Rule 10b-5 of the 1934 Securities Exchange Act: it is an act that “… must be a misstatement or omission that is sufficiently material to affect an investor’s opinion, that is made intentionally; that the investor relied upon in making his decision, and that directly caused actual losses” (Ferguson, 2012, p. 191).

In the context of our analysis, we refer to financial predation as more than simply predatory marketing; this is what we discuss in the balance of this paper.

2.2 The market agents at work in a “badfare” economy

The CMFP identifies four market agents: consumers, sellers (producers), regulators and financial predators. We postulate that these market agents are always present in any and all markets, at any point in time, to various degrees.

A number of authors have long recognized the vulnerabilities of market agents, especially that of consumers and at times of sellers as well. These form important considerations in a predatory market, where market predators capitalize on their prey’s vulnerabilities. Expressions of vulnerabilities have been listed in part as follows:

i. Cognitive: cognitive biases (Kahneman and Tversky, 1979; Lam, Liu and Wong, 2010); ownership and materialistic values (Shiller, 2005); preys’ financial illiteracy (Wang, 2009); turnaround expectations (Gjerstad and Smith, 2009); excessive optimism (positivity bias or blind trust) (Shiller, 2005; Campello and Graham, 2013) and overconfidence (Scheinkman and Xiong, 2003); misconceptions versus trends (Soros, 2008); money illusion (e.g., the confusion between real and nominal interest rates) (Brunnermeier and Julliard, 2008); noise trading (De Long et al., 1990);

ii. Emotional: Fear of losing out on an opportunity (see Lux, 1995); overreaction (De Bondt and Thaler, 1985); psychological impairment (Danis and Pennington-Cross, 2008, Kamihigashi, 2008); selfishness (Petrick, 2011; Babiak and Hare, 2006);

iii. Behavioral: Contagion (herding) and contagion by refusing to search for proper information (Shiller, 2005; Calvo and Mendoza, 2000).

In all, there is an extensive literature on the subject of possible causes to market failures but no model has been proposed so far that takes into account the moments that appear inherent to them.
2.3 The Consolidated Model of Financial Predation (CMFP)

The CMFP is interested in Bads, that is in toxic products that plague a market and that predators use to lure their prey. Our past research has shown that

\[
\text{Free-riding} = \frac{k}{\text{QB}}
\]  

(1)

where QB is the Quantity of Bads, and \( k \) is a constant valued at 1.32, which is active within the confines of a closed dynamic system (bounded rationality\(^4\)) which boundaries range 0 to 2.3 (see Figure 3 below). Only a portion of the rectangular hyperbola has a meaning as a rendition of economic behaviors; outside these boundaries, chaos is considered to prevail. This curve represents our stylized indifference curve, or put differently, the utility level of the predatory behaviors: in this case, a consumer is assumed to be free-riding. He takes advantage, for his own benefit, of the common good regardless of the potential harm he may cause, such as increasing the cost of the common good. At every point along the so-called Consumers’ predatory indifference curve, the same level of utility is reached. The consumers are indifferent between benefiting less from free-riding, but obtaining more Bads, or else enjoying the common good more but having fewer Bads. In both cases, they feel they have achieved an equal amount of predatory utility.

Figure 1 represents what is going on in the abusive consumer’s mind.

\[= = =\]

INSERT Figure 1 ABOUT HERE

\[= = =\]

This story only tells half of what is happening. The suppliers, too, are engaged in financial predatory behaviors in a “badfare” economy. Regulations are represented on the y

\(^4\) If bounded rationality is to exist, there must necessarily be some boundaries. Our model is drafted after this conclusion.
axis (in lieu of the costs of the Bads, because regulations represent an inevitable operating cost).

We have (Table 1):

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= = =
\]

INSERT Table 1 ABOUT HERE

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= = =
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The Suppliers’ predatory indifference curve is a portion of a rectangular hyperbola as well. At any point along this curve, the utility of the sellers’ predatory actions remains identical. The sellers may obey to more regulations while refraining from selling more Bads, or, should regulations be relaxed as was the case in the years prior to the US 2007-2009 crisis, they may offer more Bads. In the end, sellers enjoy the same predatory advantage (or profits).

Our stylized Edgeworth box illustrates one instance of the dynamic interactions between consumers and sellers in a “badfare” economy, as follows (Figure 2)\(^5\):

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INSERT Figure 2 ABOUT HERE

\[
= = =
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An equilibrium, albeit fragile, is achieved: the Consumers’ predatory indifference curve will move away from its point of origin towards the Suppliers’ predatory indifference curve, signifying that more utility is gained by being deceitful. In the case of the subprime crisis, this translates into more Bads (more toxic Collaterilized Debt Obligations) being bought for the

\(^5\) Note that our framework is represented in a static fashion, unlike the phase diagram used in the Hamiltonian framework. For an introduction to the latter, see Lambert, 1985, pp. 172-197. For a standard macroeconomic analyses of steady states and dynamics using phase diagrams, see e.g. Blanchard and Fischer, 1989, p. 46.
same amount of free-riding. In the process, consumers believe more and more in their capacity to beat the market; blind trust builds up\(^6\), thus falling into the indebtedness trap of the predatory suppliers (sellers) – see Figure\(^7\) 3.

\[ f(x) = \frac{k}{x} \]  

(2)

And where \( k = 1.32 \) (for reasons seen further along in this text), or

\[ k = 1 + \frac{1}{\pi} \]  

(3)

At \( k = 1.32, x = 1.15, y = 1.15 \), one is at the middle point of the Edgeworth box. At \( x = y = 1.15 \) with \( k = 1.32 \), the Consumers’ and Suppliers’ predatory indifference curves meet. Therefore, its extreme upper limit is necessarily of \( 1.15 \times 2 = 2.3 \).

The boundary of 2.3 expresses the fact that market agents always behave within limits: their behaviors make sense if there are limits to them, just like there are limits on the amount of food one can eat at once. Hence, from the market agent point of view, bounded rationality is expressed by the boundaries of zero (0) to 2.3 when submitted to the constant \( k^8 \). Market agents will behave and invest in the market with the limits of their reason, and that limit is an expression of the \( k \) constant, which essentially says that market agents want to remain equal to

\(^6\) This is often referred to as a positivity bias.
\(^7\) In this system, the operating area (where the decisions to invest occur) is considered to be constrained by 2.3\( \times 2\pi/4 \) or equivalently \((1 + k) (\pi/2)\) or equivalently: \((1 + k) / 2(k – 1)\).
\(^8\) Our past research has shown that this is the case for economic behaviors.
themselves (hence, its, relationship to π). At \( k = 1.32 \), there is equilibrium, but any \( k \) larger than 1.3 tends towards unfairness, possibilities of retaliation and chaos. The maximum value that \( k \) can reach is 4.6 (at which point, \( x = 2 \) and \( y = 2.3 \), the uppermost limit), hence nearing the Feigenbaum value of 4.669, which expresses chaos. It can be justifiably assumed that the entire system, in the market agent’s mind, is closed, dynamic, and governed by bounded rationality\(^9\).

The Suppliers’ predatory indifference curve also moves away from its own point of origin sitting on the upper right corner of the stylized Edgeworth box, signifying that the sellers are better at cheating the regulations: they can thus sell more Bads and feel they can beat the market\(^10\). Consumers and suppliers become increasingly deceitful, and thus, in actual fact, the market becomes riskier (see Bolton and Scharfstein, 1990).

A “badfare” economy sees in an increase in toxicity, in Bads being available on the market. At that Predatory Point of Equilibrium, we posit that there is no economic profit, which discourages potential competition. The sellers that are already active in the market become increasingly deceitfully in order to gain a larger share of it. In the process, those less savvy or conspicuous are evicted from the market, allowing for more concentrated abuse. The cases of AIG or Lehman Brothers speak volume to that effect, all the while Goldman Sachs ended up stronger than ever. Consumers smart or capable enough to avoid the sellers’ indebtedness trap (a “poverty trap” as put by Mehlum, Moene, and Torvik, 2003) fight each other for the Bads that are becoming available. Instead of betting on future Goods, the market agents end up gambling more and more on future Bads (QBads\(_{t+1}\)).

\(^9\) In the CMFP (e.g., Mesly, 2013a, 2013b, 2014a, b, 2015a, b, Mesly and Bouchard, 2016; Mesly and Racicot, 2017) studies has shown that the budget line of the consumers is expressed by \( B(x) = 2.2 - 0.9x \). The same logic applies to the seller. This means that their budget lines cannot actually parallel each other in an Edgeworth box: a perfect, stable equilibrium is impossible. Only a dynamic equilibrium can prevail and the information each receives is necessarily asymmetric. Furthermore, the consumers’ satisfaction (expressed by \( S(x) = x + 2k/x - 2k^{1/2} \)) is suboptimal at the perfect point of equilibrium and this is true for the sellers as well; hence, each has an incentive to depart from and move further away from the point of equilibrium. In short, consumers and suppliers realize they can fare better by being a little bit more deceitful (Mesly, 2014a).

\(^{10}\) Bernard Madoff is an exemplary case (e.g., see Gregoriou and Lhabitant, 2009).
The sellers are driven by the fear of losing out on the opportunity to benefit from weak regulations for their selfish interests and tend to rationalize their excesses (Milgrom and Roberts, 1982), ever so eager to increase their exuberant wealth. More profits can be obtained by disregarding other market agents’ welfare. Sellers need to bet on the ups or downs of the market (a trap) to deceive consumers and competition and consumers need to engage further into debt (a trap) in order to improve their market position, i.e., their possession of Bads. It is to the best advantage of all deceitful market agents to deceive the others: Bads products lead to bad behaviors, and vice-versa.

This stampede phenomenon is represented in Figure 4.

Along the way, economic losses are incurred. Consumers and suppliers’s options diminish and their traps force them to spend more and more to get out of their pits. As toxicity reaches its upper limits, bankruptcies and foreclosure sprawl; the crisis is in full effect.

2.4 The predatory net and the traps

Predatory traps – whether in the form of indebtedness or one-sided market gambling – are one out of ten components of what is referred in our CMFP as the predatory net (See Mesly, 2014a) and competitive advantage in a closed, dynamic duopolistic system – consequences for regulatory authorities). This net is composed of five structural components (sine qua non conditions of the existence of the net): predators, prey, tools (predatory mortgages, Special Purpose Entities), harm (the losses that the market agents incur\(^\text{11}\) – see

Ordover and Saloner, 1989; Cabral and Riordan, 1997) and a surprise effect (achieved by being deceitful). The net is also expressed by a strategy that includes identifying the prey’s vulnerabilities (e.g., an illiterate house buyer absorbed by the housing market herd), setting up bait (teaser rates), forcing a decision (by pressuring the eager house buyer), setting up a trap and finally subduing (by forcing foreclosure or bankruptcy).

The net is illustrated as follows (Figure 5).

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G     G     G
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INSERT Figure 5 ABOUT HERE

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G     G     G
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Predators are motivated by selfish gains (Tulogdi et al., 2010). Additionally, they are cold (displaying little if not no regard for their prey – see Ferguson, 2012), calculative (Meloy, 1997), and sneaky (Graham, 1996). To that effect, Shiller (2005, p. 76) notes: “When clever persons become professionals as deceiving people, and devote years to perfect their act, they can put seemingly impossible feats before our eyes and fool us, at least for a while.” Prey are naive and defined by their vulnerability12; they are reactive rather than pro-active13.

In regards the US subprime crisis, the predatory web translates as follows (Table 2):

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G     G     G
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INSERT Table 2 ABOUT HERE

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G     G     G
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12 A disproportionate number of victims of market fraud are 65 years old or more (Tongren, 1988; Yoon et al., 2005); these people see a decline in their cognitive capabilities with age (Charles and Piazza, 2009; Moschis, Mosteller, and Fatt, 2011).

13 In natural ecosystems, predator and prey populations maintain an equilibrium and this guarantees the survival of both (Bonsall and Hassell, 2007).
2.5 The psychological framework of the investor, according to the CMFP

The above-described market phenomenon does not happen in a psychological vacuum. Quite the contrary. It is based on the psychology of consumers and sellers that the market behaves the way it does, engages in bubbles and suffers crashes. Hence, our CMFP, based on many years of field research and secondary data collection, has provided the following model, which has found some neurobiological correlates (Hostinar, Sullivan, and Gunnar, 2014; Rolls, 2006; Lang, Davis and Öhman, 2000; Akirav, 2013; Gregg and Siegel, 2001; Gregg and Siegel (2003), including in fMRI studies\(^{14}\) (Figure 6):

\[ = = = \]

**INSERT Figure 6 ABOUT HERE**

\[ = = = \]

This is a classical model that summarizes many studies based on perceived risk, which the CMFP estimates to be the ratio between the sense of control the investor has over his investment and the transparency he receives from the object of his investment. Risk assessment provides self-protection (Frijda, 1986; Lazarus, 1991; Levenson, 1994; Ekman, 1999; Keltner and Gross, 1999; Kunzmann, Kappes and Wrosch, 2014) that may ensure survival in the marketplace.

\[^{14}\text{Most notably, the hypothalamus is the center of predatory (lateral) and prey (medial) behaviors. It controls all major homeostasis-related activities which ensure the survival and equilibrium of the body; it has a one way (instead of a bidirectional) link to the pituitary gland, which forces hormones produced by both to travel through the entire body before returning to the hypothalamus with bodily information (Squire et al., 2003; McCullough et al., 2007; Berthoud and Münzberg, 2011, Hinds et al., 2010). This is in line with the CMFP which has an unidirectional link between perceived risk and trust. Furthermore, the fear “network” includes the amygdala (Aue et al., 2013; Dölger et al., 2003; Amaral, 2002, Schaefer et al., 2014) of course, but also the the orbitofrontal cortex involved in decision making (Cardinal et al., 2002; Dolan, 2002), the anterior cingulate cortex (responsible for error detection – Paulus et al., 2004), the periaqueductal gray (PAG) (Gray and McNaughton, 2000, p. 31), and the insula. The Ventral tegmental area (VTA) is the center of reward. In other words, the CMFP has some neurobiological correlates.}
The buyer wants to feel he is in relative control while expecting to be fully informed about his investments, such as buying multiple houses. Similarly, the seller who invests his time and effort in dealing with a customer expects to be able to secure his repayment schedule and to have enough information on him to feel that he is relatively reliable (Figure 7). The higher the perceived risk, the lower the trust, trust being a core construct in economic theory (Stiglitz, 2003; Akerlof and Shiller, 2009). The more the trust and, concurrently, the impression that both market agents can win by dealing with each other, the easier the decision to invest. The better the returns on the investment resulting from the decision to invest, the lesser the perceived risk. In a situation of blind trust (extreme positivity bias) (Smythies, 2009; Dezsö and Loewenstein 2012), the perception of real risk is lessened (Odean, 1998), and the cycle tends to spin out of control (Mesly and Bouchard, 2016). As explained by Lux (1995, p. 883): “Hence, speculators are not simply blind followers of the crowd: they quickly react to others’ behavior in order not to miss profit opportunities (…)”. The market agents’ behaviors, then, tend to worsen with time: they become increasingly emotional (Shefrin and Statman, 1985), biased or irrational (Kahneman and Tversky, 1979), delinquent (Danis and Pennington-Cross, 2008), inconsistent (Smith, Suchanek, and Williams, 1988), or even pathological (Kamihigashi, 2008).

As for fairness (Figure 6), it has been the subject of many legal battles – see, for example, *Fremont Invest & Loan vs. Commonwealth of Massachusetts* during the subprime crisis. In particular, people who feel they have been treated unfairly seek compensation (Bäckman and Dixon, 1992) – people who had been deprived of the opportunity to buy a home went for it with a vengeance when the solvency criteria were relaxed by the US government’s policies.

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15 Blind trust can affect all market agents (Loughran and McDonald, 2011).
16 “People trust others even when there is no guarantee that the trustee will respond benevolently.” (Fetchnhauer and Dunning, 2009, p. 264)
3. THE THREE MOMENTS OF A CRISIS

Our stylized model conjectures that there are three key moments in any financial crisis, which we refer to as the herding, swarming and stampeding moments. Swarming includes herding; however, the reverse is not true. Similarly, stampeding includes swarming, but the reverse is not true. Herding (Dass, Massa, and Patgiri, 2008; Olsen, 2012; Biacabe, 2000) occurs when a large number of a given population of market agents regroup towards a common goal, building wealth, out of the fear of missing out on a market opportunity. Preys act spontaneously (see Gregg and Siegel, 2001) and tend to “Keeping up with the Joneses” (Dupor and Liu, 2003). As such, they are easily influenced.

Each market agent believes each one will win. Strategically, there is just one alternative and no option (as an option implies at least two alternatives): invest.

We have:

<table>
<thead>
<tr>
<th>Investor Sellers (e.g., sells a predatory mortgage)</th>
<th>Win</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investor Buyers (e.g., buys a house with a predatory mortgage)</td>
<td>Win</td>
</tr>
</tbody>
</table>

Swarming occurs when this herd, and newcomers that eventually join from current herds in the making, join and focus on maximizing their gains, out of fear of missing out on the same opportunity, but with a defined target – specific market or financial targets are the subject of such market moment. At this point, the market agents consider that some may win and some may lose, but the gain of one may not cause the loss of the other. Furthermore, there is one option and thus two alternatives: invest or wait.

Going back to Figure 6 and the psychological model of the market agents, it can be seen that both agents (seller and buyer) judge that the risk is minimal (hence the fear of missing out on a great opportunity increases), and as the risk is deemed minimal, they each nurture trust towards each other. With a sense of fairness added to this dynamic, they tend to cooperate: the
seller sells the predatory mortgage to the buyer and the buyer buys the predatory mortgage from the seller. Both envision making money and as this actually materialize, the perceived risk diminishes further – the positivity bias inflates, blind trust gains ground. Our stylized payoff matrix is in fact the game matrix of payoffs and is a representation of the “strategic form”\textsuperscript{17}.

<table>
<thead>
<tr>
<th>Sellers</th>
<th>Two players</th>
<th>Added alternatives if there are more than two market agents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sell</td>
<td>Sell</td>
</tr>
<tr>
<td></td>
<td>Wait</td>
<td>Wait</td>
</tr>
<tr>
<td>Buyers</td>
<td>Buy</td>
<td>Wait</td>
</tr>
<tr>
<td></td>
<td>Wait</td>
<td>Buy</td>
</tr>
</tbody>
</table>

Here, if there are only two market agents (consisting of a seller and a buyer), if the seller sells, the buyer feels compelled to buy given his fear of missing out on the opportunity. If the seller wait, the buyer must wait. But there are other sellers or buyers, their alternatives may be enhanced: the seller may sell and the particular buyer ay opt to wait, so that the seller will seek another buyer. The seller may wait, but the buyer may chase another seller. This is a fragile equilibrium where the seller and the buyer may feel they have achieved their best strategy; changing it would make them worse off. However, trying to improve it may be to the detriment of the other, which could lead to retaliation (e.g., the seller giving the market opportunity to another buyer or refusing to lend a predatory mortgage). The gains and losses are not predetermined. Given that swarming is a moment that follows herding, it is fair to assume that there are always other sellers and buyers. In fact, as more of those market agents join in, the higher the pressure (the fear of missing out on the opportunity) to sell and buy. All looks good, nothing looks bad.

Some market agents may feel they have not been treated fairly; after all, the justification given for creating the predatory mortgages was precisely that the Bush government wanted to give those who had not qualified in the past a chance to own a home. For some investors (the sellers investing in the buyers and selling them more predatory

\textsuperscript{17} The extensive form is a more in-depth representation of a game. For a detailed discussion on this, see Varian (1993, chap. 15).
mortgages and the buyers borrowing more money to buy more houses), the positivity bias inflates and blind trust turns out to be quite convenient. Not everything looks good.

The last but not least moment is stampeding. It necessarily follows swarming. Here, market agents act out of fear to miss the opportunity to enter or exit the market. There are thus three alternatives in this zero-sum game: continue investing, wait, or exit. The gain of one is a loss for the other and everyone rushes to maximize gains, hence the stampede.

Here, the following scenarios are possible; there is no in-between and it is a make-or-break situation. This is truly a zero-sum game in a finite environment (for example, there are simply, only so many houses for sale in the market) and this finite environment makes retaliation possible (otherwise, market agents could escape the toxic environment and move somewhere else where they would be immune):

<table>
<thead>
<tr>
<th>Sellers</th>
<th>Win</th>
<th>Loose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyers</td>
<td>Loose</td>
<td>Win</td>
</tr>
</tbody>
</table>

Obviously, the losers will exit the market, narrowing down the options to find other market agents for those remaining; all the while, those who stay and win see their negotiating power and market share (of Bads) increase. This continues until an apex of toxicity (Bads overwhelming the Goods) is reached, past which a sharp decline ensues.

Going back to Figure 6 again, it can be seen that both agents (seller and buyer) judge that the risks are high. Those who operate with a maximal degree of positivity bias (blind trust) cannot see that the market is filled with Bads. They keep investing. But the Goods of ones and actually the Bads of the others; the blind investors do not realize their Goods are actually Bads, that their pools of mortgages, for example, are infested with toxic unsustainable mortgages. For the predators, the Bads are Goods: they make money off them as long as they can find naïve buyers they can lure.
As can be intuitively sensed, there is an accumulation of uncertainty (perceived risks), expressed by an increased level of heteroscedasticity of the moments’ deviations.

3.1 First moment: Herding ($\sigma_h^2$)

The average $k$ for the 1,835 respondents that we investigated in a seven-year research on predatory behavior equals 1.35, with the constant $k$ being expressed as per equation (3) seen above.

Our analysis of the sample distribution, which is assumed to have been in a herding moment, suggests a distribution as follows (Table 3):

$$
= = =
$$

INSERT Table 3 ABOUT HERE

$$
= = =
$$

The vast majority of the sample population is concentrated around the mean, but the level achieved by the ratio predator/prey stretches rapidly and considerably near the mean. Based on this data (see Table 4), the estimated distribution for the first moment with variance of $\sigma_h^2$ (with $h$ referring to the herding moment) is therefore related to the distribution function of $f(x_h) = 1.32 \times 2.71^{-0.5s(x_h/0.32)^2}$ or

$$
f(x_h) = \frac{k}{1} e^{-\frac{1}{2\left(\frac{x_h-0}{k-1}\right)^2}}
$$

(4)

where $\mu = 0$.

This versus a Gauss’ normal distribution curve expressed by:
In a herding situation, the game between the seller and the buyer is played as follows:

<table>
<thead>
<tr>
<th></th>
<th>Sellers sell Goods</th>
<th>Sellers sell Bads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyers buy Goods</td>
<td>2.30, 2.30(^{18})</td>
<td>1.73, 0</td>
</tr>
<tr>
<td>Buyers buy Bads</td>
<td>0, 1.73</td>
<td>0, 0</td>
</tr>
</tbody>
</table>

*Note: Pairs of payoffs in the diagonal represent our stylized version of Nash equilibria with top left quadrant being the preferred one.*

The payoffs for the seller and the buyer is $2.30 each if they both stick to Goods (excitedly so). There are no incentives to buy Bads, so that if the seller tries to sell Bads, he ends up with nothing because the buyer (or consumer) will continue to buy Goods.

### 3.1 Second moment: Swarming ($\sigma^2_s$)

Our estimated distribution for the swarming moment with variance of $\sigma^2_s$ (with $s$ referring to the swarming effect) has a hypothesized function of

\[
f(x_s) = 0.66 \times 2.71^{-0.5s(x_s - 0.68)}
\]

or

\[
f(x_s) = \frac{k}{2} e^{-\frac{1}{2}(x_s - \mu_s)^2}
\]

This second moment (swarming) is thus somehow influenced by the first moment (herding) because the value 2 reflects the fact that it is the stage after stage 1, that of herding (see Table 5).

\[
= = =
\]

**INSERT Table 5 ABOUT HERE**

\[
= = =
\]

\(^{18}\) We could consider this pair of payoffs as what could be called our stylized Nash equilibrium.
In a swarming situation, the game between the seller and the buyer is played as:

<table>
<thead>
<tr>
<th></th>
<th>Sellers sell Goods</th>
<th>Sellers sell Bads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyers buy Goods</td>
<td>1.15, 1.15</td>
<td>1.73, 0.58</td>
</tr>
<tr>
<td>Buyers buy Bads</td>
<td>0.58, 1.73</td>
<td>1.15, 1.15</td>
</tr>
</tbody>
</table>

Notes: The stylized Nash equilibria appear on the diagonal of the payoff matrix of the swarming moments. The two equilibria are actually equal, which causes a hesitation between the market agents. The sellers and buyers hesitate between selling more Goods or else more Bads, and equivalently, the buyers hesitate between buying more Goods or more Bads. This renders the interaction volatile, so that both market agents will be driven towards the third moment (stampeding, which is explained below) in an attempt to reach a single optimal position.

The payoffs for the seller and the buyer is $1.15 each if they both stick to Goods or to Bads. There are incentives to sell or buy Bads because the payoffs are greater than in other scenarios but this implies a winner and a loser.

3.1 **Limit ($\sigma^2_{\text{limit}}$)**

Before we jump to the third variance, that of stampeding, let us examine what happens at the limit of the system (see Table 6), at $x = 2.3$. We have a hypothesized a distribution function of $f(x_{\text{limit}}) = 0.57 \times 2.71^{-0.5x(x_{\text{max}}/0.98)}$ or

$$f(x_{\text{limit}}) = \frac{k}{2.3} e^{-\frac{1}{2} \left( \frac{x_{\text{max}}}{k-2.3} \right)^2}$$  \hspace{1cm} (7)

Thus, at $k = 1.3$ and an associated $\sigma$ of 0.30 (for a $\sigma^2$ of 0.90), the sample population acts in its most normal (rational) manner.

21
In a limit situation, the game between the seller and the buyer is played as follows:

<table>
<thead>
<tr>
<th></th>
<th>Sellers sell Goods</th>
<th>Sellers sell Bads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyers buy Goods</td>
<td>1.15, 1.15</td>
<td>1.15, 1.15</td>
</tr>
<tr>
<td>Buyers buy Bads</td>
<td>1.15, 1.15</td>
<td>1.15, 1.15</td>
</tr>
</tbody>
</table>

Notes: In this particular case, all four options (quadrants) are equal, thus the market agents cannot make a final choice because every other option is equally acceptable. Hence, they constantly move back and forth between the four options, unable to maximize their positions. At the limit of such system, rationality is maximized, that is, it is bounded (the Edgeworth box is bounded by the maximum value of 2.3 and the minimal value of zero). Past this state of affairs, there are no other venues but irrationality.

In this scenario, there is a dynamic predatory equilibrium; there is a constant incentive for both players to try Goods and Bads, at all times. Along those lines, Besanko, Doraszelski and Kryukov (2014) have suggested that price predation tends to trouble equilibrium, as can be inferred from the three critical moments exposed here.

3.2 Third moment: Stampeding ($\sigma_p^2$)

Past the limit of 2.3 of the closed dynamic system, however, the stampede moment with a variance $\sigma_p^2$ is hypothesized to be related to or

$$f(x_p) = 0.44 \times 2.71^{-0.5(x_p/1.68)^3}$$

or

$$f(x_p) = \frac{k}{3} e^{-\frac{1}{2}(\frac{x_p}{k-3})^2}$$

(8)

Graphically, this is represented as follows (Table 7):

=  =  =

INSERT Table 7 ABOUT HERE

=  =  =

In a Stampeding situation, the game between the seller and the buyer is played as follows:

<table>
<thead>
<tr>
<th></th>
<th>Sellers sell Goods</th>
<th>Sellers sell Bads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buyers buy Goods</td>
<td>0.58, 0.58</td>
<td>0, 2.30</td>
</tr>
</tbody>
</table>

22
Buyers buy Bads | 2.30, 0 | 1.73, 1.73

Notes: The optimal position for both market agents is actually the worst market condition, where both market agents have the strongest incentives to buy and sell Bads. Thus, as those market agents move along the moments of the crises as hypothesized in our model, they have no choice but to move, literally, from good to bad, and from Goods to Bads.

The payoffs for the seller and the buyer is only $0.58 each if they both stick to Goods; Bads is the way to go but there is some hesitation because Bads could turn out to be good ($2.30 payoff) but then, this would require that one of the other player plays against market rules by way of selling or buying Bads.

3.3 Summary of the three moments of a market bubble

In summary, the CMFP has identified three unique moments in financial crises. Herding consists of a relatively spontaneous reaction. As such, it is relatively disorganized. Its aim is to acquire a Good that is perceived as being essential. Herding is based on fear: fear of a clear and present danger. For example, consumers will sign for predatory mortgages for fear of missing out on the opportunity to invest in the market and make quick money by flipping houses. Swarming is a medium- to long-term organized action. The goal is not to escape—for example, a poor economic living condition— but to as many Goods as possible, whether they are essential or not (hence, during the subprime crisis, consumers would acquire multiple houses that they, obviously, did not need, but that other buyers could potentially have needed). Herding is a pre-condition to swarming and swarming is a pre-condition to stampeding. Swarming and is equivalent with greed. Stampeding occurs when market markets destroy each other in their attempt to gain a stronger position in the market in fear of missing out on the opportunity to capitalize on it or else to exit it in fear of losing everything. Stampeding is also an expression of greed that, however, leads to panic (see Thomsett and Kahr, 2007)\textsuperscript{19}.

The three moments can be captured as follows (Table 8):

\textsuperscript{19} An example of such dynamic is the Wal-Mart’s 2008 Black Friday. Overexcited consumers lined up over night (for Goods they thought they needed desperately), swarm the stores when the doors opened early in the morning and stampeded each other in their fight to access Goods that, in the end, they did not really need. Consumers turned a blind eye to the fact that Wal-Mart prides on “everyday low price” anyway, and on the fact that their time and efforts boosted the actual price of acquiring the Goods, so that in the end, these Goods were actually more expensive than if they were sold at the regular price.
In a time sequence (with the payoffs being shown underneath the graphs), we obtain (Table 9):

In bold is the payoff table suggesting the likely behavioral scenarios. One can see how the market moves from Goods to Bads, with the Bads promising more than the initial equilibrium stage. At the very end of the stampede, a new state of equilibrium arises.

We conjecture that the evolution of a market bubble goes as follows: an economic system functions at its limit and displays rationality given the circumstances; it behaves normally. At some point, there is a herding moment by which the investors regroup around a narrower range of options with high expectations; this acts a spark on the system. The system tends to stabilize in the swarming moment, when everyone finds somewhat of a winning position in the market, which explains why the uptrend of a bubble is slower than the actual crash, which is far more brutal. The investors eventually move away from the fragile, dynamic predatory equilibrium and enter into the third moment, that of stampeding, by which extreme decisions and actions are taken, and this by a growing mass of investors. At this point, the economic system is off limit and crashes.
4. THE RISE OF THE HETEROSCEDASTICITY OF THE MOMENTS’ DEVIATIONS

We hypothesize, based on our analysis of the predatory dynamic that took place in 2007-2009, that in fact the rise of the heteroscedasticity, which refers to the increasing change in the variance of the distribution pertaining to the three bubble moments, is actually due to two inputs, that of “Goods” and that of “Bads”.

What we notice is that there is a spark (moment 1: herding) in the marketing of financial products (e.g., mortgages) that, at first glance, seem inoffensive. However, as time goes one, the offer of those “Goods” is replaced by that of “Bads” (increasingly toxic financial products such as predatory mortgages, Special Purpose Entities and Collateralized Debt Obligations in which risks are hidden in a pool of mortgages, some highly toxic). The spark of “Bads” goes somehow unnoticed because it is not as salient as that of the “Goods” that preceded it. Henceforth, the market becomes increasingly volatile; the standard deviation around the mean of the “Goods” increases as the presence of toxic products, the “Bads” increases, and the standard deviation around the mean of those “Bads” widens as well as a result of predatory pressures. In fact, market agents become more and more emotional and less and less rational (see Lerner and Keltner, 2000).

This can be represented as follows (Table 10):

\[
= = =
\]

INSERT Table 10 ABOUT HERE

\[
= = =
\]

As investors (e.g., house buyers attracted by the low interest rates) herd towards to Goods (the appealing mortgages), market predators devise and market an increasing number of Bads, luring the naïve investors in their trap. The point where the Goods curve meets the Bads curve is called a decision revolving door: at that point, the investor does not know if the Goods
are actually bad, and if the Bads are actually good. Thus, he debates, goes round and round, just like most of the other investors, who each try to catch each other to the game but obviously, catching someone in a revolving door is a lost case.

The result of the above dynamic is actually a graphical summation of what happens to the variances in the three moments of the market bubble (Table 11):

\[
\begin{align*}
&= \quad = \\
\end{align*}
\]

INSERT Table 11 ABOUT HERE

\[
\begin{align*}
&= \quad = \\
\end{align*}
\]

On the right side of Table 9, we put an equivalent of what happens on the left side but plotting the y-axis as “type of market” (positive or negative) with the negative market witnessing the Bads taking over the Goods. We call the initial moment the Action potential and the return to an equilibrium the Resting potential. From the beginning of the Action potential, at moment one, that of herding, to the end of the third moment, once the bubble has exploded (at the end of stampeding moment), predatory behaviors have developed in number and intensity. The Action potential generally results from a fundamental change in the market – for example, the elimination of regulations or the creation (as times concomitant) of new investment opportunities, such as predatory mortgages.

Examples of the Action-Resting potentials are found in the market place. Using the HPI (Historical measure of Financial Predation Index – see Mesly, 2015b and Appendix 1), a research has shown the following two instances (1982-1983; 2000-2001) – see Figure 7:

\[
\begin{align*}
&= \quad = \\
\end{align*}
\]

INSERT Figure 7 ABOUT HERE
As can be observed, the shape of the bubble curves is remarkably similar to what is predicted by the model (Table 12):

Since we assume in the CMFP that the Action-Resting curve shape is the result of a particular interplay between Goods and Bads as per Figure, we tend to posit that the 1985, 1993, 2000 and 2007-2009 markets were indeed plagued with Bads. This is particularly well documented for the 2007-2009 crisis, of course. Of interest, the 1993 crisis did not achieve its full resting potential and rapidly is followed by another crisis, that of the .com bubble.

According to our view, market crashes occur in the mandatory presence of Goods and Bads, with Bads taking over the Goods over time. Market crashes are thus due to the overwhelming presence of market predators. In other words, heteroscedasticity is a expressing of the spread that affects Goods and Bads.

5. DECISION TO INVEST IN A MARKET MARKED BY ITS MOMENTS’ THE HETEROSCEDASTIC DEVIATIONS

The heteroscedasticity of the standard deviations (or, put differently, of the variances) with each deviation being dependent on the previous one (with each moment the result of the previous moment), makes the system volatile and bound to crash. This heteroscedasticity means that investors make fewer rational decisions, and each wrong decisions drives them towards more errors (i.e., towards chaos). Indeed, studies have demonstrated that a negative outlook and a higher number of cognitive errors are correlated whereas a positive outlook has
no correlation with cognitive errors (Fetterman and Robinson, 2011). A positivity bias seems to act as an immune system against errors.

The decision to invest (DI) is a make-or-brake situation, as expressed by the functions

\[
DI = E(r_a)(k + \psi^\phi)
\]

where \( E(r_a) = r_f + \beta_a[E(r_m) - r_f] - QBads_{t+1} \) is our own stylized CAPM model, and

\[
\psi^\phi = \left( \frac{\sigma}{3} \right)^{\sigma_a/\sigma_m};
\]

\( r_a \) is the return on asset \( a \); \( r_m \) is the market return; and \( r_f \) is the risk-free rate; with the market return \( r_m \) being captured in the psychological model of the CMFP (See Figure 9); the decision to invest is conceived as the result of a combination of trust and fairness; \( \psi \) is blind trust or equivalently the positivity bias or the investor’s belief that he can beat the market; \( \phi \) is the investor’s fear of missing out on the opportunity (to enter or exit the market); \( \sigma_t \) = standard deviation of the moment \( t \) (herding (h), swarming (s), or stampeding (p)). As for \( \sigma_m \), this refers to the standard deviation of market returns.

For example, some investors may be sitting on the herding moment while others may have already reached the stampeding moment. We posit that

\[
\epsilon = f(\sigma_h + \sigma_s + \sigma_p) = QB_{t+1} = kQB_t + (1 - QB_t)
\]

where \( \epsilon \) signifies chaos (hence, \( \epsilon \) is a standard function of chaos), that is, the sum of the three standard deviations which may all exist at the same time across different layers of the market.

Because \( QB_{t+1} \) is not known, as it represents the selling of Quantities of Bads in the future \((t + 1)\), it really is an expectation. Hence, the chaos factor is, for the investor, the expectation that future Bads will come or come back and haunt him, (or put differently, that he

---

20 The \((k + \psi^\phi)\) indicates the make-or-break situation: when the second part of the equation \((\psi^\phi)\) equals 0 (there is no variance \( \sigma_t \)), it is a make. When it equals to 1 (complete blind trust), so that the total \((k + \psi^\phi)\) equals 2.3, the limit of the system is attained and it breaks.

21 Our model is analogous to the well-known build-up approach (Pinto et al., 2015, p. 75)

22 As expected, vulnerable people make more mistakes than those in control. For example, older people make more mistakes in estimating rate changes that affect the marketplace (Agarwal et al., 2008).

23 As expected, vulnerable people make more mistakes than those in control. For example, older people make more mistakes in estimating rate changes that affect the marketplace (Agarwal et al., 2008).
will be deceived). What one market agent will impact what the other does (Hellwig, 2009). Put differently, it is the possibility that market agents will retaliate against him given his involvement with Bads. As long as he feels he can cheat the system and outsmart others (regulators, consumers, other providers), he has no reason to fear, no reason to attribute a value other than zero (0) to \( \epsilon \), and hence has no barrier to continue investing. The fear of retaliation can also be calculated by the cumulated variances of the three moments at the moment of measurement since these variances infer that there has been a “distantiating” movement away from normality.

We can reformulate the Expected return equation for asset \( a \) as follows:

\[
E(r_a) = r_f + \beta_a \left[ E(r_m) - r_f \right] - QBads_{t+1}
\]

The investor will want to maximize the first part of the equation (gains) and minimize the last part (losses), that is \( QBads_{t+1} \). His decision to invest is therefore an attempt to maximize gains, minimize retaliatory losses (expressed by \( QBads_{t+1} \) while being influenced by a possible blind trust (positivity bias) given his fears to miss out of the market opportunities so that

\[
DI = E(r_a)(k + \psi^0) \text{ where } E(r_a) = r_f + \beta_a \left[ E(r_m) - r_f \right] - QBads_{t+1}
\]

Chaos (or \( QB_{t+1} \)) is the fear of retaliation or equivalently the actual market deviations showing increasing cumulative heteroscedasticity. It requires that the investor is actually capable of perceiving the Bads; in other words, that he does not suffer from blind trust.

---

24 As seen when discussing equilibrium, consumers and sellers have an incentive to become more deceitful. But the DI function indicates that as each one become so, the other retaliates by becoming in turn more deceitful. Each engage further into the trap of the other. The market, of course, longs for equilibrium amidst various momentums. Thus, equilibriums and momentums are critical in market dynamics.

25 The formula recognizes the importance of emotions, such as regret, in decision making (Damasio, 1994; Zeelenberg et al., 1996; MacGregor et al., 2000; Sevdalis, Harvey and Bell, 2009; Seiler, Seiler and Lane, 2012).

26 Neurobiologically, nocive stress induces a reduction in the performance of critical functions with leads to the make of more decision-making errors (more variance). Under nocive stress, the amygdala, the center for emotion and anxiety located in the brain, increases, while the hippocampus (critical for learning and memory) and the prefrontal cortex (responsible for decision-making) shrink (Bear et al., 1996; Lupien, et al., 2009). It has been found that emotions such as fear affect judgement (Angie et al., 2011).
We can relate this equation to our stylized CMFP’s psychological model. Let us set $QB_{t+1}$ as lack of fairness, since it indicates that the market agent will eventually suffer from the actions of another market agent, with the possibility of on-going retaliation. It can be said that the decision to invest (to cooperate) – DI –, is a function of risk assessment (fear), of a positivity bias (leading to blind trust), augmented by fear such as the fear of missing out on the opportunity to exit the market$^{27}$ when the market is, truly, bad.

Hence, we have the rendition of the DI formula in our stylized psychological model of financial predation as follows (Figure 8):

\[ \text{INSERT Figure 8 ABOUT HERE} \]

\[ = = = \]

At $\sigma_t = \sigma_h$ (first moment) or at $\sigma_s$ (second moment), this is considered a possible make, depending on $\sigma_m$. At $\sigma_t = \sigma_p$ (third moment), this is considered a possible break, depending on $\sigma_m$; The break occurs when $QB_{t+1}$ is greater than the first portion of the equation: then, there is no more win but only losses.

At $\sigma_t = \sigma_{\text{limit}}$, this is considered a dynamic predatory equilibrium, so that $\sigma_m$ is assumed to permit such equilibrium.

6. CONCLUSION

Our analysis shows that a financial market operates under the influence of two forces: equilibrium (necessarily dynamic) and momentum$^{28}$ (expressed by the moments), which dictate the right move to make at the right time. The essence of predatory behavior, thus, revolves

$^{27}$This is equivalent to the “option to exit” used in real options analysis. For more, see Mun (2006).
$^{28}$Momentum here is referred to the term as used in finance (e.g., Pinto et al., 2015).
around the interplay between equilibrium and momentum. The equilibrium is necessarily unstable because at its point, the Budget curves of the buyers and sellers cannot perfectly parallel each other and their respective Satisfaction curves are suboptimal. Only by deceiving can the situation of one market agent appears to be improved, to the detriment of the other market agent. Hence, Bads are eventually created.

Financial crises are the making of Goods and Bads in an evolving interplay that goes from Action (momentum) to Resting (equilibrium) potentials. At the heart of this dynamic is fear, fear to miss on the opportunity to enter or exit the market.

During a market crisis, the heteroscedasticity of the variances changes – it is far from stable, moments evolve and cumulate. This instability (or ambiguity) generates more fear.

The CMFP considers that the four market agents – buyers, sellers, regulators and predators – are confined by a mental frame that has its own limits of rationality (a measured bounded rationality in our model). Our model attempts to set an analytical foundation of such closed dynamic system and recognizes $k$ as the constant that regulates the market agents’ behaviors, and ultimately, their decision to invest or disinvest (enter or exit the market). Through research in the field with nearly 2000 participants, data analysis of the US market over the last 30 years, and our analytical framework, we have found $k$ to be equal to 1.32 within the boundaries of a closed dynamic system of rationality stretched between the limits of 0 and 2.3. It turns out that $k = 1 + 1/\pi$.

The decision to invest is a make-or-break one. Greed and panic build up as a consequence of present and expected market behavior. The market agents compare their vulnerabilities to the forces (especially to the Bads) of the market to determine which action course to take$^{29}$.

$^{29}$ As mentioned, we found some neurobiological correlates to the CMFP. This is normal: what appears in the market is generated by humans, who are controlled by their brains.


Government Accountability Office (GAO)


https://fred.stlouisfed.org/

https://law.justia.com/cases/massachusetts/supreme-court/volumes/452/452mass733.html

_Fremont Invest & Loan vs. Commonwealth of Massachusetts during the subprime crisis:_ 452 Mass. 733; October 8, 2008 - December 9, 2008; Suffolk County, USA.


Management, 2nd Edition


www.census.gov/compendia/statab/2012/tables/12s1192.pdf.


8. **APPENDIX 1: MEASURING THE ACTUAL MARKET DEVIATION (THE HPI)**

In Mesly (2015b), the measurement of the HPI is fully explained. In short, using US market data for the last 50 years, an Index is build based on three essential characteristic of financial information (Table 13):

<table>
<thead>
<tr>
<th>Main characteristic</th>
<th>Sub-category</th>
<th>Examples of applications in the financial world</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bounded time</strong></td>
<td>Horizon</td>
<td>Maturity, TM, holding period, TVM, F, NPV, FV</td>
</tr>
<tr>
<td></td>
<td>Cycles</td>
<td>Cycles, periodicity, Kondratieff/Presidential cycles, Elliot waves, coupon frequency</td>
</tr>
<tr>
<td><strong>Triggered Spin</strong></td>
<td>Gamma (γ)</td>
<td>Interest rate (for return on investments), diversification, return, yield, hedging, convexity, greed, speculating, bull market, expansion, call &gt; put (positive sentiment)</td>
</tr>
<tr>
<td></td>
<td>Lambda (λ)</td>
<td>Interest rate (applied onto debts), inflation, taxes, sensitivity, biases, bankruptcies, foreclosures, panic, bear market, material adverse change, contraction, put &gt; call (negative sentiment)</td>
</tr>
<tr>
<td><strong>Layered risk</strong></td>
<td>External</td>
<td>Market condition, systematic risk, risk-free rate, uncertainty, productivity, competition, industry decline, substitute products, low barriers to entry, risk-free rate, primary/secondary markets</td>
</tr>
</tbody>
</table>
|                     | Internal     | Unsystematic risk, liquidity, credit rating, propensity to default, real or potential debt, confidence in management, liabilities, sensitivity to cycles, personal history, leverage municipal bonds => stocks => futures => derivatives => hedged funds), single/dual currency, covenants, floating/fixed rate bonds, rollover risk, negotiable/non-negotiable certificates of deposits, traditional/alternative investments, waterfall structure, tranches,
There are actually six spreads being computed to calculate the deviance index (Table 14):

Table 14 – The six spreads forming deviation

<table>
<thead>
<tr>
<th>Main characteristics</th>
<th>Sub-category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bounded time</td>
<td>Horizon</td>
</tr>
<tr>
<td></td>
<td>Cycles</td>
</tr>
<tr>
<td>Triggered Spin</td>
<td>Gamma (γ)</td>
</tr>
<tr>
<td></td>
<td>Lambda (λ)</td>
</tr>
<tr>
<td>Layered risk</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td>Internal</td>
</tr>
</tbody>
</table>

The Historical Predatory Index or HPI discloses the amount of asymmetry of information that advantages predators to the detriment of their prey, by surprise.
Figure 1 – Stylized Consumers’ predatory indifference curve: Free-riding and Bads

Notes: This curve is our stylized version of an indifference curve. We call it the Consumers’ predatory indifference curve. It serves to show the trade-off between free-riding and accumulating Bads. The market agent may decide to take abuse of what is available in the economic system and buy fewer toxic products, or else he may choose to respect the rules governing the market but buy more toxic products. On all points along the curve, the market agent experiences the same utility of financial predation. As the market agent moves away from the point of origin, thus creating a new, higher-level curve, he becomes a better financial predator; he is able to enjoy more free-riding and all the while buy more toxic products.
Table 1 – Stylized Suppliers’ predatory indifference curve: Regulations and Bads

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Regulations</th>
<th>Quantity of Bads sold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present QG</td>
<td>0</td>
<td>2.3</td>
</tr>
<tr>
<td>Future QG</td>
<td>2.3</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Notes: On the right hand side, we represent the stylized indifference curve involving regulations and Quantity of Bads sold. We call it the Suppliers predatory indifference curve. The market agent may decide to strictly abide by the market regulations and somewhat relax his selling efforts, or else he may be less inclined to respect regulations and sell more toxic products. In other words, the seller will trade-off one for the other as long as he feels he achieved the same level of utility of financial predatory behavior. He may improve his position by jumping to a higher-level stylized indifference curve, which means he would be able to sell more toxic products for the same level of regulations. On the right hand side, we simply flipped the graph so that we will build our stylized Edgeworth box as in Figure 3 that follows.
Figure 2 – Stylized Edgeworth box showing Regulators’, Sellers’ and Consumers’ predatory behaviors (assumed at moment 1 – Herding)

Notes: In this Figure, we merged Figure 1 and the right Figure of Table 1. The Consumers’ predatory indifference curve tends to move away from its point of origin in an effort to go meet the Suppliers’ predatory indifference curve, which also moves away from its point of origin. Eventually, they will meet each other at a determined Point of equilibrium. In a standard Edgeworth box, the ideal Point of equilibrium would be right in the center. A Pareto optimum is reached when the Consumers’ welfare cannot be improved without damaging the Suppliers’ welfare, and vice-versa.
Figure 3 – Snapshot of a Dynamic Predatory Equilibrium (Assumed at moment 2 – swarming)\(^{30}\)

Notes: In this static Edgeworth representation of the dynamics at play between the Consumers’ and the Suppliers’ predatory indifference curves, we see that each market agent tries to maximize his position up to the point where nothing more can be gained without damaging the other agent’s position. The point on Figure 4 illustrates a Pareto optimum. Passed the Pareto optimum point, the Consumers interfere with the Suppliers’ ability to produce and sell. Passed the same point but in the opposite direction, the Suppliers compromise the Consumers’s ability to buy and consume.

\(^{30}\) Our research shows that at this predatory point of equilibrium, the two curves, the Consumers’ predatory curve (a utility curve) and the Sellers’ predatory curve do not actually meet, thus making the equilibrium unstable (see Mesly).
Figure 4 – Stampeding moment

Notes: Once the Consumers enter into the Suppliers’ guarded territory (passed the Pareto optimum), he actually falls into a debt trap. He has to borrow more and more in order to buy toxic products. On the other hand, once the Suppliers penetrate the Consumers’ privileged area, they focus more and more on Bads, that is, on toxic products to the detriment of Goods, because of the incentive to earn more profits. Thus, each market agent grows further apart, intensifying the dichotomy and making matters worse over time.
Figure 5 – The predatory net
<table>
<thead>
<tr>
<th>Structural variables</th>
<th>Examples</th>
<th>Functional variables</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predators</td>
<td>Mortgage brokers</td>
<td>To identify weaknesses</td>
<td>Greed towards home ownership</td>
</tr>
<tr>
<td>Prey</td>
<td>NINJA’s (No income, no jobs, and no assets)</td>
<td>To bait</td>
<td>Teaser rate; misleading information on financial products</td>
</tr>
<tr>
<td>Tool</td>
<td>Subprime mortgage, CDO’s</td>
<td>To force decision</td>
<td>Inflated appraisal of home; inflated credit ratings</td>
</tr>
<tr>
<td>Loss</td>
<td>Financial, loss of home</td>
<td>To trap</td>
<td>Mortgage contracts</td>
</tr>
<tr>
<td>Surprise effect</td>
<td>Mortgage rates pass the initial two-year teaser rate; toxic financial instruments</td>
<td>To subdued</td>
<td>Foreclosure of homes</td>
</tr>
</tbody>
</table>

*Source: Mesly, 2015a*
Figure 6 – Risk assessment under the CMFP

* Cooperation seller-buyer

Notes: This Figure draws the flow of information among and between market agents, starting with perceived risk and ending with a return on the initial investment. Through this process, market agents learn to trust each other, collaborate and expect a win-win scenario.
Table 3 – The actual distribution of the entire sample population

<table>
<thead>
<tr>
<th>Distribution of actual sample, with $k = 1.35$</th>
<th>Distribution as per model using $k = 1.32$</th>
</tr>
</thead>
</table>

With x-axis = participants; y-axis = predator/prey ratio (scale 0 to 7)

Note: On a distribution graph, we are stretching the y axis a bit compared to x to emphasize the curve, making it clearer to see the differences between the various moments.
Table 4 – Herding moment

<table>
<thead>
<tr>
<th>Predatory distribution curve for the first moment (herding):</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x_h) = \frac{k}{1} e^{-\frac{1}{2} \left( \frac{x_h - 0}{k-1} \right)^2}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normal distribution curve (Gauss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{1}{2} \left( \frac{x-\mu}{\sigma} \right)^2}$</td>
</tr>
</tbody>
</table>

With the first part of the equation = $k = 1.32$ and $\sigma^2 = 1$
### Table 5 – Swarming moment

<table>
<thead>
<tr>
<th>Predatory distribution curve for the second moment – swarming:</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x) = \frac{k}{2} e^{-\frac{1}{2} \left( \frac{x}{k-2} \right)^2}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normal distribution curve (Gauss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{1}{2} \left( \frac{x-\mu}{\sigma} \right)^2}$</td>
</tr>
</tbody>
</table>

With the first part of the equation $k = 1.3$ divided by 2 and $\sigma^2 = 1$
Table 6 – Limit moment

<table>
<thead>
<tr>
<th>Predatory distribution curve for the limit moment – just before self-destruction/crash); at the limit of 2.3 of the closed dynamic system:</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ f(x_{\text{limit}}) = \frac{k}{2.3} e^{-\frac{1}{2} \left( \frac{x_{\text{limit}}}{k-2.3} \right)^2} ]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normal distribution curve (Gauss)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[ f(x) = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{1}{2} \left( \frac{x-\mu}{\sigma} \right)^2} ]</td>
</tr>
</tbody>
</table>

Note: Interestingly, the two curves are almost identical. The system limit is actually the closest representation of a Gaussian normal distribution curve.
Table 7 – Stampeding moment

| Predatory distribution curve for the third moment – self-destruction or crash: |
| f(x_p) = \frac{k}{3} e^{-\frac{1}{2\lambda}(x_3-3)} |

| Normal distribution curve (Gauss) |
| f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} |

With the first part of the equation = k = 1.3 divided by 3 and \sigma^2 = 1
Table 8 – The three moments of a market crash

<table>
<thead>
<tr>
<th>The three moments of a market bubble</th>
<th>The three moments versus a Gaussian normal distribution at the limit of the system (2.3):</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="chart1.png" alt="Chart of market bubble moments" /></td>
<td><img src="chart2.png" alt="Chart of Gaussian normal distribution" /></td>
</tr>
<tr>
<td><img src="chart1.png" alt="Chart of market bubble moments" /></td>
<td><img src="chart2.png" alt="Chart of Gaussian normal distribution" /></td>
</tr>
</tbody>
</table>
Table 9 – The three moments of a market crash in sequence and payoffs

<table>
<thead>
<tr>
<th>Initial state (equilibrium)</th>
<th>Herding (moment 1)</th>
<th>Swarming (moment 2)</th>
<th>Stampeding (moment 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Initial state graph" /></td>
<td><img src="image2" alt="Herding graph" /></td>
<td><img src="image3" alt="Swarming graph" /></td>
<td><img src="image4" alt="Stampeding graph" /></td>
</tr>
<tr>
<td>1.15, 1.15</td>
<td>1.15, 1.15</td>
<td>2.30, 2.30</td>
<td>1.73, 0</td>
</tr>
<tr>
<td>1.15, 1.15</td>
<td>1.15, 1.15</td>
<td>0.58, 1.73</td>
<td>1.15, 1.15</td>
</tr>
<tr>
<td>1.15, 1.15</td>
<td>0, 1.73</td>
<td>0.58, 1.73</td>
<td>1.15, 1.15</td>
</tr>
<tr>
<td>1.15, 1.15</td>
<td>0, 0</td>
<td>1.73, 1.73</td>
<td></td>
</tr>
</tbody>
</table>

Notes: This Table 9 is a sequential summary of Table 8 with, below the individual Figures, their respective payoff matrices. As can be seen, sellers and buyers maximize their positions by engaging and nourishing an increasingly toxic market environment. This exemplifies how an otherwise rational market becomes over time an irrational one.
Table 10 – The Goods, the Bads and the Ugly

<table>
<thead>
<tr>
<th>Quantity of Goods and Bads offered</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>QG</td>
<td>QB</td>
</tr>
</tbody>
</table>

Herding | Swarming | Stampeding | Spread |

![Graphs showing the quantity of goods and bads offered over time with different behaviors like herding, swarming, and stampeding.](image-url)
### Table 11 – Action and resting potentials and heteroscedasticity

<table>
<thead>
<tr>
<th>Type of market</th>
<th>Time</th>
<th>Spread between Goods and Bads or Heteroscedasticity of the moments’ variances</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Henning</td>
</tr>
<tr>
<td>Action potential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resting potential</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** On the left side, we see a representation of the change in variance in each of the three moments as they evolve over time. The right side of the above figure is its polarized rendition.
Figure 7 – HPI and Action-Resting potentials

Notes: 1981-1982; 1990-1991; 2007-2009 - predatory mortgages. We only display the major crises that show a comparatively high peak. Source: own calculations.

Table 12 – Standard deviation predicted by the model and actual market results

<table>
<thead>
<tr>
<th>Predicted by the CMFP</th>
<th>1985</th>
<th>1993</th>
<th>2007-2009</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image_url" alt="Graph" /></td>
<td><img src="image_url" alt="Graph" /></td>
<td><img src="image_url" alt="Graph" /></td>
<td><img src="image_url" alt="Graph" /></td>
</tr>
</tbody>
</table>

Note: Recall the y axis is slightly overstretched compared to the x axis. Crises shown are: 1981-1982, 1990-1991, and 2007-2009; Source: FRED: [https://fred.stlouisfed.org/series/GDP](https://fred.stlouisfed.org/series/GDP).
Notes: The fear to miss out on the opportunity to enter the market negatively impacts the positivity bias (the belief things will go well) – obviously, the more the market agents fear, the least likely they are to think positively of the market. As the positivity bias builds up, more Bads purchases are contemplated and, at the same time, more enthusiasm fuels the decision to invest. As the investment turns out fruitful and returns on investments (ROI) increase, there are fewer reason to fear. As fear lessens, the positivity bias gains in strength – blind trust is gaining momentum.