Innovation and the Global Financial Crisis - Systemic Consequences of Incompetence

Karl-Erik Sveiby*

Karl-Erik Sveiby, Hanken School of Economics, PL 479, 00170 Helsinki, Finland

Abstract: The article applies the concept of incompetence by Polanyi (1962) and the concept of unintended consequences by Merton (1936) to explore the development of a radical financial innovation, securitization. This innovation changed the context for all actors in the financial industry repeatedly to such a degree that even the highest regarded experts repeatedly made prediction errors. The negative effects of prediction errors have since 1980 gradually became larger until today when even a single individual decision by a portfolio manager may risk global financial mayhem. The conclusion is that financial innovation has become a lot riskier than is commonly appreciated in economic theory and practice. Our limited ability to foresee the consequences of our actions are fundamental to innovation and product development. Unintended and undesired outcomes should be acknowledged as an untapped resource for improving the net effects of innovation. The article suggests approaches to deal with the risk.

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Introduction

Intense innovation has changed the financial sector dramatically in the last 30 years. Rajan (2005) identifies four main drivers: Regulation-deregulation, which generates 'circumventive' product development (Holland, 1975); institutional change caused by deregulation; globalization made possible by ICT; and general technical change mainly due to ICT.

Benefits of financial innovation have commonly been regarded as an open-ended, linear function of innovation volume and intensity: 'faster diffusion means a higher societal return' (Frame & White, 2004 p.118). Yet we know that financial innovations also have less beneficial consequences, which often are systemic in nature and this reduces the total net value for society.

The article applies the concept of incompetence by Polanyi (1962) and the concept of unintended consequences by Merton (1936) to explore the development of a radical financial innovation, *securitization*. This innovation gradually changed the context for all actors in the financial industry to such a degree that even the highest regarded experts repeatedly made prediction errors. The conclusion is that financial innovation has become a lot riskier than is commonly appreciated in economic theory and practice. The article suggests approaches to deal with the risk.

The case is a chronological analysis from 1980 until 2008, the year the global financial crisis (GFC) begins. The analysis focuses on a class of financial instruments developed with securitization known under a collective name, *Collateralized Debt Obligations*[1] (CDO). The first generation of securitization was developed in 1970 by US quasi-governmental agencies[2] to enable a new financial instrument: the *pass-through mortgage-backed bond* - the 'ancestor' of the CDO. The purpose of the innovation was to solve the agencies' funding problem by making mortgage loans more attractive for Wall Street banks. Securitization was originally based on three simple principles. A Special Purpose Vehicle (SPV), a trust controlled by the government agency, was set up and hundreds of thousands of individual mortgages were transferred from the agency to a pool owned by the SPV. The SPV then issued certificates,

[1] There is a proliferation of terminology in literature. 'Collateralized Debt Obligation', CDO, gradually became the accepted term for ABSs (Asset Backed Securities) backed by a broad variety of collateral mixes such as; CLO (Collateralized Loan Obligation) only bank loans; CBO (Collateralized Bond Obligation) corporate bonds; CFO, (Collateralized Funds Obligation) hedge fund certificates; etc. A CMO (Collateralized Mortgage Obligation) contains only mortgages. Hurst (2000) dates the term CDO to late 1997.

[2] Federal National Mortgage Association (FNMA 'Fannie Mae'), the Federal Home Loan Mortgage Corporation (FHLMC 'Freddie Mac') and the Government National Mortgage Association (GNMA 'GinnieMae').

each representing a pro-rata slice, tranche, of the principal and interest, which were sold to investors. (Silber, 1975 p.106; Finnerty & Emery, 2002).

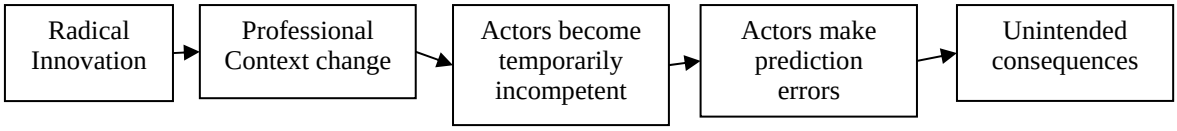
The Relationship between Innovation, Competence and Unintended Consequences

Competence in working life is, following Polanyi (1962), defined as an individual's capacity to act successfully in a professional context. Competence is thus not a property, but a relation between individual actors and professional context; a social system of rules. In finance professional competence can be seen as a combination of practical skills in the tools of the profession and rule-based problem solving, where some of the rules (heuristics) are explicit in the form of economic/financial theory. Professionals or employees are regarded by their professional peers and colleagues as competent because of the result of their performance. A professional learns the rules gradually through education, learning by doing and reflection.

Competence includes an ability to foresee the consequences of one's actions within the professional context: to make predictions, which turn out to be correct over a period of time. Polanyi (1962) draws a distinction between two kinds of errors, namely professional predictions, which turn out to be mistaken, and unprofessional predictions, which are not only false but *incompetent* (ibid p.116). The theory implies that a person can become temporary incompetent when a major shift occurs in the professional context, such as when a radical innovation is introduced.

In Schumpeterian economics it is generally assumed that competencies, which become obsolete in the process of ‘creative destruction’ are replaced by new competencies appropriate for the new context. Innovation thus both destroys and enhances firm level competences (Tushman & Anderson, 1986). However, competence in a context changing new technology has to be learned through learning by doing (Rosenberg, 1976); a process that requires time. Hence, for a while, those learning the new context will not yet be competent whereas, simultaneously, those competent in the old context are becoming less competent. Both will be making errors, such as predictions, which turn out to be false. As the case will show, this is what happened in the financial markets when securitization was introduced. Otherwise competent actors unwittingly made prediction errors, which caused unintended and undesirable consequences (Merton, 1936). The proposed theory derived from extant theory is summarized in Figure1.

Figure 1. Innovation and competence destruction - proposed chain of events.



Sources: Schumpeter 1939; Merton 1936; Polanyi 1962; Tushman & Anderson, 1986.

Financial instruments can be seen as action rules made explicit (Polanyi, 1962); competence formalized in legal contracts and codified in computer models and processes. They are generally developed in close collaboration between customer and provider (Tufano, 2003). Following the conceptualization of Gallouj and Weinstein (1997) and Gallouj and Savona (2009) the CDO is here seen as a set of material and immaterial technical characteristics created in interactions between the competences of actors in the professional context. Together they make up the final characteristics of the CDO. Changes in the characteristics define several types of service innovation – one of them is *radical innovation*, defined as creation of a completely new set of competences, technical and service characteristics. An example is the Cash Management Account invented by Merrill Lynch, the first financial process to be granted patent in 1983 (Rossignoli & Arnaboldi, 2009). Less recognized, but ultimately of much higher importance for the financial industry, (Cobas et al., 2002), is the financial innovation of securitization, a both competence enhancing and competence destroying (Tushman & Anderson, 1986) 'technology', analyzed more closely in this article.

Method and Data

The method is to start with a case where the unintended consequences are known and then to "go backwards" in the event chain in search of prediction errors in publicly available sources (See Fig.1). The research question guiding the analysis is: What evidence of actors' prediction errors can be found? The analysis focuses on critical events when four crucial competencies of financial actors are put to the test: How to evaluate credit risk, price risk, liquidity risk and model risk.

Quantitative data[1] from Thomson Banker One and Freepatentsonline are used to illustrate annual innovation volume measured as number of new product/service launches and patent applications. Identified changes in CMO/CDO characteristics are classified as *new product development,*

[1] All securities with a security code classified as 'collateralized' in Thomson Banker One's database 1985-2009, in total 2,307. Data extracted from Freepatentsonline from filings by the 20 top CMO/CDO-issuing banks: 1,772 US patent applications, EP documents, abstracts of Japan, and World Intellectual Property Organization.

(NPD). Minor changes to characteristics are collectively called *new product offerings*. The CMO/CDO varieties created with securitization are not classified in further detail. Qualitative data are of two kinds: The professional context (see Fig. 2) below is operationalized as the six editions of a classic work covering most of the time period, *Handbook of Mortgage-backed Securities* (Fabozzi, 1985, 1988, 1991, 1995, 2001, 2006), comprising in total 246 chapters. Journal articles in *Wall Street Journal* and *Financial Times* going back to 1986 and 1982 respectively are sources for indications of experts' prediction errors and their consequences.

The Case

The 1980's - The CMO and the CDO are developed

By 1980 the pass-through bond is a well-established product and easy to understand for investors but a vexing problem is how to value the new security. US home owners are free to repay the whole or part of their mortgage loan at any time. The pass-through bond amplifies this *prepayment risk*.

The second generation instrument developed with securitization is the Collateralized Mortgage Obligation (CMO) developed by FHLMC and Bankers Trust (Morris, 2008 p.39) in 1983. It partly solves the prepayment problem by adding new technical characteristics: The cash flows from principal and interest repayments in the pool are unbundled and redistributed so that the highest ranked tranches receive predetermined pay-outs and are isolated from the risk. However, this means that the cash flow of lower ranked tranches becomes more erratic, i.e. they have to take more risk[1]. The CMO looks like the perfect financial product to fill the void in home owner funding created by the Savings & Loans crisis (Mayer, 1997, p.28-31). Hence, government rapidly follows up with new legislation[2] in 1986 to smooth out tax issues (Henderson & Scott, 1988, p.38).

The general securitization technology is now in place and the professional context (shaded area) with the main actors looks like Figure 2. The ultimate purpose of the complex structure is to serve the Borrowers and Other debtors with loan capital; they mortgage their homes and contribute data about themselves to the six actors in the Professional Context. All are dependent on each others' competencies and data and they are also to a

[1] The most exposed among these is the 'Z-bond'. It does not receive any cash flow at all until all other tranches have fulfilled their conditions.

[2] In legal terms most of the CMOs hereafter were designed as 'Real Estate Mortgage Investment Conduits', REMICs.

large degree linked by legal contracts. The arrows between them in Figure 2 refer to competence/data dependence.

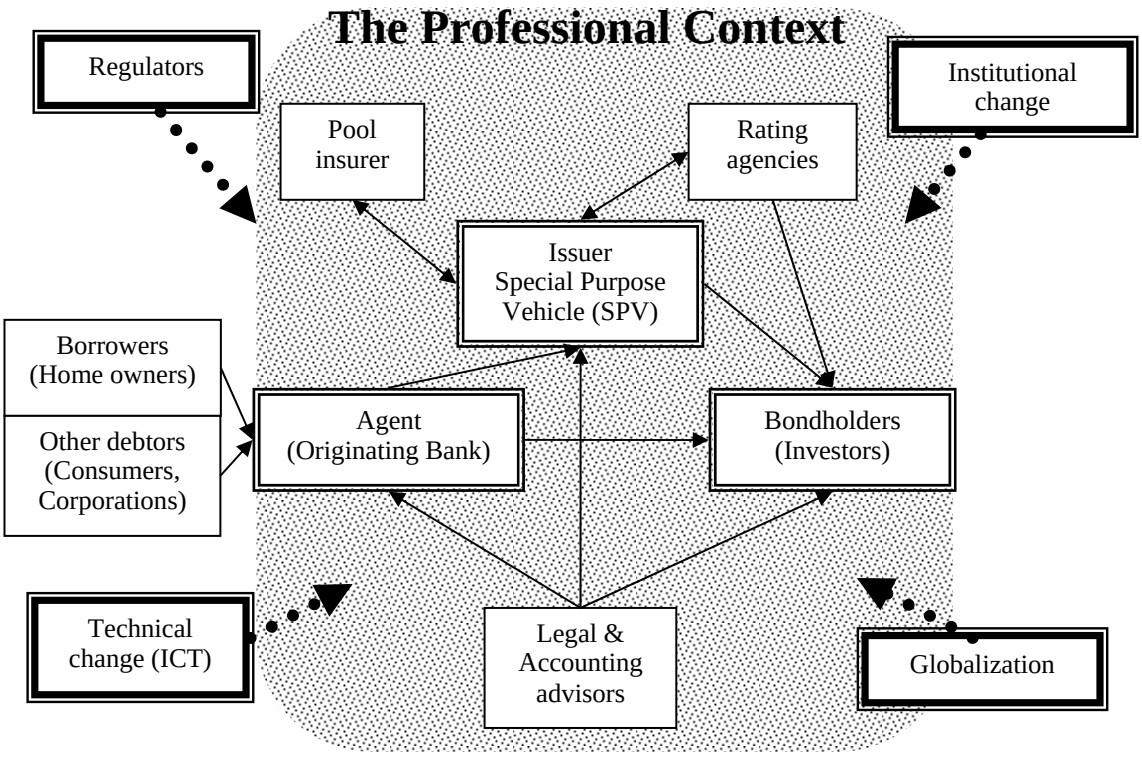


Figure 2. Securitization technology and its professional context with four exogenous drivers.

The first actors begin to form the professional context of securitization. They are young and inexperienced[1]; less than 10% of them have more than three years of experience.

Most actors in the financial industry, new as well as old, have to learn the new competencies required: how to structure the issuer (the Special Purpose Vehicle, SPV), how to originate and transfer the original mortgages, how to design the overall security package, how to ensure that the models mirrored reality (the model risk), how to ensure interest indemnity, how to isolate the bank from bankruptcy of the SPV, how to price the new security, including the pre-payment problem (the price risk), how to calculate and extract profit, etc., (list amended from Henderson & Scott, 1988, pp. 52-53).

A major benefit for the investors is that the agency-issued CMOs carry no credit risk. Both investors and the Wall Street banks hence begin to

[1] An informal poll conducted at a mortgage-backed securities conference in 1984 cited by (Fabozzi, 1985, xiii).

disregard it entirely. More important for them are the new competence requirements: to evaluate price risk and liquidity risk.

The regulators must learn how to assess the systemic implications of the new financial instruments. This is becoming quite a challenge, because securitization is beginning to cause *institutional change*; the financial industry is breaking up into sub sectors. The professional context of 1988 in Figure 2 is hence becoming even more complex, amended with new institutions offering specialist competences, such as mortgage brokers and mortgage lenders. Investment banks design and function as market makers of the new CMO bonds. Insurance companies and rating agencies begin to explore new markets as CMO pool insurers and CMO raters respectively.

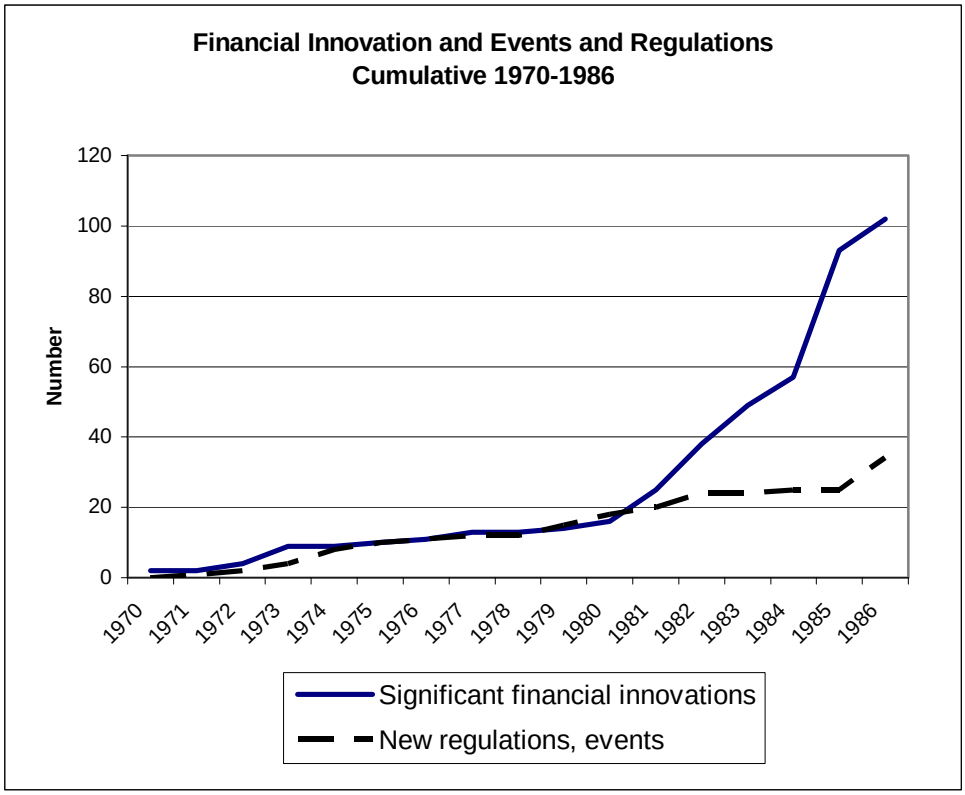
In 1985 the first edition of *The Handbook of Mortgage-Based Securities* with 20 chapters edited by finance professor Frank Fabozzi is published. The range of expertise mirrors the new professional context. Fabozzi is employed by the accounting firm Peat Marwick Mitchell; other authors come from investment banks such as Salomon Brothers, Lehman Brothers, First Boston, Morgan Stanley; the stock broker Dean Witter; the investment advisor Ryan Financial. One chapter on evaluating pre-payment risk is written by David Askin, a well-known junk bond expert from Drexel-Burnham-Lambert. He outlines the main problem with most models: they rely on data on historical pre-payment patterns collected by the FreddieMac / FannieMae agencies, (Fabozzi, 1985, p.279-306). Askin is prescient, but he will later become known also under less flattering circumstances.

The ‘originating banks’ in Figure 2 come under fierce competition from the new intermediaries and spreads go down. To compensate, they increase securitization volume to generate more fees. As an additional benefit securitization removes capital from the balance sheet while the bank still retains influence over its use.

By now the PC brings rapidly growing computing power to the desks of all analysts (Henderson & Scott, 1988, p.7) and innovation explodes. During the three most active years 1983-85 a new financial instrument is launched every second week - from 1985 increasingly referring to financial products in other currencies than US$; g*lobalization* adds new innovation opportunities.

Investors drive the outstanding volume of CMOs from around $100 billion in 1987 to around $350 billion by the end of 1990 (Davidson et al., 2003). Further deregulation allows even the old-style regional banks to join in. They are sitting on a gold mine: not yet securitized mortgages.

Figure 3. Debt innovations 1970-1990.



Sources: Finnerty & Emery, 2002; Matthews 1994; Miller, 1991.

The UK economist Colin Mayer, however, is disturbed by the potential undesirable consequences of the financial innovation wave. In a article published 1986 he lists among others: the apparent liquidity of the system may prove illusory; inexperience of pricing new instruments may cause mispricing; inadequate perception of risks among managers, and; transactions not recorded in accounting statements undermine the soundness of the financial system.

Mayer's prescient concerns are never tested empirically, neither by his academic colleagues, nor by industry experts. But the *price risk* is beginning to be taken seriously by the industry: Eight chapters of 49 in the 1988 edition of the Fabozzi handbook are devoted to prepayment issues.

The 1987 crash - Poorly Understood New Risks

In 1985 and 1986 major losses are reported[1] in the main financial media. Culprits are accused, sacked and sued under headings like 'fraud', 'unauthorized activity', etc.

On October 19 1987 the New York stock market crashes. In the aftermath multiple unanticipated losses on a/o CMOs are uncovered, among them $50 Mill for First Boston due to errors in valuation (*price risk*). The financial industry is now, for the first time, accused of bringing 'a plethora of new products to market....The scale of the losses suggests a serious lack of understanding about the way such instruments would behave' (FT 7 April 1988).

Fabozzi (1991, 3rd edition, p.751 ff), contains a study by Jacob and Gallop on previously issued CMOs, noting a 'surprising' result: 'CMO tranches have cash flow patterns that often do not resemble those of more intuitive fixed income securities.. The chapter is to be updated with new data under varied authorship in future editions (1995, p.689; 2001, p.553; 2006, p.867), but the conclusion will remain identical despite fifteen years of further product development.

Unknown at the time, CMOs also suffers from a completely new *model risk*: The new statistical models produce impressive projections for the behavior of the CMOs, many of which will later be proven to be false. However, the three Fabozzi handbook editions up until 1991 contain no critical analysis on the inherent risk in models. The 1987 crash also highlights that CMOs carry considerable *liquidity risk* when markets turn bad and the banks are not able (or refuse) to fulfill their role as market makers. FT 7 April 1988 accuses the market of having: 'illusions about the marketability of securities and distorted perceptions of value.

However, banks discover that securitization is a highly effective tool to circumvent the effects of new tougher capital requirements, known as Basle I. The freed up capital is used to create more business of the riskier kind, (Franke & Krahnen, 2005).

The 1990's

The main issue in the CMO market is the problem of how to get rid of the 10% lowest classified tranches. New intermediaries offer a solution: sell them to unsophisticated clients (WSJ Dec 20 1994). Hedge funds are new investors. Primary among them is a fund run by afore-mentioned David

[1] January 1985: a pool insurer goes under, causing losses of some $200 Mill for Bank of America (Financial Times [FT] 31 Jan 1985). 1986: a Merrill Lynch senior trader incurs a $250 Mill trading loss (Wall Street Journal [WSJ], April 30 1987) and First Boston loses $100M (FT 14 July 1987).

Askin, who invests $600 Million, mostly borrowed from the CMO-issuing banks, in a highly leveraged portfolio.

By 1994 about $1,000 billion worth of CMOs have been issued and it is 'the most successful new security product of all time', as Amerman put it the first textbook devoted entirely to CMOs (1996 p.3). Bankers Trust and JP Morgan obtain more than half their operating revenues from sources other than lending money. Also the US government is happy: an estimate made in the mid 1990's concluded that it had saved US home owners $17 Billion a year[1].

Competence requirements are shifting too. An indication is the basic JP Morgan introduction program for new recruits, which no longer includes so much as a day's training on credit assessment, (Mayer, 1997 p.27-28).

The 1994 Crash

In the spring of 1994 bond markets crash. The triggers are two small increases in short-term interest rates by the Fed amounting to 0.5%, for the first time in five years. Interest rates soar and bond prices plunge. US President Bill Clinton's chief economic advisor, Robert Rubin, has to admit that he does not know why economic fundamentals do not provide the answer, only that 'the market is functioning differently' than it had in the past, (WSJ 20 May 1994).

Investors are chocked by the high unknown *price risk* inherent in CMOs: 'The most common complaint I hear nowadays [from investors] is, 'I didn't buy this bond!'' (Fund manager cited by Inst. Investor 1994). Clearly, competence in valuing the securities is lacking among all actors. Several highly leveraged hedge funds are again caught by *liquidity risk*. Askin Capital is one of the first to go under. It pulls down with it more venerable firms, such as Kidder, Peabody.

Wall Street Journal notes that 'nearly everyone, from the resident White House expert on the markets to the seasoned chairman of the Federal Reserve Board to the managers of the biggest portfolios in the world, seemed confounded' (WSJ May 20 1994). It turns out that speculators around the world had begun to rely on US treasury markets to hedge their bets. No one had foreseen the huge impact foreign investors could have on the US home market.

The quotes above indicate that actors are unaware that the professional context has changed considerably. A series of ICT innovations has gradually made the financial world interlinked as never before; in 1994 the traders are making deals based on real-time market data from the financial centers of the whole world. Herding is now global.

[1] cited by Morris (2008 p.40).

The Fabozzi handbook reacts quickly. The 1995 fourth edition devotes no less than six chapters (of 39) to prepayment behavior and forecasting and seven chapters to valuation techniques and risk measurement. However, the pricing problem is still treated as an isolated issue by the experts; the competence to evaluate the *price risk* is clearly still not up to the task and there is no debate on the problems with statistical modeling and *model risk* on a more fundamental level. The first overview of models does not arrive until 2001. Bykhovsky (2001): 'This class of models performed poorly'. They 'dramatically under projected' the volatile behaviors in 1992-1993 leading up to the crash. The models were then adjusted and subsequently 'dramatically over projected' the behaviors in 1996-1997; they were adjusted accordingly to the effect that they 'dramatically under projected' the behaviors in 1998-1999 (Fabozzi, 2001, p.365ff).

The financial industry suffers an estimated $55 Billion loss in the 1994 crash, and it will take two more years for the mortgage markets to recover (Morris, 2008, p.40). The clean-up also reveals huge losses among investors (e.g. Orange County) and both Merrill Lynch and Prudential securities are later fined for inadequate monitoring (WSJ 5 Oct 1998).

The 1997-1998 Asian/Russian crises

The mortgage lenders are sitting on a stock of $35bn of mortgage loans which have been originated, but not yet sold as CMO/CDOs, when a financial crisis unexpectedly begins in Asia in July 1997 (FT 16 Oct 1998). It is followed in August 1998 by a Russian default on their foreign debt. Interest rates spike, bond prices plummet and it becomes obvious that the mortgage lenders[1] have underestimated the *price risk*. They have also been unable to assess *model risk*. This time home owners and corporations repay loans much faster than the models predict and more losses are posted. The 1997/1998 crisis all but wipes out the independent mortgage lenders.

In 1999 the Gramm-Leach-Bliley Act (1999) removes several of the regulations that had put restrictions on traditional US banks since the depression of 1930's.

The Synthetic CDO and the CDS

In 1997 the *credit-default swap*, CDS, is invented by JP Morgan and the Swiss Bank Corporation (Gibson, 2004). It is but a small step to develop a CDO pool containing credit-default swaps. This innovation, a derivative of derivatives, becomes known as a *synthetic CDO*. Only a year batches of CDOs and CDSs are pooled into *CDOs squared* and *synthetic CDOs*

[1] Two examples of many: ContiFinancial $129 Mill, (WSJ 17 Nov 1998) and Mego Mortgage $126 Mill (WSJ 30 Nov 1998a).

squared– the first derivative of derivatives of derivatives (Watterson, 2005).

Synthetic CDOs can be issued without even having to purchase or own the underlying bonds and therefore become an avenue for European banks to enter the derivatives markets. By 2002, synthetic CDOs make up more than 75% percent of issuance the CDO market, (Tavakoli, 2008 p.6ff), and in 2007 the notional value of outstanding credit default swaps has grown to $62 trillion (Ferguson, 2008 p.339), a staggering amount considering that the total value of all household and commercial mortgage loans in the USA amounts to $14.5 trillion that year (Federal Reserve, 2010).

However, solicited by the banks, home owners react faster and faster than predicted and this amplifies downward price swings more than upward swings in the CDOs (WSJ 24 Aug 1998) – a new behavior, which has not been predicted in models.

2000-2003 Building up for the boom

In 2000 the statistician David Li proposes a statistical model for estimating future yields of a bond based on life insurance mathematics. The innovation becomes highly influential since it reduces the complexity of calculating prices for pools containing non-standardized debt, such as corporate bonds.

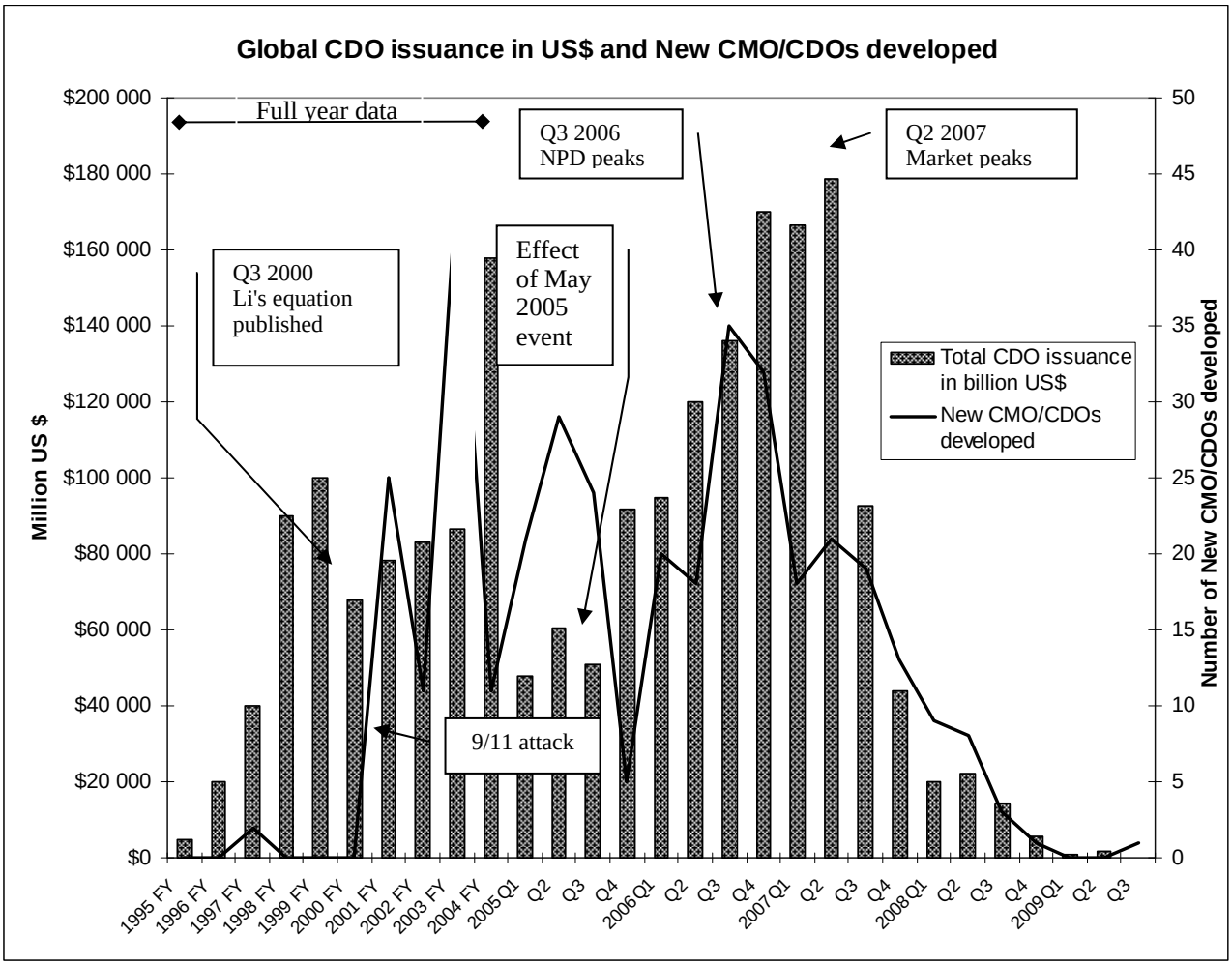
However, default rates for corporate bonds in the CDO pools now begin to increase above historic trends (Tavakoli, 2008, p.10). The reason: correlations are not constant as assumed in the models; they vary over time. In 2003 Adelson addresses this problem as *model risk* for the first time in a peer-reviewed article. Markets are unperturbed, however, and innovation accelerates; by 2005 there is 'almost daily innovation in the credit derivative market' (Li, 2006).

Referred to as 'derivatives on steroids', *CDOs cubed*[1] are introduced in 2005. A year later they have 'created thousands of new investment assets', (Ray, 2006). CMO pools are filled aided by the same predatory sales techniques that were applied in the boom leading up to 1994 crash - only now on a much larger scale and Countrywide Financial, the second largest mortgage lender in the USA, becomes implicated in a series of lawsuits (Shareholders Foundation, 2010). Rajan notes in 2005 (p.339): Overall, 'the incentives to take risk have increased... and incentives to herd and move prices away from fundamentals'.

[1] 'CDOs Cubed' are Collateralized Debt Obligations with a Russian shell doll structure, containing other CDOs which, in turn, contain other CDOs which, finally, contain investment assets of all types. If the innermost "doll" securities are credit default swaps the instrument will be a derivative of a derivative of a derivative of a derivative.

In particular synthetic CDOs are booming: from a total financial industry risk exposure of less than the equivalent of $400 billion in 2001 to an estimated $2 trillion by the end of 2005, or almost 40% of the whole U.S. corporate-bond market of $4.9 trillion that year (WSJ 12 Sep 2005).

Figure 4. Global CMO/CDO innovations and global CDO issuance 1995-2009



Sources[1]

Fabozzi mirrors the accelerating innovation in 2006 by expanding the handbook to 54 chapters featuring a new ten-chapter section on 'Alternative mortgage products' and four chapters on issues related to sub-prime loans. The book also contains an updated version Bykhovsky's chapter from 2001. It repeats the same criticism about models – not much development seems to have occurred. In total 69 experts contribute, 23 of

[1] Full year data 1995-1999: Deutsche Bank Global markets research (2000). 2000-2008: Securities Industry and Financial Markets association, SIFMA, USA, Quarterly from 2005.

them from companies, which will two years later go under or be bailed out by governments: Lehman Brothers, Countrywide, Bear Sterns, Merrill Lynch, United Bank of Switzerland, and Royal Bank of Scotland.

The End Game 2005-2008

The first serious sign that something is wrong (again) in the CDO market is the 'May 5th 2005 event' (see Fig. 4), when a synthetic CDO pool containing bonds, issued by a/o GM and Ford, causes heavy losses for investors. Reason: the bond prices did not follow Li's model. Li concedes the *model risk* in an interview: 'Actual prices in the market often differ from what the model indicates they should be….The most dangerous part is when people believe everything coming out of it'. (WSJ 12 Sep 2005). Many investors face serious losses and CDO sales drops in the third quarter 2005 accompanied by a drastic fall in new product development, (see Fig 4).

In September the bankruptcy of the automotive parts manufacturer Delphi sends another shockwave through the US financial system. Alan Greenspan feels the need to go on record on 27 September 2005: 'Recent regulatory reform, coupled with innovative technologies, has stimulated the development of financial products, such as asset-backed securities, collateral loan obligations, and credit default swaps, that facilitate the dispersion of risk'. (Greenspan cited by Kothari, 2005). The markets bounce back immediately and the last quarter of 2005 sees issuance of CDOs bouncing back (see Fig 4).

Three years later, in September 2008, the first ever global liquidity freeze coincides with the other three risks covered in this case: The default risk on sub prime loans in times of declining house prices has been underestimated; this type of model risk has not been predicted so CMO/CDO price risks cannot be calculated. All the most active players in the CMO/CDO market suffer severe negative consequences including the two original co-inventors of securitization, FreddieMac / FannieMae. They are saved by the US government, while wave after wave of indirect negative consequences rolled through the world economies.

US Fed chairman Alan Greenspan: ' [I am] in a state of shocked disbelief over the failure of the self-interest of lending institutions to protect shareholders' equity' (The Guardian 24 Oct 2008).

Summary of the Case

By 2008 securitization had become the defining technology of the US financial industry. Traditional banks had shifted from the traditional 'buy and hold the mortgage, to one of 'trade'; from one where income is generated by the gap in interest between deposit and lending rates to one where income is generated from the difference between buying and selling prices; from one where creditworthiness of the borrower is crucial to one

where turnover and trading volume determines the profit, (Kregel, 2008). New non-bank financial specialists and intermediaries had evolved into a thriving unregulated US$17 trillion 'shadow banking system', thereby surpassing the $13 trillion assets of the regulated sector of commercial banks and traditional savings institutions (Adrian & Shin, 2009).

This radical shift was accompanied by severe losses when otherwise competent actors unwittingly made prediction errors due to temporary incompetence. Their prediction errors surfaced during the recurring crises and are summarized in Table 1.

Competences to assess:	**1970's**	**1980's**	**1990's**	**2000-2005**	**2005 -> crash**
Model Risk	N/a	N/a	Lacking (1994 and 1997-1998 crashes).	Lacking (mis-appropriation of Li's invention)	Lacking (May 05 event, Sub prime debacle)
Price Risk	N/a	Lacking (1987 crash)	Lacking (1994 and 1997-1998 crashes).	Lacking (mis-appropriation of Li's invention)	Lacking (Subprime debacle)
Liquidity Risk	N/a	Lacking (1987 crash)	Lacking (1994 and 1997-1998 crashes).	Lacking (Mounting sub-prime loans)	Lacking (Sub prime debacle)
Credit Risk	High	High	Diminishing	Lacking (Mounting sub-prime loans)	Lacking (May 05 event, Sub prime debacle)
Effect of driver	**1970's**	**1980's**	**1990's**	**2000-2004**	**2005 -> crash**
Globalization	Not noticeable	Noticed mid 80's	High (Asian + Russian crises)	Reduced by 9/11 effect	Returning to high
ICT	Beginning	Noticed end 1980's (PCs)	High (Internet)	High (Internet)	High (Internet)
Institutional change	Beginning	High: new fin. firms emerge	High: Turmoil among new fin. firms.	High (New fin. firms disappearing)	Relatively high
Deregulation	Beginning	High level	Continuing	Continuing	Continuing
Innovation level	**1970's**	**1980's**	**1990's**	**2000-2004**	**2005 -> crash**
	Probably slowly increasing	Very high until 1987, then low	Increasing from low level	Very High	Decreasing before the crash.

Table 1. Summary of prediction errors and effect of innovation drivers 1970-2008.

The case also illustrates several examples of inadequate competence apart from the temporary incompetence of experts. One is the apparent inability of industrial experts to solve inherent problems with the products, such as the pre-payment problem, despite numerous efforts. Another is the lack of systemic learning; starting with the 1987 crisis lack of competence was revealed over and over again during the following 20 years. In the end it was poor credit risk assessment that triggered the crisis - an ironic twist,

since it was the introduction of securitization which had caused the destruction of credit assessment competence.

Table 2. Two waves of accelerating financial innovation have occurred since 1970: In the 1980's and the 2000's.

	1970's	**1980's**	**1990's**	**2000's**	**Total**
New[1] CMO/CDO offerings	0	59	2	336	397
Repeat CMO/CDO offerings	0	112	7	1,791	1910
Total CMO/CDO offerings[2]	0	171	9	2,127	2307
Percent new CMO/CDO *offerings*	*0*	*35 %*	*22 %*	*16 %*	*17 %*
Significant financial innovations (Matthews, 1994 + Finnerty & Emery, 2002)	14	107	6	n/a	127
Patent applications[3] globally by 20 top CDO banks	15	34	452	1,271	1772
Patent applications annually	0	n/a	*83*	*155*	--

Sources: Thomson Banker One, Freepatentsonline, Matthews, 1994,; Finnerty & Emery, 2002; author's calculations.

Four decades of financial innovations and CMO/CDO product development are summarized in Table 2. Two waves of accelerating innovation can be distinguished: the first in the 1980's, driven by deregulation and ICT.

The second wave starts in the late 1990's when several drivers combine to create an unprecedented acceleration in financial innovation. In relative terms, the most innovative decade was the 1980's with 35% CDO offerings classified as new. The 2000's wave appears lot less creative; a very high volume of CMO/CDOs was launched, but only 16% could be classified as new[4]. Innovation was primarily customization and combination of innovations originating from the 1980's and 1990's. The innovations became less creative, more distanced from the underlying real assets and more risky.

[1] A new CMO/CDO offering is operationalized as a change in at least one of these service characteristics: Lead Manager, Issuer, Type of Security, Description or Marketplace.

[2] The sharp drop in the number of security codes in the 1990's may partly be due to idiosyncratic classifications in the Thomson database, but it has no implications for the conclusions.

[3] Comparison over time is distorted by changes in patent laws in the USA in 1995, when USPTO began to grant patents for business processes. European patents rules have shifted in the same direction, but are still different. An approximate illustration of innovation activity is the annual average per decade. The 1990's annual average is for the period 1995-1999. 2000's annual average is 2000-2008.

[4] The estimate that 16% CMO/CDO offerings in the 2000's were new products concurs roughly with Tufano's (2002) estimate that 20% of all derivatives at that time were innovations, which lends some level of validity.

Discussion – Unintended and Undesirable Consequences of Innovation

This study shows that financial innovations played a crucial role in the lead-up to the GFC. The following discussion explores the role of lacking competence in this process.

The case largely confirms evolutionary economic theory as a dialectical process between innovation, which generates variety, and selection, which alters the relative economic importance of the competing alternatives (Nelson & Winter, 1982; Metcalfe, 1994). We can observe this process as new financial firms emerged and went under continuously due to incompetence in the recurring crises. Securitization forced both new and incumbent actors to create new competence. It also made existing competence less relevant, when the existing industry structure was disrupted (Tushman & Anderson, 1986), such as credit risk assessment skills. The case also shows systemic (Lundvall, 1988) and path dependent features (Liebowitz & Margolis, 1995; Pierson, 2000a) in that new products are developed through a learning process (Malerba, 1992), which generates new competences among many institutions in a tightly knit professional context. However, the evolutionary dialectic would have led to extinction of the bank as a species, at least in the Western world.

How could incompetence persist despite three decades of research, intense innovation and experiential learning? The following discussion applies Robert K. Merton's (1936) framework for 'consequences of purposive action' to try and answer this question. Consequences are both those, which are exclusively the direct outcome of the action, and those that are the indirect consequences of 'the interplay between the action and the objective situation'. Merton distinguishes five factors limiting an actor's competence to anticipate direct and indirect consequences of an action for others: lack of foreknowledge, assessment errors, myopia, ideology, and self-defeating/self-fulfilling purpose.

First, it is a fact of life that humans are limited by *lack of foreknowledge*. It is impossible to foresee all the consequences that may follow an innovation and introduction of new technologies make consequences even less predictable (Redding, 2002). The US agencies could hardly foresee in 1970 that their innovation intended to solve a technical issue was to transform the financial industry. Ten years later securitization was still only an unlabeled combination of various administrative processes. The shift happened when the financial industry embraced the PC-revolution. In a matter of a few years the technical processes and the structure were elevated from the humble back office to a generic platform for product development. ICT innovations from then on defined what was possible; they 'reversed' the product development cycle (Barras, 1990). ICT also

dramatically accelerated the innovation process itself (Rothwell, 1992). This transformation from unnamed obscurity to an explicit concept explains why banking analysts failed for so long to see securitization as an innovation and to predict its importance. The rapid growth of securitization was long interpreted as a decline of the banking sector, because the assets, which were transferred from the banks' balance sheets to the SPVs, disappeared from the financial statistics, (Cobas, 2002, p.70).

Deregulation caused institutional change and also opened up markets to new financial specialists from the mid 1980's. Globalization reinforced by ICT added further opportunities for innovation from the 1990's. The professional context for securitization hence kept changing unpredictably. Competence was created and destroyed in a tumultuous process and the actors never got the time they needed to become fully competent up until the final crash 2008.

The second factor limiting is actors' ability to predict consequences are *assessment errors;* incorrect analysis due to heuristic driven biases, a/o the belief that those actions, which have in the past led to the desired outcome, will continue to do so. The value of CDOs depend on predictions about future behaviors of US home-owners and corporations; one might say that the *prediction is the product*. However, the fast growing volume of securitized new products also began to influence the behaviors of borrowers on a large scale. Hence, from around 1993 historic data underlying the models no longer corresponded to reality. The response was to design new models, only to see them again made obsolete by a changed reality; the designers were always one step behind. What the individual innovators did not perceive was that they, as a group, contributed to a general shift in the financial environment to greater uncertainty, as a study about ratings for bonds issued by banks has shown, (Morgan, 2002). Building on data from the 1990's the econometrician Taleb (2008) concurs: historic data cannot be used for projections, because there is no way to guarantee that the data are not random.

The consequence is that after more than 25 years of development and repeated efforts by the best brains in the industry, many of the CMO/CDO varieties are still not safe to buy. They are 'unsafe at any speed', to borrow the 1960's US consumer activist Ralph Nader's slogan in his campaign against the US automotive industry's refusal to include safety equipment in American cars. Forty years on, it is normal practice in the financial industry to launch unsafe products on a regular basis.

A third factor limiting our competence is *myopia* (nearsightedness): actors desiring the beneficial consequences of an action so much, that they are blind to any other consequences. Rather than dispersing risks securitization became used to add debt in order to increase short-term profit. Also, a portion of the risk default losses of CDO pools largely

remained on the books of the issuing bank (Franke & Krahnen, 2004). As a result, rather than dispersing risk, as the regulating bodies believed, securitization had the opposite effect: to concentrate all the risks in the banking system itself (Adrian & Shin, 2009) only waiting for a trigger.

Myopia of experts is illustrated by the six editions of the Fabozzi handbook, which do not contain a single chapter on effects outside the professional context. Practically every chapter in the handbooks deals with applications of securitization, but only a couple can be said to take more reflective or critical stances. None of the editions published immediately after one of the many financial crises contains a chapter discussing what can be learned from it. At any point in time a large proportion of the chapters was addressing problems caused by the inadequacy of previous innovations, while the fundamental flaws in the products remained unsolved. This suggests that strong path dependence (Liebowitz & Margolis, 1995) and myopia go hand in hand in the case. The global professional context for securitization and the CDO was, due to its dependence on US assets, geographically tightly located on Wall Street in New York. This is known to enhance path dependence and it was further emphasized in an industry chronically driven by time pressure (Rycroft & Kash, 2002).

Quasi government agencies and legislators were deeply involved in first co-developing the basic technology in 1970 and 1983 and in later years ironing out legal issues arising from securitization. This suggests that the basic structure was more or less iron clad because innovations breaking the existing legal structure could be subject to legal action – a powerful deterrent. This is confirmed by the data, which show a reduction in creativity (Table 2 above). The dominant position of securitization can therefore be an example of path dependent lock-in – an unintended negative consequence of legislation, (Greener, 2005; Pierson, 2000a, 2000b).

Ideology limits competence as 'there is no consideration of further consequences because of the felt necessity of certain action enjoined by certain fundamental values'. During the period covered by the case economic policies was dominated by neo-classic economics. The theories became enshrined as fundamental values influencing economic policy both in the US and worldwide and they also underlie the statistical/ mathematical assumptions of many of derivatives created from the basic CMO/CDO structure. It is beyond the scope of this article to discuss the validity of the theories. The case illustrates, however, that underlying fundamental values played a decisive role in limiting the ability of both scholars and policy makers to foresee the consequences of the theories' practical application.

There is one other fundamental value involved: the general belief in the West that innovation is ‘good’, a.k.a. pro-innovation bias (Rogers, 1983; Abrahamson 1991). This may be one reason why actors believed that the solution to a problem caused by innovation was more innovation. We can detect the same bias in the industry's fascination with statistical theory and ICT. In the late 1980's actors were in awe over the first PC spreadsheets and the first generations of statistical software. When the calculations proved to yield false predictions, more powerful computers and new software were the answers.

The fifth factor limiting our competence is a feedback loop, the *self-defeating prophecy* and its opposite the self-fulfilling prophecy. The response by the financial industry to problems in the first innovation wave 1983-1987 was to create new varieties of the same basic design: to add more variables, longer data periods and to combine existing models; new CMO/CDO varieties take up some 20% of all the chapters in the Fabozzi handbooks. New solutions for the valuation problems (price risk) were proposed in every edition up until 2006 (13% of all chapters). With hind-sight we can recognize that such efforts were actually self-defeating. Innovation improved the efficiency of the calculations and accelerated the design of new varieties of the existing design, but it did not address the fundamental flaws in the products. The effect was merely to accelerate the financial industry's descent into its death-spiral.

Conclusions, Implications and Future Research

The case illustrates how actors, from novices to laureates repeatedly made errors in predicting the consequences of their actions. In the early days of the technology, inexperienced novices with limited competence designed primitive early versions of the products containing flaws, which remained despite continuous product development. Bankers and investors, limited by heuristic biases and myopia, launched and invested in products dangerous both for themselves and others over and over again. When reality did not correspond to theory industry experts tended to disregard the unpleasant information, whereas ideology played a role in limiting the competence of otherwise insightful academic experts and policy makers, who chose to assert their views or to reassure without reflection. Securitization’s impact was amplified by drivers coming from outside the professional context, which made contextual change and ensuing uncertainty a more or less permanent feature of the industry.

The consequences of the actors’ combined temporary incompetence falsify the common belief that ‘faster diffusion means a higher societal return’; faster diffusion can mean a faster journey toward a disaster. The solution to a problem caused by innovation is not necessarily more innovation; innovation may merely multiply the effects of an inherently flawed design.

The trouble for actors is that, at any point in time, all consequences of innovation are possible to know only with hindsight and then often only with a hind-sight bias, something that also this study can be accused of. But the study also shows that there exist options to reduce the risk of errors.

One is to be very careful when introducing policies, which may accelerate innovation. Such policies may instead amplify already ongoing contextual change in an industry to disaster level. The case illustrates how ongoing contextual change remains hidden while our view of the new is dimmed by the measuring tools of the old. Hence, weak signals, such as the opinions of silenced voices or trends in the fringes are important. They are easily dismissed, ridiculed or ignored as change agents push the main stream agenda.

Contributions by independent and contrarian thinkers should be encouraged also in corporate R&D. Very few critical inputs by industry experts addressed the inherent flaws of the CDO varieties in more fundamental ways. Related to this is a recommendation to allow time for breaks to look back, and reflect. Such breaks could have reduced the disturbing tendency to repeat mistakes illustrated in the case. Particularly fruitful moments to learn occur after critical events; the road to global financial meltdown was littered by lost opportunities to do so.

In terms of academic research a more detailed follow-up of Barras' (1990) reverse cycle product development theory would be valuable. Twenty years after his assertion that financial services are the 'vanguard of the service revolution' the case demonstrates a major issue with ICT-based service innovation: its systemic nature, which on the one hand is a powerful enabler for further innovation - on the other hand can send ripples of unintended consequences through society on a global scale.

The role of legislation in financial innovation is well worth further study. One hypothesis arising from the case is that a legal structure developed for a specific social benefit may generate a path dependent lock-in effect with systemic impact.

One of the observations while conducting this study was that critical and reflective texts are few and far between in the financial field. It is not surprising that industry insiders have an uncritical bias. However, financial academic research does not perform much better. Could the close liaison between the 'Ivy League' universities and Wall Street firms described by Karen Ho (2009) have anything to do with this? A study focusing specifically on the issue should yield interesting results.

Our limited ability to foresee the consequences of one's actions is a fundamental property of being human. It should hence also be seen as a

fundamental property of financial innovation and in financial product development. Financial Innovation has such a profound impact on future society that practitioners and change agents, as well as researchers and policy makers should embrace all possibilities to broaden their abilities to foresee, not only the desired outcomes, but also the unintended and the undesired. Rather than being ignored they should be acknowledged for what they are: a large, often untapped, resource for improving the net effects of financial innovation for society.

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Abbreviations: WSJ=Wall Street Journal; FT=Financial Times.

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