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Demand Heterogeneity and Economic Value: An Evaluation of the OTC Derivatives Market

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This paper provides a framework to show that the OTC derivatives market is important for improving the welfare of market participants. This framework is built on the idea that heterogeneity of market participants is the basis for innovations in financial products. The OTC market provides a flexible structure to make it possible for firms and their heterogeneous clients to trade in new products. The data provided in this paper support this framework.

JEL Codes: D61, G14, L51

1. Introduction

The rapid growth in the derivatives market in the 1970s and 1980s led to some concern in the mid-1990s about whether these securities were becoming another means for users to speculate and the potential negative impact of such activities on financial markets and the economy (Darby 1994). A decade later and as the growth of this market accelerated, a well-known and respected financial economist attempted to address this concern in a paper entitled, "Should we fear derivatives?" (Stulz 2004). Soon after this, the financial crisis and the concurrent Great Recession of 2007-2009 took place, which has brought to the fore legislative actions here in the U.S. and abroad dealing with various aspects of the OTC derivatives market (Dodd-Frank Act 2010).

The focus of this paper is: *"What is the economic value of OTC derivatives?"* The underlying framework used for reviewing the literature postulates that derivatives are a financial innovation and that they derive their economic value from enhancing the economic efficiency of markets by allowing better risk sharing when markets are incomplete (Duffie 2010). At the same time, it is recognized that markets are heterogeneous in terms of participants and in terms of the technology used (Bernado & Cornell 1997).

Tufano (2003, p. 3) defines financial innovation as: "the act of creating and then popularizing new financial instruments as well as new financial technologies, institutions and markets." Notice that this definition includes "popularizing," which suggests that "something new" to be used, and is thus not a costless activity. In their recent review of the literature on empirical studies of finance, Frame and White (2004, p. 118) states that "a financial innovation represents something new that reduces costs, reduces risks, or provides an improved product/service/instrument that better satisfies participants' demands." Bhatt (1989) considered financial innovation in the form of credit market development (that is, financial intermediation), such as interest rate swaps, as contributory to economic growth in both developing and developed countries.

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While financial innovation covers many different aspects related to the functioning of the financial system, the focus in this paper is on OTC derivatives. The view of derivatives as financial innovation is a generally accepted one. The derivatives market makes it possible for better risk sharing (Allen & Gale 1994) and involves new securities capable of spanning a variety of risk profiles (Duffie & Rahi 1995). In other words, financial innovation makes markets more complete (Cuny 1993). Among the new instruments were financial futures, considered by Miller (1986, p. 463) to be the "most significant financial innovation of the last twenty years [that is, the period from around 1965 to 1985]".

The organization of the paper is as follows. Section 2 briefly reviews the literature on economic value. This value is related to heterogeneity, which is taken to be a necessary basis for innovation. The paper then proceeds to discuss, in Section 3, a model of heterogeneity and financial innovation, and explain its use in understanding the developments in the OTC derivatives market. Section 4 concludes.

2. Literature Review: Economic Value, Heterogeneity, and Innovation

The concept of economic value is related to economic efficiency, which is the predominant focus in economics. A new economic activity, such as an innovation, generates economic value if the sum of the net benefits (net of costs) going to market participants is positive. The value added by an economic activity can be shown to be equivalent to this sum (Png 2012). Economic welfare, value added, economic value are equivalent ways of expressing essentially the same concept related to the net benefits of market participants from the use of resources. Some authors use the terms economic value, economic welfare, and surplus interchangeably, as evidenced in Bresnahan & Greenstein (2001). The *Pareto efficiency* concept defines a market outcome as efficient if one can make no further improvement, that is, making someone better off without making someone else worse off (see for example, Layard & Walters 1978; and Varian 2010).

At the market level, one can approximate the increase in welfare by summing up the profit from the innovation, plus the net benefit accruing to users. This net benefit to the buyer, known as consumer surplus (see, for example, Krugman and Wells 2013) is more difficult to obtain.

Below, the interplay between heterogeneity and innovation that provides economic value to the OTC derivatives market is discussed.

2.1 Heterogeneity and Innovation

The idea of innovation as an important aspect of capitalism has first been articulated by Schumpeter (1939), who defines innovation as "doing things differently in the realm of economic life." (p. 84). Innovators play an important part in what Schumpeter called the process of "creative destruction." While it causes disruption to markets by making existing capital obsolete, the process makes it possible for economic growth and welfare to improve over time (on Schumpeter, see, for example, McGraw 2007). The basis for "doing things differently" is the heterogeneity in how we value products or in how we transform products into characteristics that we value.

Windrum, Ciarli, & Birchenhall (2009) have formulated a model in which the role of consumer demand heterogeneity determines the evolution of environmental technologies. Malerba, Nelson, Orsenigo, & Winter (2007) have suggested that "many industries face a diverse set of customers and no single design ever emerges that satisfies all needs … If one aggregates

across different kinds of drugs, the pharmaceutical industry remains relatively unconcentrated because a variety of different types of drugs are needed to meet the diverse requirements of different humans with different ailments." p. 372. Adner & Levinthal (2001, p. 611) explain that "[r]elatively underexplored … is the effect of the demand environment on the development and evolution of technology …"

Valente (2003, p. 1) has suggested that "assuming homogeneous products requires a centralized pricing mechanism … it is also a severely limiting factor in the possibility of analyzing product-embodied innovations." The implication of heterogeneity is that "[i]f we are to say that a set of preferences exhibits heterogeneity then we would surely require that the behaviour, or choices, that they generate should also be heterogeneous." (Kirman 2006, p. 93).

Langlois (2001) emphasizes that standardization has its limits due to the demand for variety, which in turn limits reuse of knowledge. Bresnahan & Greenstein (1999) consider demand heterogeneity as playing an important role in determining the structure of the computer industry. Going from the general to the specific to meet demand heterogeneity contributes to economic value (see, for example, Bresnahan & Greenstein 2001 on information technology and its economic value.

In this paper, a framework very similar to that of Lancaster (1966) is used. It views the demand for a product as the demand for a bundle of desired characteristics. Heterogeneity as used in this paper refers to the heterogeneity in the valuation by potential users of a given bundle of characteristics, as well as in the technology for transforming goods into characteristics. Lancaster's approach has been used, for example, in Trajtenberg (1989) with respect to computed tomography scanners.

Lancaster's contribution lies in how he changed the way preferences had been traditionally represented in a utility function, which specifies the products (rather than their characteristics) that go into determining utility (see, for example, Varian 2010, for a discussion of the utility function). Heterogeneity on the supply side has also been studied in economics, for example, in the evolutionary economics literature (see, for example, Nelson & Winter 1982).

Additionally, heterogeneity may also have an impact on the structure of the market in relation to how a good is traded. For example, Malamud & Rostek (2014) have considered how heterogeneity makes it possible for a spectrum of market mechanisms to exist: decentralized exchange, dealer-intermediated exchange, and centralized exchange.

2.2 OTC Derivatives as Innovation

Financial innovation has a long history, going back to the times of Babylonia and Assyria, thousands of years BCE (Allen & Gale 1994). Financial innovation can take different forms. Double-entry bookkeeping that is traced back to the Middle Ages may be considered a financial innovation of a *process* nature, considered important for the development of capitalist organization with respect to financing (Basu, Kirk, & Waymire 2009). Interest rate swaps are *product* innovation. The ATM (automatic teller machine) is a computer-related innovation that has improved the financial infrastructure with respect to liquidity demand. New forms of financial intermediation, such as mutual funds, may be considered financial innovation (Ackermann 2013).

Research on financial innovation is of a more recent origin, going back to the 1970s and early 1980s (see, for example, Silber 1983). The empirical work that is systematic in terms of hypotheses and statistical testing is more limited, especially as related to the economic value of derivatives. As Frame & White (2004, p. 116) have put it: "A striking feature of this literature [on financial innovation] … is the relative dearth of empirical studies …". However, from this limited evidence, they conclude that "the welfare consequences of financial innovation … are largely positive, especially with product and process innovations." (Frame & White 2004, p. 134).

Tufano (2003) has surveyed the literature on financial innovation from several perspectives and suggested that the area of industrial organization may be relevant and fruitful to the task of estimating the social welfare impact.

Pesendorfer (1995) models the process of innovation by financial intermediaries as using existing standard financial instruments to create new securities, what he refers to as "customer-tailored instruments." He cites two examples of financial innovation: zero coupon bonds created by Merrill Lynch and Salomon Brothers in 1982, and collateralized mortgage obligations (CMOs) introduced by First Boston and Salomon Brothers in 1983. Allen & Gale (1991) point to the spanning role of new financial instruments in completing markets with respect to risk sharing and also to the "unprecedented rate of financial innovation" (p. 1041). To Allen & Gale (1994, p. 6), "The *theory of financial innovation* deals with the provision of opportunities for risk sharing or intertemporal smoothing …"

Van Horn (1985) looked at financial innovation as reducing inefficiencies and expanding markets, and listed futures and options among the products of financial innovation. In his review of the history and role of modern financial innovation, Miller (1986) considered the most significant financial innovation of the twenty-year period between the 1960s and the 1980s to be financial futures and options. While innovation in many types of derivatives responded to either taxes or regulation, Miller (1986) acknowledged that some were of a permanent nature, such as the Euro dollar and swaps markets, and as such they "must have reduced dead-weight transaction costs and expanded the reach of the market …" (p. 463).

Carvajal, Rostek, & Weretka (2012, p. 1895) formulated a model in which competitors innovate with asset-backed securities to satisfy "heterogeneous risk-sharing needs" of investors with respect to current versus future consumption. This function would make it possible for additional consumption/investment to take place and economic welfare to improve as a result (Shiller 2012; Cass & Citanna 1998). Schroth (2006) obtained results that suggest that buyers find economic value with derivatives as financial innovation because their demand for innovators' products is greater than that for imitators'.

In summary, the extant literature suggests a possible welfare-improving role for financial innovations in terms of meeting the heterogeneous needs of market participants. In the next section, a model of economic value as related to OTC derivatives is discussed.

3. Methodology: A Model of Economic Value as Applied to OTC Derivatives

3.1 The OTC Derivatives Market

OTC markets, including the OTC derivatives market, are large, judging by the value of the securities traded through these markets. According to Nystedt (2004, p. 42), "[t]he United States has some of the largest and most innovative OTC issuers, while also being home to

some of the world's largest ODE (organized derivative exchange) markets." The economic contribution of OTC markets lie in their ability "to specialize in their comparative advantage …" and "to take on highly customized/idiosyncratic risk." (Nystedt, 2004, p. 44).

One characteristic of the OTC market is that trading is done with a relatively small group of large dealer banks or bank-holding companies. They buy and sell large quantities of various types of OTC derivatives and often with one another.

Biais & Green (2007) studied the changes in the trading of corporate bonds in the 20th century and found that the rise of the OTC market relative to NYSE-trading took place at the same time that institutional investors became more important, and that there is a tendency for trades to migrate to where the liquidity is, creating a network effect.

3.2 A Model of Demand for Heterogeneity

This section reviews the model of economic value based on the interaction between heterogeneity and innovation that can then be used to view the evidence as related to OTC derivatives. The centuries-old proverb that necessity is the mother of invention is the basis for viewing heterogeneity as an important dimension of innovation.

Buyers are viewed, in the Lancaster model, as purchasing a bundle of characteristics. A good may possess more than one characteristic that buyers may desire.

Let us assume that there are N goods (X_1, X_2, X_3, …, X_N) and there are K characteristics (A_1, A_2, A_3, …, A_K). The buyer's maximization problem is specified as:

$$\text{Max } U(A_1, A_2, A_3, \ldots, A_K ; X_1, X_2, X_3, \ldots, X_N),$$

Subject to the following two conditions, one with respect to the production of characteristics, T(X); and one with respect to the traditional budget constraint:

A = T(X), where A and X are vectors of characteristics and goods, respectively;

$M = P_1*X_1 + P_2*X_2 + P_3*X_3 + , \ldots, + P_N*X_N,$

Where M is money income, and P_i's are good prices.

Within the context of the above model, new goods are welfare-enhancing in that (a) they are able to accommodate the heterogeneity in preferences and (b) they allow individuals to be more efficient with respect to the characteristic transformation function, T(X).

The relation between heterogeneity and innovation comes from the interaction between the utility function U = U(A; X) and the transformation function A = T(X). For example, a bank comes up with a new product that would directly meet a client's new needs (as reflected in its utility function), as well as with a new technology that can more efficiently transform goods into characteristics for the client.

The problem for the client is:

$$\text{Max } \{U = U(A; X)\} = \text{Max } \{U = U(T(X); X)\},$$

Subject to the budget constraint:

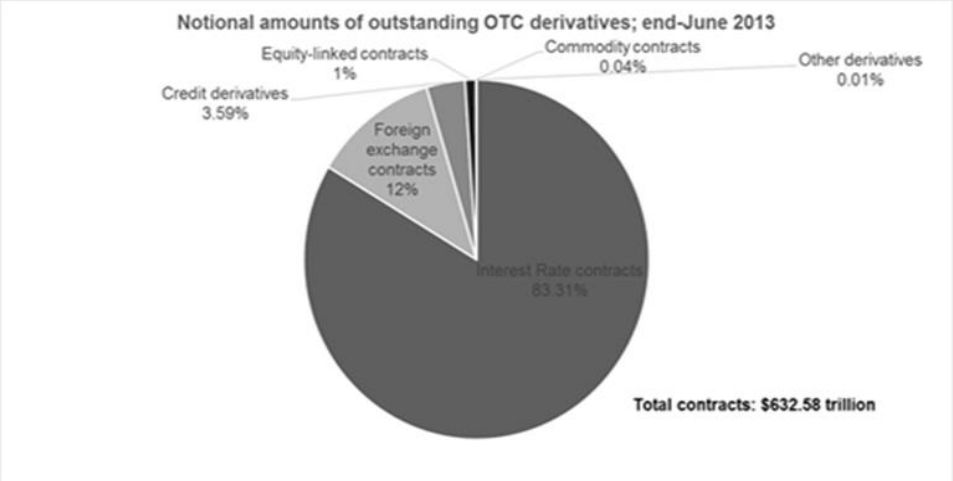
$M = P_1*X_1 + P_2*X_2 + P_3*X_3 + , \ldots, + P_N*X_N$.

This is the framework that is used to gather evidence on how the OTC derivatives market contributes to economic welfare.

4. Empirical Findings

Schinasi, Craig, Drees, & Kramer (2000) provided a good discussion of the various aspects of the OTC derivatives market. According to Ackermann (2013), "[t]he emergence of new instruments can frequently be observed in the OTC derivatives market, which is one of the most flexible and innovative market segments." (p. 219).

Figure 1: OTC derivatives market, 2013



Note: Data used in constructing the charts come from Bank for International Settlements (BIS), Statistical release: OTC derivatives statistics at end-June 2013, November 2013, Table A, p. 5.

The OTC derivatives market is very large, as shown in Figure 1 above, with total notional amounts of more than $600 trillion. Contrary to the upward trend in the OTC derivatives market prior to 2007, the financial crisis of 2007-2009 has reduced trading in these derivatives by a little bit less than 10 percent by the end of 2013. Table 1 shows the implicit number of firms for each of the 7 currencies referenced in the interest rate swaps. Depending on the currency, there are between 7 and 20 firms dealing in these derivatives. In addition, the OTC derivatives market is concentrated in a relatively small number of financial institutions, as shown in Table 2 below (reproduced in a modified form from Lin and Surti, 2013). Data from the International Swaps and Derivatives Association (ISDA 2013), as shown in Table 3, are also consistent with large dollar trade sizes in the OTC derivatives market. Interest rate derivatives vary between $86 million to $484.5 million per transaction.

This market structure is not inconsistent with innovation. As Tufano (2003) has pointed out, financial innovations are often introduced by large commercial and investment banks. A study by Lerner (2006) shows that a significant percentage of financial innovations from 1990 and 2002 was carried out by large financial institutions, such as Goldman Sachs and JP Morgan. Table 4 below shows that the heterogeneity of market participants is reflected in the different market mechanisms that are consistent with financial innovation.

The heterogeneity of products may translate into different market trading structures. According to Nystedt (2004, p. 5), “[c]ontrary to the highly standardized and usually cleared contracts offered by traditional organized derivative exchange (ODE) markets, OTC derivatives can be individually customized to an end-user's risk preference and tolerance.”.

Table 1: Herfindahl index for various types of derivatives

Type of derivative	Herfindahl Index	Number of firms*
Interest rate swaps by currency		100
Euro	549	18.2
U.S. dollar	693	14.4
Japanese yen	550	18.2
British pound sterling	880	11.4
Canadian dollar	777	12.9
Swedish krona	885	11.3
Swiss franc	1,528	6.5
Forwards, forex swaps, and currency swaps	496	20.2

Note: The numbers for the Herfindahl index cited above are taken from the Bank for International Settlements, Statistical release: OTC derivatives statistics at end-June 2013, November 2013, Table A, page 5. * The number of firms is calculated by dividing 10,000 by the Herfindahl index.

Thompson (2010) has argued that decentralized clearing may still be efficient as the moral hazard problem of protection sellers may be counteracted by the adverse selection problem of protection buyers so that full information may be revealed in bilateral arrangements. Similarly, Golosov, Lorenzoni, & Tsyvinski (2009) studied decentralized (bilateral) trading which they consider to be common with many OTC derivatives, and found that it is possible for bilateral trading to attain efficiency with low-cost learning. According to Carvalho (1997, p. 481), “exchange-traded derivatives are created to cover risks of a more generic or homogeneous nature. In contrast, hedging against more specific bets that have to be tailored to specific customers may be obtained in "over-the-counter" (OTC) deals.”

The discussion above provides some evidence that suggests that my framework of heterogeneity and innovation is consistent with the description of many aspects of the OTC derivatives market. In what follows, we provide some empirical results derived from analyses dealing with the OTC derivatives market. Additional evidence on the economic value of the OTC derivatives is provided below.

Brewer, Jackson, & Moser (1996) estimated the value of interest rate derivatives and found it to be positive in that their use lowered the cost of borrowing to consumers. Black, Garbade, & Silber (1981) found that the innovation of GNMA’s pass-through securities reduced mortgage interest rates.

Table 2: Relative size and concentration of OTC derivatives market at year-end, 2011

In this table, Panel A shows the size of global OTC derivatives market relative to global banking assets and global nominal gross domestic product. Panel B displays the derivatives exposure of U.S.-SIBs as measured by gross fair value of the banks' derivative assets, and by the net fair value of their derivative assets relative to their trading book

Panel A

	Gross notional positions (in trillions of end-2011 dollars	Relative percent of OTC derivatives
All OTC Derivatives	648	100.0%
Global Banking Assets	110	589.1%
Global NGDP	70	925.70%

Panel B

SIB	Gross FVA-to-total assets	Net FVA-to-trading book
BAML	>75%	>15%
Citi	>50%	>15%
GS	>100%	>15%
JPM	>75%	>15%
MS	>150%	>15%
WF	>50%	>15%

Note: The numbers presented in Panels A and B are taken from Figure 1 (page 7) and Figure 2 (page 8), respectively, in Lin and Surti, Capital Requirements for Over-the-Counter Derivatives Central Counterparties, IMF Working Paper WP/13/3, 2013. Gross FVA refers to gross fair value of derivatives assets in each bank (BAML: Bank of America/Merrill Lynch; Citi: CitiBank; GS: Goldman Sachs; JPM: JP Morgan Chase; MS: Morgan Stanley; and WF: Wells Fargo). Net FVA nets out the values of collateral and bilateral netting agreements. NGDP is nominal GDP. SIB refers to systemically important bank, calculated based on size, interconnectedness, and substitutability.

McConnell & Schwartz (1992) studied a successful financial instrument introduced by Merrill Lynch in 1985, known as LYON (Liquid Yield Option Note), which gave investors a way of enhancing their returns for a given risk profile and a way for corporate issuers (including American Airlines, Motorola, and Marriott) to raise funds from these retail customers. Kanemasu, Litzenberger & Rolfo (1986) studied stripped Treasury securities as "a prominent example of security innovation in response to an existing set of government securities that was not sufficiently tailored to meet investors' preferences." (p. 3).

Switzer & Fan (2008) document a substitution relationship between trades in OTC markets and trades in a central futures exchange with respect to the Canadian dollar, that is, as trades of futures in the central exchange increase, trades of forwards and swaps in the OTC market would decline. Their evidence also shows a complementary relationship between the two markets in terms of the risks hedged: OTC trades hedge against idiosyncratic risk while central exchange trades hedge against systematic risk.

Table 3. Dollar value per transaction in the interest rate derivatives market, 2013

	Notional amount outstanding ($ Tril)	Dollar value per transaction ($ Mil)
Interest rate derivatives (total)	530.4	115.3
Interest rate swaps (IRS)	301	86
FRAs	82.6	330.4
Swaptions	28.4	145.6
Interest rate options (caps, floors, collars)	12.3	156.9
Overnight Index Swaps (OIS)	53.3	484.5

Note: Data are taken from the International Swaps and Derivatives Association (ISDA) publication, Non-cleared OTC derivatives: Their importance to the global economy, March 13, 2013 (ISDA, 2013).

Table 4. Classification of different derivatives market structures

Structure	**Standardized**	**Not standardized**
Cleared, regulated	ODE markets, such as, International Currency and Swap market (ICS)	Tailor-made clearing
Not cleared, self-regulated		Pure OTC derivatives

Note: Table 3 is produced from Nystedt (2004, p. 5), Derivative market competition: OTC markets versus organized derivative exchanges, IMF Working paper WP/04/61.

4. Conclusions and Directions for Future Research

This paper takes an approach that has rarely been used in the literature for examining the role of derivatives and their economic value. A model of heterogeneity, coupled with innovation, is the key contribution of this paper to our understanding of this economic value. While the focus has been at the macroeconomic level concerning the role of financial derivatives, we should not lose track of the fact that the derivatives market performs a useful role. This paper attempts to demonstrate this with its emphasis on heterogeneity and innovation. The empirical evidence provided on OTC derivatives is consistent with this framework. The implication of the results reported in this paper is that the market process for financial derivatives is very similar to that of non-financial products, especially in relation to the role of heterogeneity and innovation.

While this research is a step in the right direction in advancing our understanding of the role of derivatives, the analysis in this paper assumes that there are no externalities in the derivatives market. In order to evaluate the systemic implications of this market, one would need to consider the externalities that are often inherent in financial products. In addition to this, examining financial innovations on a case-by-case basis would help shed more light on how

financial markets take into account heterogeneity. The recent experience with the U.S. 2007-2009 financial crisis shows it is possible to limit the impact of these negative externalities with appropriate policies and to allow the derivatives market to perform as it should be in relation to heterogeneity and innovation.

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