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Abstract

This paper proposes Entity-Netted Notionals (ENNs) as a metric of interest rate risk transfer in the interest rate swap (IRS) market. Unlike the ubiquitous metric of notional amount, ENNs normalize for risk and account for the netting of longs and shorts within counterparty relationships. Using regulatory data for U.S.-reporting entities, the size of the market measured by notional amount is $231 trillion, but, measured by ENNs, is only $13.9 trillion 5-year swap equivalents, which is the same order of magnitude as other large U.S. fixed income markets. This paper also quantifies the size and direction of IRS positions across and within various business sectors. Among the empirical findings are that 92% of entities using IRS are exclusively long or exclusively short. Hence, the vast majority of market participants are prototypical end users, and the extensive amount of netting in the market is attributable to the activity of relatively few, larger entities. Finally, some sector-specific empirical findings are inconsistent with widespread, prior beliefs. For example, pension funds and insurance companies are typically thought to be long IRS to hedge their long-term liabilities, and these sectors are indeed net long, but approximately 50% of individual entities in these sectors are actually net short.

Keywords: Interest Rate Swaps, Fixed Income Markets, Entity-Netted Notionals, Notional Amount

JEL Classification: G00**,** G10, G12, G20

[1] Office of the Chief Economist, Commodity Futures Trading Commission (CFTC), Washington, DC. ORCIDs: Lee Baker, 0000-0003-1575-6145; John Roberts, 0000-0002-1679-9465; Rajiv Sharma, 0000-0002-4096-1151; Bruce Tuckman, 0000-0002-1070-3573. Corresponding author: Bruce Tuckman (btuckman@cftc.gov). The Office of the Chief Economist has cleared this paper for public distribution. While this paper was produced in the authors' official capacity, the analyses and conclusions expressed here are those of the authors and do not necessarily reflect the views of other Commission staff, the Office of the Chief Economist, or the Commission. The authors would like to thank Amitabh Arora, Darrell Duffie, Philipp Schnabl, and seminar participants at the CFTC for helpful comments and suggestions.

1. Introduction

How big is the interest rate swap (IRS) market? Who uses IRS and why? These questions date back to the beginning of the IRS market in the 1980s, but answers have been hard to come by because of data limitations. Until very recently, there was no central depository of swap positions. Furthermore, while publicly-traded entities were eventually required to include derivatives in financial disclosures, for most of the history of the market they reported only notional amounts. But notional amount is a very poor measure of risk transfer and market size.

The notional amount of a single IRS is the amount used to compute interest payments due on that swap. For example, an IRS with a notional amount of $100 million and a fixed rate of 3% requires fixed payments of $3 million per year.[2] The notional amount of a swap counterparty or a market is the sum of the notional amounts across all swaps of that counterparty or market. This simple summation, however, makes it very difficult to interpret notional amount for two reasons. First, individual swaps carry vastly different amounts of interest rate risk. A 3-month IRS, for example, has relatively little interest rate risk, while a 30-year IRS has an order of magnitude more risk. Notional amount, therefore, which adds together the notional amounts of 3-month and 30-year swaps, is very difficult to interpret with respect to risk transfer. Second, IRS trading, described in more detail below, often leaves pairs of counterparties with long and short positions that are largely risk offsetting.[3] Notional amount, therefore, which adds together these risk-offsetting longs and shorts, significantly overstates risk transfer between pairs of counterparties.

These two conceptual and fundamental problems with notional amount lead to an order of magnitude problem with respect to market size. Consider the following. As of mid-year 2018, the BIS reported that global IRS notional amount was $481 trillion and that total principal amount of global debt securities was $102 trillion.[4] Is it credible that the IRS market is in any meaningful sense nearly five times the size of all debt markets combined? At an industry conference in February, 2018, then CFTC Chairman Giancarlo expressed his skepticism:

> Ladies and gentlemen: swaps have a problem of large numbers. We have known it for a long time. Sizing the global swaps markets in hundreds of trillions of dollars has done nothing to bring clarity to newspaper accounts, policy discussions in Congress, or regulatory policy setting in the decade since the financial crisis. Rather, it more often confuses the issue and hinders dispassionate consideration and sound policy setting. (Giancarlo (2018)).

The problems with notional amounts have also severely hampered academic investigation into who uses IRS and why. Disclosures of publicly-traded firms with respect to their IRS notional positions are essentially uninformative as to economic exposure. A firm with an IRS notional amount of $100

[2] This introduction simplifies exposition by focusing on fixed-for-floating swaps. In current regulatory usage, however, the term "interest rate swap" includes other products as well, like forward rate agreements, overnight index swaps, swaptions, and caps or floors. This point will be discussed further below.

[3] As will be discussed further below, a "long" position in an IRS has the same directional exposure as a long bond position, that is, profiting from a decline in rates and losing from a rise in rates. Similarly, a "short" position in an IRS has the same directional exposure as a short bond position. Note that the definitions of "long" and "short" in IRS markets are not consistent across the academic literature.

[4] BIS derivatives statistics can be accessed here: https://www.bis.org/statistics/derstats.htm . BIS debt market statistics can be accessed here: https://www.bis.org/statistics/secstats.htm . Total debt securities outstanding reported in the text was computed by the authors using this BIS data. Note that BIS notional amounts are also inflated by some double counting. See Bank for International Settlements (2018), p. 7.

million might be long $100 million, short $100 million, or simultaneously long and short $50 million. The vast majority of academic studies, therefore, take as an explanatory variable the binary condition of whether a firm has or does not have IRS positions. Other accounting variables can then be used to test hypotheses about which firms use derivatives and about whether firms that use derivatives outperform in terms of risk and return. Against this historical background, the current availability of data on the IRS market is transformational. Roughly speaking, the Dodd-Frank Act of 2010 and its implementing regulations require that U.S. entities report every IRS transaction and position to the CFTC. Using this newly-available regulatory data, this paper is intended as an early step in a research program to answer decades-old questions about the IRS market.

The first contribution of the paper is to define ENNs and to propose that it replace notional amount as a measure of the size of the IRS market. ENNs are designed to correct for the two problems with notional amount, namely, adding the notional amounts of swaps with different risk characteristics and adding long and short notional amounts that are, in fact, risk offsetting. More specifically, ENNs can be computed in the following three steps:

1) Convert all IRS notional amounts to 5-year swap equivalents using DV01, a broadly accepted and deeply entrenched measure of interest rate risk. Because 10-year swaps have more interest rate risk than 5-year swaps, for example, $100 million notional amount of 10-year swaps might convert to $191 million 5-year equivalents. By contrast, because 2-years swaps have less risk than 5-year swaps, $100 million notional amount of 2-year swaps might convert to only $39 million 5-year equivalents. The derivation of these ratios will be explained below.
2) Process through every pair of counterparties, netting the long and short positions between each pair. If counterparty A is simultaneously long $500 million and short $200 million 5-year equivalents against counterparty B, then, from that relationship, counterparty A is long $300 million ENNs and counterparty B is short $300 million ENNs.
3) Sum long and short ENNs to the desired level of aggregation. The long ENNs and short ENNs of a single entity are the sums of its long and short ENNs, respectively, across all its counterparties. The long ENNs and short ENNs of a business sector are the sums of the long and short ENNs, respectively, across all entities in that sector. And the ENNs of the market are the sum of long ENNs across all counterparties, or the sum of short ENNs across all counterparties—these two sums are the same, of course, because, across the entire market, longs equal shorts.

The second contribution of the paper is to compute the ENNs of the IRS market in the United States from regulatory data. The $231 trillion notional amount of the market converts to $115 trillion in 5-year equivalents, which reveals that many outstanding swaps are of relatively short term. The ENNs of the market, however, are only $13.9 trillion. Market participants are indeed, in significant quantities, both long and short IRS against individual counterparties. Therefore, by ignoring the risk netting that takes place between pairs of counterparties, notional amount significantly overstates the amount of risk transfer in the IRS market. Furthermore, at a size of $13.9 trillion, measured by ENNs, the IRS market is of the same order of magnitude as other large fixed income markets in the United States. The principal outstanding of U.S. Treasury securities is about $18 trillion; of mortgages, $15.5 trillion; and of corporate bonds, $13.5 trillion.[5]

The third and final contribution of the paper is to describe the participation of various business sectors in the IRS market. How large is each sector in the market? To what extent are various sectors

[5] From Board of Governors of the Federal Reserve System (2019).

characterized by netting within counterparty relationships? Which sectors are net long and which net short? And how much does IRS positioning vary across individual entities within a particular sector? The answers to these questions are described in the body of the paper, but a few highlights are given here.

With respect to sector sizes, swap dealers and banks are the largest market participants, with respectively, 55% and 13% of total ENNs, that is long plus short ENNs. Smaller sectors range from asset managers and hedge funds, at 7% and 6%, respectively, to government and quasi-government entities at 2.5%. Furthermore, just as notional amounts exaggerates overall market size, it exaggerates the relative importance of sectors characterized by a great deal of netting. Swap dealers, for example, account for over 76% of notional amount, but only 55% of total ENNs. Conversely, notional amount understates the relative importance of other sectors. Pension funds account for only 0.7% of total long notional amount, but 5.8% of total long ENNs, and nonfinancial companies account for only 0.6% of short notional amount, but 5.8% of total short ENNs.

With respect to netting, the swap dealer, hedge fund, other financials, and bank sectors are very much characterized by simultaneous longs and shorts against the same counterparty, which is often a clearinghouse. This positioning is likely the result of market making and intermediation businesses, along with dynamic trading. Nonfinancial companies, by contrast, exhibit the least amount of netting, likely because their own business requirements require positions that are either long or short, but not both simultaneously. The remaining sectors show intermediate levels of netting. With respect to directionality, the swap dealer, other financial, pension, and insurance sectors are net long, while all other sectors are net short. Furthermore, in absolute terms, the swap dealer and hedge fund sectors are closest to flat net interest rate risk.

Finally, with respect to the positioning of individual entities, 6% of entities are exclusively long IRS, 86% of entities are exclusively short, and only 8% of entities are both long and short. This means that the great amount of netting evident in the market is attributable to a relatively small number of larger market participants. Furthermore, sectors that are net long or net short have significant numbers of entities that are positioned in the opposite direction. Pension funds and insurance companies are the most striking examples. These sectors are both net long, most likely due to their need to hedge long-term liabilities. But 55% of individual pension funds are actually net short, as are 47% of insurance companies.

The paper is organized as follows. Section 2 reviews the literature on the IRS market. Section 3 explains the problems of using notional amount as a measure of risk transfer and, therefore, of market size. Section 4 defines ENNs. Section 5 describes the data and presents the empirical findings with respect to IRS market size and the positioning of various sectors and of individual entities within each sector. Section 6 briefly concludes.

2. Literature review

For the last 30 years, research into IRS—and over-the-counter (OTC) derivatives more generally—has been challenging because of a lack of data. While publicly-traded firms have been required to report notional amounts of OTC derivatives since 1990, the economic significance of those positions has been extremely difficult to determine. As mentioned in the introduction, notional amount alone is completely uninformative even as to the direction of the derivatives exposure, that is, as to whether a firm is long, short, or flat with respect to underlying risk factors.

Because of this data deficiency, researchers have had to pursue second best or relatively roundabout investigations. Many papers rely on survey data[6] or conduct empirical analysis with an indicator variable that divides firms into users and non-users of IRS.[7] Some papers use notional amount despite its flaws, with appropriate caveats.[8] Others restrict their samples to firms and periods that happen to allow for the separation of notional amount into longs and shorts.[9] Finally, a few papers estimate net derivatives exposure—with the help of strategic assumptions—by combining notional amounts with changes in IRS market values.[10]

This research landscape changed dramatically with the passage of the Dodd-Frank Act of 2010 in the United States and equivalent legislation elsewhere. After a few years of promulgating reporting rules and building the necessary infrastructure, regulators began to collect data from all covered entities on all IRS trades and positions. A couple of recent papers using European regulatory data explore the uses of IRS in that region.[11] In the United States, the CFTC started to collect IRS data in 2014. Various reports and policy pieces focusing on notional amounts have been produced since that time, but this is the first study using U.S. regulatory data that quantifies the size of the IRS market, in terms of risk transfer, along with the directionality of IRS exposures both across and within various business sectors.[12]

Despite historical data limitations, many papers over the last three decades have been written about IRS. One strand of the literature concludes that a significant fraction of firms, particularly financial firms and particularly large firms, use IRS.[13] This paper, which starts with regulatory data from firms with

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[6] See Geczy, Minton, and Schrand (2007), ISDA (2009), and Bodnar, Giambona, *et al.* (2013).

[7] See Kim and Koppenhaver (1992), Brewer, Jackson, and Moser (1996), Howton and Perfect (1998), Gay and Nam (1998), Brewer, Minton, and Moser (2000), Hentschel and Kothari (2001), Purnanandam (2007), Bartram, Brown, and Fehle (2009), Bartram, Brown, and Conrad (2011), Campello, Lin, *et al.* (2011), Chen (2011), Gay, Lin, and Smith (2011), Charumathi and Kota (2012), Chen and King (2014), Khumawala, Ranasinghe, and Yan (2016), Gomez, Landier, and Thesmar (2016), Bartram (2017), and Zhao and Moser (2017). Harper and Wingender (2000) conduct an event study with swap transactions as event dates.

[8] See Hirtle (1997), Carter and Sinkey (1998), Guay and Kothari (2003), Li and Marinc (2014), Deng, Elyasiani, and Mao (2017), and Nguyen, Kim, and Papanastassiou (2018).

[9] See Wall and Pringle (1989), Samant (1996), Visvanathan (1998), Guay (1999), Graham and Rogers (2002), Li and Mao (2003), Faulkender (2005), Simkin and Rogers (2006), and Chernenko and Faulkender (2011). Almost all of these rely on voluntary firm disclosures. Graham and Rogers (2002), however, take advantage of the fact that accounting rules under SFAS 119, which was effective between December 1994 and June 2000, essentially revealed long and short notional amounts separately.

[10] See Gorton and Rosen (1995), Begenau, Piazzesi, and Schneider (2015), and Rampini, Viswanathan, and Vuillemey (2019).

[11] See Abad, Aldasoro, *et al.* (2016) and Hoffman, Langfield, *et al.* (2018).

[12] The CFTC has produced a number of studies using these new regulatory data on other OTC derivatives markets. On credit default swaps, see Haynes and McPhail (2017), Capponi, Cheng, *et al.* (2017), and Riggs, Onur *et al.* (2017). On oil swaps, see Mixon and Onur (2019), and Mixon, Onur, and Riggs (2018).

[13] Bodnar, Giambona, *et al.* (2011), in a relatively recent global survey with 1,100 responses, found that 67% of firms use IRS. ISDA (2009) found that more than 80% of Fortune Global 500 use interest rate derivatives. Note that some studies specifically measure the use of OTC interest rate derivatives, while others include exchange-traded interest rate derivatives. For the non-financial sector, estimates of participation rates range from 25% to 50%, where the upper end of that range comes from samples of the largest firms, e.g., Visvanathan (1998), Howton and Perfect (1998), and Gay and Nam (1998), while the lower end from more broadly-based and random samples, e.g., Howton and Perfect (1998), Graham and Rogers (2002), Campello, Lin, *et al.* (2011), Bartram (2017), Bartram, Brown, and Fehle (2009), Bartram, Brown, and Conrad (2011), and Nguyen, Kim, and Papanastassiou (2018). Khumawala, Ranasinghe, and Yan (2016) find that 50% of large municipalities use interest rate derivatives. Finally,

positions in swaps, does not address the question of participation rates in broader populations. However, the analysis does reveal how firms with relatively small IRS positions tend to be exclusively long or short, while firms with relatively large IRS positions tend to be net long with some counterparties and net short with others. A second strand of the literature investigates how IRS usage correlates with firm characteristics, including accounting quantities, ratings, risk characteristics, geography, and business sector.[14] This paper complements these studies by showing the size and directionality of IRS positions across sectors. Lastly, a third strand of the literature asks whether firms using derivatives perform better, either in terms of higher returns, lower risk or both. More provocatively, do firms use derivatives to hedge or to speculate?[15] This paper does not address these questions directly, but the findings that certain sectors are significantly net long, others significantly net short, and others only somewhat long or short, mildly support the idea that IRS usage is tied to business-specific objectives.

3. IRS notional amount is a flawed measure of market size

3.1. The interest rate risk of an IRS is equivalent to that of a levered bond position

In a fixed-for-floating IRS, one counterparty receives a fixed rate and pays a floating rate on a notional amount for a fixed term, while the other party pays the fixed rate and receives the floating rate on the same notional amount for the same term. For example, a pension fund and a swap dealer might enter into an IRS in which the pension fund receives a fixed rate of 3% for 10 years on a notional amount of $100 million and pays future realizations of short-term LIBOR on that same notional amount. The swap dealer, of course, has the opposite position. It pays 3% and receives LIBOR on that $100 million. The $100 million is called a notional amount because those dollars are never exchanged: that amount is used only to calculate the interest rate payments on the swap, e.g., that the annual cash flow from the fixed-rate leg of the swap is 3% of $100 million, or $3 million.[16]

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studies of the banking sector also show that the use of interest rate derivatives increase with firm size. See Brewer, Jackson, and Moser (1996), Brewer, Minton, and Moser (2000), Carter and Sinkey (1998), Gomez, Landier, and Thesmar (1986), and Zhao and Moser (2017).

[14] Aretz and Bartram (2010) survey this literature. Among empirical findings, they report that firms using derivatives have greater leverage and lower short-term liquidity. Bodnar, Giambona, *et al.* (2013) find a positive relationship between derivatives usage and firms that are: larger, publicly-traded, financial, primary product and manufacturing vs. services, European vs. U.S., and with relatively high credit ratings. Rampini, Viswanathan, and Vuillemey (2019) find that better capitalized bank holding companies are more likely to use derivatives.

[15] Brewer, Minton and Moser (2000), Purnanandam (2007), and Zhao and Moser (2017) show that commercial banks using derivatives perform better than non-users. Similar results for other types of financial firms can be found in Brewer, Jackson, and Moser (1996) for savings and loan associations; Chen (2011) for hedge funds; and Anton, Toader, and Bogdan (2016) for Romanian pension funds. For nonfinancial firms using derivatives, Gay and Nam (1998), Harper and Wingender (2000), and Li and Mao (2003) show better performance; Bartram (2017), Chen and King (2014), Gay, Lin, and Smith (2011), Guay (1999), and Nguyen, Kim, and Papanastassiou (2018) show reduced risk; and Bartram, Brown, and Conrad (2011), Campello, Lin, *et al.* (2011), and Graham and Rogers (2002) show both improved performance and reduced risk. Hentschel and Kothari (2001) find derivatives users to be no riskier than non-users. In contrast, a smaller number of studies argue that firms use derivatives to increase risk or speculate: see Begenau, Piazzesi, and Schneider (2015), and Hirtle (1997) for commercial banks and Chernenko and Faulkender (2011), Geczy, Minton, and Schrand (1997), and Faulkender (2005) in other contexts. Along somewhat related themes, Gomez, Landier, and Thesmar (2016) show that, despite derivatives use, banks are still exposed to interest rate risk, while Li and Marinc (2014) argue that bank use of derivatives is positively related to systemic risk exposures.

[16] For a more detailed discussion of IRS see, for example, Tuckman and Serrat (2012), Chapter 16.

Promised cash flows from the perspective of the receiver of the fixed rate are roughly equivalent to those of a long, levered position in a coupon bond. The pension fund in the example pays nothing at the initiation of the swap; receives 3% and pays a short-term floating rate on $100 million per year; and pays nothing at the end of 10 years, when the swap matures. Similarly, the purchaser of a 10-year bond with a 3% coupon and a principal amount of $100 million, who borrows $100 million to buy that bond, has no net outflow on the purchase date; receives 3% on the $100 million principal per year; pays a short-term rate on the $100 million of borrowed funds; and, at the end of 10 years, collects the bond principal of $100 million and pays back the $100 million borrowed, for a net outflow of zero. With respect to promised cash flows, therefore, receiving fixed in an IRS is conceptually equivalent to buying a coupon bond and borrowing the money to do so.[17] Hence, the fixed receiver—the pension fund in the example—can be said to be "long" the swap, just as the owner of a bond is "long" the bond. Similarly, the fixed payer—the swap dealer in the example—can be said to be "short" the swap.

In the absence of credit risk, the cash-flow equivalence of IRS and levered bond positions implies an equivalence with respect to interest rate risk as well.[18] While swaps are subject to counterparty credit risk, the exposure of one IRS counterparty to another is typically small, and even that small exposure is often mitigated if not nearly eliminated by posted collateral.[19] And on the bond side, of course, default risk is small for the most-highly rated bonds. Hence, IRS and levered positions in highly-rated bonds are roughly equivalent with respect to interest rate risk.[20]

The equivalences just described support the claim that the interest rate risk of a 3%, 10-year IRS with a notional amount of $100 million is roughly equivalent to that of a 3%, 10-year, high-quality bond with a principal amount of $100 million. However, using notional amount as typically calculated, the same equivalence does not obtain for portfolios. More specifically, a portfolio of IRS with a notional amount of $100 million can have vastly different interest rate risk than a bond portfolio with a principal amount of $100 million.

3.2. For portfolios, IRS notional amount is not at all equivalent to bond principal amount

The notional amount of a portfolio of IRS is defined as the sum of the notional amounts of the individual IRS in that portfolio. This definition creates two significant problems for the interpretation of notional amounts. First, the notional amount of a portfolio that is receiving fixed on $100 million of a 3-month IRS and $100 million of a 30-year IRS is $200 million. The addition of the notional amount of an IRS with relatively little interest rate risk—the 3-month IRS—with the notional amount of an IRS with a lot of interest rate risk—the 30-year IRS—makes a quoted $200 million notional amount relatively

[17] For a more detailed discussion of this equivalence, See Tuckman (2013).

[18] Bonds with very different probabilities of default also differ significantly with respect to interest rate risk. See, for example, Tuckman and Serrat (2012), pp. 556-557.

[19] Should one swap counterparty default, the other is exposed only to the net present value of the swap's remaining payments. By contrast, should a bond purchased with borrowed funds default, the bondholder receives a fraction of the promised principal amount but still owes the full amount borrowed. For a more detailed explanation, see Tuckman and Serrat (2012), pp. 442-443.

[20] Because the focus of this paper is on interest rate risk transfer, financing risk and operational risk are ignored. Swap and bond positions are not equivalent with respect to financing risk: borrowing to purchase a bond is usually short term, through repurchase agreements, while the embedded financing from the floating-leg of a swap is locked in over the life of the swap. See Tuckman (2013), pp. 77-79. Portfolios of swaps and bonds with similar interest rate risks are also not equivalent with respect to operational risk because, as explained later in the text, swap portfolios tend to have many more line items than bond portfolios.

meaningless with respect to interest rate risk. Strictly speaking, the total principal amount of a portfolio of bonds suffers from the same difficulty. In the bond context, however, unlike the swap context, information typically exists about the distribution of underlying maturities. For example, the total principal amount outstanding of U.S. Treasury bonds is publicly available, as is information about the distribution of that total across maturities. Similarly, mutual fund bond portfolios and various bond market indexes report not only principal amount but also maturity distributions and even durations.[21]

The second and much bigger problem with IRS portfolio notional amounts is that long and short positions are added together. The notional amount of a portfolio that is long $100 million of 5-year IRS and short $100 million of nearly identical 5-year IRS is $200 million. Put another way, a portfolio with a notional amount of $200 million could be long $200 million of IRS, short $200 million of IRS, or simultaneously long $100 million and short $100 million. These three portfolio, however, have massively different interest rate risk profiles.

In bond and futures markets, it is relatively rare for an entity to be simultaneously long and short significant amounts of similar instruments. Long or short positions in a particular instrument in these markets are typically exited by selling or buying that same instrument. In swap markets, however, it is quite common for entities to be simultaneously long and short significant amounts of very similar swaps because, when counterparties unwind IRS exposures, they often put on new IRS positions, in the opposite direction, rather than unwinding their original positions. The reason for this practice is that new swaps are typically much more liquid than existing swaps. More specifically, the most liquid IRS on a given trade date are those that mature at some set of terms from that trade date and that carry fixed rates equal to the prevailing market rates for that set of terms to maturity.

To illustrate, consider a pension fund that, when initiating its position, receives fixed at 3% in a 10-year swap, which is one of the most liquid maturity points in the term structure. Six months later, the pension fund decides to reduce its risk in its now 9.5-year swap. The 10-year market rate might have moved to 2.75%, and 9.5-year swaps are not nearly as liquid as 10-year swaps. Therefore, instead of unwinding its 3%, 9.5-year swap, the pension fund is likely to pay fixed on a new 2.75%, 10-year swap. The notional amount of the latter would be chosen to match the fund's updated risk target. In any case, these long and short swap positions, the older 3% swap and the newer 2.75% swap, might very well both remain on the books of the pension fund for years.

In summary, the practice across the industry of stacking long and short swap positions means that notional amount—which sums long and short positions—can vastly overstate the size of swaps markets.

3.3. IRS Notional Amounts Are Very Large Relative to the Size of Bond Markets

As mentioned in the introduction, according to BIS data as of mid-year 2018, the global outstanding principal amount of debt securities was $102 trillion while the global outstanding notional amount of IRS was $481 trillion. If bond principal amounts and swap notional amounts were really comparable metrics of size, these magnitudes would be startling. They would imply that global IRS markets were nearly five times as large as the primary markets for borrowing and lending longer-term funds. Similar startling magnitudes appear in data on U.S. markets. As of March 2019, the outstanding

[21] Duration measures the percentage change in the value of a bond portfolio for a 100-basis-point decline in rates. See Tuckman and Serrat (2012), Chapter 4.

principal amount of Treasury securities was $18 trillion; of all debt securities, $45 trillion, and of all debt securities plus loans, $64 trillion. At the same time, IRS notional amount outstanding was $231 trillion.[22] Once again, if principal amounts and swap notional amounts were really comparable, swap markets would seem very large relative to bond and loan markets.

This paper argues, however, that the size of the IRS market is measured better by ENNs than by notional amounts. And according to that metric, the size of the IRS market in the U.S. is $13.9 trillion, which is much more in line with the size of other U.S. fixed income markets.

4. Entity Netted Notionals (ENNs) as a measure of size in IRS markets

How should size be defined for IRS markets, or, more generally, for derivatives markets? The size of a bond market is often understood in terms of funds raised. The $18 trillion principal outstanding in the U.S. Treasury market means that the Treasury raised approximately $18 trillion by selling its bonds. This perspective does not make much sense for derivatives markets, however, because, like IRS, most derivatives are initiated without any exchange of funds.[23] Consider, then, another way to think about the size of a bond market, namely, in terms of the amount of interest rate risk transfer. If an issuer sells $100 million of fixed rate, 5-year bonds, then the issuer and the bond buyers have, in fact, traded a corresponding amount of interest rate risk. The issuer will experience mark-to-market losses on the bonds it sold as interest rates fall, and bond buyers will experience exactly the same amount as gains. Conversely, as interest rates rise, the issuer's gains will be experienced by bond buyers as losses.

Conceptually, the ENNs metric builds on the foundation of risk transfer by correcting for the two risk-related deficiencies of notional amounts: adding the notional amounts of swaps with different risk characteristics; and adding the notional amounts of longs and shorts between any given pair of counterparties. More specifically, ENNs are computed in three steps. Step one: convert all IRS notional amounts into 5-year swap equivalents. Step two: net the long and short 5-year equivalents between any given pair of counterparties. Step three: sum the converted and netted positions to the desired level of aggregation.

In step one, all IRS notional amounts are converted into 5-year swap equivalents using DV01, a broadly accepted and deeply entrenched measure of interest rate risk. To remind, the DV01 of a swap is the change in the value of $100 notional of that swap should swap rates fall in parallel by 1 basis point. For example, $100 notional of a swap with a DV01 of 0.044 increases in value by 4.4 cents for a 1 basis point decline in swap rates.[24] Next, to explain the conversion of notional amounts to 5-year equivalents, assume that the term structure of swap rates is flat at 3%. Then the DV01s of 2-year, 5-year, and 10-year fixed-for-floating rate swaps are approximately 0.017, 0.044, and 0.084, respectively. Hence, $100 million of 2-year swaps is, in 5-year risk equivalents, $100 million times .017/.044, or $39 million. The 5-year equivalent of $100 million notional amount of 5-year swaps is, by definition, $100mm. And, lastly, the 5-year equivalent of $100 million of 10-year swaps is $100 million times .084/.044, or $191 million.

[22] Debt and loan amounts outstanding are from Board of Governors of the Federal Reserve System (2019). IRS notional amounts are from the CFTC and are described in more detail in section 5.
[23] This is a feature of derivatives rather than a happenstance. See Tuckman (2013).
[24] For a general description of DV01 and DV01 as applied to swaps, see, for example, Tuckman and Serrat (2012), Chapters 4 and 16.

There is no overwhelming reason to choose the 5-year rather than some other benchmark, but the most intuitive choice would be a maturity point that is both liquid for trading and representative of the maturity distribution of outstanding bond markets. With respect to the latter, note that the average maturity of marketable U.S. Treasuries is about 6 years, and that one broad U.S. investment grade bond index has a weighted average maturity of about 8 years.[25] Hence, given the liquidity and maturity characteristics of U.S. bond markets, either a 5-year or a 10-year benchmark seems most reasonable. In any case, should one prefer a different risk benchmark to the 5-year point chosen here, one need only multiply the results here by the ratio of the 5-year DV01 to the DV01 of a swap at the preferred maturity.

The conversion of swap notional into 5-year risk equivalents captures only the biggest component of interest rate risk, namely "outright risk," or "level risk," in which rates of all terms are assumed to move up or down in parallel. Put another way, the conversion used here ignores the smaller components of interest rate risk, like "curve risk" and "curvature risk," which arise because rates of different term are not, in fact, perfectly correlated.[26] Considering only outright risk results from a balancing of objectives. On the one hand, normalizing for a single risk factor gives a very intuitive metric. On the other hand, ignoring other risks means that positions with different risk characteristics may be treated similarly. In the case of IRS, focusing on outright risk alone seems best because it is overwhelmingly the largest component of interest rate risk.[27] Furthermore, with the immediate goal of creating a better metric that notional amount, which makes no risk adjustment, normalizing for outright risk constitutes a very significant improvement.

In step two of the ENNs calculation, for each pair of counterparties, long and short 5-year equivalents are netted against each other. If counterparty A is simultaneously long $500 million and short $200 million 5-year equivalents against counterparty B, then, from that relationship, counterparty A is long $300 million ENNs and counterparty B is short $300 million ENNs. Counterparties are defined at the level of legal netting entities, which is very often different from the level of parent companies. In any case, the $500 million long and the $200 million short in the example above are netted only if the long and short positions are between the same two legal entities and, therefore, would actually net in the event of a default. Note, too, that, for netting purposes, a clearinghouse or a central counterparty (CCP) is a single legal entity. All of a counterparty's longs and shorts against the same CCP legally net, which, of course, is one of the main advantages of clearing.

While CCPs are important participants in the IRS market, they should not appear as part of market size or as a sector in terms of risk transfer. Consider a $100 notional swap between a pension fund, which is long, and a swap dealer, which is short. If the swap is subsequently given up for clearing, it is split into two swaps: one with the pension fund long $100 notional against the CCP and one with the swap dealer short $100 notional against the CCP. Ignoring risk equivalents for the moment, the size of this trade in terms of interest rate risk transfer is still only $100. The pension fund is long $100 and the swap dealer is short $100. The CCP is just a conduit for that risk transfer. The swap between the pension fund and the CCP and the swap between the CCP and the swap dealer have identical payment terms.

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[25] Office of Debt Management (2019), p. 23, reports that the weighted average maturity of marketable U.S. Treasuries was 69.2 months as of year-end 2018. The investment-grade bond index cited in the text is the iShares Core U.S. Aggregate Bond ETF. A weighted average maturity of 7.80 years as of June 5, 2019, was accessed on that date from https://www.ishares.com/us/products/239458/ishares-core-total .

[26] For a discussion of these risks see, for example, Tuckman and Serrat (2012), Chapters 5 and 6.

[27] See, for example, the discussion in Tuckman and Serrat (2012), pp. 186-190.

Put another way, it would be an exaggeration to say that the amount of risk transfer from this cleared trade is $200, $100 from each of these two swaps.[28]

ENNs netting is restricted to swaps denominated in the same currency. A swap denominated in U.S. dollars is not netted against a swap denominated in Euro, even if they do net from a legal perspective. This choice is motivated by the view that there is too much exchange rate risk to ignore in a trade that is long U.S. dollar denominated swaps and short an interest-rate-risk-equivalent amount of Euro denominated swaps at current exchange rates.

To recap, step two of the ENNs calculation nets long and short 5-year equivalents, for each counterparty pair, according to the rules just described. At the end of this step, each counterparty is long ENNs against some of its counterparties and short ENNs against the others.

In step three, long and short ENNs are summed to the desired level of aggregation. The long ENNs and short ENNs of each entity are the sums of its long and short ENNs across its counterparties. The long and short ENNs of each business sector are the sums of the long and short ENNs across all entities in that sector. And the long and short ENNs of the market are the sum of the long and short ENNs across all entities in the market. Since, by construction, every long ENNs position in a counterparty pair has a corresponding and equal short ENNs position, when summing across all entities in the market total long ENNs must equal total short ENNs. However, when summing across all counterparties of an individual entity, or across all entities in a particular sector, no such equality need hold. Total long ENNs for an individual entity or particular sector may be greater than, equal to, or less than total short ENNs.

5. Data description and empirical results

5.1. Data

The data set used in this paper come from swap positions reported to swap data repositories (SDRs) on March 15, 2019. SDR data are required from all U.S. reporting entities, by legal entity identifiers, and are accessible by the CFTC in its role as a swaps regulator. The term "U.S. reporting entity" includes U.S. entities and U.S. subsidiaries of foreign entities. Less obviously, however, it also includes swap dealers registered with the CFTC, even if they are not, from other perspectives, U.S. entities. For trades between a U.S. reporting entity and a non-U.S. reporting entity, the data set might not include the identity of the latter counterparty.

This paper refers to the coverage of CFTC data as the "U.S. IRS market." But there are no clear boundaries separating the U.S. market from other swap markets. In which market is a trade between a U.S. and a foreign entity? Are the trades of a CFTC-registered, European swap dealer part of the U.S. or the European IRS market? In fact, given this paper's relatively broad definition of the U.S. market, it turns out that swaps denominated in 34 currencies are included in the study. Details on the distribution of notional amount and ENNs across currencies are given in Table A1. About 40% of notional amount is denominated in U.S. dollars, and about 78% is denominated in U.S. dollars, Euros, and British Pounds.

The present study includes data on the dominant interest rate swap products, namely, fixed-for-floating swaps, forward-rate agreements (FRAs), overnight index swaps (OIS), swaptions, and interest

[28] Note that this discussion pertains exclusively to interest rate risk. Credit risk is a different matter and would require a different discussion.

rate caps and floors.[29] The exposition of the paper to this point focused on fixed-for-floating swaps, but applies to all of these products. For example, the DV01 of a swaption equals the delta of that swaption times the DV01 of its underlying forward swap. Other products, however, which are often included in lists of interest rate products, namely money market basis swaps and inflation swaps, have been excluded from this study. The basis risk between one money market rate and another, and the risk of rising or falling inflation rates, are qualitatively different from the kind of interest rate risk studied here. Exotic interest rate swaps are also excluded, partly because the type of risk might be out of scope, but also because of current limitations on analytics with respect to these derivatives.[30]

The analyses to follow separate entities into sectors. These classifications are based on S&P's Cross-Reference Services and manual classifications by CFTC staff. Because all analyses are done at the level of legal entities, each subsidiary of a holding company is classified independently. A large bank holding company, therefore, might have some of its entities classified as banks, some as swap dealers, and some as asset managers. Entities that cannot be classified, or that have not been classified because of their small size, are included in an "unclassified" category.

The definitions of sectors are for the most part intuitive, but some clarifications are warranted here. Swap dealers are entities that are registered as such with the CFTC. Banks include deposit-taking entities that are not swap dealers. As just explained, subsidiaries of bank holding companies are classified independently, and bank holding companies themselves are classified as "other financial." Subsidiaries of insurance companies that invest assets in connection with insurance products and liabilities are classified as part of the insurance sector. Other insurance company subsidiaries, like stand-alone retail mutual funds, are classified as asset managers. Table A2 gives the number of legal entities in the data set, by sector. The sample includes about 63,000 legal entities, of which about 48,000 can and have been classified into sectors.

Inter-affiliate swaps are excluded from the data set. It is common practice, for example, for a conglomerate to execute most of its swaps with external counterparties through a particular affiliate, which then executes back-to-back swaps with the part of the conglomerate that actually needs the swap. For the purposes of this paper, namely, for quantifying risk transfer, it makes sense to count only the swap between the conglomerate's external-facing affiliate and its external counterparty.[31]

There are relatively few swaps in which a foreign CCP faces a U.S.-reporting entity on one leg of a swap and a non-U.S.-reporting entity on the second leg. In these cases, however, that second leg will not necessarily be reported to the CFTC. As a result, positions of that CCP may not appear balanced although, given how CCPs work, every leg does have a perfectly offsetting leg. For this reason, the analysis here adds into the data set swaps facing CCPs that must exist but that are not reported. These swaps, which, of course, cannot be classified into sectors, are bucketed as part of a "CCP adjustment."

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[29] For a description of these products, see, for example, Tuckman and Serrat (2012): fixed-for-floating swaps, Chapter 16; FRAs, pp. 403-404; OIS, pp. 429-431; swaptions, pp. 487-490; and caps and floors, pp. 483-487.

[30] This paper reports that the notional amount of included products is $231 trillion. The notional amounts of the omitted products, namely, basis swaps, inflation swaps, and exotic swaps, are $43 trillion, $8 trillion, and $11 trillion, respectively.

[31] There is an unintended consequence of omitting inter-affiliate swaps with respect to sector classification. The entity in which a conglomerate concentrates its external swap trades is likely to be in the "other financial" sector, although the ultimate end user of the swap may be in another sector. By counting only the swaps between the conglomerate and external counterparties, size of the "Other Financial" sector will be exaggerated relative to the sector of the end user.

5.2. The Size of the IRS market and of Market Participants, by Sector

Table 1 presents the size of the IRS market, by sector, in terms of notional amounts, 5-year equivalents, and ENNs. Column (1) lists the sectors used in the analysis, sorted in descending order of total notional amount, i.e., long plus short notional amounts, which are given separately in columns (2) and (3), respectively. Columns (4) and (5) convert each sector's long and short notional amounts to 5-year equivalents. Columns (6) and (7) give the total long and short ENNs for each sector, and column (8) gives the net ENNs for each sector, which is just the difference between its long and short ENNs. The last row of the table gives the corresponding values for the market as a whole. Columns (2) and (3) of this row report that total long and short IRS notional amount across all U.S.-reporting entities is $231 trillion. Longs and shorts across all entities are equal by definition, as explained earlier.

Swap dealers, as the primary market makers and liquidity providers, comprise about 76% of market notional amount. Hedge funds and banks have the next largest shares, with about 10% and 7%, respectively. Other financials account for about 3% of notional amount. Asset managers are a distant fifth, with about 1.5% of notional amount, and all other sectors are even smaller.

Comparing the totals of columns (2) and (3) with those of columns (4) and (5), the total notional amount of $231 trillion falls to about $115 trillion of 5-year equivalents. The difference between these totals means that swap transactions, on average, have a maturity significantly less than five years. This overall average, however, obscures the fact that certain sectors tend to transact in swaps longer than five years, while others transact in swaps shorter than five years. Most notably, the 5-year equivalents of insurance companies and pensions funds exceed their notional amounts, which means that their swaps are longer than five years. This finding is consistent with these sectors using swaps to hedge the interest rate risk of their long-term liabilities. For all other sectors, notional amounts are less than 5-year equivalents, meaning that their swaps are relatively short term.

Table 2 presents the difference between notional amounts and 5-year equivalents from a product perspective. The average maturity of every product type is less than five years, but the ratio of 5-year equivalents to notional amounts varies significantly across products. By this measure, the longest maturity product is fixed-for-floating swaps, for which this ratio is over 80%. Swaptions and caps/floors are shorter, with a ratio of 38%, as are OIS with a ratio of 17%. FRAs are the shortest product type, with a ratio of about 4%.

Returning to Table 1, columns (6) and (7) present ENNs for each sector and for the market as a whole. Total 5-year risk equivalents of $115 trillion fall to about $14 trillion ENNs. This dramatic reduction means that there is an enormous amount of risk netting within pairs of counterparties. ENNs for the market as a whole is one of the main results of this paper. Measured by notional amount, the size of the IRS market in the United States would be $231 trillion, which is an order of magnitude larger than any other fixed income market in the country and, indeed, as mentioned in the introduction, larger than the outstanding amount of all debt securities and loans combined. Measured by ENNs, however, at $14 trillion, the size of the IRS market is roughly equivalent to the Treasury market, at $18 trillion; the outstanding principal of mortgages, at $15.5 trillion; and the corporate bond market, at $13.5 trillion.

Central clearing is an important reason for the extent of netting in the IRS market: there are very few CCPs; an entity's longs and shorts all net when cleared through the same CCP; and many IRS are, in fact, cleared. To the last point, Table 3 shows the clearing percentage of IRS is about 84% of outstanding notional amount. Furthermore, sectors with high clearing percentages, like swap dealers at 85%, are

characterized by lower ENNs relative to 5-year equivalents than are sectors with low clearing percentages, like the nonfinancial sector, at between 3% and 4%.

Table 3, in fact, reveals a subtlety about the extent of clearing in the IRS market. Many commentators emphasize the extraordinary growth of clearing since the implementation of the Dodd-Frank Act. In terms of notional amounts, this is clearly correct, with the clearing rate for IRS rising from about 40% in 2010 to about 85% at present.[32] In terms of risk transfer, however, the prevalence of clearing is much lower. Table 3 shows that only about 46% of ENNs are cleared, as opposed to about 84% of notional amounts. Very simply, cleared longs and shorts with a single CCP count toward notional amount and toward the percentage of notional amount cleared. But since these cleared longs and shorts net, they do not contribute to ENNs, nor to the percentage of ENNs cleared. Hence, the percentage of cleared ENNs has to be less than the percentage of cleared notional amounts. Put another way, just as notional amount overstates market size, the percentage of notional amount cleared overstates the percentage of risk transfer that is cleared.

Returning to the discussion of ENNs in Table 1, the extent of netting varies a good deal by sector. This variation means that ENNs can differ significantly from notional amount at describing how risk transfer in the IRS market is distributed across sectors. As mentioned earlier, in terms of notional amount, swap dealers comprise about 76% of the market. In terms of ENNs, however, swap dealers account for about 60% of the longs and 48% of the shorts. Conversely, notional amounts understate the participation of most of the other sectors. For example, pension funds are only 0.7% of long notional amount and nonfinancial entities are only 0.6% of short notional amount. With respect to ENNs, however, pension funds are 5.8% of longs, and nonfinancial entities are 5.8% of shorts.

5.3. Netting and Directionality in the IRS Market, by Sector

This section now turns to how various sectors participate in the IRS market. Two questions in particular are addressed here. First, to what extent does each sector net long and short positions with the same counterparty? Second, to what extent is each sector net long or net short IRS? To frame the discussion, contrast a prototypical end user with a prototypical intermediary. The end user has a particular business need to be long IRS or to be short IRS, but not to be simultaneously long and short. IRS positions may be established for lengthy holding periods or may be dynamically adjusted as business conditions change.

An example of a prototypical end user is a nonfinancial company that finances itself with floating-rate loans from its bank, but, to hedge the risk that interest rates increase, pays fixed in IRS. This company would be exclusively short IRS and exhibit no netting of 5-year equivalents into a lower quantity of ENNs. Another example would be a nonfinancial company's planning to issue fixed-rate debt in the near future and hedging against rising rates leading up to that debt issue by paying fixed in swap. In fact, many of the short IRS positions of non-financial corporations are forward-starting swaps, which would be consistent with hedging future debt issuance. Consider a simple numerical example to see how the positions of these nonfinancial companies would be expressed in terms of the quantities defined in this paper. A nonfinancial company that is short 100 dollars of IRS in 5-year equivalents, with

[32] Note that these are rates at which new transactions are cleared, not percentages of outstanding positions that are cleared. Precise data on clearing rates do not extend as far back as 2010, but Wooldridge (2016) gives the global 40% estimate for that year. Giancarlo and Tuckman (2018) give the 85% clearing rate for U.S. reporting entities in 2017.

no long IRS positions, would have 0 long ENNs; 100 short ENNs; 100 long plus short, or total ENNs; and negative 100 net ENNs. The ratio of its net ENNs to its total ENNs would be -100% – it is exclusively short—and the ratio of its total ENNs to its total 5-year equivalents would be 100% – there is no netting of longs and shorts with any particular counterparty.

In contrast with this prototypical end user, the prototypical intermediary is a market-making swap dealer. It receives fixed from one set of counterparties, pays fixed to another set, and clears a significant fraction of both longs and shorts. For concreteness, say that a swap dealer is long 1,000 5-year equivalents with one set of counterparties, short 1,000 5-year equivalents with others, and clears 850 of these longs and 850 of these shorts with the same clearinghouse. (This numerical example is motivated by Table 3, which shows that 85% of swap dealers' IRS are cleared.) This swap dealer is long 150 ENNs and short 150 ENNs. The sum of its longs and shorts, or its total 5-year equivalents is 2,000; its total ENNs 300; and its net ENNs 0. The ratio of its net ENNs to its total ENNs is 0% – because it is neither long nor short—and the ratio of its total ENNs to its total 5-year equivalents is relatively low, at 300/2,000, or 15% — because it is simultaneously long and short to the clearinghouse.

These prototypical cases can be used to appreciate the results of Table 1 as transformed into Figure 1. The horizontal axis is total ENNs, i.e., long plus short ENNs, as a percent of total 5-year equivalents, i.e., long plus short 5-year equivalents. Lower percentages are indicative of more netting of longs and shorts between pairs of counterparties. The vertical axis of Figure 1 gives net ENNs, i.e., long minus short ENNs, as a percentage of total ENNs. A sector that is predominantly long, for example, with long 80 ENNs and short 20 ENNs, or positive 60 net ENNs, would have a ratio of positive 60%. On the other hand, a sector that is somewhat short, for example, with long 45 ENNs and short 55 ENNs, would have a ratio of -10%.

Figure 1 shows that the nonfinancial company sector very much resembles that of a prototypical end user. Its ratio of ENNs to 5-year equivalents is over 80%, indicating minimal offsets of longs and shorts within counterparty relationships. And its net ENNs are -60% of total ENNs, which indicates a strong sector preference for short positions. By contrast, the swap dealers sector very much resembles that of a prototypical intermediary. Total ENNs are about 9% of 5-year equivalents, indicating a great deal of netting within counterparty relationships, and net ENNs are only about 11% of total ENNs, indicating positioning that is relatively flat with respect to interest rate risk. In fact, swap dealers' net ENNs might be positive simply because all of the other sectors combined are net short. And who but the prototypical intermediaries to maintain a net long position to accommodate the rest of the market's net short? Note, of course, that this net long IRS position does not at all imply an overall net long fixed income position. Swap dealers that are net long in IRS could easily be short bonds, futures, and other derivatives so that, all-in-all, they are actually flat with respect to interest rate risk.

The other sectors depicted in the graph can be considered with these two limiting cases in mind. The insurance and pension sectors resemble end users with respect to their strong preference for longs—which follows from their need to hedge long-term liabilities—but these sectors also exhibit a significant amount of netting. Netting in these business models might result from dynamic hedging, which may result in flipping between buying and selling over time, and from complex portfolios of fixed income instruments, which may require simultaneous longs and short in IRS, likely with different coupons and maturities. Similar remarks apply to the government / quasi-government sector, which shows a strong preference for shorts, likely as a hedge against mortgage assets, together with a significant amount of netting.

The asset manager and hedge fund sectors cover too broad a range of entities to have strong expectations about the direction of their IRS portfolios.[33] Put another way, the investment mandates or strategies of some of these entities will require long IRS positions and some will require short positions. On average, however, there is a lot more netting in the hedge fund sector, which may indicate a greater prevalence of strategies that require simultaneous long and short positions and strategies that require dynamic hedging. The other financial sector is similarly too broad for detailed comment here.

The bank sector exhibits a great deal of netting, which can be at least partially explained by IRS intermediation on behalf of loan customers. More specifically, a customer might borrow funds through a floating-rate loan and then lock in a fixed rate of interest by paying fixed to and receiving floating from the bank in an IRS. At the same time, the bank would hedge that swap by paying fixed to and receiving floating from a swap dealer. To the extent these swaps are cleared, the longs and shorts against the clearinghouse would net. Banks prefer this set of transactions over making fixed-rate loans to customers directly because floating-rate loans are much more easily sold to investors.[34] While the extent of netting in the banking sector is indicative of intermediation, short positions significantly dominate longs. The sector is likely too diverse for a single explanation of this directionality. Banks with strong mortgage franchises may hold relatively long-term mortgage assets and hedge the resulting interest rate risk by paying fixed in swap. On the other hand, banks with long-term fixed rate debt and banks with strong deposit and commercial loans franchises[35] might need to receive fixed to hedge their interest rate exposures.

5.4. Variation of IRS Positioning Across Entities in a Given Sector

The previous section describes the participation of sectors in the IRS market, but does not explore variation across entities within each sector. In particular, it is possible that a few large entities dominate the statistics of a sector and obscure the behavior of the many smaller entities within that sector. The columns of Table 4 give the number of entities, the percentage of entities with only short IRS positions, the percentage with only long positions, and the percentage with both short and long positions. For the market as a whole, 86% of the entities have exclusively short positions; about 6% have exclusively long positions; and only 8% have both long and short positions. These results lead to two observations. First, the fact that 92% of entities are exclusively short or long means that the vast majority of entities that use IRS are prototypical end users. Second, the fact that 86% of entities are exclusively short might be due to the relative ease of establishing short positions with IRS rather than bonds, particularly for the more casual users of fixed income markets. To elaborate, long positions are relatively easily to establish by buying bonds. By contrast, to establish short positions with bonds, the bonds must first be borrowed, then sold, then eventually repurchased, and then returned to lenders. For more casual traders, therefore, it may be much easier to establish short positions with IRS.

The sector-specific results of Table 4, when compared with Figure 1, show that the participation of small entities within sectors can, indeed, be quite different from overall sector characteristics. Consider, for example, the other financial sector. Figure 1 reports that this sector has net ENNs equal to positive 23% of total ENNs and total ENNs equal to 14% of total 5-year equivalents. Table 4, however,

[33] For more detail on how hedge funds use IRS, see Pedersen (2015), Chapters 14 and 15.

[34] For some recent descriptions of the market for bank loans, see Fitch Ratings (2017) and Loomis Sayles (2018). For an example of the described combination of loan and swap transactions, see BB&T (2018).

[35] Deposit liabilities, which are sticky and pay a below market rate, can have greater interest rate risk than floating-rate loans. See Drechsler, Savov, and Schnabl (2018).

reports that 88% of entities in the sector are exclusively short IRS. Hence, relatively few large entities in this sector are responsible for both its overall positive net ENNs position and the very significant amount of netting within counterparty relationships.

Larger entities seem to dominate the characteristics of other sectors as well. According to Figure 1, the hedge fund and bank sectors have total ENNs equal to 12% and 15% of total 5-year equivalents. But according to Table 4, 69% and 56% of the entities in these sectors, respectively, are either exclusively long or exclusively short. Similarly, Figure 1 shows that the insurance, pension, asset manager, and government / quasi-government sectors are characterized by intermediate levels of netting, with total ENNs ranging from 27% to 39% of total 5-year equivalents. But Table 4 shows that between 50% and 78% of the entities in these sectors are exclusively long or exclusively short.

The only two sectors for which individual entities seem roughly representative of their overall sectors are swap dealers and nonfinancial companies. The vast majority of swap dealers are simultaneously long and short, and the sector as a whole is characterized by significant netting within counterparty relationships. At the other extreme, 96% of nonfinancial companies are exclusively long or exclusively short, and the sector is, indeed, characterized by relatively little netting.

To formalize these observations, a Logit regression is run to predict the probability that an entity is exclusively long or exclusively short. The dependent variable equals 1 if an entity's net ENNs divided by its total ENNs is 100% or -100%, and equals 0 otherwise. The independent variables are a constant, a dummy variable for each sector (excluding the unclassified sector), and an entity's total ENNs times its sector dummy. The estimated coefficients and various diagnostics are presented in Table A3. All coefficients are statistically significant well beyond the 1% confidence level except for the coefficient of total ENNs in the swap dealer sector.

With Logit regression coefficients typically difficult to interpret, the text discusses Table 5 instead, which gives the predicted probabilities that an entity in a given sector with a given total ENNs is exclusively long or short, along with 95% confidence around those predicted probabilities. The first set of columns in the table gives predicted probabilities, by sector, for entities with total ENNs equal to the 25^{th} percentile of total ENNs of their respective sectors; the second set for entities with total ENNs equal to the median for their respective sectors; and the third set for entities with total ENNs at the 75^{th} percentile. With the exception of swap dealers, the results from Table 5 are illustrated in Figure 2.

Table 5 and Figure 2 statistically confirm the results of Table 4, namely, that entities in certain sectors are more likely to be end users in the sense of being exclusively long or exclusively short IRS. Not surprisingly, nonfinancial and other financial entities are extremely likely to be either all long or all short; government / quasi-government, hedge fund, asset manager, and bank entities, less so. Somewhat surprisingly, insurance companies and pension funds, which are usually thought of as receiving fixed in IRS to hedge long-term liabilities, are roughly only 70% and 48% likely, respectively, to be exclusively long or short.

Table 5 and Figure 2 also show that, within a given sector, entities with greater total ENNs have a lower probability of being exclusively long or short. The p-values of the interaction coefficients in Table A3 shows that these effects are statistically significant for all sectors except swap dealers, and Table 5 and Figure 2 show that the effects are economically small but noticeable. One interpretation of these effects is that firms with greater ENNs positions are also more likely to be sophisticated users of IRS, which could easily entail more complex positioning that leads to simultaneous longs and shorts.

The discussion now turns to intra-sector variation in the directionality of IRS positions. If a sector as a whole is net long or net short, are nearly all of the entities in the sector positioned the same way? Or do sectors have many entities that are net long and many others that are net short, with the largest entities determining the directionality of the sector as a whole? Table 6 presents descriptive statistics to answer these questions. The contents of the first four columns are self-explanatory, and the fifth column, "Net ENNs," is simply the sign of Net ENNs taken from Table 1. For all but two of the sectors, the directionality of the majority of the entities in the sector determines the directionality of the sector. For the pension sector, however, net ENNs are positive, but the majority of entities— 55% —have negative net ENNs. And in the other financial sector, which is net long, 93% of the entities are net short.

While the pension and other financial sectors strikingly demonstrate the variation of position directionality within sectors, some variation is present in the other sectors as well. For the other two sectors with positive net ENNs, swap dealers and insurance, 36% and 47% of the entities are net short. For the five sectors with negative net ENNs, only the nonfinancial sector has an overwhelming number of entities— 96% — positioned in the same direction. For the other four such sectors, the percentages of net long entities indicate significant intra-sector variation: in the government / quasi-government sector, 18% of entities are net long; in the hedge fund sector, 21%; in the bank sector, 27%; and in the asset manager sector, 30%.

To formalize these observations, a Logit regression is run to predict the probability that an entity is net long as a function of its sector. The dependent variable equals 1 if an entity's net ENNs are positive, and equals 0 otherwise. The independent variables are a constant and sector dummies (excluding the unclassified sector). The regression results are in Table A4, and all of the coefficients are statistically significant. Once again, however, for the purpose of interpreting the Logit regression coefficients, Table 7 gives the predicted probabilities, along with 95% confidence intervals, that an entity in a particular sector has positive net ENNs. The same information is conveyed graphically in Figure 3. Note that the vertical axis in Figure 3 has no units; it is used only to separate the sectors and aid visualization.

Table 7 and Figure 3 clearly show that entities in certain sectors have a greater propensity to be long than entities in other sectors. As discussed earlier, the categories of asset managers, hedge funds, and banks are too broad to have strong expectations as to directionality. The same might be said about the other financial and nonfinancial sectors, but the overwhelming majority of these entities are net short. One possible explanation is that they are mostly hedging the borrowing available to them, namely floating-rate loans, by paying fixed in IRS.[36] The confidence interval for entities in the Swap Dealer sector is between 53% and 73% long. A weak expectation would be that swap dealers, as market makers and intermediaries, would be 50% long. But, as mentioned earlier, the rest of the sectors are net short, which requires someone—very possibly the dominant intermediaries—to be net long.

The biggest surprise in Table 7 and Figure 3, however, are insurance companies and pension funds. The confidence intervals for the proportion of entities with net positive ENNs in these sectors are (48%, 58%) and (42%, 48%), respectively. This finding is not consistent with the view that insurance companies and pension funds predominantly receive fixed in IRS to hedge their long-term liabilities.

[36] This explanation is consistent with the findings of Simkins and Rogers (2006).

6. Conclusion

This paper shows that, in terms of risk transfer, the size of the IRS market should be measured with ENNs instead of notional amounts. Notional amounts are misleading because they add together swaps with very different risk characteristics, and because they add together offsetting long and short positions within counterparty relationships. ENNs correct for these flaws by normalizing all swaps to 5-year risk equivalents and by netting longs and shorts between each counterparty pair in each currency.

Measured with notional amounts, the size of the IRS market across U.S.-reporting entities is $231 trillion, which seems very large relative to the total outstanding principal of debt securities and loans in the United States of only $64 trillion. Measured with ENNs, however, the size of the IRS market is $13.9 trillion. This order of magnitude is similar to that of the Treasury market, at $18 trillion; the corporate bond market, at $13.5 trillion; and mortgage debt outstanding, at $15.5 trillion.

An analysis of ENNs by sector shows the prevalence of netting across sectors and the extent to which various sectors are net long or net short. An analysis of individual entities reveals that the overwhelming majority of entities are prototypical end users in the sense of being exclusively net long or net short. Furthermore, the intra-sector variation of IRS positioning raises several questions suitable for future research. For example, if pension funds and insurance companies primarily receive fixed in IRS to hedge their long-term liabilities, why are so many entities in this sector net short and, furthermore, exclusively short IRS?

Table 1. Notional Amounts, 5-Year Equivalents, and ENNs for the U.S.-Reporting IRS Market, by sector, as of March 15, 2019, $Trillions.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Sector	**Notional Amount**		**5-Year Equivalents**		**ENNs**		**ENNs**
	Long	*Short*	*Long*	*Short*	*Long*	*Short*	*Net*
Swap Dealer	176.0	175.7	84.2	82.5	8.4	6.7	1.7
Hedge Fund	23.4	22.0	6.6	6.8	0.7	0.9	-0.2
Bank	15.9	16.7	11.3	12.5	1.1	2.4	-1.3
Other Financial	7.1	7.0	4.8	4.5	0.8	0.5	0.3
Asset Manager	3.3	3.5	2.2	2.7	0.7	1.2	-0.4
Pension Fund	1.7	1.7	2.3	1.8	0.8	0.3	0.5
Gov't/Quasi-Gov't	1.3	1.4	0.8	1.1	0.2	0.5	-0.4
Nonfinancial	0.5	1.5	0.3	0.9	0.2	0.8	-0.6
Insurance	1.0	0.9	1.8	1.3	0.8	0.2	0.5
Unclassified	0.3	0.5	0.2	0.4	0.1	0.2	-0.2
CCP Adjustment	0.5	0.1	0.1	0.1	0.1	0.1	-0.1
Total	**231.0**	**231.0**	**114.5**	**114.5**	**13.9**	**13.9**	**0.0**

Table 2. Notional Amounts and 5-Year Equivalents by Product Type, as of March 15, 2019, $Trillions.

Product	**Notional Amount (Long)**	**5-Year Equivalents (Long)**
Fixed-for-Floating Swaps	120.3	99.9
Forward Rate Agreements (FRAs)	45.6	1.9
Overnight Index Swaps (OIS)	40.0	6.7
Swaptions	15.6	5.8
Caps/Floors	9.0	0.1
CCP adjustment	0.5	0.1
Total	**231.0**	**114.5**

Table 3: Clearing Percentages, Notional Amounts and ENNs, by Sector, as of March 15, 2019, $Trillions

Sector	**Notional Amount**				**ENNs**			
	Long	*Cleared %*	*Short*	*Cleared %*	*Long*	*Cleared %*	*Short*	*Cleared %*
Swap Dealer	176.0	85	175.7	85	8.4	42	6.7	29
Hedge Fund	23.4	80	22.0	85	0.7	49	0.9	73
Bank	15.9	91	16.7	92	1.1	56	2.4	75
Other Financial	7.1	90	7.0	89	0.8	48	0.5	48
Asset Manager	3.3	81	3.5	81	0.7	73	1.2	84
Pension	1.7	63	1.7	72	0.8	40	0.3	53
Gov't/Quasi-Gov't	1.3	57	1.4	70	0.2	21	0.5	52
Nonfinancial	0.5	4	1.5	3	0.2	2	0.8	3
Insurance	1.0	63	0.9	60	0.8	62	0.2	51
Unclassified	0.3	69	0.5	51	0.1	37	0.2	26
CCP Adjustment	0.5		0.1		0.1		0.1	
Total	**231.0**	**84**	**231.0**	**84**	**13.9**	**46**	**13.9**	**46**

Table 4: Percentages of LEIs with IRS Positions that are Short only, Long only, or both Short and Long. by Sector

Sector	Number of LEIs	Short Only	Long Only	Short and Long
Nonfinancial	36,027	92.5%	3.6%	4.0%
Unclassified	14,782	93.1%	4.7%	2.2%
Other Financial	2,455	88.1%	5.0%	6.9%
Gov't/Quasi-Gov't	393	69.2%	9.2%	21.6%
Hedge Fund	1,369	59.5%	9.4%	31.1%
Asset Manager	4,852	51.5%	16.3%	32.2%
Bank	1,446	46.5%	9.3%	44.2%
Insurance	361	35.2%	31.9%	33.0%
Pension	942	21.4%	28.6%	50.0%
Swap Dealer	86	0.0%	< 10%*	> 90%*
Total	62,713	85.8%	5.7%	8.5%

* To protect the confidentiality of individual entities, exact percentages are not provided here.

Table 5: Predicted Probabilities that an Entity is Exclusively Long or Exclusively Short IRS, by Sector and Total ENNs, along with 95% Confidence Intervals

Sector	ENNs at 25th Percentile			ENNs at Median			ENNs at 75th Percentile		
	Predicted	Lower	Upper	Predicted	Lower	Upper	Predicted	Lower	Upper
Swap Dealer	1.6%	0.0%	47.4%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Hedge Fund	78.5%	76.0%	80.8%	77.8%	75.3%	80.1%	73.1%	70.5%	75.5%
Bank	63.5%	60.7%	66.3%	62.8%	60.0%	65.5%	57.0%	54.3%	59.7%
Other Financial	93.8%	92.8%	94.7%	93.8%	92.8%	94.7%	93.8%	92.8%	94.7%
Asset Manager	69.3%	67.9%	70.6%	69.2%	67.8%	70.5%	68.6%	67.3%	69.9%
Pension	51.8%	48.4%	55.1%	51.6%	48.3%	54.9%	51.0%	47.7%	54.2%
Gov't/Quasi-Gov't	84.8%	80.7%	88.2%	84.3%	80.2%	87.7%	82.8%	78.5%	86.3%
Nonfinancial	96.1%	95.9%	96.3%	96.1%	95.9%	96.3%	96.1%	95.9%	96.3%
Insurance	72.9%	67.7%	77.6%	72.4%	67.2%	77.1%	69.2%	64.0%	73.9%

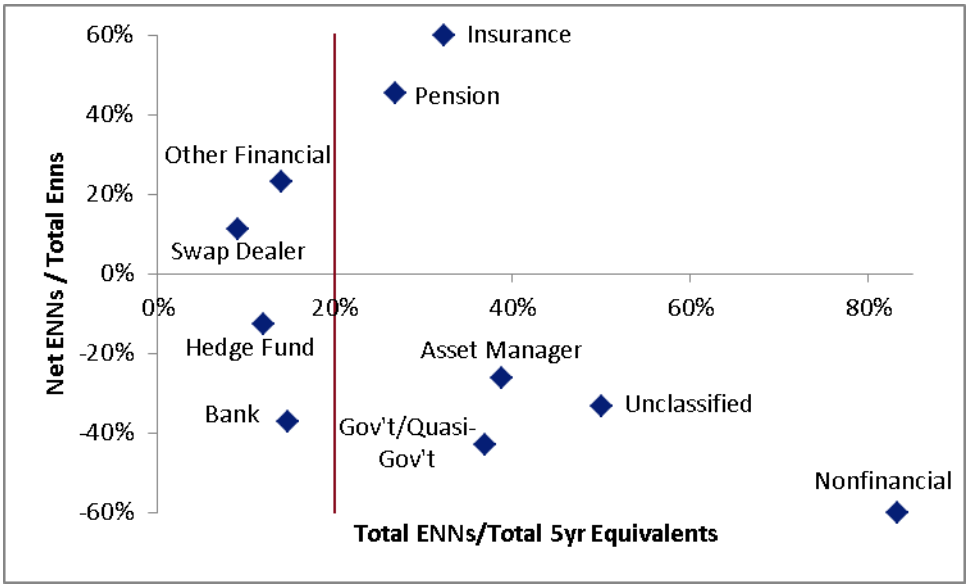
Table 6: Percentages of LEIs with Net Long and Short ENNs, by Sector

Sector	Number of LEIs	Net ENNs > 0	Net ENNs ≤ 0	Net ENNs of Sector
Swap Dealer	86	64.0%	36.0%	+
Hedge Fund	1,369	20.9%	79.1%	–
Bank	1,446	26.9%	73.1%	–
Other Financial	2,455	7.0%	93.0%	+
Asset Manager	4,582	29.5%	70.5%	–
Pension	942	45.2%	54.8%	+
Gov't/Quasi-Gov't	393	17.8%	82.2%	–
Nonfinancial	36,027	3.8%	96.2%	–
Insurance	361	52.6%	47.4%	+
Unclassified	14,782	5.2%	94.8%	–
Total	62,713	8.3%	91.7%	0

Table 7: Predicted Probabilities that an Entity's Net ENNs is Positive, by Sector, along with 95% Confidence Intervals

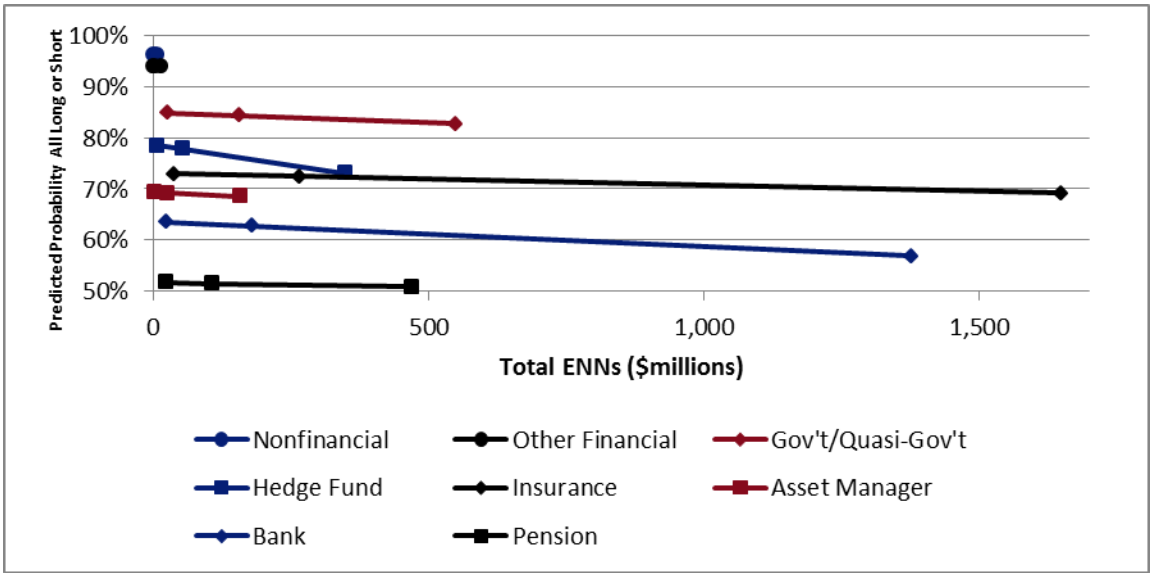
Sector	Predicted	Lower	Upper
Swap Dealer	64.0%	53.3%	73.4%
Hedge Fund	20.9%	18.8%	23.1%
Bank	26.9%	24.7%	29.3%
Other Financial	7.0%	6.0%	8.0%
Asset Manager	29.5%	28.2%	30.8%
Pension	45.2%	42.1%	48.4%
Gov't/Quasi-Gov't	17.8%	14.3%	21.9%
Nonfinancial	3.9%	3.7%	4.1%
Insurance	52.6%	47.5%	57.7%

Figure 1. Long vs. Short Positioning and a Measure of Intermediation Activity, by Sector



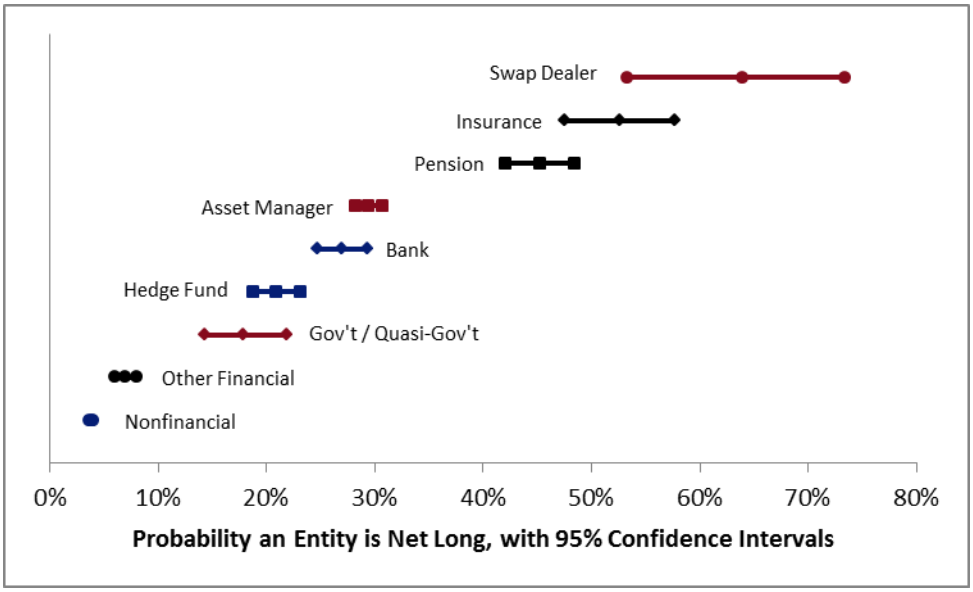
The horizontal axis gives the total ENNs, that is, the long plus short ENNs of each sector, as a percentage of that sector's total 5-year equivalents, that is, its long plus short 5-year equivalents. Low percentages result from significant netting of long and short notional amounts within pairs of counterparties. High percentages are associated with lower amounts of netting. The vertical axis gives Net ENNs, that is, long minus short ENNs, as a percentage of total ENNs for each sector. The more positive a percentage, the more a sector is net long IRS, defined such that the net IRS position gains value as interest rates decrease. The more negative a percentage, the more a sector is net short IRS, defined such that the net IRS positions loses value as interest rates decrease.

Figure 2. Predicted Probabilities that an Entity is Exclusively Long or Exclusively Short IRS



These predicted probabilities come from a Logit regression. The dependent variable equals 1 if an entity is exclusively long or exclusively short ENNs, and equals 0 otherwise. The independent variables are: a constant, dummy variables for each sector (excluding unclassified), and the total ENNs of an entity times the dummy variable of its sector. The data points on each line in the graph give the predicted probability for an entity in a particular sector with total ENNs equal to the 25th percentile, the median, and the 75th percentile of total ENNs for that sector.

Figure 3. Predicted Probabilities that an Entity is Net Long, with 95% Confidence Intervals



These predicted probabilities and confidence intervals come from a Logit regression. The dependent variable equals 1 if an entity is net long ENNs, and equals 0 otherwise, The independent variables are a constant and a dummy variable for each sector (excluding unclassified). The points on each graph, from left to right, depict the lower point of the confidence interval, the predicted probability, and the upper point of the confidence interval. The vertical axis has no units; it simply separates the sectors for better visualization.

Appendix

Table A1: Notional Amounts, 5-Year Equivalents, and ENNs, by currency, as of March 15, 2019, in $Trillions.

Currency	Notional Amount	5-Year Equivalents	ENNs
USD	91.5	40.3	6.4
EUR	65.7	41.9	4.1
GBP	23.6	11.6	1.4
AUD	11.8	2.7	0.2
JPY	7.6	6.3	0.6
CAD	6.9	2.7	0.2
Other	23.8	9.1	1.1
Total	**231.0**	**114.5**	**13.9**

Table A2: Number of LEIs (Legal Entity Identifiers) in Sample, by Sector, as of March 15, 2019

Sector	Number of LEIs	% of Total
Swap Dealer	86	0.1
Hedge Fund	1,369	2.2
Bank	1,446	2.3
Other Financial	2,455	3.9
Asset Manager	4,852	7.7
Pension	942	1.5
Gov't/Quasi-Gov't	393	0.6
Nonfinancial	36,027	57.4
Insurance	361	0.6
Subtotal	47,931	76.4
Unclassified	14,782	23.6
Total	62,713	100%

Table A3: Logit Regression of ENNs Being Exclusively Long or Exclusively Short

Independent Variable	Estimated Coefficient	Standard Error	Wald's χ^2	p-value
Constant	3.8174	0.0567	4,534.30	<0.0001
Dummy Variables				
Swap Dealer	-4.7662	0.8073	34.86	< 0.0001
Hedge Fund	-2.5158	0.0923	743.02	< 0.0001
Bank	-3.2570	0.0839	1,505.37	< 0.0001
Other Financial	-1.0997	0.1013	117.79	< 0.0001
Asset Manager	-3.0030	0.0653	2,111.74	< 0.0001
Pension	-3.7459	0.0888	1,780.37	< 0.0001
Gov't/Quasi-Gov't	-2.0883	0.1591	172.31	< 0.0001
Nonfinancial	-0.6168	0.0629	96.26	< 0.0001
Insurance	-2.8214	0.1409	401.16	< 0.0001
Interactions of Dummy Variables and Total ENNs				
Swap Dealer	-0.0003	0.0002	1.71	0.1905
Hedge Fund	-0.0009	0.0001	96.03	< 0.0001
Bank	-0.0002	0.0000	67.52	< 0.0001
Other Financial	-0.0001	0.0000	26.57	< 0.0001
Asset Manager	-0.0002	0.0000	40.68	< 0.0001
Pension	-0.0001	0.0000	9.13	0.0025
Gov't/Quasi-Gov't	-0.0003	0.0001	25.32	< 0.0001
Nonfinancial	-0.0003	0.0000	36.82	< 0.0001
Insurance	-0.0001	0.0000	16.08	< 0.0001

Table A4: Logit Regression of Net ENNs Being Positive

Independent Variable	Estimated Coefficient	Standard Error	Wald's χ^2	p-value
Constant	-2.8931	0.0369	6,154.12	<0.0001
Dummy Variables				
Swap Dealer	3.4664	0.2276	231.97	< 0.0001
Hedge Fund	1.5616	0.0760	421.90	< 0.0001
Bank	1.8935	0.0698	735.16	< 0.0001
Other Financial	0.3011	0.0874	11.86	0.0006
Asset Manager	2.0195	0.0485	1,734.09	< 0.0001
Pension	2.7014	0.0751	1,292.66	< 0.0001
Gov't/Quasi-Gov't	1.3639	0.1369	99.26	< 0.0001
Nonfinancial	-0.3255	0.0459	50.21	< 0.0001
Insurance	2.9984	0.1117	720.89	< 0.0001

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