Nicola Cetorelli, Beverly Hirtle, Donald Morgan, Stavros Peristiani, and João Santos

Trends in Financial Market Concentration and Their Implications for Market Stability

- The issue of whether concentrated financial markets—those with a few large suppliers—are more stable or less stable than less concentrated markets is important to policymakers and others concerned about potential market disruptions.
- An analysis of how U.S. financial market structure has changed over the last decade finds no pervasive pattern of high and increasing concentration.
- A complementary line of inquiry into the link between concentration and the risk or severity of market instability focuses on substitution by firms; substitution can stabilize markets by dampening the upward pressure on prices attributable to a large exiting supplier.
- The departure of a major supplier will cause less market disruption the more promptly other firms can substitute for it.

1. Introduction

Imagine two very different financial market structures. The first has many suppliers, each with only a small share of the market. The second has a few very large firms that supply most of the market, plus many smaller players that make up the rest. Which structure is more stable: the one with many small firms or the concentrated market where a few firms dominate? Which structure best describes financial markets in the United States? Those are questions we address in this article.[1]

A *stable* market is one that can endure shocks to supply or demand without collapsing—that is, without experiencing surging (or wildly oscillating) prices or sharply shrinking volumes. Stability requires certain self-correcting tendencies that ensure that a market can right itself. If supply falls because a major producer fails, for example, the resulting excess demand must push prices upward. Rising prices, in turn, must induce prompt substitution toward other suppliers or products. Substitution tends to dampen upward pressure on prices, thus stabilizing the market.

[1] Our study analyzes market concentration. That is, we focus on the risks to financial stability in markets with a few large suppliers. We do not discuss other forms of concentration that might be of concern to financial supervisors, such as concentration in a firm's asset portfolio, concentration among users of a specific product or service, or concentration of many firms with the same risk exposures. These are all very important but distinct concepts requiring separate analysis.

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Markets can experience shocks to supply or demand from many sources, such as changes in regulation, technological innovation, shifts in demographics, and knock-on effects from shocks to other markets or economic sectors. We focus here primarily on one particular type of supply shock: the failure and exit of one or more large suppliers. This is a natural channel to focus on given our interest in the relationship between market concentration and market stability, since the presence of a few large suppliers is the defining feature of a concentrated market.

The link between concentration and stability is hard to pin down, so we mostly try to identify the link by breaking it down into parts. For example, we distinguish between the *probability* of distress by a given firm and the *severity* of the market consequences in that event. After reviewing literature that investigates the link between financial market concentration and financial stability, we conclude that the link is ambiguous—some of the side effects of changing market structure may have a stabilizing influence, while other influences may be destabilizing. Our own findings are consistent with that ambiguity. We find a mixed relationship between market concentration and volatility in the investment-grade-bond and syndicated loan markets, consistent with an ambiguous relationship as suggested in the theoretical literature. We conclude that there are no simple answers to the question of whether concentrated financial markets are more stable or less stable than less concentrated markets.

Our analysis of how U.S. financial market structure has changed over the last decade produces more definitive conclusions. Using firm-level data from a variety of sources,

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including data collected by central banks, we document that in aggregate, most U.S. wholesale credit and capital markets are only moderately concentrated. Concentration in most global over-the-counter (OTC) derivatives markets is low, though rising. Overall, concentration trends are mixed, rising in some markets and falling in others. Given the rise in bank concentration at the national level, we view the moderate and mostly stable levels of concentration at the individual market level as surprising. We also find that linkages *across* markets have increased since the late 1990s as more second-tier firms have ventured into other markets. The stability implications of increased cross-market linkages are mixed; the probability of disruption is lower if firms in multiple markets are more diversified, but contagion across markets may make disruption more severe.

After documenting those facts, we return to the question of stability and concentration, but with a twist: we argue that the exit of a single large firm will cause less market disruption the more promptly other firms can substitute for the exiting firm,

Our findings should offer some reassurance to policymakers concerned about whether high or rising financial market concentration portends greater financial market instability.

and we discuss market characteristics that will speed or impede such substitution. We then rank markets by potential substitutability among firms in that market (as proxied by turnover in market share rankings) on the one hand, versus concentration on the other. We find few markets with high concentration *and* low turnover.

In sum, our findings should offer some reassurance to policymakers concerned about whether high or rising financial market concentration portends greater financial market instability. Most financial markets, at least those in the United States, are not particularly concentrated, nor are they becoming more so. Moreover, even if the opposite were true, the implications for financial stability are ambiguous; it depends on what else is changing along with market structure, and on how fluidly other firms can substitute for the incapacitated firm. Looking at concentration alone, without considering these other factors, will not always provide a reliable view of the likelihood or likely damage from a market disruption. More detailed analysis of individual markets is needed to obtain a full understanding.

Our policy recommendations are simple. Besides the obvious—monitoring trends in concentration and turnover—we advocate public policies that enhance substitution among firms within a given market by, for example, promoting standardization of products, ensuring rapid clearing of payments, and monitoring competition to ensure that key players do not become entrenched (and hence irreplaceable) because of privileged access to trading platforms or technologies.

2. The Ambiguous Link between Concentration and Stability

Why should a change in concentration affect either the probability of a firm's distress or the severity of the consequent market disruption? In this section, we review theory and empirical evidence that address this question.

History certainly suggests a link between market concentration and the severity of market disruption given the distress of a major market supplier. A good example is the market for original-issue, below-investment-grade (junk) bonds and the role played in it by Drexel Burnham Lambert. At the peak of the firm's market dominance in the mid-1980s, Drexel's market share oscillated around 50 percent, with a dollar value of issues up to ten times that of the second largest competitor (Altman and Nammacher 1987). As a result of well-known events, Drexel filed for Chapter 11 bankruptcy protection in February 1990.

Drexel's exit significantly disrupted the junk-bond market. Return spreads over Treasury securities increased from an average of 400 basis points during the 1980s to 1,000 basis points after Drexel's exit. Issuance also shrank substantially.

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The annual value of new issues declined from about $30 billion before Drexel's exit to about $4 billion in 1990, and it took three years to return to pre-exit volumes (Edwards and Mishkin 1995). Moreover, negative repercussions were also felt in other industries, as large junk-bond holders attempted to find suitable substitutes for the services Drexel had provided.[2]

Theory, however, has focused almost exclusively on the link between market concentration and the probability of a firm's distress, offering mixed conclusions about the link's direction. Some of the literature suggests a negative link between market concentration and the probability of firm distress. This literature focuses on how market concentration affects firms' incentives to take risk, a concept with direct correspondence to the probability of a firm's distress. Keeley (1990) as well as Hellmann, Murdock, and Stiglitz (2000) argue that banks in concentrated markets have incentives to reduce risk. If higher concentration reflects decreased competition and increased profitability, then banks' franchise values will be higher. Higher franchise values reduce the incentives of equity holders to engage in excessive risk-taking behavior that might jeopardize their franchise. Focusing more on how firms interact with each other, Carlin, Lobo, and Viswanathan (2004) argue that a market with a few large players will be stable *most of the time*, as firms choose optimally to act as cooperating oligopolists. However, one player will find it optimal, occasionally, to deviate from this strategy, and its action could lead to significant market instability.

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There are also links between concentration and risk through a *size channel*. The dominant banks in concentrated markets are frequently very large, and large banks have opportunities to diversify and reduce risk. Concentrated markets thus should be more stable overall (for example, Allen and Gale [2000]). However, large firms may reoptimize by changing investment strategies (entering riskier market segments or adopting lower capital ratios) so that eventually overall risk might remain unaltered. Empirical evidence based on U.S. data supports this conjecture (Demsetz and Strahan 1997; Stiroh 2006).

While these factors suggest a negative or neutral link between market concentration and firms' incentives to take on risk, other factors suggest the opposite effect. In particular, an increase in firm size may be associated with lower transparency. Size allows financial firms to expand across multiple geographic markets and lines of business. It also allows the use of increasingly sophisticated financial instruments and the evolution toward complex forms of corporate organization. This may result in reduced managerial efficiency, less effective internal corporate control, and the potential for increased operational risk. The increasing complexity of the organizations could also render both market discipline and regulatory action less effective in preventing excessive risk exposure. Large size also raises moral hazard concerns if the owners of large banks operate under the presumption that they are *too* big to be allowed to fail.

Given the ambiguous theoretical relationship between financial market concentration and financial market stability, it should come as no surprise that the scant empirical literature

[2]For example, this was the case in the life insurance sector, where foreclosures occurred as a result of sizable losses from junk-bond investments (Brewer and Jackson 2000).

on that question also reaches conflicting conclusions.[3] Using data across seventy countries from 1980 to 1997, Beck, Demirguc-Kunt, and Levine (2003) estimate the relationship between banking market concentration and the likelihood of a banking crisis.[4] They find a negative relationship; as concentration increases, the probability of crises decreases. However, De Nicoló et al. (2003) investigate empirically the role of concentration on an indicator proxying for the probability of the largest financial firms failing. Using cross-country data, they find that higher concentration is associated with higher probability of failure.

We find a similarly ambiguous relationship in our estimates of the link between concentration and volatility in two particular U.S. financial markets: investment-grade-bond underwriting and syndicated loans. Our two-step regression methodology constructs a measure of volatility from the excess variation in bond or loan spreads—variation above and beyond what one would predict given the risk of the issuer or borrower,

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contract terms (for example, maturity), and macroeconomic conditions at the time of issuance. (Our statistical methodology is described in greater detail in the appendix.) Put differently, volatility is measured by deviations in spreads that are not attributable to firm or macroeconomic fundamentals. Those nonfundamentals are presumably the types of disturbances to supply and demand that can destabilize a market.[5]

In the second stage of our regression methodology, we estimate how volatility in each market changes over time in relation to changes in the level of concentration, as measured by the Herfindahl-Hirschman Index (HHI) of concentration.[6] The estimates of the volatility-concentration relationships are not robust; they depend instead on the market in question and the period under observation (Chart 1). For syndicated loans, the relationship is nonlinear but generally negative, suggesting somewhat lower volatility as market concentration rises. For investment-grade bonds, the relationship is negative in a narrow range of low concentrations but turns positive for higher HHI levels, suggesting the opposite relationship to the syndicated loan market, at least for higher market concentration levels. However, the volatility-concentration relationship for bonds is unstable. When we exclude observations before 1990 (a period in which most banks were not allowed to compete for underwriting business), the relationship estimated over the observations in the 1990-2004 period is negative.[7]

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These findings showing variation across markets and across time do not support any particular conclusions about the relationship between concentration and volatility. Perhaps the safest view is to take these estimates as consistent with the ambiguous relationship in the literature we just reviewed. Put differently, our findings can be seen as a counter-example to hypothetical claims that concentrated markets are always more stable or less stable.

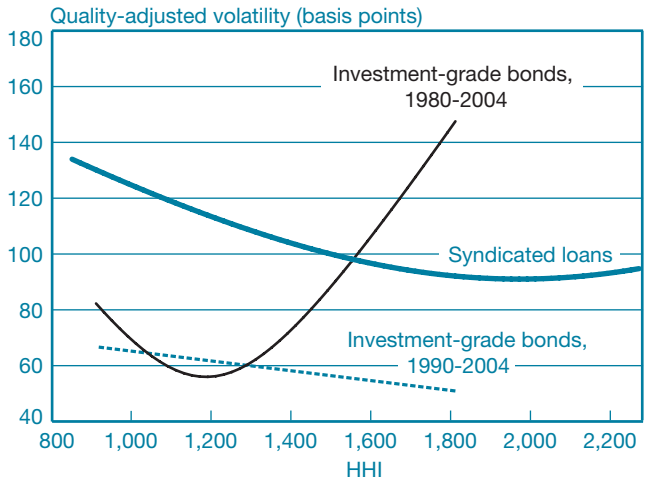
[3]Boyd and De Nicoló (2005) also conclude that theory and evidence relating concentration and financial stability are ambiguous.

[4]Banking crises are defined as events where 1) emergency measures were taken to assist a nation's banks (bank holidays, deposit freezes, blanket guarantees to depositors or creditors, or large-scale nationalization), 2) nonperforming assets reached at least 10 percent of total assets at the height of the crisis, or 3) the cost of rescue operations was at least 2 percent of GDP (see <http://www.nber.org/digest/feb04/w9921.html>).

[5]While this volatility measure does not directly reflect the impact of a large supplier's failure, we believe it provides a reasonable proxy for market resiliency to a range of supply and demand shocks. In fact, the measure tracks other, broader gauges of financial market instability fairly closely. For instance, the correlation between our annual measure of bond price volatility and the Chicago Board Options Exchange Volatility Index (VIX) is close to 70 percent. The VIX is a key measure of market expectations of near-term volatility conveyed by S&P 500 stock index option prices. Essentially, many consider this index one of the most important forward-looking indicators of investor sentiment and market volatility. We take this close correlation as evidence that the first-stage volatility estimates are doing a good job capturing changes in market stability over time.

[6]Volatile markets have more frequent and larger price disruptions (by definition), so the self-correcting tendencies required for stability are more demanding. We also looked at extreme events—that is, episodes in which our measure of excess volatility was in the tail of the distribution. The results were qualitatively similar to those reported in this article. To account for the possibility that price volatility might also depend on the business cycle, we also estimated a second-stage regression specification that, in addition to concentration, included several macroeconomic controls such as GDP growth, the unemployment rate, and inflation. Overall, the relationships depicted in Chart 1 remained fairly unchanged.

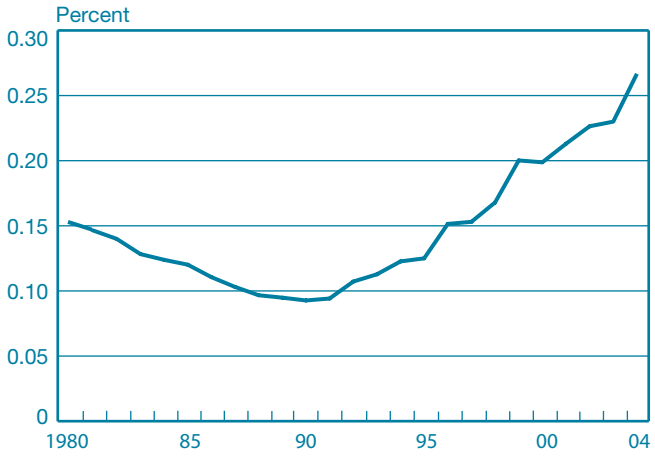
Chart 1
Relationship between Price Volatility and Market Concentration



Sources: Securities Data Corporation; Loan Pricing Corporation.

Note: HHI is the Herfindahl-Hirschman Index.

Chart 2
Share of Total Bank Assets Held by Top Four U.S. Commercial Banks



Source: Federal Financial Institutions Examination Council Reports of Condition and Income.

3. Concentration Trends

We now examine trends in concentration across a selection of major U.S. financial markets over the past fifteen years. The basic question is whether the regulatory changes of the 1990s have led to a broad pattern of high and increasing concentration in U.S. financial markets. It is already well known that bank concentration at the *aggregate* level (measured by the market share of the four largest U.S. banks) has climbed steadily since the early 1990s (Chart 2), rising from less than 10 percent of banking industry assets in 1990 to 25 percent at the end of 2004. Our review shows that high and rising concentration is not universal across individual financial markets. We find generally moderate levels of concentration in wholesale credit and capital market activities and in most OTC derivatives markets, plus a mixed pattern in terms of trend, with concentration rising in some markets and falling in others. The most noticeable exception is the prime brokerage market, where concentration is high (but declining).

Our review covers major U.S. wholesale credit and capital markets. Admittedly, these markets are not exhaustive; however, they do represent some of the most important markets for core wholesale financial and banking services.[8]

We measure market concentration by the standard *n*-firm concentration ratio, calculated as the sum of the market shares of the top *n* (two, three, or five) firms in the market, or by the Herfindahl-Hirschman Index, the sum of squared market shares of all firms in the market.[9] The HHI ranges from zero for a market with an infinite number of equally sized (very small) competitors to 10,000 for a market with a single competitor with a 100 percent market share. Guidelines published by the U.S. Department of Justice used in antitrust analysis specify that markets with HHIs of between 1,000 and 1,800 are considered "moderately concentrated," while markets with HHIs greater than 1,800 are considered "highly concentrated." Although the application is not direct, these figures are useful for interpreting the HHI figures we discuss.

3.1 Underwriting and Financial Services

The U.S. underwriting markets are dominated by a handful of large financial firms. Increased competition from bank entry, however, has changed the character and diversity of these

[7]Implicit in the relationship that we derived between price volatility and concentration is, among other things, our assumption that the pool of bond issuers does not change with competition among bond underwriters (our results assume similar conditions in the case of syndicated loans). If these assumptions do not hold, other explanations for our findings are also plausible. For instance, if more new issuers come to the market as concentration decreases, these issuers are likely to contribute to a negative relationship between price stability and concentration because, in general, there is less information available about them than about issuers with an established track record.

[8]We do not look at the markets for deposit-taking or other consumer services, since studies have shown that these activities are conducted mostly in local markets and that concentration in local markets has not been increasing (Dick 2006). Nor do we analyze payment-related markets, since concentration in these markets, especially government securities clearing, is well documented and has been actively studied from a policy perspective.

[9]In general, *n*-firm concentration ratios and HHIs display very high positive correlations.

Table 1

Concentration Trends in Underwriting and Selected Financial Services, 1990-2004

Market	Average HHI	Growth in HHI (Percent)	Top Five (Percent)
Securities underwriting			
Initial public offerings	1,149	4.32	60.7
Seasoned offerings	854	4.85	49.2
Investment-grade bonds	1,122	-3.41	56.4
High-yield bonds	1,144	-1.54	56.1
Merger and acquisition advisory services	1,160	9.44	56.8
Syndicated loan	1,391	-1.97	50.2

Source: Securities Data Corporation.

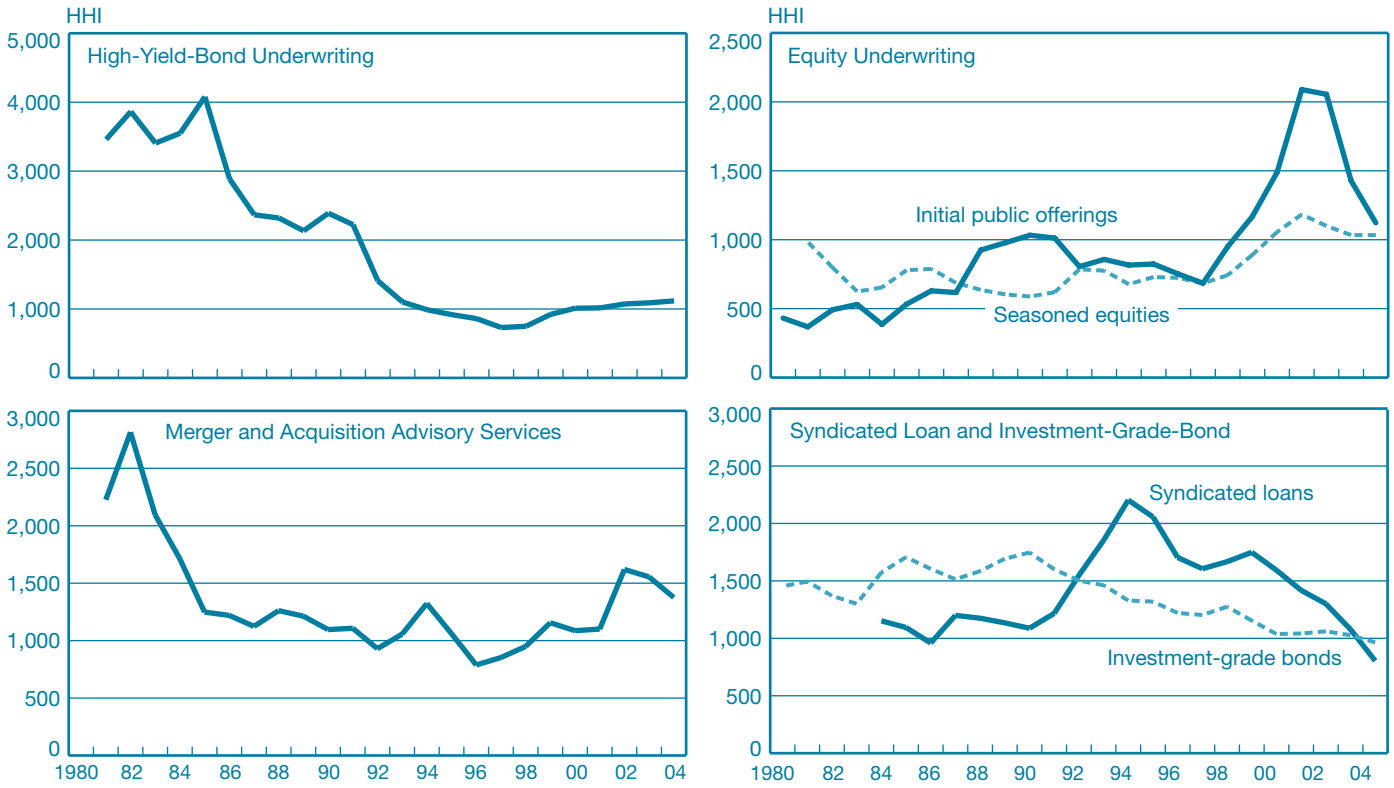
Notes: Herfindahl-Hirschman Index (HHI) calculations are based on the lead underwriter.

markets. Table 1 summarizes the levels and changes in concentration in the major underwriting and financial services markets: securities underwriting, syndicated loan, and merger and acquisition (M&A) advisory services. Chart 3 shows the change in HHI in these markets from year to year since the early 1980s.[10] Overall, these measures reveal low to moderate levels of concentration across the markets. Average HHIs range from about 850 to 1,400, within or slightly below the Department of Justice's "moderately concentrated" range.

Several markets have seen significant declines in concentration since 1980, most notably the high-yield-debt underwriting and M&A advisory services markets (Chart 3). Since 1990, the pattern across markets has been mixed, with some experiencing increases in measured concentration (equity initial public offerings [IPOs], seasoned equity, and M&A advisory services) and others experiencing declines (bond underwriting and syndicated loans). Even over the relatively short period since 1998, no consistent pattern emerges, with concentration in some markets trending up and concentration in other markets trending down.

Chart 3

Concentration in Investment Banking Markets



Sources: Securities Data Corporation; Loan Pricing Corporation.

Note: HHI is the Herfindahl-Hirschman Index.

3.2 OTC Derivatives Markets

OTC derivatives markets have grown tremendously in recent years along with rising demand for corporate risk management. Commercial banks are the largest dealers in these rapidly growing markets.[11]

Tables 2 and 3 summarize patterns in market concentration for a variety of OTC derivatives products. Table 2 reports information on concentration in global markets for interest rate and foreign exchange (FX) derivatives from the 2004 Bank for International Settlements (BIS) Triennial and Semiannual Surveys on Positions in Global Over-the-Counter Derivatives Markets.[12] Chart 4 shows how concentration in these markets has varied from year to year since 1998. Overall, global concentrations for the major categories of interest rate and FX products are low or moderate, though rising.

Concentration in credit derivatives products has declined substantially over the last few years as financial institutions have rushed to take part in this exploding market.

The BIS survey does not publish concentration measures for the credit derivatives market. The last row of Table 2 presents an estimate of concentration for the OTC credit derivatives market based on U.S. dealers reporting to the BIS survey and information gathered from the annual reports of major non-U.S. dealers. Our estimates reveal moderate levels of concentration in the credit derivatives market during the 2000-04 period. Moreover, concentration in credit derivatives products has declined substantially over the last few years as financial institutions have rushed to take part in this exploding market.

Table 3 reports concentration figures for equity-linked derivatives markets. Concentration in global markets is low to moderate for U.S. and European equity-linked derivatives, though concentration in the more specialized regional markets, such as in Asia and Latin America, is quite high. In addition to presenting BIS estimates of global market concentration, Panel B of Table 3 gives information on concentration for U.S.

[10]The HHI for the syndicated loan market starts in 1986 because our data source for this market is not comprehensive before that year.

[11]For a thorough discussion of the link between derivatives markets and the risk of systemic events, see Hentschel and Smith (1994).

[12]The BIS database on major OTC dealers is made up of data collected by central banks in major industrialized countries. The BIS reports aggregate information on nominal positions and HHI concentration, but it does not collect or make available bank-specific information on the roughly 240 reporters.

Table 2

Concentration Trends in Interest Rate and Foreign Exchange Over-the-Counter Derivatives Markets

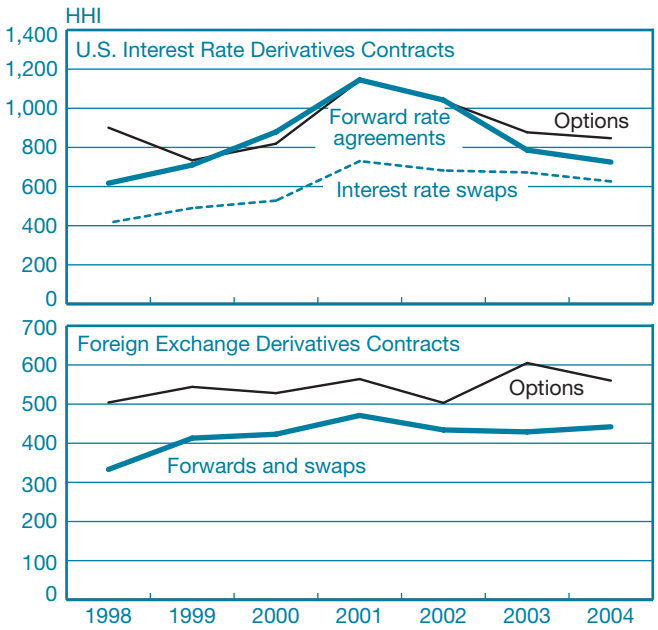
Market	Average HHI	Growth in HHI (Percent)
Panel A: Global concentration: BIS surveys, 1998-2004		
U.S. interest rate derivatives		
Forward rate agreements	843	4.64
Interest rate swaps	591	8.20
Options	908	0.75
Foreign exchange derivatives		
Forwards and swaps	420	5.30
Options	544	2.31
Panel B: Federal Reserve Bank of New York Estimates of Concentration: 2000-04		
Credit derivatives	825	-14.04

Sources: Bank for International Settlements, Triennial and Semiannual Surveys on Positions in Global Over-the-Counter Derivatives Markets (2004); Federal Reserve Bank of New York; company annual reports.

Notes: HHI is the Herfindahl-Hirschman Index; BIS is Bank for International Settlements. Estimates for the credit derivatives market are calculated from the U.S. Reporter Survey, company annual reports, and call reports.

Chart 4

BIS Estimates of Concentration in Over-the-Counter Markets



Source: Bank for International Settlements (BIS), Triennial and Semiannual Surveys on Positions in Global Over-the-Counter Derivatives Markets (2004).

Note: HHI is the Herfindahl-Hirschman Index.

Table 3
Concentration Trends in Equity-Linked Over-the-Counter Markets

Market	Average HHI	Growth in HHI (Percent)	Top Two (Percent)
Panel A: Global concentration: BIS surveys, 1998-2004			
Forward, swap, and option			
United States	924	7.44	—
Europe	827	4.30	—
Asia (ex Japan)	2,707	35.88	—
Latin America	5,771	12.81	—
Panel B: U.S. reporters only, 2000-04			
Forward, swap, and option			
United States	2,162	-0.001	53.3
Europe	3,239	-9.65	70.5
Asia (ex Japan)	4,257	25.15	77.6
Latin America	6,976	4.38	96.2

Sources: Bank for International Settlements, Triennial and Semiannual Surveys on Positions in Global Over-the-Counter Derivatives Markets (2004); Federal Reserve Bank of New York; company annual reports.

Note: HHI is the Herfindahl-Hirschman Index; BIS is Bank for International Settlements.

reporters.[13] Concentration in the U.S. OTC derivatives markets is higher, especially for the broader U.S. and European equity-linked markets. For smaller equity-linked markets, such as those in Asia and Latin America, however, concentration measures are comparable because they are essentially dominated by U.S. reporting firms.[14]

3.3 Secondary-Market Trading by Primary Dealers

An important element of liquid securities markets is the extent of secondary-market trading.[15] Table 4 presents concentration measures for the secondary-market trading volumes of

[13]We use a database on large U.S. reporters available from the Statistics Function of the Federal Reserve Bank of New York as well as call report information.

[14]We report the U.S. dealer information here to establish that it is reasonably comprehensive for the global market. In the analysis to follow, we will need firm-level data not provided in the BIS survey. For the interest rate and foreign exchange derivatives markets, we can construct reasonable proxies for firm-level data from data on U.S. reporters and from annual reports of non-U.S. reporters. However, for the equity-linked markets, we are unable to collect sufficiently comprehensive data from these sources; thus, we use the U.S. reporter data.

[15]The primary dealer information (Weekly Report of Dealer Transactions, FR 2004B) is compiled by the Statistics Function of the Federal Reserve Bank of New York.

Table 4
Concentration Trends for Primary Dealers, 1995-2004

Market	Average HHI	Growth in HHI (Percent)	Top Five (Percent)
Treasury securities			
Bills	515	4.88	37.6
Coupons	596	3.44	42.5
TIPS	1,826	11.43	71.9
Other securities			
Mortgage-backed	954	0.39	58.2
Corporate	1,336	-5.76	73.6
Federal agency	694	1.20	45.8

Source: Board of Governors of the Federal Reserve System, Weekly Report of Dealer Transactions (FR 2004B).

Note: HHI is the Herfindahl-Hirschman Index; TIPS is Treasury Inflation-Protected Securities.

primary dealers in several types of securities.[16] Concentration in secondary-market trading of Treasury securities is generally low, with the exception of the Treasury Inflation-Protected Securities (TIPS) market (row 4 of Table 4). However, the relatively high measured concentration in TIPS trading can be attributed to the early dominance of one dealer. With the TIPS market maturing, HHIs declined from 3,500 in 2002 to just below 1,500 by the end of 2004. Mortgage-backed, corporate, and federal agency securities trading also appears to be unconcentrated, with HHIs beneath or just above the

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Department of Justice's "moderately concentrated" range. Actual concentration levels in these securities may be even lower than indicated by the HHIs in the table, since the primary dealer data may not cover the full range of market participants in the trading of these securities.

3.4 Prime Brokerage

An increasingly important business for investment banks and large commercial banks is prime brokerage. Prime brokerage firms essentially service the hedge fund community. Typically,

[16]Primary dealers are banks and securities brokerages that trade in U.S. government securities with the Federal Reserve System.

Table 5
Concentration in Prime Brokerage

	Concentration	
Year	HHI	Top Three (Percent)
2001	2,006.7	65.17
2002	2,093.8	65.61
2003	1,931.2	60.53
Average HHI	2,010.5	
Growth in HHI (percent)	-1.71	

Source: HedgeWorld.com.

Note: HHI is the Herfindahl-Hirschman Index.

they provide hedge fund clients with a variety of services: financing (securities lending, margin lending, or other structured derivatives products), trading and clearing, customer support, and research. The proliferation of hedge funds over the last few years has made prime brokerage a significant source of revenues for banks and other providers.[17]

Concentration measures for the prime brokerage industry in 2001-03 show that the prime brokerage market is more concentrated than the securities underwriting market (Table 5).[18] HHIs are in the "highly concentrated" range, but concentration has remained fairly stable over the three-year period.

3.5 Global Custody

The global custody business involves processing trades across countries and safeguarding and servicing financial assets for a variety of large customers (institutional investors, brokers/dealers, and money managers). Typically, the portfolio of assets held by global custodians for their customers includes bonds, equities such as mutual fund holdings, and derivatives products. With the rapid expansion of financial markets, assets in custody surged from $7.6 trillion in 1994 to $36.3 trillion in 2000 and to more than $52.0 trillion in 2004.[19]

Global custody is a fairly specialized business requiring an international network of subcustodians and expertise in managing a large portfolio of securities denominated in several currencies. Consequently, global custody is dominated by a small number of major banks and specialist providers. The top-five market for global custody during the 1994-2004 period averaged around 76.9 percent. Overall, during this period the market was moderately concentrated, with an average HHI of 1,397.

[17]According to Boston Consulting Group, hedge fund industry revenues in 2003 amounted to $60 billion. The servicing of hedge funds has generated roughly $15 billion in revenue opportunities for prime brokers.

[18]We use the HedgeWorld Service Provider Directory League Tables to derive HHI measures of concentration. The HedgeWorld rankings are based on a large pool of hedge funds tracked by TASS Research.

[19]Our source is *The Global Custody Yearbook*, 2005 Eleventh Annual Survey, Buttonwood International.

4. Market Interdependencies

Thus far, our discussion has centered on the analysis of single markets. However, the probability of distress for a firm and the severity of market disruption may also be affected by interdependencies *across* markets. The emergence of large financial superstores in the late 1990s suggests that financial markets may now be more interrelated. In this section, we examine a variety of evidence on cross-market linkages, finding that these linkages have increased, especially since the late 1990s. This increase has been driven mainly by a growing common set of second-tier firms, rather than by increases in the number of firms with top-five market shares in multiple markets.

As financial markets become increasingly dominated by the same set of financial firms, these firms may also become more and more alike, thus actually increasing the risk of exposure to common aggregate shocks.

Is an increase in cross-market linkages a concern for overall stability? On the one hand, the ability of financial firms to operate simultaneously in several product markets should open up better diversification opportunities, reducing risk and thus the probability of firm distress. On the other hand, the diversification benefits may be spent by undertaking riskier investment strategies, making the overall effect on risk unclear.

Moreover, as financial markets become increasingly dominated by the same set of financial firms, these firms may also become more and more alike, thus actually increasing the risk of exposure to common aggregate shocks. Risk may also be enhanced when the same firms are big providers in multiple markets because alternate suppliers are needed in many places at once. This multi-market presence might potentially strain

alternate suppliers, especially if they themselves are operating in the same multiple markets. On net, firms that are active in multiple markets may be more diversified, but the financial system on the whole may be more vulnerable to firm-specific shocks.[20]

We look at cross-market linkages through two lenses. First, we examine trends in market share correlations—that is, are banks' shares in one market now more or less correlated with their shares in other markets? Second, we examine the extent to which individual firms have high shares across multiple markets and how those shares have changed.

4.1 Correlations of Market Shares

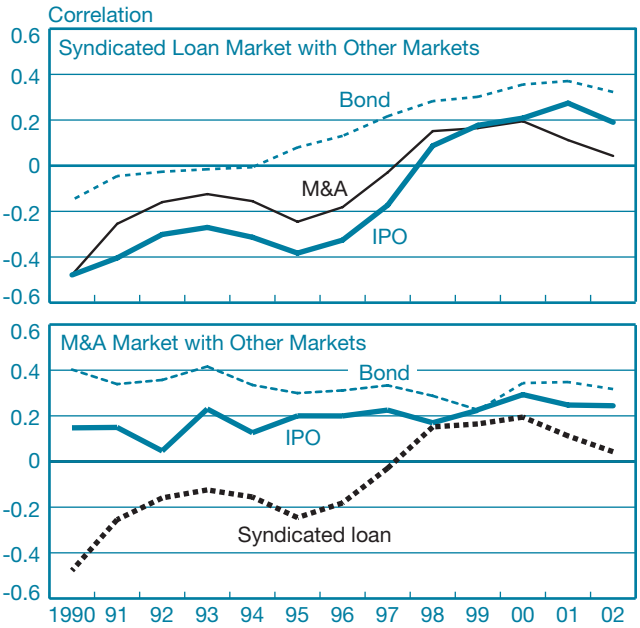
One direct measure of linkages between two markets is the correlation of market shares of individual firms in any two markets. A high positive correlation would signal that firms are likely to have similar market shares in both markets. In fact, market share correlations have increased since the late 1990s, largely reflecting the increased role of commercial banks in underwriting activities.

Charts 5 and 6 plot the market share correlation in selected securities underwriting markets and M&A advisory services from 1990 to 2004. The syndicated loan market has become increasingly more integrated with securities underwriting and M&A advisory services. The key reason for the higher correlation is bank entry; in the early 1990s, most large commercial banks at the top of the syndicated loan market hierarchy were not very active in securities underwriting, but by the end of the 1990s several leading syndicated loan underwriters were heavily involved in investment banking.

The M&A and securities underwriting markets usually have low positive correlations. Generally, correlations among these markets have trended higher, especially after the mid-1990s, indicating that many underwriters have sought to achieve some synergies by operating in both markets. Stronger commercial bank presence is again a catalyst for the rising correlations. However, during this period a number of top-tier investment banks have also made an effort to increase their market shares in financial services.

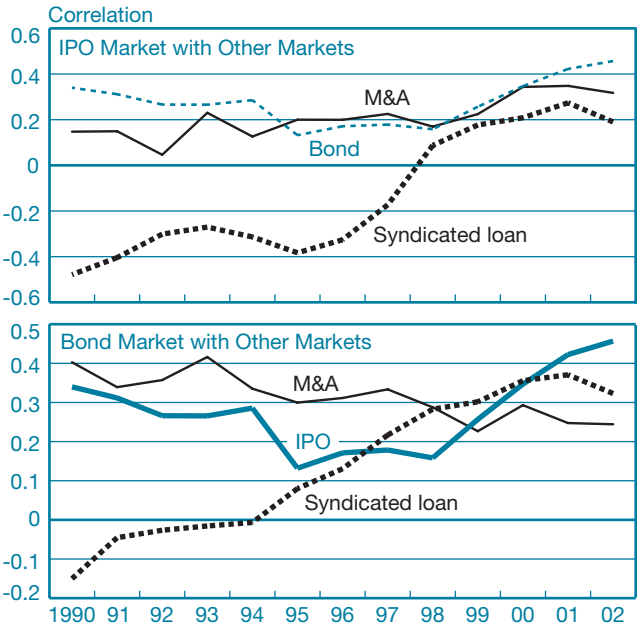
[20]The failures of Drexel and Long-Term Capital Management (LTCM) illustrate the perils of cross-market interdependencies. While Drexel's failure roiled the high-yield-debt market, the broader impact was muted because Drexel was a very small player in other financial markets. In contrast, the collapse of LTCM created widespread concerns among market participants worried about liquidity across several closely integrated financial markets.

Chart 5
Correlation in Market Shares



Sources: Securities Data Corporation; Loan Pricing Corporation.
Note: M&A is merger and acquisition; IPO is initial public offering.

Chart 6
Correlation in Market Shares



Sources: Securities Data Corporation; Loan Pricing Corporation.
Note: M&A is merger and acquisition; IPO is initial public offering.

4.2 The Presence of Large Banks in Multiple Markets

We now consider a second and even more direct measure of market interdependency: the extent to which individual firms have high market shares in multiple markets. We find that the number of firms ranking in the top five (by market share) in multiple markets has not increased since the early 1990s, though the number of firms with multiple top-ten and top-twenty market shares has increased. Taken together, those findings reveal increased linkages across markets through the emergence of more "second-tier" providers, rather than through an increased commonality among "top-tier" providers.

Table 6 presents these findings for four markets: syndicated loan, investment-grade-bond underwriting, equity IPO, and M&A advisory services. Table 7 lists the top twenty firms by market share in each of these four markets in 2004.

The first measure in Table 6 is the number of distinct firms ranking in the top five (by market share) in just one market (top panel, column 1). The maximum possible for this number is twenty—in other words, twenty different firms occupying the top five rankings in the four separate markets. The minimum possible, zero, indicates that the twenty available slots were occupied by firms all with at least two top-five ranking positions, indicating a high degree of (at least pair-wise) dependence across markets. We compute similar statistics for the top ten and top twenty firms (middle and bottom panels of Table 6).

This indicator, however, is silent about the *extent* of the linkages between these markets. Changes in the "single market" count could reflect more firms having high market shares in just two markets, in three markets, or across all four markets. This difference is important because the lower the number of firms that dominate these markets, the higher the degree of interdependency. To this end, we compute additional measures of multi-market interdependency. These indicators count how many firms occupy top-five rankings in at least *two,*

Table 6
Banks Operating in Single and Multiple Markets

Year	In a Single Market	In All Four Markets	In Three or Four Markets	In Two, Three, or Four Markets
	Among the Top Five Banks			
1990	9	0	3	4
1995	7	0	3	5
2000	7	0	3	5
2004	6	0	4	5
	Among the Top Ten Banks			
1990	17	0	5	9
1995	19	1	4	8
2000	9	3	8	10
2004	8	2	8	11
	Among the Top Twenty Banks			
1990	29	1	12	19
1995	36	1	11	16
2000	16	7	13	22
2004	22	8	12	19

Sources: Securities Data Corporation; Loan Pricing Corporation.

Note: The markets are syndicated loan, investment-grade-bond underwriting, equity initial public offering, and merger and acquisition advisory services.

Table 7
Ranking of Top-Ten Firms in Bond Underwriting, Equity IPO, M&A, and Syndicated Loan Markets in 2004

Firm	Bond Underwriting	Equity IPO	M&A	Syndicated Loan
Citigroup	5 (20)	5	10	5 (5)
Lehman	5 (10)	10 (20)	10 (10)	20
J.P. Morgan	5 (20)	10	5 (10)	5 (5)
Morgan Stanley	5 (5)	5 (5)	5 (5)	
Goldman Sachs	5 (5)	5 (5)	5 (5)	20
Bank of America	10	10	20 (20)	5 (5)
Merrill	10 (5)	5 (10)	5 (10)	20
HSBC	10			20 (10)
Barclays	10			5 (5)
Credit Suisse First Boston	10 (5)	10 (5)	5 (5)	20 (20)
Wachovia	20	20		10
Deutsche Bank	20	20	10	5 (10)
ABN AMRO Inc.	20			10
Union Bank of Switzerland	20	5	10	(5)
Paribas Corporation	20			10 (20)
Royal Bank of Scotland				10 (10)
Mizuho Financial Group				10 (20)
Friedman Billings Ramsey		10		
Lazard			10 (20)	

Sources: Securities Data Corporation; Loan Pricing Corporation.

Notes: The values 5, 10, and 20 indicate that a firm was ranked in the top five, top ten, and top twenty, respectively. Figures in parentheses are rankings in 1990; if there is no figure, the firm did not have a ranking in the top twenty that year. IPO is initial public offering; M&A is merger and acquisition.

at least *three,* or even *all four* markets (columns 2-4 of the table). We compute similar statistics for the top ten and top twenty banks, respectively. In contrast with our first measure of multi-market interdependency, an increase in these indicators suggests more interdependency.

As Table 6 shows, the number of independent firms ranked in the top five in the four markets remained constant during the 1990-2004 period. In contrast, there is a reduction in the number of "single market" firms among the top-ten (from seventeen in 1990 to eight in 2004) and, to a lesser extent, among the top-twenty rankings. The other measures offer similar interpretation. Among the top-five rankings, there were

[Our] results suggest that the markets for syndicated loans, bond underwritings, equity IPOs, and M&As became more interlinked between 1990 and 2004.

no significant changes in the number of firms with large market shares in more than one market over time. In contrast, among the top-ten and top-twenty rankings, there was a clear increase in the number of firms that have large market shares in more than one market. Significantly, the largest changes occurred in the number of firms with large market shares in all four markets (among the top twenty) and in the number of firms with large shares in three markets (among the top ten).

These results suggest that the markets for syndicated loans, bond underwritings, equity IPOs, and M&As became more interlinked between 1990 and 2004. This finding is important, because a problem experienced by one of the key players in these markets is now more likely to spread to a larger number of markets. However, given that the new interdependencies emerge among second-tier firms, the disruption arising from a problem in one of these firms is likely to be smaller than what would emerge had the new market linkages arisen among first-tier firms.[21]

5. Prompt Substitution Minimizes Disruptions

Our review of trends in financial market structure yields two main findings. First, while high and rising concentration is not universal, some markets are indeed highly concentrated or increasingly so. Second, financial markets are becoming more interdependent, and the same set of large institutions is increasingly likely to occupy top rankings in several markets.

The stability implications of higher concentration in some markets and increasing interdependence are two-sided. If the firms that dominate a concentrated market or that are spreading across markets are more diversified, then the probability of a given firm's failure should be lower accordingly. In such an event, however, disruptions may be more severe, because the exit of a dominant firm in a concentrated market leaves a bigger hole in that market *and* in any others where that firm was top-ranked.

Whether the failure of a leading financial provider will disrupt the entire market for a given product depends crucially on how quickly users can switch to other providers or products. If clients of the departed leader can readily switch to secondary providers at little extra cost, or if they can substitute a related service, the resulting disruption will be accordingly small. If switching is slow or costly, then disruptions will be more severe.

This section discusses financial product characteristics that tend to speed or slow substitution. We also compare financial markets by two simple indicators of potential substitution: the number of active providers and the turnover in providers' relative rankings. Lastly, we array markets by those indicators and by the level of concentration. Markets with low turnover, indicating less potential for substitution among providers, *and* high concentration may be more susceptible to severe market upheaval in the event of failure by a leading firm than would those markets characterized by high concentration alone. Considering both characteristics together thus may provide more insight than examining concentration in isolation.

5.1 Ready (or Not) Substitution

What determines how readily and cheaply financial market users can switch between producers or products? For the *goods* market, the answer would be tastes. Does the consumer like this product or producer better than another? For financial markets, the speed and cost of substitution depend on a variety of factors.

Substitution will be slower, all else equal, the closer the relationship between the provider and user. Bank loans, especially to small firms, are relationship-intensive compared with the more arm's-length dealing in syndicated loans (to large firms), bonds (especially investment-grade), and stocks. Banks have to learn about a small firm before they lend, and that information gets embodied in the relationship.[22] The same is true with junk bonds; underwriters require detailed knowledge of issuers before they can sell their bonds—

[21] Moreover, the presence of more firms operating simultaneously in these markets may make it easier for one of them to step in and replace the one in trouble, thereby reducing the disruptions due to its exit.

knowledge that could not be instantaneously or credibly transferred to another underwriter (Benveniste, Singh, and Wilhelm 1993). The price of bonds underwritten by Drexel dropped sharply *before* the firm failed, indicating that Drexel's services could not have been replaced easily by other firms operating in the market or by alternative financial instruments

In a fast market, with many transactions occurring over a short period . . . it would be more difficult for other market players to substitute promptly than in a slow market.

(Brewer and Jackson 2000). Relationship-intensive products also tend to be highly tailored to clients, and customization slows substitution. Bank loans to small firms are bespoke products, with pricing, covenants, maturity, and other terms negotiated case by case. Syndicated loans to larger firms are more standardized, and bonds (especially high-grade) and stocks are even more so.

A second determinant of the speed or cost of substitution is the knowledge or technology required to produce or price a particular product. OTC derivatives can require considerable sophistication to value and substantial platforms to manage and market. For instance, a recent Federal Reserve study argues that the complexity of interest rate *options* may hinder substitutability in that market more than in the market for more commoditized OTC interest rate *swaps*, where the risks are linear and noncomplex in nature and the technology to manage them is widely dispersed.[23] Some products also require more intermediation between users and "raw material" suppliers. The knowledge, technology, and relationships needed to make loans, for example, or to underwrite stocks or bonds may be more widely held than those needed to generate a supply of interest rate volatility for an options dealer.

Lastly, the speed and cost of substitution may depend on the duration of the product in question and the "speed" of the particular market. All else being equal, substitution will be slower or costlier the longer the exposure implied by a transaction. For instance, a long-term credit or counterparty relationship implies a longer exposure than a one-off service such as underwriting. The speed of the market—the frequency of transactions and the time required between initiating and consummating a transaction—also affects the speed of substitution. In a fast market, with many transactions occurring over a short period—payments, for example—it would be more difficult for other market players to substitute promptly than in a slow market.

5.2 Comparing Substitutability across Markets

How do the markets we examined rank in terms of potential for prompt substitution? It would be difficult to rank them directly by the various characteristics just discussed, as some products may not be very relationship-intensive yet still very technology-intensive. Instead of applying those characteristics directly, we rank the markets by two simple proxies that should reflect the overall potential for substitution: breadth and turnover. *Breadth* is just the number of firms actively competing in the market. A thicker, deeper market suggests easy entry and plenty of substitutes. A thin or shallow market hints at informational or technological barriers that limit entry and, by extension,

There are significant differences in breadth and turnover across markets.

substitution. *Turnover* is the average change over time in the market share ranking of firms in a given market.[24] High turnover means the leading firms are not entrenched and that users are in fact switching between providers. Low turnover suggests some friction—relationships or technological barriers—that limits substitution among providers.

There are significant differences in breadth and turnover across markets (Table 8). At one end, securities underwriting markets are very deep and have relatively high turnover. The numbers for market breadth may not fully capture the extent of likely substitution, however, since small or midsize underwriters may not be able to substitute for top-tier firms. That said, the fairly high level of the top-five ratios in underwriting and financial services markets (Table 1) suggests the presence of several interchangeable top-tier underwriters. The turnover figures also suggest considerable movement in the hierarchy

[22] A study by Polonchek, Sushka, and Slovin (1993) finds that when a bank is on the verge of failure, the values of its borrowers rise and fall with the prospects of the bank, precisely because investors know that firms may not readily switch banks.

[23] Board of Governors of the Federal Reserve System (2005).

[24] Algebraically, turnover can defined by $\sum_i \omega_i |\Delta r_i|$, where Δr_i represents the change in the ranking of the firm (i) in two consecutive years. The change is measured in absolute value, so any moves up and down will not cancel out. Also, turnover is weighted by ω_i (based on a firm's asset size), so a move from rank one to rank two counts substantially more than a move from rank fifty to rank fifty-one.

Table 8

Estimates of Substitutability for Financial Markets

Market	Breadth: Number of Participants	Turnover: Average Change in Rank
Securities underwriting (1990-2004)		
Initial public offerings	100	4.03
Seasoned offerings	60	3.64
Investment-grade bonds	40	1.95
High-yield bonds	30	2.54
Merger and acquisition advisory services (1990-2004)	100	5.89
Syndicated loan (1990-2004)	40	3.10
Derivatives (2000-04)		
Interest rate	40	2.21
Foreign exchange	40	1.57
Credit	40	1.63
Prime brokerage (2001-03)	35	0.69
Global custody (1994-2004)	20	0.87
Primary dealer (1995-2005)		
Treasury bills	21	3.67
Coupons	21	2.15
TIPS (1999-2005)	21	2.79
Corporate securities (2002-05)	21	1.35
Mortgage-backed	21	2.43
Federal agency	21	2.44
Mean turnover, all markets		2.50

Sources: Securities Data Corporation; Loan Pricing Corporation; Board of Governors of the Federal Reserve System, Weekly Report of Dealer Transactions (FR 2004B); Buttonwood International, *The Global Custody Yearbook*; Bank for International Settlements, Triennial and Semiannual Surveys on Positions in Global Over-the-Counter Derivatives Markets (2004); HedgeWorld.com; company annual reports.

Notes: Estimates of market breadth represent the approximate number of firms that are actively participating, and collectively account for most of the business in each market. The turnover measure is weighted by market share. Periods in parentheses indicate the sample over which estimates are derived. Estimates for derivatives markets are calculated from the U.S. Reporter Survey, company annual reports, and call reports. TIPS is Treasury Inflation-Protected Securities.

of underwriters over time, some of which can be attributed to bank entry, as noted above. The high turnover ratios in the M&A advisory services and syndicated loan markets also signify major changes in the hierarchy of top-tier underwriters. Overall, high breadth and turnover in these underwriting markets suggest the potential for reasonably fluid substitution.

Turnover in secondary-market securities trading by primary dealers is also relatively high. The exception is trading in corporate securities, where the turnover figure is about half that for many of the other security types, perhaps reflecting less-than-full coverage of all market participants in these data. The breadth measures are perhaps somewhat less relevant for these markets, as primary dealer status is regulated by the Federal Reserve. As noted above, the primary dealer data may not cover the full range of participants in these activities for non-Treasury securities.

In contrast with underwriting, M&A advisory services, and trading, turnover in the derivatives markets is considerably lower. To calculate the breadth and turnover numbers for these markets, we combine detailed data on U.S. participants with data derived from annual reports for major non-U.S. dealers.[25]

In contrast with underwriting, M&A advisory services, and trading, turnover in the derivatives markets is considerably lower.

The resulting figures combine activity across several derivatives products (swaps, options, and forwards) by the nature of the underlying instrument (FX, interest rate, and credit derivative). Although the markets are arguably distinct across some of these product types, we view the aggregate turnover figures as reasonably representative of the submarkets.

As intermediaries between sellers and buyers of options or swaps, top-tier derivatives dealers require ready and steady access to financial instruments (for example, callable debt or structured notes) or investors and clients (hedge funds) to facilitate these complex transactions. Top-tier derivatives dealers are required to commit significant investments and resources to building the infrastructure and maintaining these important trading relationships. Consequently, the exit of a large derivatives dealer would probably require a concerted effort by other top-tier dealers to fill the gap.[26]

The turnover ratio in prime brokerage during the 2001-03 period is also significantly lower than it is for underwriting markets. This low estimate reflects the continued dominance of just a few firms. However, the recent boom in hedge funds has encouraged more aggressive entry in the industry, as evidenced

[25]The global data from the BIS survey are available only in aggregate form, not on the firm-by-firm basis needed to calculate our turnover measure. While the BIS survey focuses on OTC products, it is not always possible to separate out OTC and exchange-traded derivatives from the annual reports. Thus, the reported turnover and concentration measures for interest rate and FX may include both OTC and exchange-traded products.

[26]For a full discussion of tiering in the OTC U.S. dollar interest rate options market and a discussion of the structure of that market more generally, see Board of Governors of the Federal Reserve System (2005).

by the 5 percent decline in the market share of the two largest firms, mostly captured by commercial bank competitors.

The low turnover scores in derivatives and prime brokerage markets are not surprising, because they do not meet the prompt-substitutability criteria outlined earlier. These markets rely heavily on client relationships that are often built over a number of years. OTC derivatives products and prime brokerage services are continually evolving to meet the changing needs of the financial community and clients. Both markets require an extensive infrastructure to satisfy their sophisticated customers. As we discussed, OTC dealers have to commit significant resources to building and maintaining a trading infrastructure. Similarly, in prime brokerage hedge fund clients require integrated products and services that encompass trading in complex financial assets, financing (margin and securities lending), and customer support services.

5.3 The Concentration-Substitution Dimension

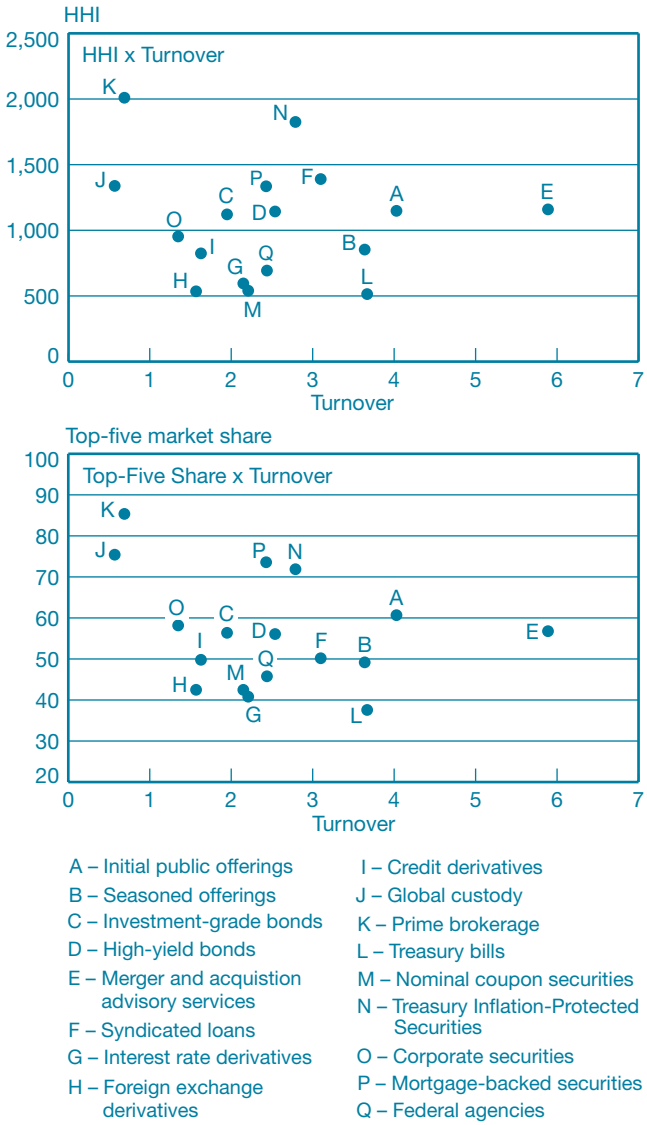
The potential for market instability depends not just on concentration, we have argued, but also on the potential for prompt substitution. To summarize these potential determinants of instability, we use a graphical approach to classify markets based on concentration and turnover. Although this approach lacks the specificity that detailed case studies of individual markets might offer, it has the advantage of being easy to calculate using available market share information for a wide number of markets. Thus, we argue, it is a useful first-cut indicator of the likely severity of market disruption that can be used to rank markets and prioritize resources for further investigation.

The resulting concentration-substitution comparison is given in Chart 7. The chart arrays the seventeen markets we have examined by our measure of market turnover (along the x-axis) and by two different measures of market concentration (along the y-axis). The first measure of concentration is the HHI, which summarizes the overall degree of concentration in each market. The second measure is the market share of the five largest firms in the market. Empirically, the two measures are correlated. However, the top-five market share measure may help us identify markets where the largest participants have very large market shares, even if the overall market appears not to be highly concentrated based on the HHI.[27]

As it turns out, the results from the two different concentration measures are quite similar. The figures show no systematic relationship between concentration and turnover.[28]

[27]This could happen if one or two firms had large market shares but there were many other small competitors.

Chart 7
Market Concentration and Turnover



A – Initial public offerings
B – Seasoned offerings
C – Investment-grade bonds
D – High-yield bonds
E – Merger and acquistion advisory services
F – Syndicated loans
G – Interest rate derivatives
H – Foreign exchange derivatives
I – Credit derivatives
J – Global custody
K – Prime brokerage
L – Treasury bills
M – Nominal coupon securities
N – Treasury Inflation-Protected Securities
O – Corporate securities
P – Mortgage-backed securities
Q – Federal agencies

Sources: Securities Data Corporation; Loan Pricing Corporation; Board of Governors of the Federal Reserve System, Weekly Report of Dealer Transactions (FR 2004B); Buttonwood International, *The Global Custody Yearbook*; Bank for International Settlements, Triennial and Semiannual Surveys on Positions in Global Over-the-Counter Derivatives Markets (2004); HedgeWorld.com; company annual reports.

Notes: The chart plots the measure of market turnover by two different measures of market concentration for the seventeen markets examined in this article. HHI is the Herfindahl-Hirschman Index.

A possible objection to our analysis might be that a market with a naturally high level of turnover is also a market where the dynamics of entry and exit are such that one would never

[28]The correlations between turnover and the top-five market share and HHI variables are negative but not statistically significant.

observe a high level of concentration (the substitutability indicates low barriers to entry and hence low incumbent advantage). That we do not observe any relationship indicates instead that the two market characteristics convey independent information on market stability.

Focusing on market-specific patterns, Chart 7 also indicates that relatively few markets appear to be in the potentially unstable neighborhood of high concentration and low turnover (the upper-left-hand regions). Among the markets we examine, prime brokerage and global custody tend most strongly to fall into this region. While some other markets have relatively low turnover (for example, the FX, interest rate, and credit derivatives markets), they have low concentration, even when the markets are split into the more disaggregate subcategories by product type. Two other markets with somewhat high concentration—the mortgage-backed-security (MBS) and TIPS primary dealer markets—also have relatively high turnover. It is not unusual initially to observe higher concentration in newly created markets such as the TIPS and MBS markets. As the markets have matured, concentration has come down with the entry of additional primary dealers.

By focusing solely on market concentration, one misses important factors influencing market stability.

As this simple example suggests, more detailed analysis is necessary to understand the true stability characteristics of particular markets. Such analysis could include examining trends in concentration, considering additional measures of concentration and market substitutability, and conducting descriptive case studies of individual markets.[29] In our view, the basic analysis in Chart 7 is not sufficient to draw strong conclusions about individual markets in the absence of more detailed study. Instead, our point in presenting the chart is that by focusing solely on market concentration, one misses important factors influencing market stability. In particular, understanding the extent to which prompt substitution can take place is a crucial second factor in assessing financial market stability.

6. Conclusion

Our review of the literature shows that, theoretically, higher concentration may either increase or decrease the probability of a firm leaving the market as a result of distress. However, anecdotal evidence, and common sense, indicates that the market disruption generated by such an event would be more *severe* in concentrated markets. Hence, even if concentration were to reduce firms' incentives to take risk and thus the potential for distress, public oversight would still be justified.

We find that market concentration has *not* followed a universal upward trend: concentration has increased in some markets and fallen in others. Markets have become more interdependent, it seems, as the same small set of financial firms has become more dominant across multiple markets. We argue that the risk or severity of financial instability depends not just on concentration, but also on whether other firms can *promptly substitute* for an exiting firm. By examining the concentration-substitution dimension, we are able to identify potentially problematic areas where the exit of a large player might exacerbate financial instability.

What does our analysis say about the role of policymakers? If the severity of disruptions is limited by the availability of ready substitutes, what can or should policymakers do to enhance substitution? The answer depends on those factors that limit substitution in the first place. If close relationships are the limiting factor, *laissez-faire* may be optimal. Financial relationships are delicate, dynamic, and sometimes implicit contracts that are probably hard to improve from the top down. However, if the drag on substitution is customized products, policymakers might help in efforts to standardize. Standardization is a public good or externality, so public officials are right to lead efforts in that direction.[30] The recent initiative to remove the backlog of uncleared derivatives transactions and to hasten future clearing appears to be a good step. Policymakers may also have a say when the friction that limits substitution is some technological barrier; if privileged access to a key trading or pricing platform entrenches dominant providers and limits the choices of users, policymakers clearly have a legitimate interest to ensure both stability *and* competition.

[29] See Board of Governors of the Federal Reserve System (2005) for an example of a detailed market study—in this case, that of the OTC markets for U.S. dollar interest rate options.

[30] All producers might gain from standardization, but no individual producer may have an incentive to lead and coordinate standardization initiatives.

Appendix: Price Stability and Market Concentration—Econometric Strategy

We describe our investigation of the link between price stability and market concentration. The analysis focuses on investment-grade bonds and syndicated loans because pricing information is more transparent in these two markets. Information on corporate bond issuance was obtained from the Thomson Financial Securities Data Corporation database. The final sample of bond issues excludes convertible issues and offerings by financial companies. The Loan Pricing Corporation DealScan database provides extensive information on syndicated loans granted to large and midsize corporations.

The price of an investment-grade bond at issue is defined by its credit spread (yield to maturity minus a comparable-maturity Treasury yield). Similarly, for syndicated loans the price is measured by the credit spread over LIBOR. The relationship between price stability and concentration is derived from a two-step estimation procedure. Let y_{ti} represent the bond (or loan) spread for firm (i) at time (t). In the first stage, the credit spread is regressed on a set of explanatory variables defined by the vector $x_{ti\bullet}$. In particular,

$$y_{ti} = \alpha_t + \beta x_{ti\bullet} + u_{ti}. \tag{A1}$$

The initial price of corporate bonds or syndicated loans is primarily determined by borrower and deal characteristics represented by $x_{ti\bullet}$ and macroeconomic conditions measured by the time-varying parameter α_t. In the case of bonds, $x_{ti\bullet}$ includes the Standard and Poor's (S&P) rating and firm size to capture the creditworthiness of the issuer. The bond price regression also controls for issue characteristics that are normally expected to affect the price of the security. In particular, we control for bond maturity, coupon rate, callability, sinking fund provisions, subordinate debt, and 144a issues.

In the case of loans, $x_{ti\bullet}$ includes both a set of firm-specific variables and loan-specific variables. Included in the former set are proxies for the overall risk of the firm, such as its age and sales; proxies for the risk of the firm's debt, such as the firm's profit margin, its interest coverage, leverage, and earnings volatility; and proxies for the losses the firm's debt holders can incur in the event of default, such as the firm's tangible assets and the firm's net working capital (current assets less current liabilities) divided by total debt. The regression controls for the firm's growth opportunities and its sector of activity. We also control for loan-specific variables, including controls for the purpose of the loan and for the type of loan contract; controls to distinguish, among other things, loans that are senior, those that are secured, and those that have a guarantor; and information on the maturity of the loan, its size, and variables to control for the size of the loan syndicate.

The first-stage regression residual measure $\hat{u}_{ti}$ represents the portion of the credit spread not explained by fundamentals. This component includes all the idiosyncratic shocks that may affect the issue markets. In the second stage of the estimation, we use the squared residuals $\hat{u}_{ti}^2$ to construct a measure of price instability. This quality-adjusted volatility measure is next regressed on the annual Herfindahl-Hirschman Index (HHI) of market concentration,

$$\hat{u}_{ti}^2 = \gamma_0 + \gamma_1 HHI_t + \gamma_2 HHI_t^2 + \varepsilon_{ti}. \tag{A2}$$

Essentially, equation A2 asserts an additive form of heteroskedasticity on the error structure of the price equation A1. To obtain asymptotically efficient estimators, we use an iterative procedure described in Kmenta (1986).

The results of the first-stage estimation are not reported in this article. As expected, in the case of bonds the S&P rating is the most significant variable impacting bond spreads. A one-notch increase in the S&P rating (for example, from BBB to BBB+) lowers the spread on investment-grade bonds by roughly 12 basis points. Callability and bond maturity are also important factors increasing the costs to bond issuers.

The coefficients for the control variables in our model on loan spreads are generally consistent with what we would expect. Older and larger firms, as well as firms with more tangible assets, pay significantly lower spreads. The market-to-book ratio comes in strongly negative. Our proxies for default risk have their expected signs, and all but profit margin is strongly significant. The statistical insignificance of profit margin is likely due to the inclusion of interest coverage in our model. Our loan-specific controls are also generally consistent with our expectations. In contrast to the purpose of the loan, which appears to play only a limited role in the loan interest rate, the type of loan contract is important in this regard. Credit lines, for example, carry lower interest rates than do term loans and bridge loans. The other loan controls show that

larger loans and loans extended by larger syndicates have lower spreads. Loan features that increase loan safety (dividend restrictions, secured interests, guarantors, and sponsors) generally have positive effects on spreads. This finding is consistent with the well-established result that banks tend to require these features for riskier credits. Finally, longer term loans have lower spreads, but the effect is not statistically significant.

Regarding the second stage of our method, we find that the estimates for the parameter vector (γ_0, γ_1, γ_2) of the additive specification are significant for both investment-grade bonds and syndicated loans. Chart 1 illustrates more clearly the nonlinear volatility-concentration relationships for investment-grade bonds and syndicated loans estimated from the second-stage equation A2.

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