Does Financial Innovation Enhance or Inhibit Real Innovation?☆

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Abstract

We present evidence that financial innovation plays a role in increasing the level of real innovation. We focus on non-financial firms' innovation performance, measured by patent-based metrics, and employ an exogenous change in the market for over-the-counter (OTC) derivatives in 1987. Distance from financial centers is used as an instrument for the likelihood of derivatives use. We find that firms with higher likelihood of derivatives usage innovate more and have higher quality of innovations. The relationship is stronger for firms with ex-ante more volatile cash flows and returns. This evidence shows that risk management has real consequences on firms' innovation.

Keywords: Innovation, Derivatives, Distance, Risk management

JEL: G31, G32, O31

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1. Introduction

The last four decades have witnessed a wave of financial innovation. Merton Miller wrote in 1986 that the last 20 years in American financial history had been unprecedented in terms of the extent of financial innovation.[1] Since then, financial markets have continued to produce an ever-increasing number of innovative products. Financial derivatives account for a large part of this market. The Bank for International Settlements reports that the total market value of over-the-counter (OTC) derivatives in June 2016 was US $20.7 trillion.

Theoretical arguments exist both, in favor of and against the use of financial innovation. Merton (1992) argues that financial innovation is the growth engine behind real economic growth. New financial securities help entrepreneurs raise capital which may not be forthcoming from traditional financing routes such as equity or debt capital. This increases the funds available for firms' investing, which in turn has a positive knock-on effect on the growth of new innovation and the spread of existing innovation.[2] To the contrary, Gennaioli et al. (2012) claim that financial innovation can increase the volatility of financial markets. In addition, financial innovation is being criticized for being one of the causes behind the global financial crisis of 2007-08.

A major challenge faced by the empirical literature is that innovation, both financial and "real" (or manufacturing), are likely to be endogenous with company and market characteristics. Thus, a correlation between derivatives market characteristics and innovation may tell us little about the causal effect of financial innovation on real innovation. While previous literature has shown that venture capital and private equity (Kortum, and Lerner (2000), Lerner, Sorensen, and Stromberg (2011)), and increase in banking competition (Amore, Schneider, and Zaldokas (2013), Chava et al. (2013)) foster innovation, the effect of financial

[1] Miller, M.H. (1986), "Financial Innovation: The Last Twenty Years and the Next", Journal of Financial and Quantitative Analysis.

[2] Alternatively, the effect could even be reversed wherein high-value projects create demand for more efficient financial securities which then arise endogenously (Michalopoulos, Laeven and Levine (2015)).

derivatives on technological progress has not been investigated. To bridge this gap in the empirical literature we exploit the introduction of a standardized, legal document for trading OTC financial derivatives in 1987 as a natural experiment. We argue that this introduction was an exogenous shock to the costs of hedging using such derivatives.

In 1987 the International Swaps and Derivatives Association (ISDA) introduced the Master Agreement which led to the reduction in transaction costs, legal fees, and expected default costs when trading currency and interest-rate OTC derivatives contracts.[3] Using a hand collected panel dataset of 1,877 U.S. firms, we estimate that the users of derivatives innovate more in the post-1987 period as compared to non-users. The results are robust after we control for firm characteristics such as firm size, leverage, profitability, tangibility, industry concentration, and age. We also control for time-invariant firm-level characteristics (using firm fixed effects), and economy-wide shocks (using year fixed effects), and confirm that our results are statistically and economically significant. Users of derivatives have, on average, more than 20% more patents compared to non-users in the post-1987 period. The difference between users and non-users of derivatives is even higher when we test for the quality of innovation, measured by the number of citations to granted patents.

Given that the 1987 ISDA Master Agreement reduced the costs of hedging, we expect to find that firms that were involved in risk management (users of derivatives) benefited more, and increased their real innovation output. However, we also know that users of derivatives may have unobservable differences from non-users of derivatives. These unobservable differences may drive both their derivatives usage policy and their innovation output, thereby, leading us to the incorrect conclusion of a causal impact of derivatives usage on innovation. To address this endogeneity concern, we introduce an instrumental variable for derivatives usage.

[3]Refer to Flanagan S. (2001) for institutional details related to agreements for OTC derivatives and costs of drafting such agreements.

We use the distance of firm headquarters to the nearest financial center as an instrument for derivatives use. The location of headquarters is relevant for our analysis because most important financial decisions, such as hedging, are finalized there (Servaes, Tamayo, and Tufano (2009)). Further, previous literature has argued that financial centers are efficient, centralized locations for lending, clearing of payments, and quick and easy access to the knowledge and services of complementary and competitive institutions (Reed (1980)). Intuitively, we expect that firms which have headquarters closer to financial centers and derivatives dealers, are more likely to use derivatives compared to firms headquartered farther away. Given that currency derivatives were traded predominantly in OTC markets, we argue that proximity to dealers or investment banks enables access to derivatives. Following previous literature, we define financial centers as cities with the maximum number of bank branches of the world's top 300 commercial banks in 1985.[4]

For the instrument to be valid, it needs to satisfy the exclusion restriction, that is, the instrument should affect innovation activity only through the derivatives usage choice. Existing research on the geography of innovation has documented that innovative firms tend to cluster in urban areas due to the availability of labor, the mobility of labor, and the presence of other small, innovative firms (Doms et al. (2010), Glaeser et al. (2010), Kerr (2010)). However, our measure of distance is only marginally correlated with distance from an urban area or a city. Our measure of distance captures the proximity to providers of derivatives (and also, providers of capital) but does not coincide with proximity to labor and other small, innovative firms. In other words, firms in large urban areas are as likely to be in the first quartile as they are to being in the fourth quartile based on our measure of distance.

To test for the importance of derivatives use on innovation, we focus on firms which

[4]Choi et al. (1986) find fourteen financial centers and rank them based on the number of bank branches in 1975 and 1985. We use the list of financial centers in 1985 in our main analysis.

have a record of innovation. These firms are more likely to alter their innovation policy as compared to firms which have no historical record of innovation. We report three main findings. First, we find that longer distance to financial centers leads to lower currency derivatives usage after 1987. This evidence is in line with the existing literature that finds a positive relationship between distance and funding (Giround (2012), Bernstein, Giroud, and Townsend (2016)). We investigate whether this result can be explained by the well-known size phenomenon in risk management: larger firms are more likely to use derivatives.[5] Our placebo test using size quartiles, as opposed to distance quartiles, shows no evidence in favor of the size argument.

Second, we show that currency derivatives use leads to a large and statistically robust increase in innovation. This result is stronger for firms with ex-ante more volatile cash flows and returns, firms which are more likely to benefit from risk management. Using IV specifications, we confirm that the use of currency derivatives leads to higher patents and citations in the following year, and two and three years after the current year.

Finally, we try to establish the channel behind the relationship. In our first test we investigate whether ex-ante exposure to foreign exchange shocks is the channel that explains the relationship between derivatives use and patenting activity. We categorize firms as more exposed based on their pre-1987 cash flow sensitivity to foreign currency; equity returns sensitivity to foreign-exchange index; and standard deviation of equity returns. We find evidence that firms which are more likely to hedge (those with higher ex-ante exposure), benefit more from the lower costs of hedging after the shock.

In a second test we examine whether our measure of distance could, potentially, be a proxy for access to capital. If easier access to capital was a channel through which the derivatives use affects innovation, we expect to see the effect to be more prevalent in firms

[5]A number of papers have documented a strong positive correlation between firm size and derivatives use (Nance, Smith and Smithson (1993), Geczy, Minton and Schrand (1997), Rampini, Sufi and Viswanathan (2014) among others).

that have banking relationships. We identify firms to have a banking relationship if they had raised a syndicated loan before 1987, or if they had a long term credit rating prior to 1987. However, we do not find support for the above hypothesis. On the contrary, we find that the positive effect of derivatives use on innovation occurred primarily among firms which do not have a banking relationship.

In our third test we study whether financial constraints are the channel behind the derivatives-innovation relationship. The use of derivatives may reduce the financial constraints of firms by reducing the volatility of expected future cash flows. Using three alternative measures of financial constraints, the Kaplan-Zingales index, cash/assets ratio, and property, plant and equipment to assets ratio, we classify firms as financially constrained, or unconstrained. The results provide some evidence in favor of the financial constraints channel. Overall, we find evidence that derivatives use has a significant impact on innovation. Firms that use derivatives are able to reduce cash flow fluctuations and lower firms' financial constraints. Our results suggest that by reducing the risk of existing, traditional investment projects, firms generate more stable cash flows and divert more internal resources to innovative projects.

Our paper contributes to two strands of literature. First, the paper is related to the real effects of hedging and derivatives use. A significant body of empirical literature studies how firms use derivatives. Examples include broad cross-sectional analyses (Nance, Smith and Smithson (1993), Mian (1996), Geczy, Minton, and Schrand (1997), Graham and Smith (1999), Guay (1999), Allayannis and Ofek (2001), Graham and Rogers (2002), Guay and Kothari (2003), Bartram, Brown and Fehle (2009), Bartram, Brown and Conrad (2011), Bretscher et al. (2016)), as well as specific industries such as gold mining (Tufano (1996), (1998), and Petersen and Thiagarajan (2000)) and the oil and gas industry (Haushalter (2000), Jin and Jorion (2006), Doshi et al. (2015)). A number of papers provide evidence that firms indeed use derivatives to hedge certain exposures and, thereby reduce future constraints on profitable investment opportunities. Perez-Gonzales and Yun (2013) document that energy utilities are able to use weather derivatives to reduce distortions in future investments. Campello et al. (2011) find that hedgers pay lower interest rate spreads and are less likely to face restrictions on capital expenditures. In this paper, we choose to focus on another aspect of growth which may be affected by firms' usage of derivatives. We look at manufacturing or "real" innovation carried out by firms and examine whether derivatives usage by firms affects innovative activity.

Second, our paper contributes to the literature on finance and innovation. This literature studies the effect of market characteristics including banking deregulation (Cornaggia et al. (2015), Amore, Schneider, Zaldokas (2013), and Chava et al. (2013)), bankruptcy laws (Acharya and Subramanian (2009)), labor laws (Acharya, Baghai and Subramanian (2013), and (2013)), competition (Aghion et al. (2005)), credit markets (Hsu, Tian and Xu (2014)), banking relationships (Hombert and Matray (2016)), and liquid options markets (Blanco and Wehrheim (2016)) on innovation. We add to the evidence on capital market constraints and innovation by providing evidence of a new channel behind our findings, i.e., risk management and its effect on innovation.

The rest of our paper is organized as follows. Section 2 describes some institutional details of the OTC derivatives markets and the ISDA Master Agreement. Sections 3 and 4 describe the empirical methodology and data, respectively. Section 5 examines the impact of derivatives use on innovation using a naive regression of usage on innovation. Section 6 presents the main results of the paper, examining the impact of currency derivatives on innovation, and robustness tests. Section 7 examines potential channels through which derivatives can affect firm innovation. Section 8 concludes.

2. Over-the-Counter Financial Derivatives

Derivative markets exist because of high trading (or other related) costs or trading restrictions in the market for the underlying asset. Derivatives are traded either on organized exchanges or over-the-counter. OTC derivative contracts are privately negotiated contracts between two parties. Exchange-traded contracts are standardized contracts executed over an exchange such as the Chicago Mercantile Exchange (CME), the world's largest derivatives exchange.

The key advantage of OTC contracts is the unlimited flexibility in designing the contract. One of the main disadvantages of OTC contracts is that both the buyer and the seller must spend time and effort in identifying each other. Another disadvantage of OTC contracts is credit risk, or the possibility that the counter-party will renege on future contractual obligations. In order to deal with these disadvantages, the early derivatives trades were mostly carried out on organized exchanges.[6] From the late 1800s to the early 1980s, the majority of derivatives trading continued to take place over such exchanges. The growth of the OTC derivatives market began in the 1980s with the formation of the International Swaps and Derivatives Association.

A notable measure is the size of the OTC derivatives market compared to the exchange-traded derivatives market. One of the earliest reports by the Bank for International Settlements shows that the notional amount of OTC contracts outstanding in June 2000, was US $94.04 trillion. Thus, OTC contracts represented close to 87% of the gross notional amount on all derivatives contracts.

2.1. International Swaps and Derivatives Association Master Agreement

A typical OTC derivative contract starts with a telephone call between two parties (or brokers, if any are involved) in which the basic economic terms, such as delivery quality, quantity, location, date and price are established. Requirements for credit support, such as collateral requirements, margin and/or guarantee requirements are also established. One party prepares and issues a letter, or historically telex, to the other party which describes

[6]The first derivatives exchange, the Chicago Board of Trade (CBOT), was formed in the United States in 1848. The earliest derivatives contracts on the CBOT were forward contracts on bushels of corn. Refer Whaley (2006) for a history of the development of financial derivatives markets.

the economic terms of the oral agreement and asks for a confirmation in reply. The letter or telex, usually, states that the terms are intended to be binding agreements.

Although the parties intend the initial exchange of terms to constitute binding agreements, these initial agreements do not necessarily contain all the non-economic provisions that most parties require for arrangements that may last over many years in the future. Examples of non-economic provisions include representations and warranties, covenants, events of default, consent to jurisdiction and closing documents. Initial agreements also do not contain provisions for netting of swap payment obligations. These non-economic provisions were first put together into one agreement, the "Master Agreement", in 1987 by the International Swaps and Derivatives Association (originally the International Swaps Dealers Association), which made all future transactions between two parties relatively simple.

There are a number of reasons to believe that the release of the 1987 Master Agreement came as a surprise to most, if not all, market participants. ISDA began as an informal swap documentation project undertaken by eleven financial institutions. In 1984, a meeting between these eleven institutions was organized to discuss the development of documentation standards to reduce the amount of time and effort spent by swaps dealers in renegotiating non-economic contractual terms. This initial attempt to draft a standard agreement failed.[7] After the initial failure, the group focused on developing standard definitions for terms commonly used in swap agreements. When the definitions were finalized, the group of financial institutions created ISDA as an entity to release the definitions document and hold the copyright. In the early years of ISDA, membership in the organization was limited to swaps dealers only. The membership was expanded to include law firms, accounting firms and end-users of derivatives only in later years. Thus, the internal workings of ISDA was known to a handful of market participants. End-users of derivatives such as non-financial

[7] Refer Flanagan (2001) for details of the issue related to the drafting failure. The author documents facts based on interviews with lawyers from Cravath, Swaine and Moore, who were and continue to be ISDA's primary United States counsel.

corporations were not members and would have information about legal documents only to the extent that they have existing relationships with derivatives dealers.

The initial drafting of definitions was done by ISDA members based in New York, who continued to publish new and updated definitions until early 1987. In 1987, ISDA members based in London started working on a standard agreement. Most of the members in New York were not part of this exercise. In the spring of 1987, the Master Agreement was released. Given the recent failure to draft a common agreement and the unresolved disagreement across members in New York, the release of the Master Agreement came as a surprise to most members.

The 1987 ISDA Market Agreement changed the ease of entering into and executing OTC transactions, which brought about a surge in the market for OTC derivatives. Essentially, this agreement set up the terms (representations and warranties, obligations, definitions, events of default among others) that the parties will include in any future transactions. In addition, the ISDA Master Agreement allowed for netting payments among all transactions made under the agreement between the parties (called "cross-transaction payment netting"). This reduced transaction costs since numerous swap payments were incorporated into a single payment. Overall, the ISDA Master Agreement brought many benefits, to the parties using interest-rate and currency derivatives, including a reduction in transaction costs, lower legal fees, less legal risk, and reduced default risk.[8,9]

[8] "The transaction costs are reduced because the parties as a whole make fewer payments. The legal fees are lower because there is less drafting and consequently fewer reviews of contracts. The legal risk is less because the contract forms are carefully drafted and updated in response to litigation and regulatory developments. The default risk is reduced because of close-out netting." Flanagan S., 2001, Harvard Negotiation Law Review.

[9] Initially the 1987 ISDA Master Agreement applied to interest-rate derivatives and currency derivatives, but in 1992, the agreement was modified to account for all derivatives including those with equity, equity indices and commodities as underlying assets.

3. Methodology

The main test evaluates whether an exogenous change in the market for financial innovation leads to a change in real innovation. We use the introduction of the ISDA Master Agreement in 1987 as an exogenous shock to the market for financial innovation.

The "naive" regression specification is the following:

$$y_{it} = \alpha + \beta \cdot user_{it} \cdot post_t + \beta_i \cdot user_{it} + \beta_t \cdot post_t + \beta_X \cdot X_{i,t-1} + \epsilon_{it} \tag{1}$$

where, subscript it denotes observation for firm i in year t. The independent variable, y_{it} is the measure of innovative activity for firm i. The variable, $user_{it}$ is a dummy variable that takes the value one if firm i reports using currency derivatives in year t and zero otherwise and $post_t$ is a dummy variable that takes the value one if the year of observation is after 1987 and zero otherwise. The $X_{i,t-1}$ is the vector of lagged firm characteristics. It also includes macroeconomic variables which affect average patent numbers in the country.

In terms of inference, if we are to obtain unbiased estimates of β then we must be sure that the usage of derivatives is uncorrelated with other determinants of patents and citations. However, we know that both patents count and derivatives usage is correlated with size and investment opportunities. Whenever, the decision to use derivatives is endogenous, OLS based measures of the coefficient β are biased. In this paper, we use both time-series and cross-sectional variation in derivatives usage to overcome these concerns. Because the ISDA Master Agreement was introduced in 1987, we argue that this introduction is an exogenous change in the time-series variation in the costs of hedging currency and interest-rate risks. In addition, we expect that derivatives usage will disproportionately affect firms that were "closer" to the sellers of derivatives in 1987, irrespective of innovative opportunities or innovation policy post-1987. We use physical distance of the firm's headquarters to the nearest financial center as an instrument for expected derivatives usage in the post-1987 period.

Based on existing literature, we define the list of the world's largest financial centers in 1985. Choi et al. (1986) compile a list of fourteen cities across the world with the largest number of bank branches of the world's largest 300 commercial banks. The authors argue that these financial centers are efficient, centralized locations for financial services providers, derivatives dealers and commercial banks included. We obtain the physical distance of the firm headquarters to the nearest financial center, which is a measure of the direct point-to-point aerial transit path, or the distance "as the crow flies".

Formally, the first-stage of the 2SLS-IV specification is given by:

$$user_{it} = b \cdot dist_i \cdot post_t + b_t \cdot post_t + n_i + a_X \cdot X_{i,t-1} + e_{it} \tag{2}$$

where $dist_i$ measures the distance of the headquarters of firm i from the nearest financial center. This variable proxies for the potential ease of availability of derivatives to the firm after 1987. The variable, $post_t$ is an indicator variable that takes the value of one for the years after 1987, n_i are firm fixed effects and $X_{i,t-1}$ are the vector of lagged control variables.

Next, we use $\widehat{user}_{it}$ to test for the effect of derivatives usage on patents and citations using the second stage specification:

$$y_{it} = \alpha + \beta_{user} \cdot \widehat{user}_{it} + \eta_i + \lambda_X \cdot X_{i,t-1} + \epsilon_{it} \tag{3}$$

where, y_{it} denotes the patent counts and citation counts for firm i, and $\widehat{user}_{it}$ are the predicted values from equation (2). If the conditions for a valid instrumental variable are met, then β_{user} captures the causal effect of derivatives usage on innovation activity. We implement the instrumental variable estimator using two-stage least squares (2SLS).

For the instrument to be valid, it must strongly affect derivatives usage. In the 1980s, and also now, currency derivatives were (are) predominantly traded over-the-counter. Even after many years of growth in the derivatives markets, the Bank for International Settlements reports that in the year 1998, exchange-traded derivatives accounted for only 0.45% of the total notional amount of currency derivatives outstanding globally.[10] Given the importance of OTC derivatives markets, we argue that being located close to dealer-banks is key for firms to obtain derivatives, especially at the time of introduction of the ISDA Master Agreement. The ISDA agreement reduced expected credit risks in OTC markets. However, we argue that the search costs (the other key costs associated with OTC markets) would be lower for firms closer to dealer-banks and these firms will be more able to benefit from the ISDA Master Agreement.

Other papers have argued the importance of proximity to financiers in obtaining financing. Giroud (2012) finds that plants which are closer to headquarters have higher levels of investment. Bernstein, Giroud, and Townsend (2016) document that firms which are subject to an increase in proximity to venture capital providers, by a reduction in travel time, engage in increased innovation and are more likely to complete an IPO. We use physical distance, travel distance and travel time between firms and dealer-banks as measures of proximity. We assume that proximity to a dealer-bank is a proxy for derivatives use, therefore, banks which are close to dealers are more likely to use derivatives.

The instrument needs to not only affect the likelihood of derivatives usage, but also satisfy the exclusion restriction. The instrument should not affect innovation activity, as measured by patents, through any other channel other than the decision to use (or not) derivatives. Formally, this requires that the instrument should not be correlated to the residuals in equation (1).

Existing literature has identified that there are some places which are more favorable than others for economic activities. Also, we know that urban environments with a spectrum of

[10]The Bank for International Settlements publishes a semi-annual report with statistics on OTC derivatives. The earliest available version is dated November 2000. The notional value of exchange-traded contracts in the report is obtained from FOW Tradedata, the Futures Industry Association, and other futures and options exchanges. The total notional amount of currency derivatives traded globally was US$ 18,011 billion. Exchange-traded contracts amounted to US $81 billion, around 0.45% of the total notional amount.

knowledge resources, and competence profiles of the labor supply create rich opportunities for knowledge transfer, which ultimately result in increased innovation.[11] Although, location is an important determinant of innovative activity, there is heterogeneity in the extent to which firms depend on different inputs for the innovation process. In addition, inputs such as the presence of labor and mobility of labor have been found to be important determinants. Papers have documented that the higher levels of individual education (as opposed to city-level averages), higher number of small firms, and higher mobility of technical workers are positively correlated with levels of entrepreneurship and innovation (Doms et al. (2010), Glaeser et al. (2010), Kerr (2010)). Based on these findings, we argue that the distance of firm headquarters from the nearest financial center does not impact innovation, other than through the channel of derivatives usage.

4. Data Description

The data set is constructed from several data sources combining information on patent data, firms' use of financial derivatives and other firm characteristics. In this section we describe the construction of the sample and our main variables.

The patent data comes from Google patents database which holds the entire history of patents awarded by the U.S. Patent and Trademark Office (USPTO), representing a total of 7.8 million patents. We start with the patents and matched firm identifiers as made available by the authors of Kogan et al. (2015). They have matched all patents in the Google patents database to U.S. firms in the CRSP database.[12] We combine this dataset with firm financial information using the CRSP-Compustat Merged database on WRDS. We focus on granted patents applied for in the period 1977-2002, which includes the years when the first two versions of the ISDA Master Agreements were released (1987 and 1992) and also a few years

[11]Backman and Loof (2015) provides a summary of the recent literature on the geography of innovation.
[12]We thank the authors for assembling and making the data available to us.

before the 1987 Master Agreement. We exclude firms with negative or zero book values and firms which are in the financial (SIC codes between 6000 and 6799) and utilities (SIC codes between 4900 and 4949) sectors. We also exclude firms for which the headquarter information is not available. The main sample includes 44,329 firm-years based on 1,877 firms that have data for all variables described below.

4.1. Construction of the Dependent Variable

In this paper, we use two types of widely accepted patent-based measures of firm innovative activity that have been shown not only to capture firms' technological contribution but also to be economically meaningful (Hall, Jaffe, and Trajtenberg 2005). The first measure of innovative output, *Pat* is a simple patent count for each firm in each year. However, patent counts do not reflect the importance, or novelty of a patent.[13] Therefore, our second metric of innovation, *Cit*, involves measuring the value of a patent by counting the number of citations a patent has received following its approval.

Pakes and Shankerman (1984) show that the distribution of the value of patents is extremely skewed, i.e., most of the value is concentrated in a small number of very important and highly cited patents. Hall et al. (2005) among others demonstrate that patent citations are an accurate measure of the value of innovations. Intuitively, the rationale behind using patent citations to identify important innovations is that, if firms are willing to further invest in a project that is building upon a previous patent, they have to cite that patent. This in turn implies that the patent that is cited is technologically influential and economically significant.

[13]A well-documented issue in the patent literature is that of truncation bias. The truncation bias stems from the lag in patent approval (of about two years) and the general lag in citations. Thus, towards the end of the sample, patents and citations under report the actual patenting activity since many patents, although applied for, might not have been granted, or cited. However, our sample ends in the year 2001 and the patent database extends for 9 more years, upto and including the year 2010. We believe that due to this large gap between the last date in our dataset and the last date of the patents dataset, our results are unlikely to suffer from a truncation bias.

4.2. Main Explanatory Variables: Financial Innovation and Distance

We hand-collect data on derivatives usage including and after the year 1987 for all U.S. firms in our database. We use data on usage of currency derivatives. We focus on currency derivatives because this category of derivatives was covered under the 1987 ISDA Master Agreement. Specifically, we use Securities and Exchange Commission (SEC) filings on EDGAR and LexisNexis Academic application, with a list of keywords to identify firms that relied on currency derivatives at least once in the 1985-2001 period.[14] We use an indicator variable that takes the value of one if the firm is categorized as a currency derivatives user in the year.

We calculate distance of a firm's headquarters from the nearest financial center as an instrument for derivatives use. We obtain the address of the firm's headquarters from Compustat.[15] We use the address details, including the 5-digit ZIP code, city and state of location of the headquarters to obtain the latitude and longitude corresponding to the location.

Based on the existing literature, we use the following definition of financial centers: cities with the maximum number of bank branches of the world's top 300 commercial banks (Choi et al.(1986), Reed(1980)). Previous papers argue that these financial centers are efficient, centralized locations for lending, clearing of payments, and quick and easy access to the knowledge and services of complementary and competitive institutions (Nadler et al. (1955), Kindleberger (1974), Duffy and Giddy (1978)). Choi et al. (1986) rank the top financial centers in the world as of 1985. The largest financial centers, ranked by size (highest to

[14] We use a set of phrases to check for usage - "hedge", "exchange contract", "forward exchange contract", "forward exchange agreement", "foreign currency option", "foreign currency swap", "notional". We read the relevant part of each 10-K to confirm that the firm uses currency derivatives in the fiscal year.

[15] One concern is that Compustat only reports the last state of operations, and we may be unable to observe changes in headquarters that may be endogenous to changes in derivative markets. However, using data from Compact Disclosure database, Pirinsky and Wang (2006) argue that the majority of headquarter changes are driven by mergers and acquisitions. Our results are robust to excluding firm-year observations with sales or asset growth exceeding 100%, which are usually associated with mergers and other restructuring events.

lowest), are New York, Tokyo, London, Frankfurt/Hamburg, Hong Kong, Singapore, Paris, Los Angeles/ San Francisco, Milan/Rome, Toronto/Montreal, Brussels, Zurich/Geneva, Amsterdam, and Panama.

We calculate the physical distance between firm headquarters and all financial centers as the length (in kilometers) of the shortest curve between the two points along the surface of a mathematical model of the Earth. Then we obtain the minimum distance, i.e., the distance from the nearest financial center. For robustness, we also calculate the travel distance and travel time by car for all firms which are headquartered in the United States and Canada. We restrict ourselves to firms in North America, which accounts for 97% of the firms in our sample. The travel distance and time are calculated using maps obtained from OpenStreetMap and Open Source Routing Machine (OSRM).[16]

4.3. Other Explanatory Variables

The data on total assets, sales, industry Standard Industrial Classification (SIC), R&D expenditures, book equity, book debt, net property plant and equipment, operating income, and firm age comes from the CRSP-Compustat Merged database. In the empirical specification, we follow Hall and Ziedonis (2001) among others, and include firm's sales to control for firm size; profitability to control for the role of internal resources in financing; book leverage, and asset tangibility to control for existing dependence and access to bank credit. Following Aghion, et al. (2005), we control for industry concentration using the Herfindahl index (HI) constructed at the 4 digit SIC level. We include a variable that captures the number of years since the firm's IPO (as reported in CRSP) to control for the firm's age. In robustness

[16] OpenSteetMap is a project created to provide free, geographic data such as street maps. All maps and routing software are created by volunteers. The maps used in our paper is available for public download at http://download.geofabrik.de/. The map of North America downloaded for our paper was updated as on 3 June 2016. OSRM is a high-performance open-source C++ routing engine for shortest routes on road networks that runs with open-source maps from OpenStreetMap. The key benefit of using this method is that it is not based on APIs from third-party providers, such as Google. Therefore, the results can be replicated at any time without the risk of potential changes in APIs due to change in terms of use. The disadvantage is that the maps are not validated by a centralized authority but are maintained by volunteers.

checks, we also use the squared Herfindahl index to control for non-linear effects of industry concentration, and control for the stock of R&D as in Aghion, Van Reenen, and Zingales (2013). All the control variables are lagged by one-year to reduce simultaneity concerns. All continuous variables are winsorized at the 1st and the 99th percentiles to remove the influence of extreme outliers. We cluster our standard errors by firm.

Although the introduction of the ISDA Master Agreement is plausibly exogenous to the investment opportunities of individual firms, other concurrent events can potentially complicate inference. The introduction of the ISDA Master coincided with changes in regulation across the U.S.. While analyzing the effect of currency derivatives, we investigate and test for the implications of these concurrent events. We control for changes in banking regulation: inter-state banking regulation (Black and Strahan (2002)), intra-state banking regulation (Jayaratne and Strahan (1992)), changes in tax regulation (Atanassov and Liu (2015)), and anti takeover-regulation (Atanassov (2013)).

5. Derivatives Usage and Real Innovation

5.1. Descriptive Statistics

Table 1 reports the summary statistics of the variables used in the analysis. Following the literature, our main proxy for innovative activity is the number of patents and citations. The average patent counts for a firm in the sample is 18 patents, with a median of 1 patent. Similarly, the average number of citations for a firm in the sample is 158 citations, with a median of 5 citations. The average (median) firm in the sample has total assets of $2.111 ($0.185) million. The average (median) revenue is $2.171 ($0.250) million. The mean (median) profitability of firms in the sample is 0.140 (0.144). Mean (median) tangibility ratio is 0.321 (0.291). The average (median) Herfindahl index is around 0.415 (0.357). On average, firms in the sample have been in the CRSP-Compustat database for 24 years.

We use an indicator variable to classify firms as currency derivatives users whenever the SEC filings describe such contracts in the post-1987 period. Table 1 reports information for the post-1987 sample for 12,194 firm-year observations. Currency derivatives are used by 22% of the sample firms. Although our derivatives usage statistics appear to be very low, they compare well with numbers from the literature (Chernenko and Faulkender (2011)).

Table 2, shows the variables we use to capture the proximity of firms in our sample to financial centers in the world. These include: (1) distance (the physical distance between the headquarters of the firm and the nearest financial center), (2) travel distance (the travel distance by car, in 1,000 kilometers, between the firm's headquarters and the nearest financial center using road networks), and (3) travel time (the time, in hours, it takes to travel by car between the firm's headquarters and the nearest financial center).

Table 2, Panel A provides evidence that distances vary substantially. The averages of the distance and travel distance are 667 km and 821 km. Yet the 10^{th} and the 90^{th} percentiles are 28 km and 1,636 km for distance and 47 km and 2,033 km for travel distance. The average travel time between the headquarters of the firm and the nearest financial center is 9 hours. The 10^{th} and the 90^{th} percentiles are 0.65 hours and 21.59 hours, respectively. The correlation coefficients between the variables, distance, travel distance and travel time are high. The correlation between distance and travel distance is 0.9969, between distance and travel time is 0.9968, and between travel distance and travel time is 0.9995. This correlation may be one of the reasons explaining why our results are similar when we use distance or travel distance. Since we are interested in the distance rankings, our main results are based on the distance variable.

In Table 2, Panel B we sort firms into four groups based on the distance from a financial center and present firm and derivatives usage characteristics. Firms in group 1 (4) exhibit the lowest (highest) distance to a financial center. The results reveal that firms which are closest to a financial center are significantly larger compared to firms which are located the farthest. The average revenue differences between groups 1 and 4 is \$0.57 million, significant at the 1% level. Distant firms are smaller, and their innovation measures are smaller as well. This is consistent with the fact that larger firms may have greater resources available to invest in innovative activities. The difference in natural logarithm of (1 + Pat) between firms in groups 1 and 4 is 0.36, significant at the 1% level. In the case of citations, the difference between firms in groups 1 and 4 is 0.42, also significant at the 1% level. In addition, profitability and tangibility are also changing with distance. The difference in profitability between groups 1 and 4 is -0.008, while the difference in tangibility is -0.075. Both are statistically significant at the 1% level. The net debt/assets ratio, and book leverage are increasing with distance. The difference in net debt/assets ratio between groups 1 and 4 is -0.038, while the difference in book leverage is -0.015. Both are statistically significant at the 1% level. Firms closer to financial centers are more likely to use currency derivatives post-1987. The fraction of currency derivatives users is 0.056, 0.054, 0.058, and 0.047 for firms in groups 1-4 respectively. These results agree with the existing literature on risk management, which reports that firms of smaller size hedge less despite facing significant financing frictions and high probabilities of distress.[17]

Although the summary statistics indicate that proximity to financial centers may enable firms to innovate more, and at the same time maintain less leverage ratios, there may be confounding issues that potentially account for these correlations. In the following sections, we investigate the impact of financial derivatives usage on patents and citations using instrumental variable specifications.

5.2. Multivariate Analysis

We start by estimating the dynamic effects around the event year, 1987. In Figure 1, we re-estimate equation (1), where the variable, *Post*, is replaced by dummy variables for each year.[18] The figure shows estimations from the year 1985 onwards because there are

[17] A number of papers find a robust positive relationship between firm size and derivatives use: Nance, Smith and Smithson (1993), Geczy, Minton and Schrand (1997), Carter, Rogers and Simkins (2006b) among others. Refer to Rampini, Sufi and Viswanathan (2014) for a review of the literature on hedging and firm size.

[18] We omit all control variables to alleviate concerns of endogeneity, while standard errors are clustered at the firm level.

no declared users of derivatives before the year 1985. Reassuringly, the chart suggests the absence of a trend before 1987. In particular, the level of patents granted to derivatives users is no more than the level of patents granted to non-users. The chart also suggests a lag between the 1987 ISDA Market Agreement introduction and a significant increase in patenting activity by derivatives users. The first year in which the coefficient is significantly different is 1990, three years after the shock. In Figure 2, we estimate a similar model but replace the dependent variable with $Ln(1 + Cit)$. This figure also suggests the absence of a trend before 1987, i.e., the level of citations received by derivatives users is no more than the level of citations received by non-users.

We then turn to formal, statistical tests of the effect of the 1987 ISDA Master Agreement on the level of innovation. The results are reported in Table 3. The dependent variable in columns 1–4 is *Ln(1 + Pat)*, with patents measured in the first year after the current year. The dependent variables in columns (5) and (6) are patents measured two and three years after the current year, respectively. Columns 1–2 show the results without any control variables. We find that users of currency derivatives are more likely to obtain patents a year later as compared to non-users after 1987. In columns 3–6 we control for Ln(Sales), Book leverage, Profitability, Tangibility, the Herfindahl Index, and Age and for serial correlation by clustering the standard errors at the firm level. The results remain robust to these additional controls.

Consistent with the literature, we find that larger firms have more patents, while book leverage is negatively correlated with patents. We find that the Herfindahl Index does not have significant impact on patent counts. Firm age is negatively related to innovation which implies that older firms are less likely to innovate. The signs of the coefficients for profitability and tangibility also agree with the existing literature. The results remain consistent when in columns (2) and (4), we include year fixed effects (while dropping the variable, *Post*). In columns (5) and (6), we repeat the same tests for patent measures two and three years after the current year. The results are similar, with positive and significant at the 1% level coefficient of interest. They confirm that users of currency derivatives are more likely to apply for (and successfully obtain) patents post-1987 as compared to non-users of currency derivatives.

In Table 4, we use citation counts as the dependent variable. Looking at citations gives us an idea of the quality of innovation. Column (1) shows that users of currency derivatives have more citations as compared to non-users after 1987. Control variables include Ln(Sales), Book leverage, Profitability, Tangibility, the Herfindahl Index, Age, and firm fixed effects. We include year fixed effects in columns (2), (4), and (6). The coefficient of interest continues to be positive and significant at the 1% level. Columns (3) and (4) reveal that currency derivatives users have more citations two years after the current year as compared to non-users. The results in columns (5) and (6), show that derivatives users have also more citations three years after the current year.

These results suggest that users of currency derivatives are more innovative in the post-1987 period as compared to non-users. A likely hypothesis supporting our results is: derivatives users were able to smooth their cash flows and allocate more resources to more innovative projects as compared to non-users. Derivatives users were, thus, more able to invest in risky technologies. However, we know that both the usage of derivatives and innovative activity are endogenous decisions of the firm. In other words, a firm which uses derivatives may have different innovation opportunities post-1987 when compared to a non-user. These opportunities may drive both, the decision to use derivatives and the decision to invest in "patent-able" technologies. To delineate the causal impact of derivatives usage on patenting activity, we use an instrumental variable.

6. Innovation Activity

6.1. Instrumental Variable Specifications

Table 5, columns (1) and (2) show the results of the first stage of the 2SLS-IV estimation. In both specifications, the dependent variable is an indicator variable that, in the post-

1987 period, is equal to one for currency derivatives users, and zero for both non-users and all pre-1987 observations. The results suggest that firms which are farther away from financial centers are less likely to use currency derivatives in the post-1987 period. In column (1), we use distance quartiles as a measure of proximity, while in column (2) we use the physical distance between firm headquarters and the nearest financial center as a measure of proximity. Column (1) shows that quartile 1 and quartile 2 firms are 6.7% and 5% more likely to use currency derivatives after 1987 as compared to quartile 4 firms and all firms before 1987. These differences are significant at the 5% and 10% level, respectively. In column (2), the coefficient of distance is negative and significant at the 5% level. This result suggests that firms with a greater distance between firm headquarters and the nearest financial center, are less likely to use derivatives after 1987. In other words, being physically close to dealer-banks at a financial center increases the likelihood that the firm will have access to derivatives, more specifically, currency derivatives. The high F-statistic suggests the instrument is not weak.

In the following columns of Table 5 we present the main result of derivatives usage on innovative activity. Columns (3), (5) and (7) present 2SLS-IV estimates of the effect of currency derivatives on firm innovation corresponding to the first-stage specifications in column (1). These fixed effects specifications show a positive and significant effect of derivatives usage on patents in the first, second, and third year after the current year. The coefficient estimates 0.451, 0.477, and 0.517, all of which are statistically significant at the 1% level. The coefficient estimates are smallest for the first year after the current year and increase monotonically. Columns (4), (6), and (8) present 2SLS-IV estimates of the effect of currency derivatives on firm innovation corresponding to the first-stage specifications in column (2) (using the distance instead of distance quartiles). The results continue to hold. Overall, they support the hypothesis that derivatives use results in positive, statistically large effects on innovation.

In Table 6, we present the main result of derivatives usage on quality of innovation.

Columns (1), (3) and (5) present 2SLS-IV estimates of the effect of currency derivatives on firm innovation corresponding to the first-stage specifications from column (1), Table 5. Table 6, column (1) shows a positive and significant effect of derivatives usage on citations in the first year after the current year. The coefficient is significant at the 1% level. Columns (3), and (5) show that the effect of currency derivatives usage is also positive and significant in the second and third year after the current year. The coefficient estimates 0.966, and 0.995, are statistically significant at the 1% level. These results support the hypothesis that derivatives use results in higher quality of innovation.

The theoretical literature on derivatives usage documents that hedging using derivatives can reduce the likelihood of negative cash flow outcomes and the probability of bankruptcy (Froot, Scharfstein and Stein (1993)). Recent empirical papers have documented the positive impact of derivatives usage. Perez-Gonzales and Yun (2013) find that firms which are most exposed to weather shocks are most likely to increase firm value when they use weather derivatives. They also find that the more-exposed firms reduce distortions in investment and increase capital expenditure compared to a group of control firms. Campello et al. (2011) also find that derivatives usage can increase firm value through the channel of reduced interest rates and increase in debt capacity. Our main results are in line with existing literature. By reducing cash flow volatility, derivatives usage can, potentially, lead to more allocation of resources to innovative projects. As a result, firms may be more likely to invest in profitable, yet risky ventures such as investments in innovation.

6.2. Robustness Tests

In this section, we present a series of robustness and falsification tests. First we include additional control variables in our main specification. Second, we use alternative definitions of proximity as instruments for derivatives usage, and alternative measures of innovation. Finally, we address issues of endogeneity and do further miscellaneous robustness checks.

6.2.1. Additional Control Variables

We include additional control variables which have been identified by the literature as important determinants of innovation outcomes. Aghion, Van Reenen, and Zingales (2013) argue that not including the stock of R&D implies that the coefficient of the variable of interest on the right-hand side will reflect both the increase in R&D expenditures and the productivity of R&D. The R&D stock is calculated following the 15% depreciation rate used in the literature (Hall, Jaffe, and Trajtenberg (2005)). We have treated missing R&D expenditures as zero. Our results also hold if we use interpolations to replace missing values of R&D (Amore, Schneider, and Zaldokas (2013)) or R&D expenditures divided by Assets. We include the square of the Herfindahl Index to account for non-linear effects of industry competition on innovation. Aghion et al. (2005) argue that the relationship between competition and innovation is an inverted-U relationship. Firms at low levels of competition increase innovation to "escape" competition and increase incremental profits from innovation. Whereas, firms in very competitive industries, may reduce innovation because they lag behind the leaders in innovation and cannot obtain incremental profits. We also include the capital-to-labor ratio, following the literature on the production function of patents (Hall and Ziedonis (2001), and Aghion et al., (2013)).

Other state-level changes in regulation have also been documented as determinants of innovative activity. The literature on credit constraints and innovation documents that changes in banking regulation has had significant impact on the level of patents and citations in the U.S. economy (Amore, Schneider, and Zaldokas (2013), Cornaggia et al. (2015), Chava et al. (2013)). We include state-year fixed effects which account for changes in inter-state, and intra-state banking deregulation in the U.S. and the implementation of the IBBEA Act (Interstate Banking and Branching Efficiency Act). Changes in tax legislation and state-level anti-takeover legislation also increase the patenting activity of firms (Atanassov and Liu (2015), Atanassov (2013)). We include these legislation changes in our specifications.

Table 7 shows the results from the second stage of the 2SLS-IV estimation, where the first stage has been estimated using the specification in Table 5, column (1). Columns (1) and (2) show the impact of currency derivatives use on the number of patents one year after the current year. The coefficients are positive and significant at the 1% level. Columns (3), (4) and (5), (6) show the impact of currency derivatives use on the level of patents in the second and third year after the current year, respectively. The coefficients in all columns are positive and significant at the 1% level. These results support the main result of the paper - increased derivatives use results in higher innovation outcomes.

6.2.2. Alternative Definitions of Proximity

Table 8, columns (1) and (2) show the results of the first stage of the 2SLS-IV estimation using quartiles of travel distance, and travel distance, respectively. In both specifications, the dependent variable is an indicator variable that, in the post-1987 period, is equal to one for currency derivatives users, and zero for both non-users and all pre-1987 observations. In column (1), we use travel distance quartiles as a measure of proximity, while in column (2) we use the travel distance between firm headquarters and the nearest financial center as a measure of proximity. Results in column (1) indicate that quartile 1 firms are 5.1% more likely to use currency derivatives after 1987 as compared to quartile 4 firms after 1987 and all other firms before 1987. Similarly, results in column (2) indicate that firms headquartered farther from financial centers (larger travel distance) are less likely to use derivatives after 1987. The coefficient is significant at the 5% level.

In columns (3) and (4), we use travel time by car as a measure of proximity. In column (3), we use travel time quartiles, while in column (4) we use travel time as our main independent variables. Results in column (3) show that quartile 2 firms are 5.8% more likely to use derivatives as compared to quartile 4 firms after 1987 and all other firms before 1987. Results in column (4) suggest that firms which are farther from financial centers (longer travel time) are less likely to use currency derivatives. The coefficient is significant at the 10% level. These results suggest that being physically close to dealer-banks at a financial center increases the likelihood that the firm will have access to derivatives, more specifically, currency derivatives.

In the last four columns, Table 8 presents the result of derivatives usage on innovative activity. Columns (5), (6), (7) and (8) present 2SLS-IV estimates of the effect of currency derivatives on firm innovation corresponding to the first-stage specifications in columns (1), (2), (3) and (4), respectively. These fixed effects specifications show a positive and significant effect of derivatives usage on patents in the first year after the current year. The coefficient estimates 0.419, 0.396, 0.407, and 0.890, are all statistically significant at the 1% level. Overall, these robustness tests support the main result of the paper, derivatives use leads to positive and statistically significant outcome on firm-level innovation.

6.2.3. Alternative Measure of Innovation

To confirm that firms that use derivatives not only innovate more (where innovation output is measured using number of patents and number of citations) but also invest more in innovation, we replace the dependent variable in our main specifications with the stock of R&D. The results are reported in Table 9. The dependent variable in columns 1 and 2 , $R\&Dstock/Assets_{t+1}$ measures the R&D expenditures in the first year after the current year. The dependent variables in columns 3–4 and columns 5–6 measure R&D expenditures two and three years after the current year, respectively. The results, consistent with our previous findings, suggest that users of currency derivatives have higher output of innovation because they are also more likely to invest more in R&D in the three years after 1987, as compared to non-users. Further, in alternative specifications we replace the dependent variable with the number of patents scaled by firms' R&D expenditures. Consistent with the previous findings, our unreported results show that firms that use derivatives are more efficient in producing innovation after 1987, compared to firms that don't use derivatives.

6.2.4. Additional Endogeneity Tests

Although the introduction of the ISDA Master Agreement was arguably exogenous to individual firms, in Table 10 we examine the robustness of our results by running one key placebo test. We examine the size issue: do larger size firms locate closer to financial centers and have larger number of patents compared to smaller firms?

We create size quartiles based on the average pre-1987 (from 1977 to 1987) revenues of each firm in our sample. The variable *Size Quartile 1* denotes the quartile of firms with the smallest average pre-1987 revenues. All other variables are defined as before. Column (1) reports that quartile 1 firms do not show any difference in patents post-1987 as compared to firms in quartiles 2 and 3. In columns (2) and (3), we focus on patents two and three years after the current year, respectively. In both cases, there is no differential impact on quartile 1 firms' patenting activity compared to quartile 2 and 3 firms post-1987. The coefficient for the variable, *Post* is positive and significant in all the three specifications. These results suggest that, on an average, firms patent more after 1987 as compared to before 1987. However, there is no differential impact of the 1987 ISDA Master Agreement on firms in different size quartiles. This evidence is against the argument that firm size is the causal mechanism behind our main results. Although it is very difficult to address all endogeneity concerns, these results help to alleviate such concerns to a reasonable extent.

6.2.5. Miscellaneous Robustness Checks

This section presents some additional robustness checks. The results are tabulated in the Internet Appendix section of the paper.

Entry and exit of firms. An alternative explanation for our results is that the introduction of the ISDA Master agreement led to an increase in innovation for all firms, but more firms were incorporated close to financial centers after the introduction. In that case, our results could be driven by survivorship bias. To purge the sample of entry and exit effects, we restrict the sample to only those firms that are present during the entire period from 1977 to 1997, which is the period ten years before the introduction of the ISDA agreement until ten years after the introduction of the ISDA agreement. The results are reported in Table I.1. They remain robust although the sample size is reduced by more than 80%.

Technological class fixed–effects. In addition to using firm fixed-effects we control for the existence of any systematic differences across patents' technological fields by rescaling our dependent variables, number of patents and number of citations. Following Hall and Ziedonis (2001), we remove all field effects, by dividing the number of patents and citations by the corresponding field mean. The results are reported in Table I.2. While they are weaker, the results are overall consistent with our main findings.

Universal Banking. A second concern with our instrumental variables specification is that the ISDA Master Agreement was launched in the same year in which the Glass-Steagall Act was partially repealed. Large commercial banks located in New York City were able to offer underwriting services, traditionally, offered by investment banks. As a result, firms located close to investment banks would obtain more banking services from their existing relationship banks, which could, potentially, lead to more funds for innovative activities.

To address this concern, we eliminate firms located in New York state and check whether other firms substantiate our main result. Table I.3 shows the results of the first-stage of the IV regression excluding one state at a time. The coefficient to the variable of interest, *Distance*Post*, is provided in the table. Eliminating firms headquartered in New York state, we continue to obtain similar results as the main result in our paper. Firms closer to financial centers have a higher likelihood of derivatives use. The results also indicate that no one state entirely drives the main result of the paper.

7. Channels

The evidence presented so far demonstrates that firms closer to financial centers use currency derivatives more frequently. The greater derivatives usage leads to larger number of patents and citations. In this section, we focus on possible mechanisms behind these results.

Previous literature has found a robust correlation between firm size and derivatives use. Larger firms tend to be frequent users of derivatives. Since our distance variable is negatively correlated with firm size (larger firms locate closer to financial centers), our results may be driven by firm size (and not by distance). However, placebo tests described in an earlier section address this concern to some extent. Next we test whether risk management and/or financial constraints can explain the derivatives-innovation relationship.

7.1. Risk Management

In our first test, we investigate whether ex-ante exposure to foreign exchange shocks is the channel that explains the relationship between derivatives use and patenting activity. If risk management is the channel for increase in innovation, then we would expect that firms with higher exposure to foreign exchange shocks before 1987, those that are more likely to face higher volatility in cash flows in the absence of a suitable hedging instrument, to benefit the most from the lower costs of derivatives. We estimate the sensitivity of cash flow/assets to changes in an index of foreign currencies using the following specification.

$$\frac{CF_{it}}{A_{it}} = \alpha_i + \beta_i^{FX} \cdot FX_t + \lambda_i \cdot ln(A_{it}) + \epsilon_t \tag{4}$$

where, CF_{it} is the free cash flow to firm i in year t, A_{it} is the total assets of the firm i in year t, and FX_t is the average level of a trade-weighted basket of foreign currencies in year t. In equation (4), we also control for the level of assets (Perez-Gonzalez, and Yun (2013)).

We measure free cash flow as operating income before depreciation minus investment. It is important to subtract investment to obtain a measure of free cash flow because we want to estimate the hedging demand of the firm after operational hedges (Chernenko and

Faulkender (2011)). For example, consider a firm whose operating cash flows and investment opportunities are both positively related with foreign currency changes. This firm is naturally hedged against currency fluctuations and therefore, has less "hedging" demand for currency derivatives. On the other hand, consider a firm whose operating cash flows are positively correlated and investment opportunities are negatively correlated with foreign exchange changes. For this firm, free cash flows are positively correlated with currency fluctuations and therefore, this firm has higher "hedging" demand. The difference between these firms arises from the correlation between investment opportunities and currency fluctuations. For this reason it is important to estimate the currency sensitivity of post-investment cash flows.

The estimated coefficient, β_i^{FX} captures the sensitivity of cash flows to currency fluctuations, "CF exposure". Firms can potentially gain from using derivatives irrespective of the sign of these betas. Some firms may benefit if the value of a U.S. dollar reduces vis-a-vis other currencies, while other firms may be negatively affected in the same scenario. As a result, the absolute value of these betas is informative about firms' hedging opportunities as a function of each variable. We categorize firms as "Low CF exposure" if the coefficient, β_i^{FX} is in the first quartile and "High CF exposure" if it is in the fourth quartile. Table 11, columns (1) and (2) show the results. The derivatives-innovation relationship is positive and significant for firms with high ex-ante exposures to currency fluctuations. In other words, firms which had a high ex-ante hedging demand benefited more from the reduction in hedging costs, and were able to obtain more innovation through patents. In contrast, firms with the lowest ex-ante exposure to currency fluctuations do not exhibit significant derivatives-innovation relationship. These firms were not affected by the introduction of the ISDA Agreement because they had no need to use these derivatives.

In our second test, we calculate currency exposures using the equity returns of firms. We estimate the betas of firm equity returns to returns on the market and a foreign-exchange index using the following specification.

$$R_{it} = \alpha_i + \beta_i^C \cdot R_{FX,t} + \beta_i^M \cdot R_{M,t} + \epsilon_t \tag{5}$$

Based on Jorion (1990), we use a trade-weighted basket of foreign currencies of the main trading partner countries of the U.S.. We use the value-weighted CRSP index to calculate market returns. The regression uses monthly data and calculates the returns over a five-year period ending in the 1987 financial year. Based on the coefficient, β_i^C we categorise firms as "Low FX beta" if the absolute value of the coefficient is in the first quartile and "High FX beta" if it is in the fourth quartile. Table 11, columns (3) and (4) show the results. The derivatives-innovation relationship is positive and significant for firms with high betas. For firms with the lowest betas, there is no impact of derivatives usage on innovation.

In the third test, we use a more noisy measure of risk to categorize firms, the standard deviation of equity returns. We calculate the standard deviation of monthly equity returns for each firm for five years before 1987. We categorize firms as "Low SD of returns" if the standard deviation is in the first quartile and "High SD of returns" if it is in the fourth quartile. Table 11, columns (5) and (6) show that firms with more volatile returns increase patenting more, with the use of derivatives, compared to firms with less volatile returns.

Looking further at the impact of derivatives use, we check whether firm's exposure reduces with derivatives usage. We calculate the beta of equity returns to foreign exchange index returns or FX beta, as shown in equation (5) for each firm-year using a rolling five-year window. Table 12 reports the results, where FX beta is the dependent variable. In columns (1) and (2) we focus on the subsets of firms categorized as "Low CF exposure" and "High CF exposure". The results show that the FX beta increases more for firms with low CF exposure. If firms with high CF exposure were using derivatives for hedging, we should observe a reduction in the FX betas. The results point in the same direction. Firms with high CF exposure see no change in the FX betas whereas firms with low CF exposure see an increase in their FX betas. In a relative sense, the FX betas of high CF exposure firms increases less with derivatives use. In columns (3) and (4), we focus on the subset of firms which we categorized as "Low FX beta" and "High FX beta". Firms with low FX beta see an increase in betas whereas there is no such increase for high FX beta firms.

7.2. Banking Relationships

Our distance measure could, potentially, be a proxy for access to capital. The relevant, alternative explanation is that firms located closer to banks are more likely to have relationships with banks and, thus, greater access to capital.

If easier access to capital was a channel through which the derivatives use affected innovation, we expect to see the effect to be more prevalent in firms that have banking relationships. To test this hypothesis, we identify firms which had relationships with banks based on syndicated loans information from the LPC Dealscan database. We classify a firm as one with "Bank relationship" if the firm had raised a syndicated loan before and including the year 1987. If the firm had not raised a syndicated loan on or before the year 1987, we categorize it as one with "No relationship". Table 13, columns (1) and (2) report the results. Firms with no banking relationship increase patenting more compared to firms with an existing banking relationship. Given that the LPC Dealscan reporting is low in the years before and including 1987, we also run the same test with marginally different definitions of a banking relationship. We categorize firms as those with relationships if they have raised syndicated loans on or before one to five years from the year of the ISDA Master Agreement. In columns (3) and (4), we classify firms as firms with "Banking relationship before 1992" ("No relationship before 1992") if they raised (did not raise) syndicated loans on or before 1992 (five years from the ISDA Master Agreement). The results suggest that firms without a banking relationship show a greater increase in innovation.[19]

[19] In unreported tests, we obtain similar results if we define firms with banking relationships as those which raised syndicated loans on or before one to four years after 1987.

In a final test, we use the presence of a credit rating as another proxy for bank relationships. The presence of a long term credit rating suggest that the firm has a relationship with a bank. We categorize a firm as "With credit rating" if the firm has a long-term credit rating before or on 1987. Columns (5) and (6) show the results. Firms without credit ratings increase their innovation more as compared to firms with credit ratings. These results provide support against the channel of relationship banking.

7.3. Financial Constraints

We also test whether financial constraints are the channel behind the derivatives-innovation relationship. The argument is that derivatives may reduce volatility of expected future cash flows and reduce financial constraints of firms, thus enabling investment in more risky, innovative projects. To test this hypothesis, we first calculate the average industry-level (as measured by the 3-digit SIC industry code) measure of financial constraints, the Kaplan-Zingales Index. To calculate the index, we follow Lamont, Polk and Saa-Requejo (2001) who use the original coefficient estimates of Kaplan and Zingales (1997). In Table 14, columns (1) and (2) we report the results. We find some evidence that firms in constrained industries have a greater increase in patents as compared to firms in less-constrained industries.

Our second test investigates whether firms with lower cash show a greater increase in patents. Empirical papers in the innovation literature have highlighted the importance of financial constraints on innovation. Rampini, Sufi, and Viswanathan (2014) argue that derivatives use and financing, draw on the same source of collateral with a firm. Due to the requirement of posting cash and high-grade securities as collateral for OTC transactions, we use the availability of cash pre-1987 as a measure of firm-level constraints. We sort firms based on average pre-1987 cash/assets ratio. Firms in the first quartile are categorized as "Low cash" firms and those in the fourth quartile are categorized as "High cash" firms. Columns (3) and (4) show that low cash firms have a higher increase in patents when compared to high cash firms. However, it is unlikely that the difference in coefficients is statistically significant from zero.

In our final test, we investigate whether firms with less tangible assets have a greater increase in innovation compared to firms with more tangible assets. Firms with less tangible assets are less able to collateralize their assets and, therefore, are more likely to face constraints in raising debt capital, before the spread of derivatives in 1987. We sort firms based on their average pre-1987 ratio of property, plant and equipment to assets. We categorize firms as "Low tangibility" if the ratio is in the first quartile and as "High tangibility" if the ratio is in the fourth quartile. Columns (5) and (6) show that firms with less tangible assets have a greater increase in innovation compared to firms with high tangibility of assets. These results provide evidence in favor of the financial constraints channel.

8. Concluding Remarks

Understanding the determinants of innovation is important because innovations establish companies' comparative advantages (Porter (1992)) and are important drivers of growth (Solow (1957)). A recent literature examines the effect of capital market conditions on the level of innovation. Our paper focuses on the usage of derivatives and its impact on real innovation.

Derivatives are powerful tools for shifting risks. However, the lack of data on derivatives usage by firms has hindered empirical research in identifying the impact of derivatives. In this paper, we address this issue by exploiting, an arguably exogenous change in the market for OTC derivatives which led to a reduction in the costs of derivatives use. Using this natural experiment and data from U.S. firms, we find evidence consistent with the idea that derivatives use leads to an increase in innovation. We find that the use of derivatives is more effective at increasing innovation in firms which are more likely to benefit from risk management. Firms which have higher cash flows volatility are more likely to obtain derivatives, reduce overall risk, and invest in innovation.

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Figure 1: Effect of the ISDA Master Agreement on Innovation

The figure shows the evolution of innovation around the year of introduction of the ISDA Master Agreement. The specification is the same as equation (1) with *Ln(1 + Pat)* as the dependent variable, the variable, *Post* has been replaced by a collection of year fixed effects and there are no controls. The solid dot plots the point estimates and the dashed line plots the 95% confidence interval. Standard errors are clustered at the firm level.

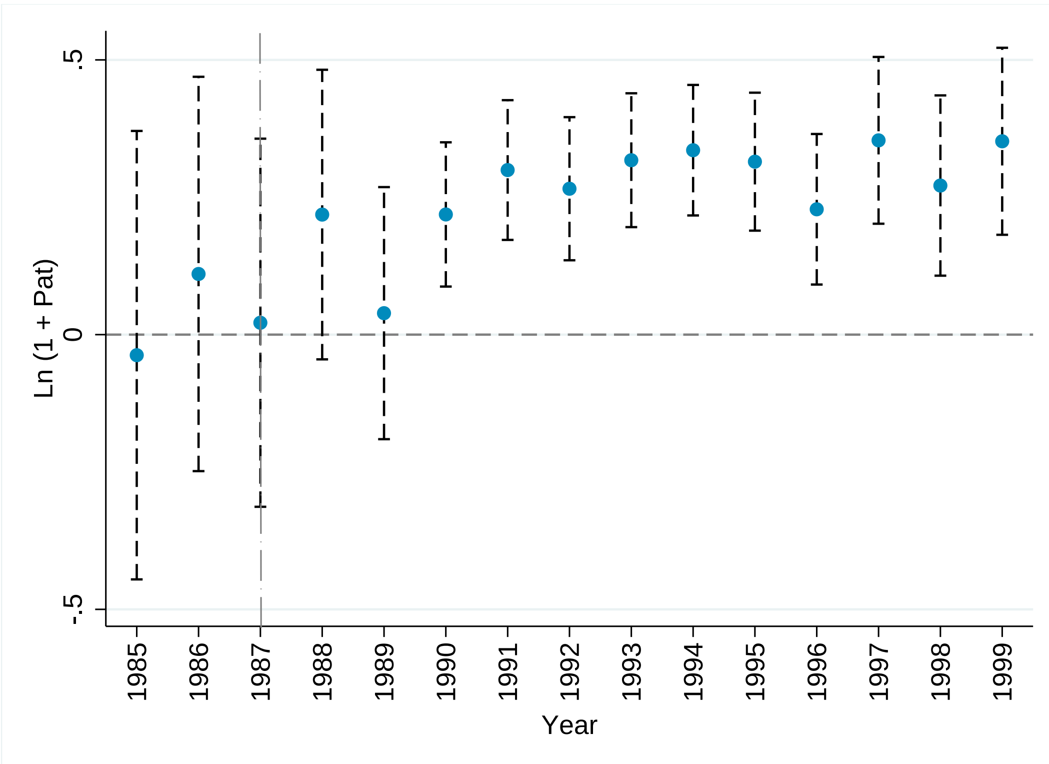

Figure 2: Effect of the ISDA Master Agreement on Innovation Quality

The figure shows the evolution of innovation quality around the year of introduction of the ISDA Master Agreement. The specification is the similar to equation (1) except that the dependent variable is *Ln(1 + Cit)*, the variable, *Post* has been replaced by a collection of year fixed effects and there are no controls. The solid dot plots the point estimates and the dashed line plots the 95% confidence interval. Standard errors are clustered at the firm level.

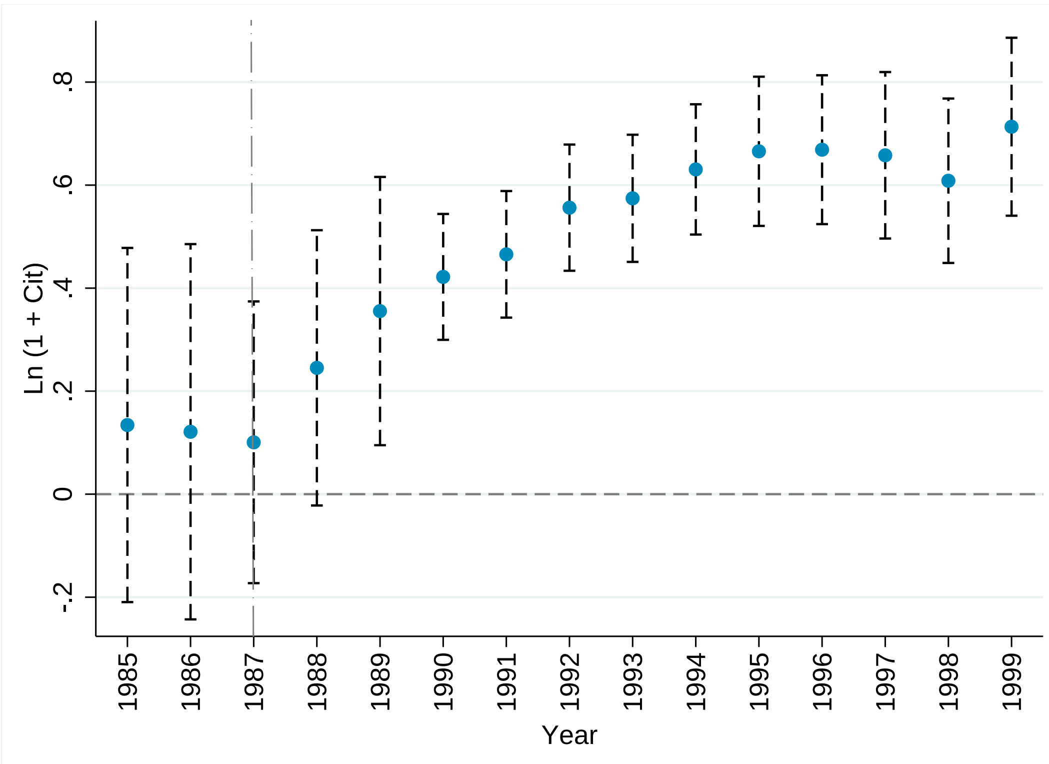

Table 1. Summary Statistics

This table reports summary statistics for key variables used in the analysis. *Assets* and *Sales* of the firm are in US$ thousands. *R&D/Assets* is research and development expenses of firm to total assets. *Book leverage* is the total debt of the firm to total assets. *Profitability* is defined as ratio of the earnings before interest, tax, depreciation and amortization (EBITDA) to total assets. *Tangibility* is defined as the ratio of net property, plant and equipment to total assets. *Herfindahl* is equal to the sum of the squared share of the firm in total industry sales in a given 4-digit SIC industry in a given year. *Age* is the number of years that the firm has been on the CRSP-Compustat Merged database. *Patents* is the number of patents applied for (and granted) by the firm. *Citations* is the number of citations to the patents owned by the firm. *Currency derivatives* is a dummy variable that takes the value of one if the firm uses currency derivatives in the year. The table reports currency derivatives usage including and after 1987.

	N	Mean	Std. Dev.	Min	p10	Median	p90	Max
Assets	44,329	2,111	9,500	0	15	185	3,891	304,012
Sales	44,329	2,171	8,144	0	19	250	4,341	195,805
R&D/Assets	44,329	0.025	0.036	0.000	0.000	0.009	0.075	0.165
Book leverage	44,329	0.238	0.163	0.000	0.030	0.222	0.455	0.717
Profitability	44,329	0.140	0.095	-0.180	0.031	0.144	0.248	0.391
Tangibility	44,329	0.321	0.173	0.029	0.125	0.291	0.583	0.807
Herfindahl	44,329	0.415	0.235	0.076	0.166	0.357	0.794	1.000
Age	44,329	24	16	0	7	19	53	72
Patents	44,329	18	91	0	0	1	28	3,639
Citations	44,329	158	894	0	0	5	217	46,914
Currency derivatives	12,194	0.222	0.416	0	0	0	1	1

Table 2. Measures of Distance from Financial Centers

This table reports measures of distance between firm headquarters and financial centers. Panel A presents summary statistics. *Distance* is measured as the physical distance, in thousands of kilometers, between the firm headquarters and the nearest financial center (as in Choi et al. (1986)) along the surface of a mathematical model of the Earth. *Travel distance* is measured as the distance on road networks, measured in thousands of kilometers. *Travel time*, measured in hours, is the time taken to travel by road between firm headquarters and the nearest financial center. Panel B reports firm characteristics for firms in different quartiles based on the Distance. Group 1 (2, 3, and 4) represent the first (second, third, and fourth) quartile firms.

Panel A: Measures of distance to financial centers

	N	Mean	Std. Dev.	Min	p10	Median	p90	Max
Distance	1,877	0.667	0.610	0	0.028	0.477	1.636	2.577
Travel distance	1,820	0.821	0.717	0	0.047	0.610	2.033	2.509
Travel time	1,820	9.005	7.712	0.01	0.651	6.752	21.591	27.509

Panel B: Distance groupings, firm characteristics, and derivatives usage

	Group 1	Group 2	Group 3	Group 4	Diff 1 vs. 4	Diff 1&2 vs. 3&4
Sales	1,974.224	1,398.549	1,316.221	1,404.644	569.580***	328.990***
	(67.965)	(65.292)	(39.684)	(57.041)	(89.247)	(58.740)
Assets	2,145.916	1,325.212	1,216.326	1,299.032	846.883***	481.883***
	(99.453)	(85.915)	(44.075)	(49.056)	(112.920)	(74.297)
Ln(1+Pat)	1.295	1.378	1.300	0.937	0.359***	0.214***
	(0.016)	(0.014)	(0.013)	(0.013)	(0.020)	(0.014)
Ln(1+Cit)	2.055	2.270	2.091	1.638	0.417***	0.292***
	(0.021)	(0.019)	(0.018)	(0.018)	(0.028)	(0.019)
Profitability	0.141	0.151	0.161	0.149	-0.008***	-0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Tangibility	0.294	0.308	0.337	0.369	-0.075***	-0.052***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Book leverage	0.237	0.217	0.217	0.251	-0.015***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Cash/Assets	0.109	0.096	0.093	0.085	0.023***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Net debt/Assets	0.132	0.123	0.127	0.170	-0.038***	-0.020***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)
Currency	0.056	0.054	0.058	0.047	0.009***	0.003
derivatives	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)

Table 3. Impact of Financial Innovation on Number of Patents

This table reports OLS regression results. We use natural logarithm of $(1 + Pat)_{t+k}$ as the dependent variable where *Pat* is the patent count in year $t + k$, k=1, 2, and 3 denoting one, two and three years after the current time period, t. *Currency derivatives* is a dummy variable taking the value of one if the firm uses currency derivatives, as per its SEC filings, in the year and zero otherwise. The variable *Post* takes the value one for years after 1987 and zero otherwise. Control variables include one-year lagged values of *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	$Ln(1 + Pat)_{t+1}$				$Ln(1 + Pat)_{t+2}$	$Ln(1 + Pat)_{t+3}$
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives * Post	0.314***	0.292***	0.224***	0.219***	0.212***	0.212***
	(0.050)	(0.053)	(0.046)	(0.047)	(0.047)	(0.049)
Post	0.110***		0.036		0.042	0.051*
	(0.021)		(0.028)		(0.028)	(0.029)
Ln(Sales)			0.258***	0.291***	0.247***	0.234***
			(0.020)	(0.021)	(0.021)	(0.021)
Book leverage			-0.123*	-0.211***	-0.149**	-0.145**
			(0.063)	(0.063)	(0.064)	(0.065)
Profitability			-0.258***	-0.303***	-0.218**	-0.226**
			(0.085)	(0.086)	(0.087)	(0.090)
Tangibility			0.287***	0.252***	0.270***	0.292***
			(0.093)	(0.091)	(0.094)	(0.096)
Herfindahl			-0.183**	0.062	-0.157*	-0.130
			(0.084)	(0.088)	(0.082)	(0.082)
Age			-0.015***	-7.16e-0	-0.015***	-0.015***
			(0.002)	(0.004)	(0.003)	(0.003)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes	No	No
Observations	44,329	44,329	44,329	44,329	43,208	42,007
R-squared	0.839	0.845	0.854	0.859	0.858	0.861

Table 4. Impact of Financial Innovation on Number of Citations

This table reports OLS regression results. We use natural logarithm of $(1 + Cit)_{t+k}$ as the dependent variable where Cit is the citation count in year $t + k$, k=1, 2, and 3 denoting one, two and three years after the current time period, t. *Currency derivatives* is a dummy variable taking the value of one if the firm uses currency derivatives, as per its SEC filings, in the year and zero otherwise. The variable *Post* takes the value one for years after 1987 and zero otherwise. Control variables include one-year lagged values of *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	$Ln(1 + Cit)_{t+1}$		$Ln(1 + Cit)_{t+2}$		$Ln(1 + Cit)_{t+3}$	
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives * Post	0.513***	0.496***	0.495***	0.467***	0.474***	0.445***
	(0.046)	(0.050)	(0.047)	(0.051)	(0.047)	(0.052)
Post	0.085**		0.087**		0.098***	
	(0.034)		(0.034)		(0.035)	
Ln(Sales)	0.324***	0.310***	0.329***	0.318***	0.328***	0.319***
	(0.024)	(0.024)	(0.024)	(0.025)	(0.024)	(0.025)
Book leverage	-0.203**	-0.113	-0.190**	-0.120	-0.169**	-0.120
	(0.081)	(0.081)	(0.082)	(0.082)	(0.082)	(0.083)
Profitability	-0.451***	-0.553***	-0.478***	-0.524***	-0.486***	-0.428***
	(0.113)	(0.114)	(0.114)	(0.116)	(0.114)	(0.117)
Tangibility	0.084	0.216*	0.072	0.216*	0.109	0.231*
	(0.125)	(0.128)	(0.123)	(0.127)	(0.124)	(0.128)
Herfindahl	0.239**	0.091	0.206**	0.086	0.174*	0.076
	(0.097)	(0.104)	(0.098)	(0.105)	(0.098)	(0.106)
Age	0.039***	0.017*	0.038***	0.020**	0.038***	0.028***
	(0.003)	(0.010)	(0.003)	(0.009)	(0.003)	(0.009)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes	No	Yes
Observations	44,329	44,329	43,208	43,208	42,007	42,007
R-squared	0.901	0.906	0.906	0.911	0.909	0.914

Table 5. Distance from Financial Centers and Innovation

This table presents 2SLS-IV estimates of the impact of currency derivatives on patents. Columns 1 and 2 report first-stage estimates of the effect of distance from financial centers and a post-1987 indicator variable on currency derivatives use. Columns 3 to 8 report the second stage of the 2SLS-IV estimates of the impact of currency derivatives on patents. The instrumental variables are based on the distance of the headquarters of the firm from the nearest financial center, *Distance quartiles* (Columns 3, 5 and 7), and *Distance* (Columns 4, 6 and 8). The variable, *Post* takes the value one for years after 1987 and zero otherwise. All specifications include firm fixed effects, and controls for *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	Currency derivatives		$Ln(1+Pat)_{t+1}$		$Ln(1+Pat)_{t+2}$		$Ln(1+Pat)_{t+3}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Currency derivatives			0.451***	0.457***	0.477***	0.483***	0.517***	0.522***
			(0.150)	(0.150)	(0.155)	(0.154)	(0.158)	(0.157)
Distance quartile 1 * Post	0.067**							
	(0.030)							
Distance quartile 2 * Post	0.050*							
	(0.029)							
Distance quartile 3 * Post	0.068**							
	(0.029)							
Distance * Post		-0.032**						
		(0.015)						
Post	0.149***	0.215***						
	(0.019)	(0.014)						
Ln(Sales)	0.019***	0.018***	0.254***	0.252***	0.242***	0.240***	0.228***	0.227***
	(0.005)	(0.005)	(0.020)	(0.020)	(0.021)	(0.021)	(0.021)	(0.021)
Book leverage	0.070***	0.057**	-0.140**	-0.162**	-0.168**	-0.186***	-0.167**	-0.184***
	(0.022)	(0.022)	(0.067)	(0.066)	(0.068)	(0.066)	(0.069)	(0.067)
Profitability	0.077***	0.080***	-0.276***	-0.271***	-0.239***	-0.236***	-0.251***	-0.248***
	(0.027)	(0.027)	(0.088)	(0.088)	(0.089)	(0.090)	(0.092)	(0.092)
Tangibility	-0.112***	-0.130***	0.315***	0.284***	0.302***	0.278***	0.326***	0.304***
	(0.031)	(0.033)	(0.098)	(0.105)	(0.099)	(0.107)	(0.100)	(0.108)
Herfindahl	0.005	0.008	-0.191**	-0.187**	-0.166**	-0.163**	-0.138*	-0.135
	(0.027)	(0.027)	(0.085)	(0.085)	(0.083)	(0.083)	(0.083)	(0.083)

(Continue)

Table 5. – Continued

	Currency derivatives		$Ln(1+Pat)_{t+1}$		$Ln(1+Pat)_{t+2}$		$Ln(1+Pat)_{t+3}$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Age	0.002***	0.002***	-0.016***	-0.016***	-0.016***	-0.016***	-0.016***	-0.016***
	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No	No	No
F-statistic	62.48	69.52						
Observations	44,329	44,329	44,329	44,329	43,208	43,208	42,007	42,007
R-squared	0.376	0.375	0.854	0.854	0.857	0.857	0.860	0.860

Table 6. Distance from Financial Centers and Innovation Quality

This table presents 2SLS-IV estimates of the impact of currency derivatives on citations. Columns 1 to 6 report second-stage estimates of the effect of currency derivatives use on citations. We use natural logarithm of $(1 + Cit)_{t+k}$ as the dependent variable where Cit is the citations count in year $t + k$, k=1, 2, and 3 denoting one, two and three years after the current time period, t. The instrumental variables are based on the distance of the headquarters of the firm from the nearest financial center, *Distance quartiles* (Columns 1, 3, and 5), and *Distance* (Columns 2, 4, and 6). Control variables include one-year lagged values of *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	$Ln(1 + Cit)_{t+1}$		$Ln(1 + Cit)_{t+2}$		$Ln(1 + Cit)_{t+3}$	
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives	0.981***	0.959***	0.966***	0.943***	0.995***	0.974***
	(0.174)	(0.173)	(0.175)	(0.174)	(0.178)	(0.177)
Ln(Sales)	0.315***	0.321***	0.319***	0.324***	0.317***	0.321***
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Book leverage	-0.239***	-0.174**	-0.225**	-0.159*	-0.209**	-0.151*
	(0.087)	(0.085)	(0.088)	(0.086)	(0.088)	(0.086)
Profitability	-0.489***	-0.501***	-0.516***	-0.528***	-0.532***	-0.542***
	(0.119)	(0.119)	(0.119)	(0.120)	(0.119)	(0.120)
Tangibility	0.138	0.220	0.122	0.206	0.161	0.234*
	(0.132)	(0.140)	(0.131)	(0.138)	(0.131)	(0.140)
Herfindahl	0.232**	0.221**	0.200**	0.189*	0.170*	0.161
	(0.099)	(0.099)	(0.100)	(0.100)	(0.100)	(0.100)
Age	0.038***	0.038***	0.037***	0.038***	0.038***	0.038***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No
Observations	44,329	44,329	43,208	43,208	42,007	42,007
R-squared	0.899	0.899	0.904	0.904	0.908	0.908

Table 7. Robustness Check: Additional Control Variables

This table presents 2SLS-IV estimates of the second-stage of the impact of currency derivatives on patents. We use natural logarithm of $(1+Pat)_{t+k}$ as the dependent variable where Pat is the patent count in year $t+k$, k=1, 2, and 3 denoting one, two and three years after the current time period, t. The instrumental variables are based on the distance of firm's headquarters to the nearest financial center, *Distance quartiles*. All control variables are defined in Table A.1.. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	$Ln(1+Pat)_{t+1}$		$Ln(1+Pat)_{t+2}$		$Ln(1+Pat)_{t+3}$	
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives	0.921***	0.815***	0.839***	0.742***	0.697***	0.639***
	(0.143)	(0.139)	(0.145)	(0.142)	(0.146)	(0.143)
Ln(Sales)	0.225***	0.223***	0.219***	0.208***	0.209***	0.191***
	(0.023)	(0.026)	(0.024)	(0.027)	(0.025)	(0.028)
R&D/Assets	2.636***		2.532***		2.525***	
	(0.472)		(0.479)		(0.501)	
R&D stock/Assets		0.692***		0.599***		0.573***
		(0.194)		(0.196)		(0.200)
Book leverage	-0.255***	-0.231***	-0.258***	-0.230***	-0.214***	-0.199***
	(0.066)	(0.072)	(0.067)	(0.073)	(0.068)	(0.075)
Profitability	-0.248***	-0.221**	-0.171**	-0.147	-0.142	-0.115
	(0.084)	(0.098)	(0.087)	(0.101)	(0.089)	(0.104)
Tangibility	0.034	-0.009	-0.003	-0.034	-0.009	-0.013
	(0.125)	(0.141)	(0.127)	(0.141)	(0.127)	(0.143)
Herfindahl	0.019	0.181	0.073	0.188	0.154	0.296
	(0.276)	(0.310)	(0.285)	(0.320)	(0.295)	(0.334)
$Herfindahl^2$	0.038	-0.069	-0.008	-0.073	-0.083	-0.154
	(0.228)	(0.259)	(0.234)	(0.266)	(0.243)	(0.277)
Age	-0.030***	-0.029***	-0.029***	-0.027***	-0.026***	-0.024***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.004)
Ln(K/L)	0.046**	0.038	0.046*	0.037	0.048**	0.040
	(0.023)	(0.026)	(0.024)	(0.026)	(0.024)	(0.027)
Inter-state deregulation	0.033	0.044*	0.041*	0.050**	0.050**	0.055**
	(0.023)	(0.023)	(0.023)	(0.023)	(0.024)	(0.024)
Intra-state deregulation	-0.035	-0.043*	-0.037	-0.042	-0.037	-0.036
	(0.024)	(0.026)	(0.025)	(0.027)	(0.026)	(0.028)
State corporate tax changes	-0.112	-0.092	-0.135	-0.121	-0.153	-0.155
	(0.084)	(0.090)	(0.090)	(0.097)	(0.096)	(0.104)
Anti-takeover provisions	0.005	-0.021	-0.0382	-0.045	-0.051	-0.075
	(0.074)	(0.076)	(0.081)	(0.082)	(0.083)	(0.093)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No
Observations	30,374	26,287	29,680	25,626	28,888	24,886
R-squared	0.873	0.884	0.873	0.885	0.874	0.886

Table 8. Robustness Check: Alternative Definitions of Proximity

This table presents 2SLS-IV estimates of the impact of currency derivatives on patents. Columns 1 to 4 report first-stage estimates of the effect of distance from financial centers and a post-1987 indicator variable on currency derivatives use. Columns 5 to 8 report the second stage of the 2SLS-IV estimates of the impact of currency derivatives on patents. The instrumental variables are based on the travel distance, by car, from the headquarters of the firm to the nearest financial center, *Travel dist quartiles* (Columns 1, and 5), and *Travel dist* (Columns 2, and 6), and travel time by car, *Time quartiles* (Columns 3, and 7) and *Time* (Columns 4, and 8). The variable, *Post* takes the value one for years after 1987 and zero otherwise. All specifications include firm fixed effects, and controls for *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	Currency derivatives				$Ln(1+Pat)_{t+1}$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Currency derivatives					0.419***	0.396**	0.407***	0.890***
					(0.162)	(0.158)	(0.156)	(0.145)
Travel dist quartile 1 * Post	0.051*							
	(0.031)							
Travel dist quartile 2 * Post	0.057*							
	(0.030)							
Travel dist quartile 3 * Post	0.062**							
	(0.029)							
Travel dist * Post		-0.030**						
		(0.015)						
Time quartile 1 * Post			0.047					
			(0.031)					
Time quartile 2 * Post			0.058*					
			(0.030)					
Time quartile 3 * Post			0.055*					
			(0.030)					
Time * Post				-0.002*				
				(0.001)				
Post	0.144***	0.209***	0.147***	0.188***				
	(0.019)	(0.016)	(0.019)	(0.016)				
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No	No	No
F-statistic	42.38	46.53	38.84	46.52				
Observations	43,349	43,349	43,349	43,349	43,349	43,349	43,349	43,349

Table 9. Robustness Check: Alternative Measure of Innovation

This table reports OLS regression results using $R\&Dstock/Assets_{t+k}$ as the dependent variable. $R\&Dstock/Assets_{t+k}$ measures the R&D expenses in year $t+k$, k=1, 2, and 3 denoting one, two and three years after the current time period, t. *Currency derivatives* is a dummy variable taking the value of one if the firm uses currency derivatives, as per its SEC filings, in the year and zero otherwise. The variable *Post* takes the value one for years after 1987 and zero otherwise. Control variables include one-year lagged values of *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	$R\&Dstock/Assets_{t+1}$		$R\&Dstock/Assets_{t+2}$		$R\&Dstock/Assets_{t+3}$	
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives * Post	0.010***	0.017***	0.008**	0.015***	0.005	0.014***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Post	-0.009***		-0.010***		-0.011***	
	(0.003)		(0.003)		(0.003)	
Ln(Sales)	0.011***	0.008***	0.014***	0.012***	0.017***	0.014***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Book leverage	-0.018***	-0.022***	-0.017***	-0.024***	-0.017***	-0.026***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Profitability	-0.123***	-0.114***	-0.108***	-0.100***	-0.088***	-0.083***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)
Tangibility	0.010	0.011	0.009	0.009	0.006	0.006
	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)
Herfindahl	-0.046***	-0.040***	-0.046***	-0.038***	-0.044***	-0.035***
	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)
Age	0.002***	0.002***	0.001***	0.003***	0.001***	0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	Yes	No	Yes	No	Yes
Observations	37,618	37,618	38,303	38,303	38,949	38,949
R-squared	0.810	0.817	0.809	0.816	0.807	0.815

Table 10. Placebo Test: Size Quartile Effect on Patents

This table reports changes in patents for size quartiles post-1987. The variable, *Size quartile* is a measure of pre-1987 average firm size. The variable *Post* takes the value one for years after 1987 and zero otherwise. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	$Ln(1+Pat)_{t+1}$	$Ln(1+Pat)_{t+2}$	$Ln(1+Pat)_{t+3}$
	(1)	(2)	(3)
Size quartile 1 * Post	-0.032	-0.004	0.034
	(0.062)	(0.064)	(0.066)
Size quartile 2 * Post	0.011	0.034	0.057
	(0.068)	(0.069)	(0.071)
Size quartile 3 * Post	0.018	0.032	0.053
	(0.074)	(0.076)	(0.077)
Post	0.160***	0.145**	0.128**
	(0.056)	(0.058)	(0.060)
Ln(Sales)	0.282***	0.268***	0.255***
	(0.021)	(0.021)	(0.022)
Book leverage	-0.133**	-0.163***	-0.139**
	(0.060)	(0.061)	(0.063)
Profitability	-0.390***	-0.400***	-0.378***
	(0.087)	(0.090)	(0.093)
Tangibility	0.472***	0.515***	0.586***
	(0.092)	(0.093)	(0.095)
Herfindahl	-0.254***	-0.260***	-0.245***
	(0.077)	(0.077)	(0.077)
Age	-0.025***	-0.026***	-0.026***
	(0.002)	(0.002)	(0.002)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	No	No	No
Observations	44,329	43,208	42,007
R-squared	0.852	0.857	0.856

Table 11. Risk Management and Innovation Output

This table reports OLS regression results using $Ln(1+Pat)_{t+1}$ as the dependent variable. Columns 1 and 2 report results separately for firms with low and high CF exposure. Low (High) CF exposure firms are defined as firms that are in the first (fourth) quartile when sorted based on beta of cash flows to foreign currency shocks pre-1987. Columns 3 and 4 report results separately for firms with low and high FX beta. Low (High) FX beta firms are defined as firms that are in the first (fourth) quartile when sorted based on beta of equity returns to foreign-exchange index returns pre-1987. Columns 5 and 6 report results separately for firms with low and high standard deviation of returns. Low (High) SD of returns firms are defined as firms that are in the first (fourth) quartile when sorted based on standard deviation of equity returns five years before 1987. All specifications include firm fixed effects, and controls for *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	Low CF exposure	High CF exposure	Low FX beta	High FX beta	Low SD of returns	High SD of returns
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives	0.445	0.962***	0.272	0.724**	0.605*	0.697***
	(0.286)	(0.327)	(0.299)	(0.307)	(0.337)	(0.264)
Ln(Sales)	0.263***	0.186***	0.264***	0.289***	0.412***	0.137***
	(0.046)	(0.034)	(0.042)	(0.039)	(0.051)	(0.027)
Book leverage	-0.085	-0.199*	-0.297**	-0.234*	0.094	-0.351***
	(0.136)	(0.121)	(0.137)	(0.133)	(0.220)	(0.079)
Profitability	-0.217	0.0261	-0.144	-0.422*	0.033	-0.176**
	(0.235)	(0.133)	(0.148)	(0.221)	(0.350)	(0.082)
Tangibility	0.205	0.441***	0.267	0.300	0.677**	0.397***
	(0.224)	(0.164)	(0.183)	(0.210)	(0.292)	(0.134)
Herfindahl	-0.337**	-0.253	-0.267	0.031	-0.136	-0.034
	(0.162)	(0.189)	(0.170)	(0.176)	(0.224)	(0.153)
Age	-0.013***	-0.013**	-0.014***	-0.021***	-0.024***	-0.017***
	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.004)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No
Observations	11,169	9,969	10,558	11,062	11,167	10,197
R-squared	0.876	0.806	0.846	0.862	0.870	0.659

Table 12. Additional Results on Risk Management

This table reports OLS regression results using *FX beta* as the dependent variable. Columns 1 and 2 report results separately for firms with low and high CF exposure. Low(High) CF exposure firms are defined as firms that are in the first (fourth) quartile when sorted based on beta of cash flows to foreign currency shocks pre-1987. Columns 3 and 4 report results separately for firms with low and high FX beta. Low(High) FX beta firms are defined as firms that are in the first (fourth) quartile when sorted based on beta of equity returns to foreign-exchange index pre-1987. All specifications include firm fixed effects, and controls for *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	Low CF exposure	High CF exposure	Low FX beta	High FX beta
	(1)	(2)	(3)	(4)
Currency derivatives	0.738***	2.888	1.220***	1.902
	(0.224)	(1.789)	(0.246)	(1.190)
Ln(Sales)	-0.149***	-0.247***	-0.049	-0.235***
	(0.047)	(0.063)	(0.046)	(0.070)
Book leverage	0.214	1.616	-0.138	1.307
	(0.148)	(1.156)	(0.287)	(1.144)
Profitability	0.631**	1.353***	0.147	1.059***
	(0.309)	(0.376)	(0.262)	(0.350)
Tangibility	-0.191	0.019	-0.081	0.733
	(0.278)	(0.761)	(0.154)	(0.674)
Herfindahl	-0.020	-0.472	-0.017	-0.304
	(0.181)	(0.291)	(0.258)	(0.215)
Age	-0.003	-0.018	0.004	-0.015
	(0.005)	(0.022)	(0.004)	(0.016)
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No
Observations	6,515	5,327	5,677	6,363
R-squared	0.285	0.157	0.277	0.144

Table 13. Access to Credit and Innovation Output

This table reports OLS regression results using $Ln(1+Pat)_{t+1}$ as the dependent variable. Columns 1 and 2 report results separately for firms with and without bank relationship before 1987. Bank rel-ship (No rel-ship) before 1987 firms are defined as firms which had (had not) raised a syndicated loan before and including 1987. Columns 3 and 4 report results separately for firms with and without bank relationship before 1992. Bank rel-ship (No rel-ship) before 1992 firms are defined as firms which had (had not) raised a syndicated loan on or before 1992. Columns 5 and 6 report results separately for firms with and without credit rating before 1987. With (Without) credit rating firms are defined as firms which have (do not have) an S&P long-term issuer credit rating before 1987. All specifications include firm fixed effects, and controls for *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	Bank rel-ship before 1987	No rel-ship before 1987	Bank rel-ship before 1992	No rel-ship before 1992	With credit rating	Without credit rating
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives	-0.586	0.560***	0.118	0.720***	0.169	0.782***
	(0.559)	(0.155)	(0.252)	(0.187)	(0.260)	(0.168)
Ln(Sales)	0.299***	0.252***	0.266***	0.249***	0.314***	0.195***
	(0.076)	(0.021)	(0.033)	(0.024)	(0.034)	(0.022)
Book leverage	0.238	-0.173**	-0.095	-0.150*	-0.068	-0.200***
	(0.256)	(0.070)	(0.116)	(0.081)	(0.133)	(0.066)
Profitability	-0.464	-0.261***	-0.416***	-0.190*	-0.393*	-0.203***
	(0.520)	(0.088)	(0.160)	(0.105)	(0.226)	(0.079)
Tangibility	-0.488	0.390***	0.019	0.509***	0.280	0.358***
	(0.417)	(0.099)	(0.166)	(0.120)	(0.184)	(0.095)
Herfindahl	-0.804***	-0.135	-0.270**	-0.137	-0.366**	-0.032
	(0.301)	(0.089)	(0.129)	(0.113)	(0.158)	(0.074)
Age	-0.005	-0.017***	-0.016***	-0.016***	-0.016***	-0.018***
	(0.011)	(0.003)	(0.004)	(0.003)	(0.005)	(0.003)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No
Observations	3,245	40,493	14,904	28,920	17,717	26,113
R-squared	0.874	0.850	0.862	0.847	0.864	0.760

Table 14. Financial Constraints and Innovation Output

This table reports OLS regression results using $Ln(1+Pat)_{t+1}$ as the dependent variable. Columns 1 and 2 report results separately for financially constrained and unconstrained firm. Constrained (unconstrained) firms are defined as firms that are in the fourth (first) quartile when sorted using the average industry-level Kaplan-Zingales Index before 1987. Columns 3 and 4 report results separately for firms that have low and high cash levels. Low (high) cash firms are defined as firms that have cash/assets ratio in the first (fourth) quartile when sorted based on average cash/assets ratio before 1987. Columns 5 and 6 report results separately for firms that have low and high asset tangibility. Low (high) tangibility firms are defined as firms in the first (fourth) quartile of firms when sorted based on average property, plant and equipment/assets before 1987. All specifications include firm fixed effects, and controls for *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels respectively.

	Constrained (High KZ index)	Unconstrained (Low KZ index)	Low cash	High cash	Low tangibility	High tangibility
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives	19.07***	14.72***	0.670***	0.561***	0.672***	0.630***
	(4.546)	(3.233)	(0.189)	(0.190)	(0.168)	(0.221)
Ln(Sales)	-0.109	-0.099	0.219***	0.247***	0.121***	0.238***
	(0.147)	(0.086)	(0.047)	(0.043)	(0.044)	(0.052)
Book leverage	-1.454***	-1.194***	-0.210*	-0.326**	-0.170*	-0.180
	(0.296)	(0.260)	(0.115)	(0.145)	(0.089)	(0.143)
Profitability	-1.800***	-1.379***	-0.147	-0.086	-0.036	-0.331
	(0.339)	(0.263)	(0.144)	(0.161)	(0.123)	(0.214)
Tangibility	2.510***	1.962***	0.196	-0.016	0.081	-0.020
	(0.452)	(0.461)	(0.246)	(0.170)	(0.211)	(0.203)
Herfindahl	0.229	0.145	-0.033	-0.061	-0.026	-0.055
	(0.353)	(0.163)	(0.174)	(0.159)	(0.153)	(0.175)
Age	-0.024***	-0.010*	-0.025***	-0.008	-0.015***	-0.023***
	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)	(0.006)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	No	No	No	No	No	No
Observations	3,904	4,050	10,791	10,779	10,662	11,012
R-squared	0.975	0.913	0.808	0.891	0.794	0.874

Table A.1. Variable Definitions

This table provides a summary of all explanatory variables used in the analysis.

Variable name	Variable description
Firm characteristics and innovation measures:	
Assets_{it}	Total assets of firm i in year t (in US$ thousands).
Sales_{it}	Sales by firm i in year t (in US$ thousands).
$\text{R\&D/Assets}_{it}$	Research and development expenses of firm i in year t divided by its Assets in year t.
$\text{R\&D stock/Assets}_{it}$	Research and development expenses stock (computed following the conventional 15% depreciation rate used in the related literature (Hall, Jaffe, and Trajtenberg, 2005)) of firm i in year t divided by its Assets in year t.
$\text{Book leverage}_{it}$	Total debt of firm i in year t divided by its Assets in t.
$\text{Net debt/Assets}_{it}$	Total debt minus cash and short term investments of firm i in year t divided by its Assets in year t.
Cash/Assets_{it}	Cash of firm i in year t divided by its Assets in year t.
$\text{Profitability}_{it}$	Earnings before interest, tax, depreciation and amortization (EBITDA) of firm i in year t divided by its Assets in year t.
Tangibility_{it}	Net property, plant and equipment of firm i in year t divided by its Assets in year t.
Herfindahl_{it} ($\text{Herfindahl}^2{}_{it}$)	Equal to the sum of the squared share of firm i in total industry sales at the 4 digit SIC industry code in year t. (Equal to $\textit{Herfindahl}_{it}$ squared.)
Age_{it}	Age of firm i in year t based on the years from a firm's IPO (from CRSP).
K/L_{it}	Capital of firm i, represented by property, plants, and equipment (PPE), in year t divided by its labor in year t, measured by the number of employees.
Pat_{it}	Count of the number of granted patents in year t by firm i.
Cit_{it}	Count of the number of citations to granted patents received by firm i from the grant year to year t.
$\text{Currency derivatives}_{it}$	A dummy variable that takes on a value of one if firm i reports using currency derivatives in year t, and zero otherwise.
FX beta_{it}	Beta of equity returns to foreign-exchange index returns calculated by running a regression of monthly equity returns for firm i on CRSP value-weighted market index returns and returns on a trade-weighted basket of foreign currencies for a five-year rolling window before and including year t.
Measures of distance to financial centers:	
Distance_i	Equal to the physical distance between firm i headquarters and the nearest financial center, calculated as the shortest distance between the two points along the surface of a mathematical model of the Earth.
Travel distance_i	Equal to the travel distance (by car, using road networks, in 1000 kilometers) between firm i headquarters and the nearest financial center.
Travel time_i	Equal to the travel time, in hours (the time it takes to travel by car), between firm i headquarters and the nearest financial center.
Distance quartile 1_i (2_i, 3_i)	A dummy variable that takes on a value of one if the firm is in the first (second, third) quartile based on physical distance between headquarters and financial centers.
Travel dist quartile 1_i (2_i, 3_i)	A dummy variable that takes on a value of one if the firm is in the first (second, third) quartile based on travel distance between headquarters and financial centers (the least distance to financial centers).

(Continue)

Table A.1. – Continued

Variable name	Variable description
Time quartile 1_i (2_i, 3_i)	A dummy variable that takes on a value of one if the firm is in the first (second, third) quartile based on time distance between headquarters and financial centers (the least distance to financial centers).
Size quartile 1_i (2_i, 3_i)	A dummy variable that takes on a value of one if the firm is in the first (second, third) quartile based on size, measure by average pre-1987 (from 1977 to 1987) revenues.
Additional control variables:	
Post_t	A dummy variable that takes on a value of one for each year t after 1987, and zero otherwise.
Inter-state deregulation_{it}	A dummy variable that takes on a value of one if inter-state banking deregulation has been implemented before or in the year t in the state in which firm i's headquarters are located.
Intra-state deregulation_{it}	A dummy variable that takes on a value of one if intra-state banking deregulation has been implemented before or in the year t in the state in which firm i's headquarters are located.
State corporate tax changes_{it}	A dummy variable that takes on a value of one if year t represents a year with a significant tax change in the state in which firm i's headquarters are located.
Anti-takeover provisions_{it}	A dummy variable that takes on a value of one if an anti-takeover legislation has been implemented before or in the year t in the state in which firm i's headquarters are located.
Low (High) CF exposure_{it}	A dummy variable that takes on a value of one if the firm is in the first (fourth) quartile when sorted based on beta of cash flows to foreign currency shocks pre-1987.
Low (High) FX beta_{it}	A dummy variable that takes on a value of one if the firm is in the first (fourth) quartile when sorted based on beta of equity returns to foreign-exchange index returns pre-1987.
Low (High) SD of returns_{it}	A dummy variable that takes on a value of one if the firm is in the first (fourth) quartile when sorted based on standard deviation of equity returns five years before 1987.
Bank rel-ship (No rel-ship) before 1987_{it}	A dummy variable that takes on a value of one if the firm had (had not) raised a syndicated loan before and including 1987.
Bank rel-ship (No rel-ship) before 1992_{it}	A dummy variable that takes on a value of one if the firm had (had not) raised a syndicated loan before and including 1992.
With (Without) credit rating_{it}	A dummy variable that takes on a value of one if the firm has (does not have) an S&P long-term issuer credit rating pre-1987.
Constrained $(\text{Unconstrained})_{it}$	A dummy variable that takes on a value of one if the firm is in the fourth (first) quartile when sorted using the average industry-level Kaplan-Zingales Index before 1987.
Low (High) cash_{it}	A dummy variable that takes on a value of one if the firm has cash/assets ratio in the first (fourth) quartile when sorted based on average cash/assets ratio pre-1987.
Low (High) tangibility_{it}	A dummy variable that takes on a value of one if the firm is in the first (fourth) quartile when sorted based on pre-1987 average property, plant and equipment/assets.

Internet Appendix

Table I.1. Impact of Financial Innovation on Innovation: Balanced Panel

This table reports OLS regression results. We use natural logarithm of $(1+Pat)_{t+k}$ $((1+Cit)_{t+k})$ as the dependent variable in the first (last) three columns. The sample is restricted to only those firms that are present during the entire period from 1977 to 1997. *Currency derivatives* is a dummy variable taking the value of one if the firm uses currency derivatives, as per its SEC filings, in the year and zero otherwise. The variable *Post* takes the value one for years after 1987 and zero otherwise. Control variables include one-year lagged values of *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	$Ln(1+Pat)_{t+1}$	$Ln(1+Pat)_{t+2}$	$Ln(1+Pat)_{t+3}$	$Ln(1+Cit)_{t+1}$	$Ln(1+Cit)_{t+2}$	$Ln(1+Cit)_{t+3}$
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives * Post	0.242***	0.239***	0.231***	0.359***	0.359***	0.359***
	(0.057)	(0.058)	(0.060)	(0.055)	(0.057)	(0.058)
Post	0.091***	0.068**	0.037	0.002	0.009	0.013
	(0.031)	(0.032)	(0.032)	(0.027)	(0.028)	(0.030)
Ln(Sales)	0.290***	0.283***	0.275***	0.260***	0.273***	0.275***
	(0.056)	(0.057)	(0.057)	(0.046)	(0.048)	(0.049)
Book leverage	-0.131	-0.124	-0.102	-0.103	-0.131	-0.099
	(0.146)	(0.146)	(0.142)	(0.146)	(0.148)	(0.147)
Profitability	-0.224	-0.271	-0.186	-0.568***	-0.538***	-0.430*
	(0.187)	(0.190)	(0.195)	(0.232)	(0.226)	(0.228)
Tangibility	-0.019	-0.068	0.016	0.016	-0.031	-0.024
	(0.209)	(0.204)	(0.200)	(0.218)	(0.228)	(0.235)
Herfindahl	0.003	-0.020	-0.077	-0.232	-0.249	0.259
	(0.164)	(0.164)	(0.170)	(0.197)	(0.194)	(0.191)
Age	-0.017***	-0.015***	-0.011*	0.053***	0.053***	0.055***
	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No
Observations	8,452	8,452	8,452	8,452	8,452	8,452
R-squared	0.914	0.913	0.912	0.952	0.952	0.952

Table I.2. Impact of Financial Innovation on Innovation: Alternative Measures of Innovation

This table reports OLS regression results. We use natural logarithm of $(1 + Pat^C)_{t+k}$ $((1 + Cit^C)_{t+k})$ as the dependent variable in the first (last) three columns. To control for the technological field–fixed effects, the number of patents and citations are divide by the corresponding field mean. *Currency derivatives* is a dummy variable taking the value of one if the firm uses currency derivatives, as per its SEC filings, in the year and zero otherwise. The variable *Post* takes the value one for years after 1987 and zero otherwise. Control variables include one-year lagged values of *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	$Ln(1+Pat^C)_{t+1}$	$Ln(1+Pat^C)_{t+2}$	$Ln(1+Pat^C)_{t+3}$	$Ln(1+Cit^C)_{t+1}$	$Ln(1+Cit^C)_{t+2}$	$Ln(1+Cit^C)_{t+3}$
	(1)	(2)	(3)	(4)	(5)	(6)
Currency derivatives * Post	0.262***	0.256***	0.260***	0.175**	0.078	-0.036
	(0.055)	(0.058)	(0.061)	(0.080)	(0.081)	(0.082)
Post	0.005	0.018	0.023	- 0.144***	-0.172***	-0.204***
	(0.022)	(0.023)	(0.024)	(0.042)	(0.043)	(0.044)
Ln(Sales)	0.183***	0.181***	0.178***	0.393***	0.379***	0.365***
	(0.019)	(0.020)	(0.021)	(0.032)	(0.033)	(0.033)
Book leverage	-0.099*	-0.109*	-0.102*	-0.226**	-0.255***	-0.204**
	(0.056)	(0.057)	(0.059)	(0.102)	(0.104)	(0.105)
Profitability	-0.135*	-0.106	-0.140	-0.336***	-0.337***	-0.381***
	(0.076)	(0.080)	(0.084)	(0.137)	(0.141)	(0.147)
Tangibility	0.090	0.090	0.090	0.212	0.235	0.246
	(0.088)	(0.092)	(0.097)	(0.154)	(0.159)	(0.161)
Herfindahl	-0.327	-0.299	-0.205	-1.296***	-1.263***	-1.066***
	(0.238)	(0.247)	(0.257)	(0.420)	(0.431)	(0.449)
Age	-0.008***	-0.009***	-0.010***	-0.004	-0.005	-0.006
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	No	No	No	No	No	No
Observations	44,329	43,208	42,007	44,329	43,208	42,007
R-squared	0.801	0.802	0.804	0.754	0.755	0.758

Table I.3. Additional Robustness Tests: Excluding States

This table reports the first-stage estimates of 2SLS-IV regressions using currency derivatives use as the dependent variable and distance from financial centers as the main explanatory variable. Each regression includes an interaction of distance from financial centers, *Distance* and the variable *Post* that takes the value one for years after 1987 and zero otherwise. Control variables include one-year lagged values of *Ln(Sales), Book leverage, Profitability, Tangibility, Herfindahl*, and *Age*. Unreported coefficients are available upon request. Each row excludes firms which are headquartered in one state. The standard errors, reported in parentheses, are heteroskedasticity consistent and clustered by firm. ***, **, and * denote significance at the 1%, 5% and 10% levels, respectively.

	Currency derivatives		
	Interaction term coefficient *Distance * Post*	Standard error	Observations
Excluding New York	-0.040**	(0.016)	39,751
Excluding Alabama	-0.032**	(0.015)	44,196
Excluding Arkansas	-0.032**	(0.015)	44,173
Excluding Arizona	-0.032**	(0.015)	43,880
Excluding California	-0.033**	(0.015)	40,531
Excluding Colorado	-0.031**	(0.015)	43,732
Excluding Connecticut	-0.031**	(0.015)	42,293
Excluding District of Columbia	-0.033**	(0.015)	44,272
Excluding Delaware	-0.031**	(0.015)	44,060
Excluding Florida	-0.026*	(0.015)	43,204
Excluding Georgia	-0.030**	(0.015)	43,415
Excluding Idaho	-0.032**	(0.015)	44,176
Excluding Illinois	-0.034**	(0.015)	40,658
Excluding Indiana	-0.032**	(0.015)	43,718
Excluding Kansas	-0.032**	(0.015)	44,059
Excluding Kentucky	-0.032**	(0.015)	44,071
Excluding Louisiana	-0.031**	(0.015)	44,226
Excluding Massachusetts	-0.031**	(0.015)	42,524
Excluding Maryland	-0.033**	(0.015)	43,822
Excluding Maine	-0.032**	(0.015)	44,257
Excluding Michigan	-0.033**	(0.015)	42,060
Excluding Minnesota	-0.035**	(0.015)	43,072
Excluding Missouri	-0.033**	(0.015)	43,286
Excluding Mississippi	-0.032**	(0.015)	44,299
Excluding Montana	-0.032**	(0.015)	44,318
Excluding North Carolina	-0.032**	(0.015)	43,173
Excluding Nebraska	-0.032**	(0.015)	44,224
Excluding New Hampshire	-0.032**	(0.015)	44,091
Excluding New Jersey	-0.032**	(0.015)	41,931
Excluding Ohio	-0.033**	(0.015)	41,754
Excluding Oklahoma	-0.032**	(0.015)	44,065
Excluding Oregon	-0.032**	(0.015)	44,131
Excluding Pennsylvania	-0.033**	(0.015)	44,076
Excluding Rhode Island	-0.032**	(0.015)	44,115
Excluding South Carolina	-0.031**	(0.015)	44,105
Excluding South Dakota	-0.032**	(0.015)	44,040
Excluding Tennessee	-0.032**	(0.015)	44,279
Excluding Texas	-0.034**	(0.015)	43,890
Excluding Utah	-0.036**	(0.015)	41,005
Excluding Virginia	-0.032**	(0.018)	44,148
Excluding Washington	-0.034**	(0.015)	43,077
Excluding Wisconsin	-0.031**	(0.015)	43,928