Risk Pricing of Wholesale Funds and the Behavior of Retail Deposit Rates: How Bank-Specific Risk Drives Substitution and Local-Market Competition *

[PRELIMINARY & INCOMPLETE – DO NOT QUOTE/CITE]

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Abstract

This paper focuses on how bank-specific risk indirectly affects the pricing of retail deposits. Using bank-market data, we show that predicted risk-priced premiums on bank wholesale funds produce two channels associated with the substitution into retail funds. In the first channel, an increase in own-bank risk encourages the bank to substitute between the two sources of funds. In the second channel, an increase in risk of the bank's local market rivals creates competitive pricing pressure that inhibits the bank from substituting into retail deposits. Both channels are byproducts of the difference in guarantees between the two types of deposits, and in the way the retail rate decision is modeled. We then present evidence that certain bank/local-market characteristics allow the bank to mitigate its response to own and competitive pricing pressures. These characteristics allow the bank to more easily substitute between wholesale and retail funds. Our approach to characterizing the effect of risk on liability management has implications for regulatory and monetary policies focused on financial stability.[166]

JEL Classifications: G21, G28, E52, E44

Key Words: Risk Pricing, Retail Market Competition, Deposit Rate Contagion

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1. Introduction

Understanding the channels by which bank-specific risk affects bank liability management has implications for antitrust policy, monetary transmission and prudential regulations focused on financial stability. This paper explores the risk-induced substitution between wholesale and retail deposits. We argue that the bank's own risk and the risk of the bank's rivals in a local market affect the pricing of the bank's retail deposits, and determine the ability of the bank to use retail deposits as a marginal source of funds. We show that the bank's own-risk pressure will encourage it to substitute into retail funds, while local-market rival-risk pressure inhibits that substitution. However, by managing its risk-priced pressure through interest-rate derivatives usage, local market power and multi-market presence, the bank can more easily treat retail deposits as a marginal source of funds.

We focus on risk-pricing as a mechanism through which bank-specific risk affects retail deposits rates. We assume an aggregate bank's predicted risk-priced premium on wholesale funds incentivizes it to substitute between wholesale and retail deposits by altering retail rates. We argue that this risk-induced substitution creates two channels – own-bank and rival-bank effects. Through the first channel, an increase in the bank's predicted risk-priced premium induces the bank to substitute away from more expensive uninsured wholesale funds and towards cheaper insured retail deposits, by raising retail rates. The larger this predicted risk premium and reliance on wholesale funds the greater is the pressure for the bank to increase retail rates, all else equal. This pricing pressure is aggregate-bank specific and is independent of the market in which the bank operates. Through the second channel, increased risk of the bank's local market rivals incentivizes those rivals to raise their retail rates. Consequently, the bank faces greater deposit rate pressure in a local market where its predicted rival-risk premiums are high. This rival-risk pricing pressure is bank-market specific. The extent of this rival-risk pressure depends on the size of each of the predicted rival-risk premiums and on the distribution of deposits among rival banks in a particular market. The increased rival-risk pricing pressure affects the bank's retail rate by decreasing its supply elasticity for retail deposits in that market. This risk pressure is a second component of the bank's retail deposit pricing decision. Thus, we model the bank's retail rate decision as depending on its predicted own-risk premium associated with its wholesale funding and the deposit-weighted predicted risk premiums associated with the wholesale funding of its rivals in a particular market. Both of these channels are driven by the single mechanism of risk pricing of bank-specific risk in the uninsured wholesale market and the substitution into guaranteed retail deposits it implies.

Most studies on retail pricing behavior emphasize two themes – substitution between wholesale and retail funds due to changes in the costs of wholesale funds, and competition in local markets due to market-specific characteristics. Those studies employing a substitution argument usually focus on fluctuations in wholesale rates, but it is often unclear whether rates change due to variation in bank-specific risk or changes in policy-induced rates or both. In studies that explicitly include risk, the exact role risk plays in substitution is often unclear. Recent papers on the role of risk in promoting retail deposits as a marginal source of funds do not isolate a market-discipline mechanism. Those studies employing measures of competition in local markets often use market-specific concentration ratios, which do not focus on the mechanism by which competition takes place. Those that include rival rates as price pressure use contemporaneous competitor rates as regressors and include only a small percentage of total local-market rivals. These approaches to competition could lead to biased results.

We focus on these same two themes of substitution and competition, but with a single mechanism that drives both – risk-pricing pressure in the wholesale funds market and the consequent substitution into retail deposits. A key assumption behind our two-component pricing model that sets it apart from others is that pricing decisions are made at the aggregate bank level by estimating risk-pricing premiums for the bank and its rivals. These two predicted premiums are indictors of wholesale pricing pressures that determine the extent to which the bank will change retail rates at the bank-market level to substitute between wholesale and retail deposits. This approach produces explicit measures of pricing pressure through own-risk and local market rival-risk. The latter component is an instrument for price competition in a particular market. The predicted risk premiums are estimated from past-period balance sheet measures of risk available to the bank on itself and all of its bank rivals in any local market.

We explore how the bank can mitigate its retail rate response to risk-pricing pressures, allowing it to more easily substitute between wholesale and retail funds. We assess whether bank-specific derivatives usage, market-specific concentration ratios, and bank-market-specific deposit and branch share ratios can be used to manage risk-pricing pressures. We then examine whether these characteristics allow a multi-market bank to mitigate risk-driven pricing pressures by price discriminating.

Using predicted risk-priced premiums to explain retail pricing has several advantages. It ties together risk, risk pricing, and substitution from wholesale to retail funds into a single framework with a risk-driven measure of price competition. The use of bank-market retail rates as the dependent variable and predicted aggregate-bank risk and local-market rival-bank risk pressure allows us to test assumptions previously used to characterize retail rate behavior across banks and across markets. Our approach allows us to mitigate cross-market correlation problems and omitted variable problems present in other econometric retail rate studies. Finally, our approach to retail deposit pricing and our characterization of local market competition has implications for policies aimed at promoting financial market stability.

Section 2 lays out an argument for how an increase in predicted bank-specific risk results in retail-pricing components for own-bank risk pressure and rival-bank risk pressure. This section also builds an argument for how market power and multiple market presence mitigate local market rival risk pricing pressure, decreasing the cost of retail deposits, allowing the bank to substitute more easily into retail deposits. Section 3 lists the hypotheses tested and presents the empirical models used to test those hypotheses. Section 4 presents the data and results. Section 5 outlines some policy implications.

2. The Risk Pricing of Wholesale Funds and the Retail Deposit Rate Behavior

2.1 The Risk-Pricing Mechanism and Retail Rates

In this section we explain how bank-specific risk working through predicted risk-priced premiums in the wholesale market set up an own-risk and rival-risk decision that influences the bank in setting its retail rates. Our argument relies on the presence of a market for uninsured funds (wholesale deposit market) and a market for insured funds (retail deposit market). Wholesale deposits are purchased in a national (or large regional) market and are subject to risk pricing (market discipline). Retail deposits are purchased in a local market (e.g., an MSA) where the bank has some market power. That market power is embodied in the supply function of retail deposit funds facing the bank, and is determined by local-market conditions, including the competitive behavior of the bank's rivals in that market. The bank uses these two markets to manage its liabilities to minimize the cost of raising a given amount of deposits.

We start with a simple pricing model based on a bank's own risk-pricing pressure to switch into retail deposits, and then explain how the risk-pricing pressure of its rivals inhibits this substitution through price competition. This rival-risk pressure defines an explicit measure of price competition to which the bank reacts. For expositional purposes, we initially assume that each bank operates in a single retail deposit market. Changes in predicted risk-priced premiums across banks in the previous period are exogenous shocks driving each of the two pricing components in the current period.[1] In this set up, heterogeneity in own-bank risk premiums account for the heterogeneity in retail pricing across banks. Heterogeneity of rival-bank risk facing the bank in a local market accounts for the heterogeneity in retail pricing across local markets.

[1] Other papers assume the cost-of-funds, mix-of-liabilities or competition determine risk taking behavior [Boyd et al see Craig-Dinger (2010)]. Because measures of risk in the short run (quarter-to-quarter) are quite volatile, as are retail rates, we argue that risk affects retail rates and define a risk-driven price competition.

After explaining the mechanism that drives the two risk components of retail pricing we argue that certain aggregate bank, market and bank-market characteristics allow the bank to mitigate the effect of these two risk-pricing shocks on its retail rates. First we show that the response to own-risk depends on the level of rival-risk, and vice versa, in any given market. For the bank to raise additional retail deposits when its own-risk is high, its rival-risk pricing pressure should be low. Second, because these two pricing components are risk driven, the bank's use of risk management tools, like interest rate derivatives, affects its response to own-risk and rival risk pricing pressure. Third, local market power and a multi-market presence can also be used to manage the effects of own-risk and rival-risk pricing pressure.

Own-Risk Effect facing The Bank

(Own-Bank Risk ↑ => $S^{\text{Wholesale DP}}$↓)

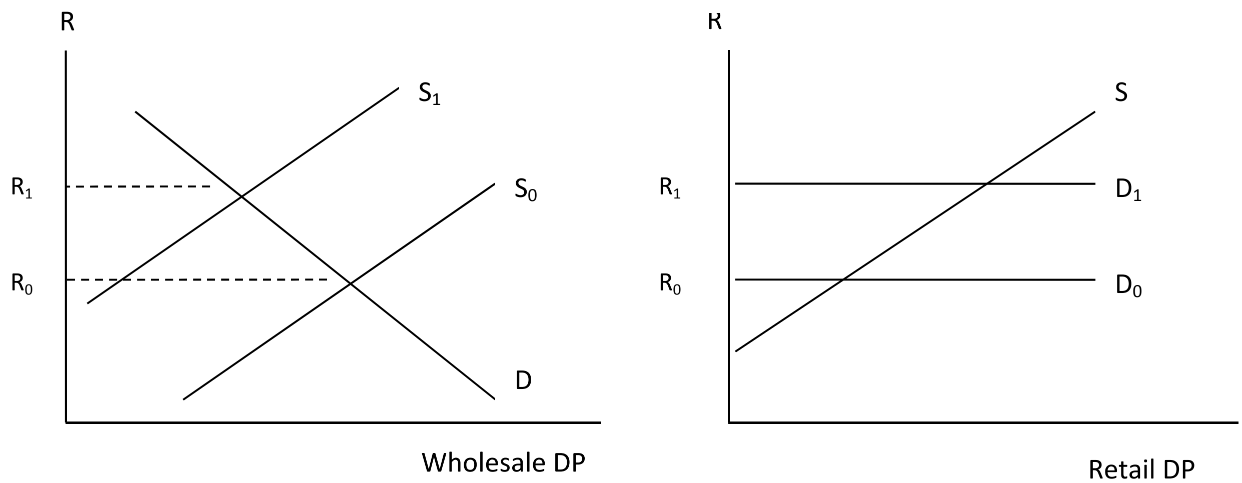

FIGURE 1

Referring to *Figure 1*, assume that bank-specific default risk rises, as proxied by financial statement variables available in period t-1. Consequently, in the wholesale market, uninsured depositors decrease the supply of funds to the bank in time period t, driving the wholesale rate up. That is, depositors discipline the bank by pricing perceived bank-specific risk. Because financial information on its risk in time period t-1 is publicly available, the bank predicts in t-1 the risk premium depositors will force it pay in time period t. The bank responds to its predicted risk premium, and consequent loss of wholesale funds, by appropriately setting the retail deposit rate in period t so as to substitute into cheaper retail deposits.[2] Thus, an increase in bank-specific risk and the resulting predicted increase in the cost of wholesale funds incentivize the bank to move into cheaper inputs by raising retail rates.[3] We call this effect on retail rates due to a change in predicted own-bank risk pressure the *Own-Risk Effect*.

Most other retail rate studies also assume interest rates drive a substitution between wholesale and retail funds. That substitution is usually argued to follow from fluctuations in wholesale rates, although it is often unclear whether rates change due to variation in bank-specific risk or due to changes in policy-induced rates [e.g., Kiser (2003)]. Recent papers that refer to risk assume implicitly or explicitly that a higher risk premium can induce a substitution from wholesale to retail funds [e.g., Gambacorta (2004), Craig-Dinger (2010), Acharya-Mora (2012)]. However, none of these studies isolate a measure of a risk-priced-premium nor otherwise show explicitly the effect of market discipline on retail rates. Some of these studies include direct balance-sheet proxies for risk, some of which show coefficients that have counter-intuitive or insignificant signs, raising the possibility that their results could be due to risk-related constraints other than risk-priced premiums.[4]

Next, we apply to the bank's rivals in a local market the same risk-pricing argument we applied to the bank. The predicted risk-pricing pressure from the bank's rivals proxies for a type of price competition facing the bank that should affect how the bank sets its retail deposit rate. Referring to Figure 2, assume that the bank is faced with a group of competitors for retail deposits in a particular local market. Assume that these competitors receive shocks in the way of an increase in their own bank-specific solvency risk as proxied by financial statement variables in period t-1. The bank's rivals will react similarly to how the bank reacted to its own-risk effect. Due to risk pricing in the wholesale market, predicted to occur in period t, they will be faced with higher wholesale risk premiums and have incentives to substitute into retail funds by raising their retail rates in the local market. The bank uses this information on its local market rivals in period t-1 to predict the extent to which their risk premiums will pressure them to raise their retail rates. The bank uses this increase in the predicted price pressure of its rivals to gauge the extent to which that pressure will adversely impact the bank's supply elasticity of retail funds in period t. This competitive pricing pressure will incentivize the bank to initially substitute away from retail deposits and into wholesale funds, increasing the bank's demand for wholesale funds. Because the cost of wholesale funds is increasing in the quantity of funds, the bank will

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[2] The upward-sloped supply of retail funds assumes that the bank has some market power, possibly due to product differentiation. This assumption is common in spatial and representative consumer models of retail deposit pricing. [need citation for banks. e.g., Carlton-Perloff (2005) chapter 7].

[3] Note that even though there is not risk pricing of insured deposits, the probability of bank default indirectly affects the pricing of retail rates. Note, however, that insured deposits behave as if they are risk-priced.

[4] E.g., regulatory or bank-imposed constraints associated with risk.

react by paying a higher wholesale rate and, therefore, has incentive to raise retail rates further in period t.[5] Thus increases in the predicted risk premiums of its rivals will put competitive pressure on the bank's retail deposit rates. We call this effect on retail rates of the bank due to a change in predicted rival-bank risk pressure the *Rival-Risk Effect*.[6]

Rival-Risk Effect facing The Bank

(Rival-Bank Risk ↑ => $S^{\text{Retail DP}}$↓)

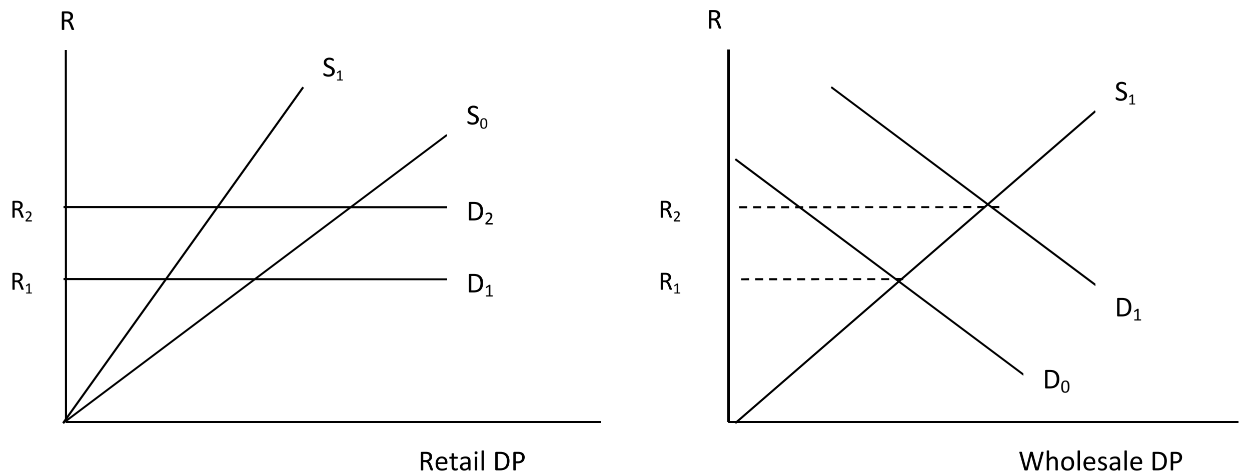

FIGURE 2

The argument that risk is a driver of competition is also at the heart of the risk-contagion literature.[7] Our approach using a predicted risk-priced premium associated with the bank's rivals to characterize local market competition is a type of price contagion. Recent studies have emphasized price contagion in local retail markets [Acharya-Mora (2014), Craig-Dinger (2010)], but these studies include rival rates

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[5] Kashyap-Stein (2000) and Kishan-Opiela (2000) assume the cost of wholesale funds increases in the quantity of funds (i.e., the more a bank borrows in the wholesale market the greater its perceived liquidity risk. Jordan (2000) assumes a constant funds cost. Park-Peristiani (1998) give a rational for both supply functions.

[6] When depositors decrease their deposits at risky rival banks they will increase their supply of funds at relatively safer banks. Because we assume the market for wholesale funds is large and competitive, we assume the increase in the supply of funds at the safer banks is small enough so as not to offset the *Rival-Risk Effect*. RIVAL sub into safer banks.Acharya-Mora (2014) find some evidence that retail deposits increase in local markets due to substitution our of failing or near-failing banks. However, they find no evidence that this shows up in the market for wholesale funds.

[7] Kaufman (1994) presents a general definition of contagion. Cooperman et al. (1992) examine CD rate contagion, but omit rival bank rates. Jordan (2000) and Billet-Garfinkal-O'Neal (1998) emphasize deposit-quantity contagion. The movement of quantities is consistent with risk and price contagion.

contemporaneously (setting potential endogeneity), they include data on a scant number of rivals (setting up potential bias) and they mainly emphasize contagion during the recent financial crisis.

Our characterization of rival-risk price pressure affects market power through its impact on the elasticity of deposit supply facing the bank. This market power can be characterized as arising from oligopolistic pricing behavior that is driven by risk-pricing pressure from the bank's rivals in a particular market. This rival-risk effect and the price competition it implies is consistent with Bertrand-Nash oligopolistic price competition in which each firm sets its price based on information about how other firms will react to that price. That is, each bank uses aggregate bank-specific information on its rivals, available in time t-1, to form predictions of rival risk-priced premiums in a local market. In time t banks simultaneously set retail rates based on these predicted risk premiums.[8] Models of Bertrand pricing often do not specify the mechanism by which prices changes take place. We argue that a predicted risk-pricing mechanism increases the price of wholesale funds, incentivizing banks to substitute into cheaper inputs by raising retail rates.

2.2 Mitigating Effects on Own and Rival Risk-Pricing Pressure

We now build an argument for why the retail rate response of the bank to its own-risk and rival-risk pricing pressures might be mitigated. First we argue that the response to own-risk and rival-risk effects are impacted by each other's level. When own-bank risk increases the bank is pressured into raising retail deposit rates. If the bank at the same time is faced with a high level of rival-bank risk, the bank will not respond as vigorously to its own-risk shock as it would in the absence of high rival risk. That is, because the high level of rival-risk pressure decreases the bank's elasticity of retail deposit supply, the cost of substituting due to own-risk is higher. Thus, its response to own-risk is attenuated. Likewise, if the bank faces an adverse risk shock from its rivals, it might realize it would do little good to respond to that shock when its own-risk pressure is at a high level. Thus the bank is less responsive in both cases due to the lack of options to raise funds when the other risk-priced pressure level is high.

[8] Our argument is consistent with hybrid models of oligopoly/monopolistic-competition [e.g., see references in Carlton-Perloff (2005), p. 230]. We view our argument as a static Bertrand-Nash pricing model in which information on a bank and its competitors available in period t-1 is used simultaneously by all banks to set retail rates in period t. This one-period game is viewed as being reset each period as new risk-pricing shocks occur and that are relevant for the next period. We can assume that our model controls for monopolistic-competitive factors that might affect retail rates in any local market. If we have controlled for these factors, a risk-priced shock should have banks pricing retail rates at the cost of wholesale funds in equilibrium (i.e., at marginal cost). This is consistent with the classic Bertrand-Nash model. Cosimano-Fullenkamp-Sheehan (1997, 1999), VanHoose (2010), Kopecky-VanHoose (2012) present retail rate models consistent with Bertrand pricing

Second, the bank might have a mitigated response to risk pricing pressure due to its ability to hedge the volatility in its wholesale risk premium. For example, the aggregate bank could engage in interest-rate derivatives usage. This action mitigates the need to raise retail deposits by cushioning the effect of adverse shocks to wholesale rates on retail rates. In general, interest-rate derivative usage can hedge against volatility in market rates, but not against volatility due to bank-specific risk. However, Kishan-Opiela (2012) document that changes in wholesale market rates (e.g., large CD rates or policy affected rates) can exacerbate risk-priced premiums of banks that have weak balance sheets. This evidence implies that it would be possible for the bank to use derivatives to hedge the volatility in its risk premium. Because of the previous argument on the interconnectedness of own-risk and rival-risk effects, derivatives usage could indirectly allow a bank to respond less to rival-risk pressure.[9]

The bank has no direct instrument to hedge the risk pricing pressure it faces from its rivals in a particular market. However a third possible way to mitigate its retail rate response is through market power in a particular local market. Market power, as measured by deposit share or branch share, could be used to counter the risk-pricing pressure from the banks own-risk and rivals-risk effects by producing a smaller effect on the bank's supply elasticity of retail deposits.

Up to this point we assume the bank operates in a single local retail market. A presence in multiple markets, however, provides a fourth way the bank can mitigate the effect of risk pricing pressure on its retail rate setting behavior. If the bank has differential market power across its multiple markets and faces increased retail price pressure from its own-risk or rival-risk effects in any particular market, then the bank can spread that increased pressure differentially to reduce the cost of raising a given amount of deposits. This strategic type of pricing allows the bank to avoid local market competition.

2.4 Risk Pricing Pressure and the Multiple-Market/Spatial Banking Literature

We mention the multi-market and spatial bank literature to illustrate how our approach differs from most other retail pricing studies and to show how it can answer important questions that are assumed in other studies. This literature has set the stage for the way most retail rate papers have structured the pricing of retail deposits in recent years. This multi-market literature assumes that large multi-market banks pay low wholesale rates due to low risk and make centralized local market rate decisions to mitigate information problems associated with their branches. These assumptions are consistent with results that these banks pay lower retail deposit rates and set their rates uniformly over broad markets

[9] Brewer-Deshmukh-Opiela (2014) show evidence that interest rate derivatives usage cushions the effects of liability shocks, allowing the bank to optimally choose its least cost liability funding mix..

[Radecki (1999), Park-Pennacchi (2003), Hannan-Prager (2004)]. However, this explanation is not consistent with recent stylized facts that some large banks are perceived as risky and that there exists a variance in retail rates among markets of the same bank [Craig-Dinger (2010), Driscoll-Judson (2013)].

The above-mentioned multi-market approach sets up an econometric model where the aggregate bank competes with other aggregate banks at a national level [Park-Pennacchi (2003), Hannan-Prager (2004), Acharya-Mora (2014)]. These studies include local markets by regressing average aggregate-bank retail rates on average market conditions. This set up ignores cross-market correlations in rates [Craig-Dinger (2010)], possibly resulting in bias in estimates of aggregate and market variables on retail prices.

Our approach does not rely on the above-mentioned two assumptions. First, we estimate a predicted risk-priced premium for each bank rather than assume it is low for some banks. This allows us to understand the effect of risk on retail rate pricing. Second, we assume the pricing decision is made at the aggregate level, but using own-aggregate and rival-aggregate bank information, where the latter is focused at the local-market level. Thus, our approach allows us to understand how aggregate own-bank risk and aggregate rival-bank risk contribute to retail deposit pricing. Our argument can reach the same conclusions as the above-mentioned assumptions, but as special cases and for different reasons than specified above. [10] Our model is consistent with the stylized facts of retail rates. Whether banks have lower rates or price uniformity is endogenous to the size of the predicted risk premium, derivatives usage, market power, and how own-risk and rival-risk is spread over the bank's multiple markets.[11]

The decision process in spatial models is characterized similarly to ours. In Barros (1999) decisions to set rates uniformly are made based on relative location of markets. If they are adjacent to each other one market competes with the other. If the bank cannot separate the markets from each other in space, as perceived by depositors, they will set uniform prices over all markets. This view is modeled as a centralized decision made using space information available at the market level. Our approach is unique in that we use rival risk rather than space variables to determine local-market pricing decisions.

2.5 Advantages of a Risk-Pricing Framework

This paper is about the transmission of bank-specific risk across banks and across local markets through retail deposit rates. Unlike other studies, the use of a bank-market dependent rate variable

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[10] For the retail rate to be uniform across markets banks could set their own-risk and rival-risk components the same across all markets. To obtain a low rate relative to other banks the bank must have low own-risk and/or low rival risk in its markets. If the bank spreads risk pressure over markets it could obtain low and uniform rates.

[11] The internal markets literature assumes that an aggregate bank acts as an internal market gathering funds from member banks and distributing it optimally among its markets [Scharfstein-Stein (1999), Campello (2002)]. These decisions are made using knowledge at the market level. Our approach is consistent with this process.

decomposed into aggregate and bank-market risk-pricing effects has several advantages for structuring the retail pricing problem. First, the use of predicted premiums as proxies for pricing pressure mitigates two frequently arising econometric problems in the retail pricing literature. We mitigate endogeneity problems associated with using contemporaneous rival rates by using predicted rival price pressure based on last period risk [Acharya-Mora (2014)].[12] The use of bank-market retail rates and bank-market rival-risk pressure also mitigates problems of cross market price correlations [Craig-Dinger (2010)].

Second, risk-pricing/market-discipline is the general approach in the literature for measuring risk-related costs (risk premia) associated with uninsured funds [Flannery (1998), Flannery-Nikolova (2004)]. There is a body of evidence documenting that changes in risk can exact substitution between wholesale to retail deposits [Billet et al. (1998), Jordan (2000), Kiser (2003), Craig-Dinger (2010), Acharya-Mora (2014)]. However, no paper that we are aware of uses predicted risk-priced premiums as the relevant prices that initiate substitution between wholesale and retail funds.

3. Hypotheses and Empirical Model

3.1 Hypotheses Tested

From the above-mentioned arguments, we summarize the implications of our model. We divide these hypotheses into two broad groups: (1) Own-Risk and a Rival-Risk Effects and (2) Factors mitigating the two effects, for a total of five models that we test in Section 4 for each asset type (i.e., for Small CDs, MMFDAs and Interest-Checking Accounts).

Own-risk and rival-risk effects

Own-Risk and Rival-Risk Effects

Hypothesis 1: If the bank's own-risk increases its retail rates increase.
Hypothesis 2: If the bank's rival-risk increases its retail rates increase.

Interaction of Own-risk and Rival-risk Effects

Hypothesis 3: For an increase in the bank's own-risk, the higher its rival-risk level the less its retail rates will respond to its own-risk. For an increase in the bank's rival-risk, the higher its own-risk level the less its retail rates will respond to its rival-risk.

Factors mitigating the two risk effects

Interest-Rate Derivatives Usage

Hypothesis 4: The larger the banks usage of interest rate derivatives, the less responsive its retail rates to own-risk and rival-risk pricing pressures.

[12] We view this endogeneity issue as an omitted variable problem. The omitted variable is the predicted risk-pricing premium, or retail pricing pressure faced by the bank's rivals. It is obtainable using last-period risk data.

Market Power (Deposit Share/Branch Share)

Hypothesis 5: The larger the banks Deposit/Branch Share in any given market, the less responsive its retail rates to own-risk and rival-risk pricing pressures.

Multiple-Market Presence

Hypothesis 6: The larger the banks multi-market presence, the less responsive its retail rates to own-risk and rival-risk pricing pressures.

3.2 Empirical Strategy

We now operationalize our conceptual approach in an empirical model to test the above hypotheses. In section 2 we emphasized that our two-component pricing model assumes that the pricing decision is made at the centralized level, which takes into consideration the bank's aggregate condition (including risk), but also considers the aggregate condition of the rival banks it meets in local markets. Thus, it uses these two predicted prices to set rates at the bank-market level. Therefore, we have to model this decision process at the bank-market level.

To measure the effect of our two risk-driven components on retail deposit pricing behavior we focus on retail rates at the bank-market level over time. Our survey retail deposit rate data (from *Rate Watch*) are associated with an aggregate bank operating in a particular MSA (i.e., bank-market observations). These rates are modeled as decomposed into a component from aggregate bank risk, and a component from the composite risk of the aggregate bank's rivals in a particular local market. Additionally, we include the influence of other aggregate bank, bank-market and market level control variables.

Each bank operates in one or more local markets where it faces its own aggregate bank risk premium pressure and risk pressure from competitors in each particular local market. Initially we model the bank's local market risk-driven competitive pressure on the bank as a decision from headquarters that is independent of the own-risk pricing pressure it receives from its headquarters. Thus, the retail rates of each bank reflect the risk-premium pressure of its own aggregated bank and the risk-premium pressure of its competitors in each local market.

In this centralized decision process each aggregate bank makes a rate decision for each of its markets. Therefore, we can think of this problem as a bank setting its rate at the market level. More formally, we model the retail rate decision, denoted by $r_{\bar{i}\bar{j}}$, facing a particular bank $\bar{i}$ (we define the bank and bank values as the financial variables aggregated to the high holder) in a particular market $\bar{j}$ in which it operates, at time *t*. The setting of this rate depends on the bank's predicted risk-priced premium $(\widehat{ownbnkprem})$, and on the predicted deposit share-weighted predicted risk-priced premium $(\widehat{rivdlbnkprem})$ of its rivals in its market $\bar{j}$.

$$
\begin{aligned}
r_{\bar{i}\bar{j},t} &= \beta_1(\widehat{ownbnkprem})_{\bar{i},t-1} + \beta_2(\widehat{rivdlbnkprem})_{\bar{i}\bar{j},t-1} \\
&+ \sum_{l=1}^{m}\theta_l(ownbnkcontrol_{l,\bar{i},t-1}) + \sum_{l=1}^{h}\phi_l(mktcontrol_{l,\bar{j},t-1}) \\
&+ u_t + \upsilon_{\bar{i}\bar{j}} + \varepsilon_{\bar{i}\bar{j},t}
\end{aligned} \tag{1}
$$

Equation (1) includes a time fixed effect u_t , a bank-market fixed effect $\upsilon_{\bar{i}\bar{j}}$ and an error term $\varepsilon_{\bar{i}\bar{j},t}$.[13] $\widehat{ownbnkprem}$ and $(\widehat{rivdlbnkprem})$ are predicted in time t-1 to impact a bank's cost of wholesale funds in time t, and are estimated from risk associated with the aggregated bank. We use equation (1) to test Hypothesis 1. We expect β_1 >0 and β_2 >0.[14]

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[13] Note that we use data at the bank-market level over time. Bank-market fixed effects control for omitted variables that affect the retail rate and are constant over time for a bank within a given MSA. That is, the bank-market fixed effect controls for variation in rates across bank and markets. We do not want to use bank fixed effects as in other models. Then we would not be able to separate out the effect of what the aggregate bank contributes to the retail rate. If we do market effects, we are not able to separate out what the market contributes to retail rates. So we include a bank-market rate, which has both of these components. We control for omitted variables <u>that are associated with both the bank and the market</u> and then use risk from the bank and rival risk from the market to separate out the components of these two dimensions that are associated with risk. By setting bank fixed effects, one assumes that there is a common rate set by a bank across its markets. By setting market effects one assumes what goes on in the market is constant. We want to emphasize that the variation is over time and over banks and over markets. Possible omitted variables at the bank and market level. Then we focus on within variation – i.e., at the bank market level over time. We assume there is an effect on rates that is specific to a particular bank in a particular market that the bank-market fixed effect captures. It is constant over time. We then control for factors that are bank and market specific. One of the market-specific variables we are interested in is rival risk. The variation in rival risk across markets is exploited. The variation in own risk across banks is exploited. We then estimate these two variables over time. Therefore we exploit cross market and cross bank variation separately. {I need to argue how to connect the bank-market fixed effect with the bank variable and market/rival variable.

[14] There might be several banks within a holding company. Therefore, *i* represents a particular bank within the holding company. The combination subscript *ij* represents the i^{th} holding company in the j^{th} *market*. We only report one retail rate of a bank belonging to the i^{th} holding company in the j^{th} market. If there are more than on bank within a market that belong to the same holding company, and these banks set different retail rates, then we average those retail rates within the j^{th} market for that holding company. Therefore, only one holding company (bank) per market exists in our sample. We are not trying to use risk to explain differences between the retail rates of banks that belong to the same holding company in the same market. We are trying to explain differences in rates among holding companies/single-market banks within a market.

The predicted (expected) risk-priced premium $\widehat{ownbnkprem}$ in equation (1) is estimated from the following risk-pricing equation for each aggregate bank i, as well as for each of $i's$ rivals in market j,

$$ownbnkprem_{i,t} = \sum_{l=1}^{3} \psi_l (risk_{l,i,t-1}) + \sum_{l=1}^{3} \varpi_l (liquidity_{l,i,t-1}) + \sum_{l=1}^{m} \phi_l (control_{l,i,t-1}) + w_i + z_t + e_{it} \tag{2}$$

where *risk* is bank-specific risk proxied by the ratios of non-performing loans and C&I loans-to-total loans, and the leverage ratio of the bank. *Liquidity* is proxied by the ratios of asset liquidity-to-assets, commitments-to-commitments plus loans and short-term borrowing-to-total liabilities. We also include aggregate bank fixed effects (*w*) and time fixed effects (*z*). The coefficients associated with *risk* and *liquidity* take on the usual signs that are given in the risk-pricing/market-discipline literature [see, e.g., Kishan-Opiela (2012) for a recent application of estimated risk pricing]. The predicted risk premium, $\widehat{ownbnkprem}$, is computed using the bank-specific measures of risk and liquidity and bank-specific dependence on wholesale funds to liabilities,.

For the effect of rival rates on the bank's retail pricing decision we turn to the second term in equation (1). $(\widehat{rivalbnkprem})$ is the deposit share-weighted risk premium of competitor banks that bank $\bar{i}$ faces in its market $\bar{j}$, estimated using information in period t-1 for retail pricing in period t. This measure is given by,

$$(\widehat{rivalbnkprem})_{\bar{i}\bar{j}} = \frac{\sum_{i=1}^{n_{\bar{i}\bar{j}}} [(dep_{i \neq \bar{i},\bar{j}}) * \widehat{bnkprem}_{i \neq \bar{i},\bar{j}}]}{\sum_{i=1}^{n_{\bar{i}\bar{j}}} [(dep_{i \neq \bar{i},\bar{j}})]} \tag{3}$$

In this expression, we include the weighted $\widehat{ownbnkprem}$ of each bank $i \neq \bar{i}$, where each $\widehat{rivalbnkprem}$ is weighted by the share of each rival's deposits in market $\bar{j}$, where the sum of deposits in market $\bar{j}$ excludes the deposits of bank $\bar{i}$. This measure focuses solely on the rivals' risk premium facing bank $\bar{i}$ in market $\bar{j}$. It excludes bank $\bar{i}$'s deposits in market $\bar{j}$ in both the numerator and denominator. That is, the total deposit share of bank $\bar{i}$'s rivals sums to one. This construct allows the separation of the rivals' rate from the deposit share of bank $\bar{i}$ in market $\bar{j}$. Thus, we can separately include bank $\bar{i}$'s market share to test whether its rivals' rates have a separate effect from their market share the retail rates of bank $\bar{i}$

Besides the aggregate bank variable of the predicted own-risk premium, we include the ratio of commitments-to-commitments and loans (as a proxy for funds demand), and the logarithm of real assets (to control for size effects). Our bank-market Variables – rival-bank risk premium, deposit share of the bank and branch share of the bank in a particular market. We include market variables (common to all banks in any market $\bar{j}$). These variables include the unemployment rate (proxy for local-market conditions/risk that impact rates of all banks in that market), population in the market, HHI for the whole market, number of aggregate banks in market $\bar{j}$. Because our emphasis is on bank-market observations over time for retail deposit rates, we include bank-market and time fixed effects to control for omitted variables that are constant over time and over bank-market observations, respectively.

3.2.2 Interactive Risk Effects and Bank-Market Power in Mitigating Risk-Pricing Pressure

We now specify our empirical model used to estimate the influence of the bank, bank-market and market characteristics on mitigating the two risk pricing pressures on the pricing of its retail deposits. We specify a general interactive term associated with each of the two components in equation (4), where the variable *mitigate* proxies for these characteristics included in the regressions one-by-one.

$$\begin{aligned} r_{\bar{i}\bar{j},t} = {} & \beta_1(ownbnkprem)_{\bar{i},t-1} + \beta_2(rivalbnkprem)_{\bar{i}\bar{j},t-1} \\ & +\beta_3(ownbnkprem)_{\bar{i},t-1} * (mitigate)_{\bar{i},t-1} \\ & +\beta_4(rivalbnkprem)_{\bar{i}\bar{j},t-1} * (mitigate)_{\bar{i},t-1} \\ & +\sum_{l=1}^{m}\theta_l(ownbnkcontrol_{l,\bar{i},t-1}) + \sum_{l=1}^{h}\phi_l(mktcontrol_{l,\bar{j},t-1}) \\ & +u_t + \upsilon_{\bar{i}\bar{j}} + \varepsilon_{\bar{i}\bar{j},t} \end{aligned} \tag{4}$$

Equation (4) is identical to equation (1) except for the interactive terms.

To test Hypothesis 2 there is only one interactive term, which consists of the two predicted risk pricing components interacted with each other. In Hypothesis 2 β_3 < 0, indicating that a higher level of one component mitigates the response of retail rates to the other component.

We use equation (4) to test hypotheses 3 through 5. In these hypotheses, the variable *mitigate* takes values for derivatives usage, deposit and branch share, and the number of markets the bank has a presence in. In all cases $\beta_3 < 0$ and $\beta_4 < 0$, indicating that these characteristics allow the bank to have a smaller positive response to risk pricing pressures from its own-risk and rival-risk effects.

4. Data and Results

4.1 Data

To examine the relationship between the bank's retail rate and bank's own-risk and rivals-risk in a local market, we employed data from several sources. Quarterly bank balance sheet variables were taken from the *Report of Condition and Income* (Call Report). The data are from 1997q1 to 2010q4. Bank balance sheet variables were then matched with the weekly branch level interest rate data for several types of accounts provided to us by the *RateWatch*. To match the weekly frequency of the interest rate with the quarterly frequency of the bank balance sheet variables, we chose to use the interest rate reported by a bank in a market on the last full week of each quarter. As in Acharya-Mora (2014), the data were aggregated to the top holder. For the retail interest rate, we used the average interest rate reported on six month CD by a banking organization within a local market. Bank-market level observations were then matched with local market characteristics information provided by the FDIC *Summary of Deposits* data. Data appendix contains the details regarding the construction of each variable. After merging above three datasets, we ultimately use a multidimensional unbalanced panel data with interest rate offered by 4076 banks in 350 MSAs over the period 1997q1-2007q4 in our final regression analysis. Summary statistics of the variables are reported in table 1. Bank balance sheet variables show substantial variation across banks and over-time. Among all the balance sheet variables, liquidity ratio has the largest variation as shown by relatively higher standard deviation. Several banking organizations appear in several markets at a given time; the average (mean) number of markets per-bank is approximately 18 in our sample. However, the distribution of this variable is skewed as shown by median of only 2.

4.2 Empirical Results

4.2.1 Empirical Results for 6-month CDs

We start by estimating equation (1) for our entire sample to test Hypotheses 1 and 2 that the coefficients for predicted own-risk and rival-risk premiums matter for pricing retail deposit rates. Table 2 column 2 shows these estimated coefficients. The coefficients on own-risk and rival risk are both positive and significant at better than the 1% and 10% levels, respectively. These results are consistent with our hypotheses that there are substitutive effects between wholesale and retail funds, and that rival bank risk impacts the bank's retail rate decision.

Next, we estimate equation (1), testing hypotheses 1 and 2 for single market banks. We argued that a multiple-market presence could allow the bank to spread risk-pricing pressure over its markets that might differ in market power.[15] Thus, we want to test for the two pricing components abstracting from that price-mitigating effect. We interact a multiple market dummy variable with each of the two pricing components to separate out the risk-pricing pressure fore single-market banks. The interaction dummy variable is 1 if the bank operates in more than one market and zero otherwise. Column 3 shows that own-risk and rival-risk coefficients are both positive and significant at the 1% and 5% levels, respectively. With both components the coefficients for single-market banks are larger than those for the full sample. This shows that single-market banks are more responsive to predicted own-risk and rival-risk premiums. The coefficients for the interaction with the dummy variable are negative, as expected, but significant only for own-risk. These results go against the idea in some studies that single-market banks set rates independently of the factors used by multi-market banks [Park-Pennacchi (2003), Hannan-Prager (2004), Dick (2006)]. That is, single-market banks respond to own-risk and rival-risk pressures. The result for the interaction term implies there is something about a multiple-market presence that allows banks to mitigate the effect of risk-pricing pressures. Unfortunately, the number of markets in which a bank has a presence is highly positively correlated with its asset size. Therefore, there could be something associated with asset size (e.g., decision process of large banks, or low risk premiums as in P-P and H-P (but we control for this)) that allows this responsiveness. We explore this by another route below.

As mentioned above, certain characteristics might impact the bank's response to risk-pricing pressure from its own-risk and rival-risk in a particular market. When own-bank risk increases the bank is pressured into going into the retail market to raise deposits. If that bank at the same time is faced with high rival-bank risk, the bank will not respond as vigorously to its own risk shock as it would in the absence of high rival risk. Thus, its response to own-risk will be attenuated. This same argument applies when rival-risk pressure increases when own-risk pricing pressure is high [i.e., these two components are intertwined]. Thus, in addition to the two risk components separately, we interact the own-risk and rival-risk variables. That is, we estimate equation (1) testing Hypothesis 3. These results appear in Table

[15] Although we do not have an argument for how risk pricing is affected by asset size, studies have indicated different retail price-setting behavior for large and small banks [Park-Pennacchi (2003), Hannan-Prager (2004), Dick (2006)]. In our retail rate regressions we control for asset size. We do not interact asset size with either of our two measures of price pressure. However, regressions for single market banks picks up part of the effect of small asset size on the response to own-risk and rival risk. Additionally, multiple-market presence is highly correlated with asset size. We look to separate these by an additional interaction of multiple market presence with measures of market power and our two risk-pricing components. Acharya-Mora (2014) address this to some extent by excluding very small banks. We address this by looking at the two pricing components for single-market banks.

2 column 4. As anticipated, the coefficient on the interactive term is negative and it is significant at the 1% level. The coefficients associated with the separate effects of own-risk and rival-risk are both positive and significant at the 1%. Interestingly, the two separate effects are similar in size for each of the last two models. That is, in general when all banks are considered, whether they are faced with own-risk or rival-risk pricing pressures, they respond similarly.

We now include aggregate-bank and bank-market characteristics that might allow the bank to mitigate risk-pricing pressure from itself and from its rivals. The aggregate bank has a means to hedge shocks to its wholesale funds costs. It can engage in interest rate derivatives usage to hedge these risk shocks. Derivatives usage should allow the bank to continue accessing wholesale funds at a reasonable cost, mitigating the need to raise retail rates to substitute into retail deposits. Thus, if the bank uses interest rate derivatives it should have a muted price response to its own-risk pricing pressure relative to non-users [Brewer-Deshmukh-Opiela (2014)]. If a bank can mitigate the response to its own-risk premium, it can also mitigate the effect of its rival-risk premium (as noted above, these two are intertwined). Therefore, derivatives usage should allow the bank to have an attenuated response to both its own-risk and rival-risk pricing pressures. We estimate equation (4) to test Hypothesis 4, that interest rate derivatives usage allows banks to mitigate their retail rate response to risk-pricing pressures. We do this by interacting each of the two components is interacted with a dummy variable that is 1 for banks that have positive interest rate derivative usage and zero otherwise. The coefficient results are indicated in Table 3, column 2. These results show the interactive negative for each of the two components, but significant at the 1% level only for the derivatives usage dummy interacted with the predicted own-risk premium. The coefficients of the own-risk and rival-risk effects separately are still both positive and significant at the 1% and 5% levels, respectively. The coefficients on these separate effects are larger than for model 1, where multi-market banks are included, but characteristics that might mitigate pricing are not present.

Next we include two measures of bank-market-specific market power. First, we argue that if the bank has a greater deposit market share in a particular local market, given all else constant, it can mitigate the effects of its own-risk and rival-risk pricing pressure. Thus, we use equation (4) to test Hypothesis 5, where the mitigating interactive terms are the deposit share of the bank in a particular market. This specification appears in Table 3, model 5, in column 3. Each of the interactive terms is negative, as expected, but only the one associated with the rival-risk effect is significant, at the 1% level. These results indicate that as deposit share in a particular market rises, the bank is able to mute its response to rival-risk pricing pressures. Thus, our results show that a common measure of market power attenuates the effect of direct pricing pressures on retail rates. This provides a channel by which a concentration ratio affects retail rates, unlike other studies that relate the concentration ratio directly to retail rates. The coefficients on these separate effects are significant and larger than for model 1.

Finally, we argue that if the bank has a greater branch market share in a particular local market, given all else constant, it can mitigate the effects of its own-risk and rival-risk pricing pressure. The inclusion of this variable can be argued from a bank-quality or spatial-bank point of view. These results are estimated from equation (4), testing Hypothesis 6. Table 3, and appear in column 4. The coefficients on the interactive term are negative and positive, respectively, for own-risk and rival-risk effects. Both are insignificant. The separate effects of own-risk and rival-risk are still positive and significant at the 1% and 10% levels, respectively.

In summary, we find evidence that bank-specific risk acting through risk-pricing in the wholesale market has a positive own-bank and positive local market rival-bank effect on the pricing of retail deposits. We find that these two channels by which risk affects retail rate pricing are weaker when we include banks that operate in multiple markets. We explore possible reasons for this weaker pricing effect. We show that the use of interest rate derivatives by the aggregate bank allows a bank to have an attenuated response to its own and rival risk pricing pressures. Additionally, market power, as measured by the bank's deposit share in a particular local market, allows the bank to mitigate its retail rate response.

4.2.2 Empirical Results for MMDAs

[Table 4 and Discussion]

4.2.3 Empirical Results for Interest-Rate Checking Accounts

[Table 5 and Discussion]

The result that rates on MMDAs and interest-rate checking are less sensitive to risk-pricing pressures than are small CDs is consistent with studies that show low substitutability by depositors between the various components of monetary aggregates [e.g., Kishan-Opiela (1993)].

5. Policy Implications [Incomplete Section]

In general, our approach helps to understand the role that bank-specific default risk plays in bank liability management. First, our results offer evidence on the distortionary effects of *de jure* deposit insurance guarantees on retail prices. A major implication of our arguments and results is that a full *de jure* deposit insurance guarantee allows some banks to bypass the market discipline implications of risk pricing in the wholesale funds market. However, the ability to effectively bypass discipline and use the retail deposit market as a marginal source of funds depends on the size of the own-risk and rival-risk effects, aggregate bank characteristics and on local market power. In particular, the bank's ability to mitigate risk-pricing pressures from its wholesale funds market depends on the size of its own-risk and rival-risk premiums, on whether the bank uses interest rate derivatives and whether the bank has market power in its local markets as measured by deposit share.

The existence of a bank-lending channel hinges on frictions associated with the ability to substitute freely among different sources of liabilities (i.e., the Miller-Modigliani theorem does not hold). The arguments and results in this paper imply that some banks, despite their funding frictions, might be able to bypass the lending channel by using retail deposits as a guaranteed marginal source of funds similarly to wholesale funds. The ability to substitute freely between these sources of funds depends on the risk pressure a bank encounters in a particular local retail market. Banks that use interest rate derivatives and have market power in some local markets can more easily substitute between these sources of funds and therefore can more easily bypass the lending channel [see, Kishan-Opiela (2012) for a lending channel through risk pricing, and Purnanadam (2007) for the effects of interest derivatives usage on the lending channel].

That some banks can avoid this competition means that they promote more stability. This implies that greater deposit share/branch share and multi-market operations spread the risk of contagion over the banking system so that region specific contagion is less dangerous.] Regulators might want to take action to discourage a risk-driven competition that promotes more systemic risk. This type of competition has implications for prudential regulation. Fourth, if banks can easily use retail funds as a marginal source of funds, monetary policy has a weaker effect through the bank lending channel (particularly the risk-pricing channel). Thus, deposit insurance guarantees weaken the effect of monetary policy trough the banking system. Contagion is often measured in local or regional markets. Our evidence shows that with multi-market banking, contagion can spread to several markets.

Government subsidies encourage risk taking that then spreads over many markets. Thus, any competitive rates could be interpreted as partially the result of competition due to rate contagion. However, we show that this contagion can be quickly contained if there are sufficient banks that have market power, derivatives usage and multi-market operations.

Egan-Hortacsu-Matvos (WP 2014) although they argue a similar story, they do not bring in competition in local markets and the role it plays.

Even though banks do not have direct linkages (e.g., through their balance sheets) their default probability can affect the pricing of retail deposits of other banks. This is just price contagion associated with risk. What we set up a pricing problem where risk is explicitly included in predicted values of how risk will affect retail rates in the next period.

We measure/take into account explicitly the propagation of risk between banks that have no direct linkages. The retail rate of one is affected by risk of the other only in terms of where and how they compete.   That is a bank can be risky, but only if it is large and its risk is high will it impact other banks and then only in the market it faces other banks. There can be other spillovers to other markets, but only through the multi-market presence of banks that are trying to avoid this risk competition. This is the particular way in which spillover of risk shocks appear in our story.*

***While several studies look at direct linkages between risk of one bank and behavior of another through balance sheets, we show how risk can be propagated through competition in local markets. We also show the effect of multi-market banking in spreading the effects of risk on retail rates beyond the market of origination. ***

*** Our paper is one of only a few to document risk/retail price contagion [See, Cooperman-Lee-Wolfe (1985), A-M (2014) and C-D- (2010)]. [Mention shortcomings of each]. We cannot find articles on price contagion, probably because prices were not available on retail rates in particular markets in the past. ***

See Schmalensee (RAND J 1989) for good regulatory regimes.

See Kopecky-VanHoose (2012) p. 4 double underlined.

Our approach also has clear implications for public policy. In determining whether price competition takes place one has to separate out the effect of service differences among bank and markets. Our paper implies that risk differences could be an additional complication. Prudential regulatory policy often uses rate differences across banks or markets to determine whether risky banks are promoting contagion. With the own-risk and rival-risk effects and market power spread between markets, it is difficult to understand the effects of price contagion. In general, the helps to better understand how banks manage risk in order to lower costs. The ability to switch easily between insured and uninsured liabilities, however, inhibits monetary policy through the lending channel. Kishan-Opiela (2012).[16]

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[16] Kishan-Opiela (2012) document the effect of tight monetary policy on loans through bank risk premiums. If some banks are able to easily substitute into retail deposits, monetary policy’s effect on loan growth is dampened.

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TABLE 1
Summary Statistics

Variable	Mean	Median	25per	75per	Std. dev.
Unused_commt ratio(%)	12.02	11.05	6.92	16.06	6.82
Liquidity ratio(%)	25.92	23.95	15.96	33.77	13.21
Wholesalefund ratio(%)	21.1	19.73	13.12	27.48	10.68
Non-performing loan ratio(%)	1.45	0.83	0.34	1.78	1.96
Capita-asset ratio(%)	10.12	9.56	8.28	11.41	2.63
CI loan ratio(%)	15.70	13.79	8.96	20.17	9.55
Interest derivative ratio(%)	0.43	0	0	0	2.34
Real total asset (in2005$,000)	1,566,448	129,711.2	64,030.7	$1.77e^{+09}$	$2.83e^{07}$
Branch share per-mkt(%)	4.92	2.53	0.72	7.35	5.79
Deposit share per-mkt(%)	5.22	1.85	0.42	6.74	7.87
Num of mkts_banks	18.39	2	1	11	38.74
Num of banks_mkt	63.78	35	20	74	66.68
HHI(0 to 1 scale)	0.13	0.12	0.09	0.15	0.07
Imputed Large CD rate(%, annualized)	4.01	4.0	2.80	5.19	1.46
Mktdis_ownrate	-0.18	-0.17	-0.24	-0.12	0.10
Mktdis_ownrate_modified	0.87	0.87	0.76	0.88	0.09
Mkttdis_rivalrate	0.89	0.88	0.85	0.93	0.07
Ratewatch_intrate(%)	2.32	1.99	1.15	3.44	1.42

TABLE 2
Response of the Bank to Own-Risk and Rival-Risk Pressure
[Certificates of Deposit, 6-month maturity, $20,000 denomination]
Dependent variable is retail rate at bank-market level. All results include bank-market fixed effects and time fixed effects.

rhs variables	*model 1*	*model 1&5*	*model 2*
(1)	(2)	(3)	(4)
relevant hypotheses			
own-risk	0.208*** (0.004)	0.455*** (0.000)	1.907*** (0.000)
rival-risk	0.243* (0.052)	0.315** (0.028)	1.919*** (0.000)
Own-risk*mulmktdum		-0.386*** (0.002)	
Rival-risk*mulmktdum		-0.088 (0.451)	
own-risk *rival-risk			-1.851*** (0.000)
bank-market variables			
deposit share MSA ratio	0.006*** (0.002)	0.006*** (0.002)	0.006*** (0.000)
Branch_dep MSA ratio	-0.059 (0.426)	-0.049 (0.497)	-0.053 (0.477)
number banks MSA	0.001** (0.043)	0.001** (0.047)	0.001** (0.032)
aggregate-bank variables			
derivatives usage aggregate bank	-0.0001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)
log(assets)	-0.009 (0.629)	-0.006 (0.764)	-0.004 (0.829)
commitment-loan ratio	0.005*** (0.000)	0.006*** (0.000)	0.005*** (0.000)
market-variables			
Hhi	-0.099 (0.217)	-0.098 (0.261)	-0.099 (0.256)
MSA unemployment rate	-0.018*** (0.000)	0.000 (0.000)	0.018*** (0.000)
number of observations	102,644	102,644	102,644

TABLE 3
Mitigated Response of the Bank to Own-Risk and Rival-Risk Pressure
[Certificates of Deposit, 6-month maturity, $20,000 denomination]

Dependent variable is retail rate at bank-market level. All results include bank-market fixed effects and time fixed effects.

rhs variables	*model 3*	*model 4*	*model 4*
(1)	(2)	(3)	(4)
relevant hypotheses			
own-risk	0.231***	0.286***	0.212***
	(0.002)	(0.000)	(0.005)
rival-risk	0.280**	0.385***	0.239*
	(0.026)	(0.005)	(0.056)
own-risk *derivatives usage	-0.216***		
	(0.000)		
rival-risk *derivatives usage	-0.170		
	(0.133)		
own-risk * deposit share		-0.008	
		(0.340)	
rival-risk *deposit share		-0.024***	
		(0.006)	
own-risk *branch_dep			-1.178
			(0.815)
rival-risk *branch_dep			0.973
			(0.834)
bank-market variables			
deposit share MSA ratio	0.006***	0.034***	0.006***
	(0.002)	(0.000)	(0.002)
Branch_dep MSA ratio	-0.061	-0.050	-0.008
	(0.418)	(0.511)	(0.827)
number banks MSA	0.001**	0.001*	0.001**
	(0.045)	(0.089)	(0.043)
aggregate-bank variables			
derivatives usage aggregate bank	0.0002**	-0.0001**	-0.0001***
	(0.016)	(0.000)	(0.000)
log(assets)	0.000	-0.008	-0.009
	(0.000)	(0.665)	(0.626)
commitment-loan ratio	0.005***	0.005***	0.005***
	(0.000)	(0.000)	(0.000)
hhi	-0.013	-0.099	-0.098
	(0.238)	(0.255)	(0.258)
MSA unemployment rate	-0.018***	-0.018***	-0.018***
	(0.000)	(0.000)	(0.000)
number of observations	102,644	102,644	102,644

Data Appendix

Banks are aggregated to the top holder level (rssd9348).

Ratewatch interest rate:	Proprietary weekly data on interest rates on several bank products provided by the ratewatch. The data are aggregated to top holder by taking the average rate of a high-holder within a market(MSA).
Implicit interest rate on large time deposits:	Interest expense on large time deposits (riada517), divided by quarterly average of large time deposits (rcona514)
Total Asset:	rcfd2170
Total Loan:	rcfd1400
Unused commitment ratio:	Definition used by Acharya & Mora(2013). Unused commitmets are rcfd3814 + rcfd3816 + rcfd3817 +rcfd3818 + rcfd6550 + rcfd3411. Unused commitments ratio is computed as unused commitments divided by the sum unused commitment and total loans.
Liquidity ratio:	As in Acharya & Mora (2013) Liquid assets are cash, federal funds sold & reverse repos, and securities excluding MBS/ABS: Cash: rcfd0010; Federal funds sold: rcfd1350 (before 2002Q1) and rconB987 + rcfdB989 (from 2002Q1). Securities excl. MBS/ABS before 2009Q2: rcfd1754+rcfd1773 - (rcfd8500 +rcfd8504 +rcfdC026 +rcfd8503 +rcfd8507+rcfdC027). And from 2009Q2: rcfd1754 + rcfd1773 - (rcfdG300 + rcfdG304 + rcfdG308 + rcfdG312 + rcfdG316 + rcfdG320 + rcfdG324 + rcfdG328 + rcfdC026 + rcfdG336 +rcfdG340 + rcfdG344 + rcfdG303 + rcfdG307 + rcfdG311 + rcfdG315 + rcfdG319 + rcfdG323 + rcfdG327 + rcfdG331 + rcfdC027 + rcfdG339 + rcfdG343 + rcfdG347).
Wholesale fund to liability ratio:	Wholesale funds are the sum of: large-time deposits, deposits booked in foreign offices, subordinated debt and debentures, gross federal funds purchased, repos, and other borrowed money: rcon2604 + RCFN2200 + rcfd3200 + rcfd2800 (rconB993+rcfdB995 from 2002q1) + rcfd3190
Non-Performing loans to total loan ratio:	Loans past due 90 days or more and nonaccurals: (rcfd1403+rcfd1407)
Capital to asset ratio:	Capital: (rcfd3210)
C&I loan to total loan ratio:	C&I loan: (rcon1600)

Interest Derivative to total asset ratio :	Interest Derivative: (rcfd8693 +rcfd8697 +rcfd8701+rcfd8705+rcfd8709+rcfd8713+ rcfd3450+ rcfda126 + rcfd8725+ rcfd8729 + rcfd8733 + rcfd8737+rcfd8741+rcfd8745 + rcfd8749 +rcfd8753) up to year 2000q4 After 2000q4: (rcfd8693 +rcfd8697 +rcfd8701 +rcfd8705 +rcfd8709+rcfd8713+rcfd3450+rcfda126 +rcfd8725 +rcfd8733+rcfd8737+rcfd8741+rcfd8745)
Bank_market deposit share:	source: FDIC's Summary of Deposits
Branch_deposit share:	computed as the sum of the number of branches of a bank in a market (MSA) divided by the total deposits of the bank in the market. Source: FDIC's Summary of Deposits.
Number of high-holders in a market:	Source: FDIC's Summary of Deposits
Market concentration (HHI):	Source: FDIC's Summary of Deposits
MSA unemployment rate:	BLS.