Essays on Financial Economics, Delivered Under the Similitude of a Dream

by

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DEDICATION

To Meaghan ...

and the Contraction Mapping Theorem

ACKNOWLEDGEMENTS

The writing of this dissertation has followed a tortuous path filled with detours pursuing projects on monetary theory, sovereign debt, and heterogeneous agent models with aggregate uncertainty that never quite panned out—not to mention an extended digression to attend law school. As a result, there is no shortage of individuals to whom I would like to express gratitude for their support, encouragement and advice during my time in graduate school. I apologize in advance for what will surely be an underinclusive list.

First, I would like to thank my committee: Chris House, Toni Whited, Jeremy Kress, Gabriel Rauterberg, and most importantly the late John Leahy. John became my advisor in my third year during which I wrote what became Chapter I of this thesis. It would have been a significantly lower quality paper had he not helped guide me. The spirited conversations in his office (and over zoom during the pandemic) about economic theory, contemporary policy and college sports were truly the highlight of my PhD experience. In addition, he was an extraordinarily gifted teacher who was unflinchingly supportive when I told him about my foolhardy idea to go to law school while writing my dissertation. Believe it or not, I genuinely enjoyed solving the problems he wrote for the general equilibrium portion of the preliminary exams after my first year. He is greatly missed. While Chris has not been a member of my committee for long, I thank him enormously for stepping in to fill the void left by John's passing. I will remember him fondly for getting me interested in the theory of investment during his first year macro class and his quasi-calligraphy on the blackboard (the only person I've ever met who can write the Greek letter ξ legibly). To Toni, I will be forever grateful for the depth and clarity with which she taught her structural corporate finance class—where I finally developed the skill to read the equations of dynamic models like music—and her kindness as a supervisor. It was a delight to teach financial economics with you. She is also the only person who ever bothered to explain what the "identification" of a model *really means*. Much like with John, every conversation with Jeremy was a delightful amalgam of incisive legal analysis, commiseration about the inanities of law school and Michigan football. Chapter II of this dissertation owes its origins to a conversation in his office in February 2024. But for his deep knowledge of bank regulation, there would be a far more boring essay in its

place. My biggest regret in graduate school is that I did not take more of Gabriel's classes. He has left an indelible mark on the way I think about economics and the law, particularly with respect to the theory of the firm. I can only hope to bring a fraction of his indefatigable curiosity to my future work.

It is no surprise that even with an excellent committee, this dissertation could not have been written without the assistance of many others over many, many years. I certainly would not be here without my undergraduate advisor, David Rahman of the University of Minnesota, who gave me far more of his time than he needed to. I fondly recall presenting him a poorly posed optimization problem which he kindly described as "ungrammatical." I also thank Simran Sahi who taught me international economics and always looked out for promising students interested in graduate school, ultimately helping me get my job at the Federal Reserve Board. From the Fed, I owe an enormous debt to Giovanni Favara, Egon Zakrajšek, Rebecca Zarutskie, Tom Zimmermann and Ander Pérez Orive. From the FDIC, I am grateful to Jon Pogach for letting me spend the summer of 2022 at its Center for Financial Research, as well as Haelim Anderson and Chacko George for helpful comments and suggestions on an early version of Chapter III. In the Michigan Econ office, I thank Lauren Pulay for helping me find teaching positions as law school led me to stick around the university longer than most PhD students. I also thank Ed Cho and Ron Caldwell for making me a better teacher. At the law school, I am grateful to Matt Andres, Jim DeSimpelare, John Hudson, Barb McQuade, Amy Sankaran and Steven Schaus for excellent instruction which sharpened my thinking about my own research, although they probably never knew that. A special shoutout is reserved for Seth Quidachay-Swan and Christie Schauder from the law library whose assistance proved invaluable for Chapter II.

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Unfortunately, it is not possible to acknowledge all that Meaghan has done to help this

dissertation come to fruition. You made an uncountable (or at least countably infinite) number of sacrifices so that I could make myself even busier with the quixotic side quest of law school. You ensured I did fun things around Ann Arbor instead of just nervously pacing around our apartment. You had confidence in me when I found it hard to find. And perhaps most importantly, you had the tact and the grace never to ask how a project could remain urgent for seven years. Thank you for everything you have done. I love you.

PREFACE

A few words are in order with respect to the unusual subtitle of this dissertation. Aficionados of Early Modern English Literature might recognize the reference to John Bunyan's allegory "Pilgrim's Progress", although readers should not infer from this subtitle the author's endorsement of Bunyan's ideas, Christianity, the existence of god, the idea of epistemic certainty or anything beyond Cartesian solipsism. The motivation for the borrowed subtitle is an admiration for Bunyan's use of language and the extraordinary clarity of his exposition.[1] John Cochrane once quipped that "economic theory consists of quantitative parables." He was undoubtedly correct, and my greatest dissatisfaction with the current state of economics is the weakness of the prose. Critics of economics frequently rail against the heavy use of mathematics when they ought to be railing against the often incomprehensible writing that the profession is letting ossify into a norm. Gérard Debreu's "The Theory of Value" and Bob Lucas' "Expectations and the Neutrality of Money" are two classic and mathematically sophisticated works that nevertheless read like parables, where the underlying economics shines through in the writing even if the reader might still be far from mastering the technical details. Economics is fundamentally the study of trade-offs, yet I remain adamant that *there exists no trade-off between style and clarity.*

In my third year, one faculty member candidly told my cohort that "no one reads papers"; instead you learn the frontier of the field by attending seminars. My plea to future economists is to spend time crafting the parable that forms the contribution of your paper and not to hide the proverbial ball. When knowledge is disseminated largely through proximity to certain researchers as opposed to the written record, there is an enormous destruction of value. I should warn the reader that I do not know whether I have lived up to my goal. I have tried to write in a manner where the papers are useful to those from other subfields who have little background knowledge of the topic or methods. But you will be the judge.

Each of the three essays that follow owes its existence to a particularly lucid paper that captured my imagination. My papers are not thematically unified and employ more varied methods than most economics dissertations. I would not encourage future graduate students (especially those looking for a professorship) to write a dissertation like this one that applies

[1] Teddy Roosevelt was alluding to Bunyan when he coined the term "muckraker."

computational, quasi-experimental and historical methods to vastly different topics. But at the very least, it was fun to do.

Following Blanchard and Fischer (1989), I am tempted to say that all that is needed to understand the papers that comprise this dissertation is a firm grasp of high school mathematics, but that would need to be a very good high school. To end this preface, I have curated some wisdom from a few of my favorite economists.

> *"Everything reminds Milton [Friedman] of the money supply. Everything reminds me of sex, but I try to keep it out of my papers."*
>
> — *Bob Solow*

> *"I see the world through equilibrium glasses; I don't think they fail me often . . . No doubt the reader's glasses differ from mine. But we are all looking at the same world and the technology for making glasses is constantly improving. Someday it will all be clear."*
>
> — *Fischer Black*

> *"A nonprofessional would find this whole meeting very mysterious. The discussion is very abstract; it is full of insiders' language; people break into hysterical laughter for incomprehensible reasons. There are also some people here who are more directly concerned with practical matters. There are even more such people out in the streets . . . and those are people who could not care less about rational expectations or . . . identifying restrictions, whatever those words mean . . . I would like to assure the practical people in this room and also the ones in the streets . . . that although the battles that are fought in conferences like this appear to be fought with antique pop guns, the bullets are real and they may soon be fired at you by the Federal Reserve."*
>
> — *Bob Solow*

> *"That paper is full of mistakes . . . I don't feel bad about that paper because it attracted interest from people who could do it better. That's basically the philosophy of doing it. When we do research, the idea is that you don't produce a finished product. You produce an input. You write the paper with the hope that it will be superseded. It's not a success unless it's superseded. "*
>
> — *Tom Sargent*

> *"My only regret is that I have not drunk more champagne in my life."*
>
> — *John Maynard Keynes*

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ABSTRACT

This dissertation contains three essays covering different areas of financial economics. Economic agents—such as households, firms and governments—often desire to smooth cash flows and mitigate their exposure to risk through the purchase and sale of contractual claims on real assets. Financial economics studies the supply and pricing of these claims.

In Chapter I, "Evictions, Risk Premia and Welfare", I study rental housing markets where households may renege on their rental agreements and eviction is costly. In a quantitative model, the endogenous default by some households, coupled with the inability of landlords to screen tenants perfectly, leads to a highly inefficient form of social insurance in which the least financially stable households tacitly insure one another through higher rental prices because higher income individuals do not participate in the same housing market, leaving them outside the risk pool and therefore unable to dilute the exposure. After calibrating the model to demographic and eviction data from the City of Detroit, I find that a simple insurance scheme that pays landlords when tenants default can lower rents enough, via a lower risk premium, to reduce the eviction rate by 76% while also increasing household consumption.

In Chapter II, "Bank Competition and *de novo* Entry", I address the question of whether two Congressional reforms that removed barriers to interstate branching for banks had meaningful economic effects on interest rates and bank entry into new markets. A longstanding quirk of the American bank regulatory framework was the freedom states had to discriminate against out-of-state banks. The branching reform provisions in the Riegle-Neal Act and the Dodd-Frank Act were two efforts to liberalize interstate banking although the Acts' other measures, for example with respect to bank holding companies and interstate bank acquisitions, are far better known. I exploit the 1997 decision of Ohio to embrace interstate branching fully under the authority of Riegle-Neal and the federal preemption of all state law prohibitions on interstate branching under Dodd-Frank to evaluate whether the branching reforms resulted in greater bank entry into new markets and more competitive interest rates. The results of the difference-in-differences estimations suggest that the branching reforms significantly increased the share of out of state *de novo* bank branches after both pieces of

legislation while loan rates fell and deposit rates increased.

And in Chapter III, "'Thou Shalt Not Let Debt/EBITDA exceed...': Corporate Debt Covenants Over the Business Cycle", I explore how the restrictions imposed on corporate borrowers in syndicated lending agreements vary over the business cycle. Previous research has glossed over the institutional detail of debt covenants despite the near ubiquity of such restrictions in lending markets. I present new empirical evidence that covenants become more strict following output contractions, and then I explain this phenomenon with a stylized model of risky debt under asymmetric information in which the lender optimally chooses covenant tightness to screen borrowers. The model delivers a clear trade-off of covenant tightness for lower credit spreads as well as an endogenous shift to tighter covenants as market conditions deteriorate.

CHAPTER I

Evictions, Risk Premia and Welfare

Abstract This paper argues that a simple insurance scheme to reduce the default risk from renting to low-income households can substantially increase social welfare. Nonpayment of rent is a significant cost for landlords. Yet even in high-eviction neighborhoods, only a small fraction of households are ejected, while all tenants face a rental price that compensates landlords for the risk. These households have high marginal utilities of consumption, and an alternate risk-sharing scheme that pays landlords when tenants default can increase consumption and reduce evictions as a result of lower rental prices. To estimate the welfare gain, I calibrate a dynamic general equilibrium model with rental housing and eviction risk. The results suggest that for a high eviction city, the nonpayment insurance policy can reduce rents enough to lower the eviction rate by 76% and households value the policy as equivalent to a 10.7% permanent increase in consumption.

1.1 Introduction

Around a million households are evicted in the United States every year. Housing policy has been an active area of research in economics for decades, but scholarly work on evictions has been surprisingly sparse across the social sciences. The highly-publicized work of Desmond (2016) from the sociology literature is a notable exception, using largely ethnographic methods to paint a bleak picture of the consequences of eviction on America's urban poor. However, a nascent literature in economics using quasi-experimental methods has cast substantial doubt on Desmond's central claim that evictions are a cause and intensifier of poverty. Collinson and Reed (2018) and Humphries et al. (2019) argue that being evicted is more likely a reflection of deep poverty than a cause, demonstrating that households who were spared eviction by chance did not experience better economic outcomes, even in the short run, than similar households who were removed from their residences by court order. This research suggests that policies which increase barriers to evict nonpaying tenants will not necessarily benefit the households they were designed to help.

Given these findings, this paper pivots from the focus on evicted households themselves to ask what effect nonpayment risk has on *non-evicted* households in the same rental market. In some neighborhoods of Chicago, more than 10% of households are taken to eviction court in a given year.[1] But even in these high-eviction areas, 90% of households pay their rent in full every month. If landlords are unable to distinguish default risk among potential tenants, then the market clearing rental price implicitly reflects expected eviction costs and foregone rental income. Such a rental price—above what would prevail in the absence of nonpayment risk—represents a pecuniary externality of eviction and another subtle cost of poverty such as the lack of banking services and grocery stores in poor neighborhoods.

Although evictions can be triggered for many different contract violations, the lion's share of cases—well over 90% in cities that have been studied—arise from nonpayment of

[1] Humphries et al. (2019)

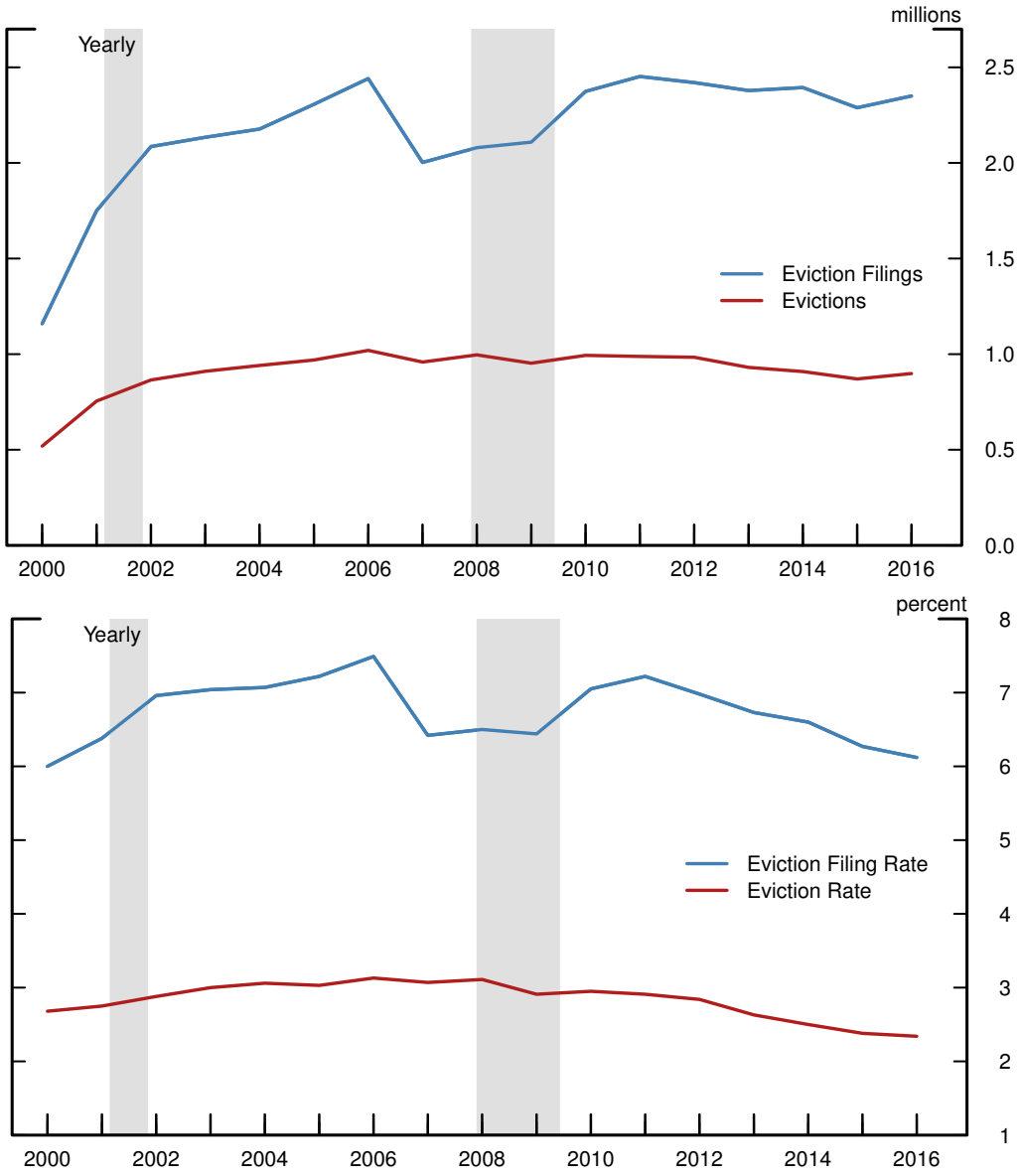


Figure 1.1: Evictions in the United States

Note: the series in the lower figure are normalized by the total number of renter households in each year.

rent.[2] The unprecedented income shock resulting from the Covid-19 pandemic highlighted the issue, as the Federal government—as well as some states and cities—temporarily halted eviction proceedings. But as illustrated in Figure 1.1, eviction filings and completed evictions are extremely common at all points in the business cycle. Admittedly, the Eviction Lab's

[2]These figures come from the "Eviction Lab" at Princeton University that has compiled eviction records at an annual frequency since 2000.

national data are not comprehensive as they do not cover all 50 states,[3] however a spot check of eviction filing rates using the Eviction Lab's county-level data in Figure 1.2 supports the conclusion of remarkable stability over the business cycle. The observed stability also justifies the stationary competitive equilibrium studied below, as there is likely little additional insight gained from considering a model that accounts for business cycle fluctuations.

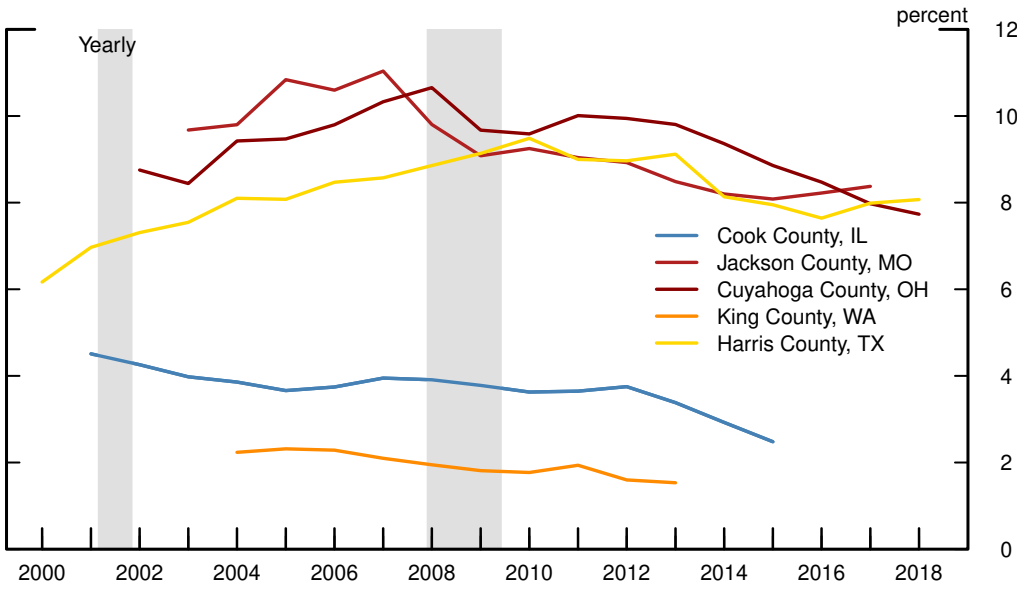


Figure 1.2: Eviction Filing Rates in Selected Counties

When default risk is embedded in non-state contingent rental rates, a highly inefficient form of social insurance arises in which poor households tacitly insure one another against eviction. Less financially-stable households receive a lower rental price than their default risk would imply while more stable low-income households must pay higher rates. If the default risk premium that arises from evictions were spread evenly across the population it might not be a significant concern. However, wealthy households either do not rent housing or rent units that do not compete with low-income housing so the burden of higher rental rates falls on the households that can least afford it. These households are often "hand-to-mouth" with few liquid assets and high marginal utilities of consumption, implying that if the risk

[3]Which means that the reported numbers for total evictions actually represent underestimates, Desmond et al. (2022)

premium were large enough there could be significant welfare gains from reducing it.

Whether this risk premium is an economically significant burden or a negligible part of the rental price is an empirical question. Landlords insist default risk is nontrivial. A Human Rights Watch report on landlord-tenant law in Arkansas quotes one landlord to low-income households, "[y]ou might rent a trailer and make only $2,400 a year off of it. And then you blow it all on an eviction" Albin-Lackey (2013). Unfortunately however, there does not exist an obvious control group of identical units without nonpayment risk to infer risk premia directly from microdata.

To overcome the endogeneity of the default risk premium and study its welfare consequences, I extend a standard incomplete markets model in the spirit of Bewley (1977), Hansen and Imrohoroğlu (1992), Huggett (1993) and Aiyagari (1994) to include housing services and eviction. Faced with uninsurable income shocks and a borrowing constraint, some households optimally default on their rental contract which increases the user-cost of housing for landlords who competitively supply apartments of varying quality. Under a plausible calibration, the cheapest units rent for a price that is 16% above the user-cost of housing that would prevail in the absence of eviction risk. For a concrete example, suppose a two-bedroom apartment in a high-eviction area would rent for $1,000 a month if payment were certain. The model-implied risk premium suggests that a single mother with extremely low default risk who rents this apartment would be paying $1,920 a year to compensate her landlord for the eviction costs of other tenants in similar units. For households in high-eviction areas this is a substantial fraction of annual income. Desmond (2016) finds that more than 20% of all renter households spend at least half their income on rent. So put another way, eliminating a risk premium of the size implied by the model in this paper would be equivalent to an 8% raise for these households.

The case for a policy intervention is bolstered by the observation that most poor people in the United States live in market-rate housing. Rent control, vouchers and public housing are frequently studied topics for addressing the issue of housing affordability. Nevertheless,

Census Bureau data from the American Housing Survey (table 17) indicate that in 2013 approximately 66% of low-income households received no government housing assistance whatsoever.[4]

Since the default risk premium affects rental prices via the user-cost of housing, Section 1.5 explores a policy that exploits this channel directly and avoids the pitfalls of the traditional avenues of subsidized housing. On the surface the policy is an insurance scheme among landlords who pay a percentage of the rent they charge into a fund which compensates the landlords whose tenants default for both foregone rental income and eviction costs. But because the rental market is competitive, landlords make zero profits with or without the policy and are in principle indifferent between living in the economy with the insurance scheme and living in the baseline economy. The true economic incidence of the policy is a transfer from tenants in expensive units to tenants in cheaper units, so households with high default risk are now being subsidized by agents who can more easily afford it. It should also be noted that a private insurance scheme that prices risk based on similarly situated rental units would not achieve the same welfare gains because such private policies would not distribute the nonpayment risk over the entire universe of households.

One key property of the proposed policy is that it addresses the pecuniary externality directly and thus creates fewer distortions than other types of subsidies. Rent control is particularly well-known for its unintended consequences and difficulty in achieving its desired goals. In a survey of work on the subject Arnott (1995) remarks that "[e]ven if the optimal rent control package would be beneficial, the actual ... package thrown up by the political process may be harmful." Among other problems, current housing subsidies have been to found to result in (i) welfare gains accruing to incumbent tenants at the massive expense of newcomers; (ii) reductions of maintenance or investment in rental properties; (iii) housing mismatch such as an elderly widow living in too large an apartment because she can't afford to downsize; (iv) reduced labor mobility from tenants stuck in a particularly cheap unit;

[4]Figures for 2019 are similar although the survey methodologies were not identical as 2019 used self-reported data on rent-reductions.

and (v) increases in housing discrimination as a result of shortages. The landlord insurance scheme, by contrast, requires little fine tuning to avoid these disturbances to the rental market.

Related Literature

In addition to the literature on incomplete markets, this paper contributes to a body of work on consumer default and enriches the current set of models of rental markets. With respect to the former, the present model is most related to Chatterjee et al. (2007) where the authors consider an environment with unsecured consumer loans and examine a policy intervention in bankruptcy regulation. The asymmetric information problem in the model, between landlords and tenants, is also closely related to the "lemons" problem in the classic work of Akerlof (1970). Previous studies of rental markets have not modeled default explicitly, abstracting away to focus on different matters. Kaplan et al. (2020) study the macroeconomic consequences of rental markets to the extent that renting reflects the outside option to purchasing a home, although they are primarily interested in business cycle fluctuations. Susin (2002) examines the effect of rent vouchers on unsubsidized units, and Davis and Ortalo-Magné (2011) look at the dispersion of rental prices across metropolitan areas, finding that rental rates are largely determined by differences in income. The insight added by the model in this paper is that at the low end of the market, rental contracts have more in common with consumer debt than previously considered.

The following section details several stylized facts about unregulated housing markets and key moments to match for a useful model of low-income rental housing. Section 1.3 describes the baseline economy and Section 1.4 presents quantitative results. Section 1.5 introduces the nonpayment insurance policy, Section 1.6 discusses the welfare gains and Section 1.7 concludes.

1.2 Stylized Facts

Rental markets are highly idiosyncratic. Differences in landlord-tenant law and local regulations that impinge on market functioning lead to substantial heterogeneity between jurisdictions. Since the focus of this paper is on unregulated markets, I focus on data from just one jurisdiction—the City of Detroit—for the purposes of evaluating the fit of the model described in the following section and for evaluating welfare gains from the insurance policy proposed in Section 1.5.[5]

The City of Detroit is a particularly suitable choice of rental market to study in this paper. First, the state of Michigan has a statutory ban on municipalities from instituting any form of rent control, so there is no concern about the policies and regulations of neighboring towns affecting the choice of renter location at the margins of the jurisdiction. Second, the social issue of eviction is particularly prominent in Detroit and thus economic policy has larger scope to increase social welfare. The fortunes of the city are well-known to have risen and fallen with the profitability of the American automotive industry and the secular decline of employment in manufacturing has hit the city particularly hard.

In Table 1.1, I summarize several key statistics that capture the financial health of households and the state of the rental market in Detroit during the late 2010s. The work of Branche-Wilson and Cooney (2020) estimates that as of 2019 there were approximately 140,000 renter households in Detroit, of whom approximately 50,000 report that they do not have enough money to make ends meet, which supports other observed behavior such as Detroit's eviction rate that exceeds the national average along with elevated rates of uninsured driving and water shutoffs. The quantitative model in the next section seeks to create a model economy that can replicate these data moments.

The key statistic, the eviction rate, is a notoriously difficult figure for researchers to pin down, since eviction events do not all look the same. There is some ambiguity in what

[5]There is also the issue of data collection practices which are not necessarily uniform across regions, so it can be difficult to compare estimates of eviction rates and poverty measures across geographic locations.

Households paying $\geq 50\%$ of income on rent	27%
Eviction rate	5.72%
"Hand-to-mouth" households	61%
Median Rent to Income	31.7%

Table 1.1: Stylized Facts about the Rental Market in Detroit, Michigan

Note: The statistics on percentage of households paying more than half their income on rent and the eviction rate come from Branche-Wilson and Cooney (2020) who used American Community Survey data from 2017 and 2018. The "hand-to-mouth" figure represents the fraction of Detroit households who describe their income as not enough, just enough, to "make ends meet", which ultimately derives from a 2018 survey. The median rent to income statistic is the quotient of the median gross rent and the median income in Detroit from the 2022 ACS.

should be properly-categorized as an eviction depending on the exact research question that is being studied.[6] As an example, Detroit has a significantly higher eviction filing rate than similar cities, roughly 1 eviction filing per 5 renter households in 2018 compared with 1 in 13 for the Cleveland area and 1 in 15 for the Pittsburgh area.[7] But the filing rate alone is not indicative of the true cost of evictions to landlords. The ethnographic evidence from Milwaukee in Desmond (2016) shows that landlords often renegotiate with low-income tenants, similar in spirit to corporate restructuring. In this context, an eviction filing also serves as a device for establishing a credible threat, enhancing the landlord's negotiating position by showing they are serious about collecting rent. In this sense, an eviction filing is an option contract, giving the landlord the right but not the obligation to enforce an eviction. If the tenant decides to pay rent, the eviction filing can be withdrawn and the option to eject the tenants goes unexercised. The upshot is that a household might have an eviction filing made against them but ultimately pays the rent, remaining in the unit the whole time, which undermines the value of eviction filing rate as the relevant measure of eviction rate for the purposes of this paper. Another approach is to rely on the frequency of judgments from eviction cases, however many of these are uncontested claims for money damages that will likely never be collected and thus do not tell us much more than that the

[6]Desmond (2016) discusses at length some of the issues involved.

[7]Estimates are from the Eviction Lab's 2018 county data, Gromis et al. (2022). The city proper has a filing rate of 18.5%.

landlord is owed something.

An alternative approach is to rely on survey evidence from low-income households themselves, although pitfalls arise here as well since many households' subjective experiences differ. Consider a renter who cannot pay rent and moves out of their unit immediately without imposing any other costs on their landlord. The individual might consider themselves evicted—and for some research questions perhaps that would be a plausible definition—but for my purposes, this household establishes only a negligible loss to the landlord which must be insured in turn by other paying households. In contrast, imagine a different household, who lives in a unit without paying rent for an extended period while the landlord files an eviction complaint. These tenants might not consider themselves as having been evicted (perhaps as a matter of pride) if they leave the unit before the eviction order is carried out by the sheriff and they are physically removed. However, it is very much these households who impose an economic cost on other renters and the ones we most need to include in our definition.

To overcome these data limitations, I opt for a definition of eviction rate that is most meaningful in the context of inferring costs associated with nonpayment of rent and the removal of tenants. To this end, I define the eviction rate for Detroit as the number of "orders of eviction" issued by the courts as a fraction of total renter households in the city. It should be noted that orders of eviction are distinct from the "judgments" in eviction cases. These orders are the final recourse of landlords for removing tenants, and they arguably represent the least ambiguous possible measure of the *economically costly* eviction rate. Although the most-recent Eviction Lab data[8], 2018, lack information on orders of eviction in Detroit, 2019 data from the nonprofit organization Eviction Machine indicate that 30.9% of eviction filings ultimately result in orders of eviction. Taking the 18.5% filing rate and assuming the same ratio of filings to orders of eviction in 2018 as 2019, I conclude that the proper moment for my model to match is an eviction rate of 5.72%. This rate should be contrasted with the

[8]Gromis et al. (2022)

13% of Detroit residents who claim to have experienced an eviction in the previous year in the survey by DMACS (2017) and the 6.8% figure for eviction judgments from the Eviction Lab.

1.3 Model

We used to fuss when the landlord dissed us,
No heat, wonder why Christmas missed us?
Birthdays was [sic] *the worst days,*
Now we sip champagne when we thirsty

—The Notorious B.I.G.

Demographics, Preferences and Endowments

A city is populated by a measure one continuum of infinitely-lived households who allocate stochastic endowment income y_t between non-durable consumption c_t and rental housing h_t^s. Time is discrete, and the length of each period is a quarter. The only means of saving is through the purchase of non state-contingent bonds b_{t+1} which pay a fixed net return r_f. Borrowing is ruled out, so $b_t \geq 0 \ \forall t$.

Households maximize expected lifetime utility and order streams of consumption and housing using an increasing and concave period utility function $u(c_t, h_t^s)$ discounted at rate $\beta \in (0, 1)$. They are *ex ante* identical in the sense that all households face the same optimum problem and are only heterogenous to the extent that they enter each period facing different state vectors, which are fully explained below.

$$\sum_{t=0}^{\infty} \beta^t u(c_t, h_t^s)$$

Preferences are assumed to display constant relative risk aversion (CRRA) and an intratemporal elasticity of substitution between housing and consumption equal to one.

$$u(c_t, h_t^s) = \frac{\left(c_t^\alpha (h_t^s)^{1-\alpha}\right)^{1-\sigma} - 1}{1-\sigma}$$

Agents are also limited to renting a single apartment at price R_t^s from a finite set of choices $h^s \in \mathcal{H} = \{h^i\}_{s=1}^S$ such that $h^0 < h^1 < \cdots < h^S$ which captures the "lumpy" character of housing. The value of housing services h^0 is assumed to represent an "unstable housing" state with $R^0 = 0$ and is the state to which households move if they are evicted.

Eviction

Rental contracts are assumed to be of the "month-to-month" variety in the sense that leases last only a single period and households can move apartments frictionlessly at the end of each period of their own volition. However, households cannot be ejected within a period for nonpayment, which is the only motivation for eviction. In reality, tenants and landlords often negotiate informal agreements and proceed to court only as a last resort, but for simplicity I assume that nonpayment in a period triggers the eviction process.

Motivated by the legal formalities of evictions in most American cities, the removal process in the model is lengthy and results in several months of foregone rental income. In addition, landlords incur court and removal fees which I capture with a cost E for each eviction. Since evictions often vary in length depending on the circumstance of the case, in the model households can stay in their unit they are removed according to a Poisson process with arrival rate γ. Additionally, when a household finds itself in h^0 following an eviction, it is assumed that even if they are able to pay, they may only move into a better unit with probability ψ, which captures the persistence of housing instability and difficulty of transition out of eviction. The maximization problem is thus contingent on whether or not the household is in *good standing*. They move into bad standing upon default and back into good standing only after having been ejected with probability γ and redeemed with probability ψ.

To prevent households with significant savings from defaulting, it is assumed that court

judgments can seize assets. For parsimony, I abstract from the transfer of assets to the landlords and assume some portion of assets are forfeited to the court who dispose of them outside the model economy. Thus in the event of default the household has at their disposal not b but b^E in that period from which to make their consumption-saving decision, which is motivated by laws that limit the amount of assets that can be seized through the courts. In the quantitative exercises I set $b^E = 0$.

Household Optimization

The position of the household is fully summarized by the vector $\mathcal{S} = \Big[b, y, h^s_{-1}, e\Big]$ where $e \in \{0, 1\}$ represents entering the period in good standing or bad standing respectively. The value of being in each state can be divided into four cases: (i) the most interesting case is when the household enters the period in good standing $e = 0$ and is currently housed $h^s_{-1} \neq h^0$. The value of entering the period is then the maximum of continuing in good standing and not defaulting, V^N, or exercise the option to default, V^D.

$$V(b, y, h^s_{-1}, e = 0) = \max \Big\{ V^N(b, y, h^s_{-1}, e = 0),\ V^D(b, y, h^s_{-1}, e = 0) \Big\} \tag{1.1}$$

The value of not defaulting can be expressed as

$$\begin{aligned} V^N(b, y, h^s_{-1}, e = 0) = \max_{h^s,\, b'} \Big\{ & u(c, h^s) \ + \ \beta \mathbb{E}\big[V(b', y', h^s, e = 0)\big] \Big\} \\ & \text{s.t.} \\ & c = b - \frac{1}{1 + r_f} b' + y - R^s \\ & b' \geq 0 \\ & h^s \in \mathcal{H} \end{aligned} \tag{1.2}$$

where the expectation operator is with respect to the income process. If the household

chooses to default, they do not pay rent that period, lose any assets, transition to the evicted (or bad standing) state $e = 1$ and remain in their unit the eviction process concludes with probability γ.[9] Note that the value function V^D is meaningful only when the household enters the period in good standing, i.e. $e = 0$.

$$V^D(b, y, h^s_{-1}, e) = \max_{b'} \left\{ u(c, h^s_{-1}) \ + \ \beta \mathbb{E}\big[(1-\gamma)V(b', y', h^s_{-1}, e=1) + \gamma V(b', y', h^0, e=1)\big] \right\}$$

$$\text{s.t.}$$

$$c = b^E - \frac{1}{1+r_f} b' + y \tag{1.3}$$

$$b' \geq 0$$

(ii) if the household is currently in good standing but they were homeless last period, so $h^s_{-1} = h^0$, then default is meaningless since they are not currently in a rental contract and the problem resembles the no default case above,

$$V(b, y, h^0, e=0) = \max_{h^s,\, b'} \left\{ u(c, h^s) \ + \ \beta \mathbb{E}\big[V(b', y', h^s, e=0)\big] \right\}$$

$$\text{s.t.}$$

$$c = b - \frac{1}{1+r_f} b' + y - R^s \tag{1.4}$$

$$b' \geq 0$$

$$h^s \in \mathcal{H}$$

(iii) if the household defaulted last period, or has been in eviction—thus entering the period with $e = 1$ and housed in $h^s_{-1} \neq h^0$—then they pay no rent and can accumulate assets while awaiting ejection, which is consistent with the observed behavior of evicted households

[9] The option to move out in the middle of the eviction proceedings is far more realistic but greatly complicates the model set up with little added insight, so for clarity I will assume an initiated eviction means the household will stay in their current unit until they are ejected.

in Desmond (2016). Although in principle, landlords are owed these assets as damages for breach of contract, judgments against low-income households are notoriously difficult to collect and most landlords settle for ejecting the tenants.

$$V(b, y, h^s_{-1}, e = 1) = \max_{b'} \left\{ u(c, h^s_{-1}) + \beta \mathbb{E}\big[(1-\gamma)V(b', y', h^s_{-1}, e = 1) + \gamma V(b', y', h^0, e = 1)\big] \right\}$$

$$\text{s.t.}$$

$$c = b - \frac{1}{1+r_f} b' + y \tag{1.5}$$

$$b' \geq 0$$

and finally, (iv) if the household has been successfully evicted and is in the unstable housing state and in bad standing, then they enter period with $h^s_{-1} = h^0$ and $e = 1$, awaiting the opportunity to return to good standing with probability ψ and be able to enter a rental contract,

$$V(b, y, h^0, e = 1) = \max_{d'} \left\{ u(c, h^0) \; + \; \beta \mathbb{E}\big[(1-\psi)V(b', y', h^0, e = 1) + \psi V(b', y', h^0, e = 0)\big] \right\}$$

$$\text{s.t.}$$

$$c = b - \frac{1}{1+r_f} b' + y \tag{1.6}$$

$$b' \geq 0$$

Rental Firms

The city rental market is competitive and units are owned by deep-pocketed, risk-neutral foreign investors, which justifies discounting rental income at the risk free rate. Property prices are determined exogenously in a frictionless market, and the housing stock does not depreciate. An important assumption is that landlords cannot differentiate among poten-

tial tenants and thus cannot charge different rents based on default risk inferred from the individual tenant's asset or income position. Landlords can, however, observe the payment behavior of their tenants. Invoking rational expectations, expected rental income is computed based on the fraction of tenants who default each period π_s which is observable to the landlords and constant in the stationary equilibrium.

A representative rental firm maximizes the stream of expected discounted profits by buying properties of each type $s \in \mathcal{H} \setminus \{h^0\}$ at the prevailing rate p_s and renting it to households, taking as given the rental rate R^s, the default rate π_s and the probability of successful eviction γ. For simplicity, I assume it takes one period before newly purchased housing can be rented and begin generating revenue.

The share of nonpaying tenants is crucial for the firm's profits, and I denote these households for apartment type s by N_s which evolves according to

$$N_s' H_s' = \underbrace{(1 - N_s)\pi_s H_s}_{\text{inflow}} - \underbrace{N_s \gamma H_s}_{\text{outflow}} + \underbrace{N_s(1-\gamma)H_s}_{\text{remaining}} \tag{1.7}$$

where the left-hand side is next period's total number of nonpaying tenants, and the three terms on the right-hand side represent the possible state transitions of the current period's nonpaying tenants. There can be an inflow of new nonpaying tenants from new defaulters, an outflow from successful evictions, and the stock nonpaying tenants this period who remain in unit but nonpaying next period. Note further that in steady state, $H_s' = H_s$ which implies that N_s will also be constant.

Since landlords receive income only from paying tenants and they pay E to evict newly defaulting ones, the rental firm's problem for each type of property s can be written compactly as

$$\begin{aligned} V^s(H_s, N_s) = \max_{H_s'} \Big\{ & R^s(1 - N_s)(1 - \pi_s)H_s + R^s N_s \gamma H_s - E(1 - N_s)\pi_s H_s \\ & - p_s(H_s' - H_s) + \frac{1}{1 + r_f}\mathbb{E}\big[V^s(H_s', N_s')\big] \Big\} \end{aligned} \tag{1.8}$$

The first term captures revenue from tenants who paid in the previous period and continue to pay today; the second term is revenue from new tenants occupying units previously inhabited by nonpaying households; the third term is costs paid to begin eviction proceedings on defaulting tenants; and the fourth term is the revenue or expense associated with purchases or sales of property.

Optimization based on (1.8) implies that in the stationary equilibrium the rental rate equals the user cost of housing

$$R^s = p_s r_f \left(\frac{1}{(1-\pi_s)(1-N_s)+\gamma N_s} \right) + \frac{E(1-N_s)\pi_s}{(1-\pi_s)(1-N_s)+\gamma N_s} \tag{1.9}$$

which just compensates rental firms for default risk and ensures they receive zero profits in equilibrium. Note that the share of nonpaying households is $N_s = \frac{\pi_s}{\pi_s+2\gamma}$ in the steady state, and therefore the rental price without nonpayment risk is embedded in this framework when $\pi_s = 0$ which reduces to $R_s = p_s\, r_f$.

Equilibrium

This paper is primarily concerned with the eviction behavior and welfare properties of the decentralized, competitive equilibrium of the economy described above.

Definition. *A stationary competitive equilibrium for this economy is a set of decision rules* $\{\widehat{c}(b, h^s_{-1}, y, e),\ \widehat{h}(b, h^s_{-1}, y, e),\ \widehat{b'}(b, h^s_{-1}, y, e)\}$ *for consumption, housing and assets, a stationary distribution* $\lambda(b, h^s_{-1}, y, e)$ *and rental prices* $\{R^s\}_{s=1}^S$ *such that*

1. *Given rental prices* $\{R^s\}_{s=1}^S$ *the decision rules solve the household's optimum problem (1.1) - (1.6);*

2. *Given the stationary distribution induced by the decision rules, rental firms price units according to (1.9) so the housing market clears;*

3. *The stationary distribution of agents across states solves the following functional equation,*

$$\lambda(\mathcal{S}') = \sum_{b=\widehat{b}'(b,y,h^s_{-1},e)} \sum_{y\in\mathcal{Y}} \sum_{h^s=\widehat{h}(b,y,h^s_{-1},e)} \sum_{e\in\mathcal{E}} \Pi(y' \mid y) \cdot \Gamma((h^s_{-1})', e' \mid h^s_{-1}, e) \cdot \lambda(\mathcal{S}) \tag{1.10}$$

where the limits of summation for debt and housing are restricted to those values implied by the optimal decision rules, and $\Gamma(\cdot)$ is a function that captures the transition probabilities of being successfully evicted or redeemed to good standing, e.g. $\Gamma(h^0, 0 \mid h^0, 1) = \psi$ since the household left the previous period unhoused and in bad standing waiting to be redeemed.

1.4 Quantitative Analysis

Computation

I solve the household's problem (1.1)-(1.6) using value function iteration on a discretized state space, with 80 linearly spaced points for assets $b \in \mathcal{B}$, five points for income $y \in \mathcal{Y}$, three housing states $h^s \in \mathcal{H}$, and the two eviction states $e \in \mathcal{E}$. Income y follows an AR(1) process in logs, with a high degree of persistence to generate the level of income inequality and eviction rates we observe in the data.

$$\log(y') = \rho \log(y) + \epsilon \qquad \epsilon \sim N(0, \sigma_y)$$

and is discretized using the method proposed by Rouwenhorst (1995). To compute the stationary distribution $\lambda(b, y, h^s_{-1}, e)$ I use the standard practice of iterating until convergence on equation (1.10) using the same grid and policy functions from the household problem's solution. Additional thoroughness could be gained by use of a more sophisticated income process that can match the income inequality in American cities. This is especially true given that the kind of income shocks most highly correlated with evictions, such as unemployment,

are not well-captured by a highly persistent autoregressive process. Nevertheless, as a first pass on the topic, I opt to start with the simple and commonly-employed log-normal income process.

The equilibrium of the model is found using a procedure similar in spirit to Huggett (1993), but rather than computing a market clearing interest rate to characterize the model solution, I am interested in finding an equilibrium vector $\{\pi_s\}_{s=1}^{S}$ of nonpayment rates which are used by landlords to determine rental prices. The algorithm is fully specified in Appendix A. For simplicity, the results that follow are from a special case of the model in which it is assumed that households are unable to default[10] in the higher-quality housing, so there is only one type of risky rental property and thus one risk premium to solve for.

Calibration

The model is calibrated by fixing a set of parameters according to straightforward calculations and well-accepted values from previous literature, Table 1.2, and then internally calibrating the novel parameters, Table 1.3, in order to match the moments in Section 1.2.

Parameter	Value	Description	Source
α	0.55	Consumption weight	Davis and Ortalo-Magné (2011)
σ	2	Coefficient of relative risk aversion	Standard value
γ	0.5	Eviction rate	Six month average eviction
ρ	0.97	Persistence of income process	Kaplan et al. (2020)
σ_y	0.26	Std. deviation of income process	Kaplan et al. (2020)
r_f	0.01	Risk free rate	Standard value

Table 1.2: Fixed Parameters

[10]Or equivalently, will be immediately removed for nonpayment.

Parameter	Value	Description
β	0.965	Subjective discount factor
ψ	0.44	Redemption rate
E	0.53	Eviction costs
p_s	$\{50, 69\}$	Price of housing unit
h^s	$\{0.06, 0.78, 0.92\}$	Utility from housing

Table 1.3: Internally Calibrated Parameters

Results

The model solution under the above calibration yields reasonable results. Firstly, there is no "strategic default" in the model. Only households in the lowest income and asset states choose to default, so there are no opportunistic rich families electing not to pay rent in order to enjoy a free stream of housing services. Second, the model-implied nonpayment rate among renters is 5.61% which is in line with the 5.72% figure for Detroit. Additionally, the model generates a very close fit for asset-holding behavior with the proportion of "hand-to-mouth" households—using the common definition of having less than four weeks worth of income in liquid assets—at 55.3% compared to the data figure of 61% for Detroit residents.

The model performs less well matching moments on income relative to housing costs, which is not surprising given the extreme simplifications used to model the housing market and unrealistic income process. The model suggests that 54.4% of households spend more than half their income on rent which is double the percentage from survey estimates. Moreover, the median rent to income ratio is also notably higher than empirical estimates with the model figure at 58% compared to 31.7% in the data, which could also be remedied by a more realistic housing market and income process.

The central question of the paper is the rental housing default risk premium, which I define in the context of this model as the markup over the rental rate that would prevail

without nonpayment risk, analogous to measures of risk premia in the asset pricing literature defined as returns above a benchmark risk free rate,

$$\varrho_s = \frac{R^s - p_s\, r_f}{p_s\, r_f} \tag{1.11}$$

where $p_s\, r_f$ is the user cost condition without nonpayment risk. The model implied risk premia for the housing units h^1 under this parameterization is $\varrho_1 = 16.04\%$. This figure is consistent with the hypothesis that units rented to low-income households factor in an economically large default risk premium vis-à-vis more expensive units.

1.5 Nonpayment Insurance

As the baseline model demonstrates, nonpayment risk puts significant upward pressure on rental rates. These higher prices are paid by all households renting the same type of unit, independent of their likelihood of default, which decreases their consumption. To reduce this default risk premium, this section proposes an insurance scheme that compensates landlords when renters default as well as covers the expenses associated with carrying out the eviction.

The proposed policy introduces a transfer between landlords of households in good standing and those who must evict tenants. Rental firms no longer need pay eviction costs E or forgo rental income while households are in eviction, but they must now pay a fraction of their rental income to cover those expenses. As a result, the rental firm's problem becomes,

$$V^s(H_s) = \max_{H'_s} \left\{ (1-\tau)R^s H_s - p_s(H'_s - H_s) + \frac{1}{1+r_f}\mathbb{E}\big[V^s(H'_s)\big] \right\} \tag{1.12}$$

Note that this expression no longer depends on the fraction of nonpaying households, N_s, since landlords receive transfers to cover missing rent and do not pay eviction costs. Optimization once again leads us to a simple user-cost condition pinning down the equilibrium rental price,

$$R^s = \frac{p_s \, r_f}{1 - \tau} \tag{1.13}$$

The household's problem is unmodified from the baseline economy.

Equilibrium

The notion of equilibrium in the economy with the landlord insurance scheme is fundamentally the same as that of the baseline economy from section (1.3) but with the addition of a condition equating insurance payments and payouts.

Definition. *A stationary competitive equilibrium with nonpayment insurance is a set of decision rules* $\{\widehat{c}(b, h^s_{-1}, y, e),\ \widehat{h}(b, h^s_{-1}, y, e),\ \widehat{b'}(b, h^s_{-1}, y, e)\}$ *for consumption, housing and assets, a stationary distribution* $\lambda(b, h^s_{-1}, y, e)$*, rental prices* $\{R^s\}_{s=1}^S$ *and insurance levy* τ *such that*

1. *Given rental prices* $\{R^s\}_{s=1}^S$ *the decision rules solve the household's optimum problem (1.1) - (1.6);*

2. *Given the stationary distribution induced by the decision rules, the housing market clears;*

3. *The stationary distribution of agents across states solves the following functional equation,*

$$\lambda(\mathcal{S}') \;=\; \sum_{b=\widehat{b'}(b,y,h^s_{-1},e)} \; \sum_{y \,\in\, \mathcal{Y}} \; \sum_{h^s=\widehat{h}(b,y,h^s_{-1},e)} \; \sum_{e \,\in\, \mathcal{E}} \Pi(y' \mid y) \cdot \Gamma((h^s_{-1})', e' \mid h^s_{-1}, e) \cdot \lambda(\mathcal{S}) \tag{1.14}$$

4. *Insurance receipts and payouts balance,*

$$\sum_{s \in S} \left(\tau R^s \int \mathbb{1}\{h^s\} \, di \right) = \sum_{s \in S} \left(E \int \mathbb{1}\{DEF_i, h_i = h^s\} \, di + R^s \int \mathbb{1}\{h^s, e_i = 1\} \, di \right) \tag{1.15}$$

where the indicator functions in equation (1.15) are equal to one if household i is living in the given housing state s and zero otherwise, DEF_i indicates whether the household has defaulted on their rental contract, and e_i indicates whether the household is in the bad standing state.

Discussion

The nonpayment insurance policy described above has the virtue of being straightforward, however nothing in its design guarantees that it will improve the fortunes of agents in the model economy. For some calibrations of the baseline model that imply a relatively low eviction rate, the insurance scheme does not lower the eviction rate and actually raises rent prices for the low-cost units. However, for an economy with the calibration given in Section 1.4, the introduction of nonpayment insurance dramatically reduces both rental prices and the overall eviction rate.

The solution of the model with insurance yields a value of τ =3.87%. By construction, the markup of the low-cost unit (and high-cost unit) over the risk free user cost in this economy is

$$\varrho_s^I = \frac{R^s - p_s\, r_f}{p_s\, r_f} = \frac{\frac{p_s\, r_f}{1-\tau} - p_s\, r_f}{p_s\, r_f} = \frac{\tau}{1-\tau} \tag{1.16}$$

which amounts to 4.03%, substantially less than the 16.04% risk premium observed in the baseline economy. Further, the eviction rate falls from 5.61% in the baseline economy to 1.3% in the economy with nonpayment insurance. This decline is the result of compounding effects. With a lower rental rate, fewer households need to default on their lease agreements which strengthens the tenant pool, reinforcing the drop in the necessary risk premium.

1.6 Welfare Analysis

To gauge the welfare properties of the proposed policy beyond the lower eviction rate, I appeal to the criteria of compensating variation in the sense used by Lucas (1987) in

which I ask the question "how large of a permanent increase in consumption would make a household picked at random from the baseline economy indifferent to living in the economy with nonpayment insurance?"

By definition $V_B(\mathcal{S}) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\Big(\widehat{c}_{B,t}, \widehat{h}_{B,t}\Big)$, where $\widehat{c}$ and $\widehat{h}$ are the optimal decision rules, is the value to the household of being in state $\mathcal{S}$ in the baseline economy. Answering the question above amounts to solving for $\mu(\mathcal{S})$ in the following equation, where V_I is the value to the household of being in the same state but in the economy with nonpayment insurance.

$$V_I(\mathcal{S}) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u\Big((1+\mu(\mathcal{S}))\widehat{c}_{B,t}, \widehat{h}_{B,t}\Big)$$

After invoking the functional form of the period utility function and simplifying, we arrive at a closed form expression. A full derivation is given in Appendix A.2.

$$\mu(\mathcal{S}) = \left(\frac{V_I(\mathcal{S}) + \frac{1}{(1-\sigma)(1-\beta)}}{V_B(\mathcal{S}) + \frac{1}{(1-\sigma)(1-\beta)}}\right)^{\frac{1}{\alpha(1-\sigma)}} - 1$$

I may then compute the average compensation needed to make the households indifferent using the equilibrium stationary distribution for the baseline economy.

$$\mathbb{E}[\mu(\mathcal{S})] = \int \mu(\mathcal{S})\lambda(\mathcal{S})\, d\mathcal{S} = \mathbf{10.7}\%$$

It is important to note that the compensation $\mu(\mathcal{S})$ is a state-contingent function and thus can be negative for some states, implying that the consumer prefers the baseline economy, and positive for other states, suggesting the consumer prefers the economy with rental firm insurance. Thus the policy will not guarantee a Pareto improvement. Nonetheless, by the ergodicity of the income process, households will spend some time in every income and asset position in the economy, so it is conceivable that the policy could be a Pareto improvement (all values of $\mu(\mathcal{S})$ are positive) even as the policy increases rental prices for higher end units

because as time tends tends to infinity, it is with probability one that even the wealthiest household will find themselves in the lowest income and asset-holding position.[11]

Incredibly, in the calibration considered in Section 1.4 and many others, such a situation arises. The compensation is strictly positive over the entire state space. The key reason for this is that the high risk premium in the baseline economy actually pushes some households to rent more housing than they otherwise would. The risk premium renders the cheap apartments too expensive for the utility stream they deliver and some households of more modest means are thus "overhoused" in the baseline economy although they would prefer to receive more consumption and a less expensive apartment. Part of this result is a consequence of the small number of housing options and income states. In a richer model, high income and high asset households would almost certainly prefer the baseline economy. Moreover, if the market furnished additional housing choices for lower value properties, households with a positive probability of default could downsize to more affordable units.

A Two-Period Model

To better understand the source of the inefficiency and the origin of the welfare gain from the insurance scheme, consider a highly stylized two-period version of the model. There exists a measure one continuum of households who are observationally indistinguishable to landlords. Similar to the baseline model, there are two housing options that provide utility streams h_1 and h_2 and whose underlying property prices are p_1 and p_2, such that $h_1 < h_2$ and $p_1 < p_2$. Rents are priced to reflect the user-cost including default risk. For simplicity, I ignore the pre-cautionary saving decisions of households (which is to say there is no savings technology through consumption loans) although rental firms may borrow at the risk free rate r_f in the capital markets.[12]

Each household is initially endowed with b units of the consumption good c, as well as

[11] This feature of many incomplete market models has been referred to as the "American nightmare" property.

[12] Although the absence of a borrowing decision renders the solution nearly trivial, the discussion of the welfare gains is greatly clarified.

stochastic income $y \in \{0, y_\ell, y_h\}$ with $y_\ell < y_h$ which (once revealed) will be the same in both periods. In period 1, the household observes its income draw, selects which housing it prefers, h_1 or h_2, and remains there for both periods. In recognition of the difficulties introduced by the finite horizon, where it would be optimal for every household to default on its rental agreement in the final period, I assume that income seizure is available so that only truly destitute households may default. Put differently, if a household can afford to pay the rent, it must. And as before, households must be able to pay the rent owed in the initial period to be able to take possession of the unit.[13]

Formally, the household's problem for an agent who does not default can be written as follows, where R is the market clearing rental rate for the chosen level of housing.

$$\begin{aligned} \max_{h_s} \; & u(c, h_s) \; + \; \beta u(c', h_s) \\ & \text{s.t.} \\ & c = b + y - R^s \\ & c' = y' - R^s \\ & c, c' \geq 0 \\ & h_s \in \{h_1, h_2\} \end{aligned} \tag{1.17}$$

For simplicity, I posit that consumption and housing bundles are ranked by a utility function of the form $u(c, h) = c + \log(h)$. The only properties necessary to demonstrate the welfare gain are (i) some level of substitutability between consumption and housing, and (ii) the household finds it necessary to have some positive level of housing.

Given the exogenously-determined property prices and free entry by landlords, competition to supply housing will bid profits to zero. The landlord's problem is a simplified version

[13]The same reasoning explains why the model considers housing over two periods rather than one. The option to default in a single period model would lead every destitute household to choose the highest utility housing option, since they will default either way. By requiring that the household be able to pay rent in the first period, the model achieves a separation in housing decision based on household type, as well as greater realism.

of (1.8). A rental firm that currently owns H_s units of properties of type s and expects a renter default rate of N_s will seek to maximize profits, solving

$$V^s(H_s, N_s) = \max_{H'_s} \left\{ R_s H'_s + R_s(1 - N_s)H'_s - p_s(H'_s - H_s) + \frac{1}{1 + r_f} p_s H'_s \right\} \tag{1.18}$$

Note that there are no eviction costs beyond the foregone rental income. In period one, the landlord first makes a property investment decision before the households make their rental decision. Taking rents and property prices as given, the landlord expands or contracts its holdings (third term) which then become operational in time for the households to move in. By assumption, all households can afford their rent in the first period, so the landlord recoups the market rent on all units now rented (first term), and in the second period some fraction N_s of the tenants default with potentially less income collected (second term), and at the end of the second period, the landlord sells its holdings (fourth term). The first order necessary condition for optimization implies that $R^s = \frac{p_s \, r_f}{2 - N_s} \frac{1}{1 + r_f}$. As before, if $N = 0$, the rental price is the simple user-cost.[14]

An equilibrium in this economy is (i) a set of decision rules for consumption and housing that maximize household utility, and (ii) rental prices that clear the housing market such that rental firms make zero profits. To analyze the pecuniary externality, I am interested in parameterizations such that household default behavior puts upward pressure on rental prices that induces deadweight welfare losses, as in the baseline model above. Suppose it is common knowledge that a fraction ω_0 of households will receive $y = 0$ (and thus will default in the second period), while a fraction ω_ℓ will receive y_ℓ and all remaining households receive y_h. Further, let $y_\ell + b < \frac{p_2 \, r_f}{2} \frac{1}{1 + r_f} < y_h$ so that (with certainty) the low and zero income households are unable to afford the more expensive housing, while the high income households can.[15] Next, to ensure that (i) the zero income households are able to afford

[14]The present formulation is less elegant than the baseline model because the timing implicitly assumes that both "periods" of the model in which rent is due occur during one compounding period for the landlord.

[15]The function of this assumption is that high income households can afford both types of housing, and further there cannot be default in the expensive units because every household that is able to move in is assumed to have sufficient income to ensure there is no default risk premium.

their initial rent, and (ii) the low income state y_ℓ is sufficient to cover the h_1 rent in period two, let $b, y_\ell > \frac{p_1\ r_f}{2-\frac{\omega_0}{\omega_0+\omega_\ell}} \frac{1}{1+r_f}$.

Households in the model are atomistic, so they do not take into account the effect of their individual behavior on aggregate prices. Additionally, all households of the same "type" face the same optimum problem and therefore make the same decision. Recall next that the landlord's equilibrium condition depends on the default rate N_s for each type of housing. By construction, the low and zero income households cannot afford to move into the more expensive units,[16] while the high earners make enough to be certain of payment. As a consequence, we may conclude that any equilibrium must support $R_2 = \frac{p_2\ r_f}{2} \frac{1}{1+r_f}$. For R_1, only two different prices are consistent with market equilibrium: $R_1^* = \frac{p_1\ r_f}{2-\frac{\omega_0}{\omega_0+\omega_\ell}} \frac{1}{1+r_f}$ *or* $R_1^{**} = \frac{p_1\ r_f}{2-\omega_0} \frac{1}{1+r_f}$. The reason is simply that the only agents with any choice are the high earners. If households who receive y_h opt to live in the expensive units, a separating equilibrium arises, and R_1^* prevails, whereas if the high earners choose to "pool" with the other households in h_1, the default frequency must fall, and R_1^{**} will clear the market. Which of the two equilibria prevails (or if both are permissible and there exists an equilibrium selection problem) depends on the utility streams provided by each type of housing.

The most crucial assumption for the demonstration of the welfare gains is that the percent increase in utility from the cheap to expensive housing exceeds the discounted value of the difference in rental price between the units (the second inequality below). Although a somewhat intricate mathematical expression, the economic intuition is straightforward. For the high income households presented with prices $\{R_1^*, R_2\}$ to prefer h_2, the increase in utility must outweigh the increase in price.

Assumption I.1. $\frac{1}{1+r_f}\left(\frac{p_2\ r_f}{2} - \frac{p_1\ r_f}{2-\omega_0}\right) > \log(\frac{h_2}{h_1}) > \frac{1}{1+r_f}\left(\frac{p_2\ r_f}{2} - \frac{p_1\ r_f}{2-\frac{\omega_0}{\omega_0+\omega_\ell}}\right)$

By contrast, the first inequality represents the scenario of a high income household who, faced with prices $\{R_1^{**}, R_2\}$, would choose h_1. A household in the position of both inequalities

[16] It is assumed that they cannot afford those units if there were no risk premium, so it follows they could not afford the units if a risk premium were present.

above captures the inefficiency of the baseline model. Presented with R_1^*, all high earners would optimally chose the high cost units, even though there would be a Pareto improvement for all households by virtue of the lower risk premium if they deviated in their housing choice.

Proposition I.2. ***(Inefficiency of Laissez Faire)*** *An economy that satisfies Assumption I.1 is not efficient under* $\{R_1^*, R_2\}$.

Proof. The objective is to show that the equilibrium with $\{R_1^{**}, R_2\}$ is a Pareto improvement to $\{R_1^*, R_2\}$. Note first that either price for R_1 is an equilibrium. The result then follows from a comparison of the utility streams. Substituting the model's primitives into the high income household's lifetime utility stream, the second inequality of Assumption I.1 ensures that $u(c, h_2) + \beta u(c', h_2) > u(c, h_1) + \beta u(c', h_1)$ so that high earners prefer the h_2 when the prevailing price of the alternative housing is R_1^*. In the case of R_1^{**}, the first inequality of Assumption I.1 guarantees that $u(c, h_2) + \beta u(c', h_2) < u(c, h_1) + \beta u(c', h_1)$. It should be noted that a high earner's utility when inhabiting h_2 does not depend on the market clearing price for h_1 because there is by assumption no risk premium. Therefore the y_h households unambiguously prefer the R_1^{**} equilibrium. All that remains to be shown is that the other households also prefer the economy under R_1^{**}, which is trivially true. When high income households opt for h_1, the rental price falls which increases resources for consumption of the zero income households in period one and y_ℓ households in both periods. □

The question then becomes what kind of intervention can solve the equilibrium selection problem. For the purpose of this model, I define constrained efficiency as the selection of the Pareto efficient equilibrium. As is shown next, a judiciously chosen tax τ can ensure the R_1^{**} equilibrium arises by forcing the high income households to pool with the others.[17]

Proposition I.3. ***(Constrained Efficiency)*** *The constrained efficient equilibrium can be implemented with an appropriate tax on the* h_2 *units.*

[17]The tax here is similar in spirit to the state-contingent borrowing tax in Bianchi (2011) which is used to mitigate the pecuniary externality from overborrowing in a small open economy with a collateral constraint.

Proof. The argument proceeds by contradiction. Let $\tau > \left(\log(\frac{h_2}{h_1}) + R_1^*\right)\frac{1}{R_2} - 1$ be a tax on the expensive units such that any household who selects h_2 will pay $(1+\tau)R_2$. Consider now the high earners' problem under the R_1^* by comparing utility streams. It follows immediately that high income households in the $\{R_1^*, R_2\}$ equilibrium will deviate to h_1, which is a contradiction because R_1^* clears the housing market *only if* high earners live in the h_2 units. The deviation by high earners would lead to positive profits for landlords, inducing entry into the market, since the default rate falls from $\frac{\omega_0}{\omega_0+\omega_\ell}$ to ω_0 when high earners pool with the other household types. By contrast, the pooling equilibrium under $\{R_1^{**}, R_2\}$ remains valid under the tax and becomes the model's unique equilibrium. □

While the model above is highly stylized and abstracts from many important features of the full model, it encapsulates the fundamental welfare loss from the market incompleteness. Some agents will find themselves in a position where the risk premium on less expensive housing is sufficiently steep that the combination of consumption and housing from a more expensive apartment actually increases utility, although they would be far better off in the counterfactual where they rented the cheaper units by virtue of the resulting reduction in the risk premium. And what is more, a suitable intervention (although not an insurance scheme here) can increase social welfare.

1.7 Conclusion

This paper has shown that a simple model of rental housing with nonpayment risk implies a large risk premium paid by low-income households. Insuring landlords against tenant default lowers the user-cost of housing and thus rental prices for the least expensive units, spreading the eviction costs across the broader universe of renters. The welfare effects of the policy are estimated to be large. The value to the average household is worth a sizable 10.7% permanent increase in consumption, and the eviction rate in the model economy falls from 5.61% to 1.3% in the new stationary equilibrium.

It should be stressed that the model in this paper was chosen for its simplicity in demonstrating the potential for a novel form of social insurance. Although straightforward, the proposed policy likely faces political pitfalls such as pressure on the agency running the insurance fund not to evict tenants in many circumstances or conversely the agency could be captured by rental firms.

Future research should aim to make the analytical framework presented here more realistic, such as by modifying the income process, endogenizing the housing supply with a construction sector, and allowing for the option of homeownership. Another avenue for further research is the introduction of imperfect competition among rental firms. Arnott (1995) notes that imperfect competition is an understudied yet salient feature of rental housing from which I have abstracted in this first pass on the topic.

CHAPTER II

Bank Competition and *de novo* Entry

Abstract Prior to the passage of the Dodd-Frank Act, states were able to restrict the formation of branches by out-of-state banks. Nevertheless, many banks operated branches in states in which they were not chartered by virtue of mechanisms from earlier statutes that allowed banking institutions to bypass branching restrictions through the purchase of individual branches or merger with an in-state bank. In such a regulatory framework, it is an empirical question whether state prohibitions on *de novo* branching posed a meaningful barrier to entry and restraint on competition in local banking markets. By exploiting Ohio's 1997 abandonment of branching restrictions and the Dodd-Frank Act's federal preemption of state branching laws in 2010, this paper presents novel evidence that branching restrictions had large and statistically significant effects on both bank entry and interest rates in local markets. The results of the difference-in-differences estimation suggest that abandoning branching restrictions likely caused a 31.7 percentage point increase in the share of *de novo* branches from out-of-state banks, a 41 basis point decrease in loan rates, and a 30 basis point increase in deposit rates. Taken together, the empirical exercises imply that state branching laws were in fact a meaningful impediment to commercial bank competition.

2.1 Introduction

The Interstate Banking and Branching Efficiency Act of 1994 ushered in a new era of bank regulations. One of the less celebrated changes of that law—which is better known as the Riegle-Neal Act—was a revision of the limits on branching across state lines for banks who did not have a toehold in other states via merger. However, in a political compromise, the new statute did not compel states to allow out-of-state banks to open new branches. Instead, the statute permitted states to "opt in" to interstate branching or maintain their existing regulations. The question posed by this paper is whether the liberalization of bank branching restrictions had meaningful economic effects on local banking markets.

The answer to this question is of interest both to economists and to bank regulators because the patchwork system of regulation that existed at the time of the Riegle-Neal Act was not one of absolute prohibition on the entry of out-of-state banks. Before 1994, the ability of a bank charted in State A to engage in banking services in State B could often be accomplished by means other than the direct entry of establishing a new branch in State B.[1] In many states, banks could purchase a single branch of a locally chartered bank, or better yet acquire a State B chartered bank, to bypass restrictions on branching. These alternatives to true *de novo* branching—which potentially carry the advantages of acquiring an existing customer base—raised the possibility that this portion of Riegle-Neal—codified at 12 U.S.C. § 36(g)(2000) for national banks and 12 U.S.C. § 1828(d) for state banks—was largely inconsequential. By this reasoning, any bank that wanted to enter a state with branching restrictions had no shortage of regulatory workarounds to exploit. If this were how banks competed across state lines, then this statutory modification would have been of little economic value. In fact, bankers and their lawyers continued to speculate about the efficacy of interstate branching reforms up to the passage of the Dodd-Frank Act, whose § 613 forced the states who "opted out" to accept *de novo* branches from out-of-state banks so

[1]The entry into a new market by direct formation of a new branch is known in the banking industry as *de novo* branching.

long as those banks obeyed the regulations the state imposed on its domestically chartered institutions. See e.g., Bader (2011) [2]; Grasmick (2010).[3]

To test this hypothesis, the empirical strategy of this paper takes advantage of two events, the first of which is the May 1997 decision to "opt in" to interstate branching by the State of Ohio without requiring reciprocal treatment for Ohio banks. Although many states opted in to *de novo* branching before Dodd-Frank, Ohio did not discriminate against banks that were chartered in states which would not grant the same branching privileges to Ohio banks. The second event studies the public policy sledgehammer of federal preemption in July 2010 which did away with all state restrictions on *de novo* branching, including the reciprocity requirements of the other "opt in" states. The results of the analysis below are unambiguous that interstate branching liberalization policies did have economically meaningful effects both in terms of the entry by out-of-state banks through *de novo* branching *and* on interest rates in local banking markets. Using a difference-in-differences design that exploits the "opt out" states as a control group, I find that eliminating restrictions on *de novo* branching led to a more than 30 percentage point rise in the share of new branches formed by out-of-state banks as well as a 40 basis point decrease in loan rates. The results from the Dodd-Frank reforms were also economically and statistically significant, although more attenuated, with the branching liberalization policy estimated to have caused a 12 percentage point rise in the share of new branches formed out-of-state banks.

The value of these findings lies largely in legal and economic history, as bank branching has become an increasingly minor form of commercial bank competition in the American economy. According to the work of Benson et al. (2023), "[p]rior to 2007, approximately 2,000-4,000 new branches opened each year; however, after 2010, approximately 750-1,250 new branches opened each year." Nevertheless, the results of the empirical exercises in this paper provide compelling evidence about the effect of state regulations on commercial bank

[2] "While the changes as a result of Dodd-Frank will give banks greater access to new markets nationwide, it remains to be seen whether banks will take advantage of the new laws and increase branching activity."

[3] "It remains to be seen if there will be a influx of banks into California by outsiders that have been previously unwilling to buy their way in."

competition in the mid-twentieth century as well as additional corroboration of the pro-competitive impact of the Riegle-Neal Act along the previously unstudied margin of entry into new markets through *de novo* branching.

Related Literature

This paper is related to two primary strands of the literature that span the scholarship in law, economics and finance. First, there is a long line of research on the effect of deregulation on bank competition and lending markets, as well as sustained interest in the Riegle-Neal Act itself, by academic economists. Jayaratne and Strahan (1996) used branching regulations to study the nexus between financing frictions and economic growth, although those authors focused on intrastate branching laws as opposed to the *de novo* interstate branching studied here. Early work on the relaxation of interstate banking restrictions in the 1980s was done performed by Amel and Liang (1992) and McLaughlin (1995), which was later later-complemented by Sapienza (2002) who studied the impact of increasing bank consolidation on credit terms, and Berger et al. (2005) who used a state-level instrument measuring the permissiveness of bank branching restrictions to study how bank size affects credit supply to firms with more opaque credit risks.

With respect to the Riegle-Neal Act in particular, Dick (2006) analyzed the impact of the regulatory framework on bank size, market structure, and costs,[4] and Zarutskie (2006) studied the impact of the Riegle-Neal Act on firms, finding that newer business relied less on external debt after the law went into effect. Most recently, the authors in Oberfield et al. (2025) exploit the regulatory changes introduced by the Riegle-Neal Act to study a spatial theory of multi-branch banking. Their concern was to explain the "sorting" of different banks into different markets from either span-of-control incentives or from a mismatch in a region's supply of deposits compared to its demand for loans. Critically, those authors did not study entry via *de novo* branching as I do here.

[4]It should be noted that this paper did not distinguish the regulation of *de novo* branching from other regulatory changes in the Riegle-Neal Act.

The second line of research into which this paper fits is the legal scholarship on bank regulation. Although much ink was spilled at the passage of the Riegle-Neal Act—for instance Tart (1995), Stritzel (1995), Rollinger (1996)—the paper that comes the closest to examining the question considered here is the work of Johnson and Rice (2008) who performed a retrospective assessment of the first decade of the Riegle-Neal Act, including a state-by-state cataloguing of existing restrictions on interstate *de novo* branching. However, those authors conducted only correlational exercises of the impact of the reform on bank branching. Another central question posed by this paper is *how* commercial banks compete against one another in an evolving regulatory framework that restricts a specific form of competition. Along these lines, the work of Kress (2019), Kress (2020) and Kress (2022) has studied how the shifting regulatory framework has affected antitrust regulation in the banking system, casting doubt on the value of traditional merger analysis in an era that has permitted the creation of enormous financial institutions.

The remainder of the paper proceeds as follows. Section 2.2 provides a history of federal and state bank branch regulation, as well as an in-depth look at the 1997 Ohio reforms and § 613 of the Dodd-Frank Act. Section 2.3 then presents the data, empirical exercises and results, while Section 2.4 concludes.

2.2 History of Bank Branch Regulation

Despite the extensiveness of branching restrictions imposed on American banks since the founding, there exist few scholarly works dedicated to the subject. Two notable, but dated, exceptions are Bradford (1940) and Chapman and Westerfield (1942). Most of the modern work that touches on branching regulations is found within larger studies on the entire bank regulatory apparatus, treating branching restrictions incidentally, and often sloppily in only as much depth as necessary to connect it to other restrictions on bank activity. The present section aims to provide a sufficiently comprehensive treatment of the history of branching regulations to provide a full understanding the economic consequences of the Riegle-Neal

Act's reforms.[5] The primary insight is that the debate over bank branching in the United States has been a protracted chipping away at deep-seated intuitions about the very nature of banking. These public policy intuitions were likely highly flawed from the outset, fueled by peculiarly American political objectives and only successfully reined in by experimentation at the state level.

The evolution of American banking regulations in general is largely a story of removing highly protectionist policies often reported to be motivated by the desire to prevent undue concentrations of economic and political power. In many respects, the debate mirrors other early economic conflicts between urban and rural interests, and ultimately the fear of powerful, eastern, monied interests which can map on to a Jeffersonian vision of yeoman bankers which indeed became the ethos of bank regulation for most of US history. The debate over bank branching in particular extends all the way to the founding. Alexander Hamilton's plan for the First Bank of the United States did not contemplate branching, although he had recognized possible beneficial properties in such a system. Bradford suggests that Hamilton was concerned with agency problems, especially the lack of high quality managers for the branches. But despite those concerns, the organic statute that created the First Bank of the United States, enacted at the first Congress, placed in the charter a provision that,[6]

> "It shall be lawful for the directors aforesaid *to establish offices wheresoever they shall think fit*, within the United States, for the purposes of discount and deposit only, and upon the same terms and in the same manner as shall be practiced at the bank, and to commit the management of the said offices and the making of said discounts to such persons, under such agreements and subject to such regulations as they shall deem proper." 1 Stat. 191 (1791). (emphasis added).

In the end, eight branches were created in major cities around the country in addition to

[5]For much of the information that follows, I refer the reader to the previously cited works as well as the article by Johnson and Rice (2008) and the treatises of Malloy and Lovett (2019) and Sparks (2017).

[6]Interestingly, although modern scholars often refer to the "charter" of the First or Second Bank of the United States, the 1791 statute refers in Section 7 to"the constitution of the said corporation."

the headquarters in Philadelphia. An obvious explanation for Congress' decision to authorize branches is that (i) the bank was to serve as the fiscal agent of the federal government, and (ii) the notes of the Bank were meant to provide the country with a medium of exchange. Neither goal could be accomplished easily in a horse and carriage era if there were only a single location. The charter of the Second Bank of the United States, passed in 1816, also allowed for the establishment of branches, although some of Hamilton's worries turned out to be well-founded with the discovery of fraudulent activities and blatant self-dealing by the managers of the Baltimore branch. One of those men was the cashier of the Baltimore branch, James McCulloh, who is better known as the defendant (whose surname was misspelled by the court clerk) in the landmark decision of *McCulloch v. Maryland*, 17 U.S. 316 (1819) on the distribution of power between the federal government and the states. See also, Bogen (1981).

After the collapse of the Second Bank of the United States in 1836 by dint of President Jackson's veto, the states became the exclusive chartering authorities for banking institutions, and so-called "unit banking" where a bank was contemplated to be a solitary institution, was the overwhelming standard. In the pre-Civil War period, most state banks were established under special charters that required bespoke laws passed individually by the state legislature. Branching provisions in this period could therefore vary from bank to bank within the same state. Bradford notes that the State Banks of Indiana and Ohio were successful banking institutions of this period with branch systems throughout their respective states. In fact, the State Bank of Indiana was likely a direct result of the lack of circulating currency when the Second Bank's charter expired. The most contested part of the bill in the Indiana legislature that established the bank was the number of branches.[7] Harding (1895). With the passage of the National Bank Acts of 1863 and 1864, the practice of unit banking was applied to the new "national banks", charted by the Office of the Comptroller

[7]The bill fixed the number at ten with repeated attempts to reduce the number to five "with the thought on the part of many that the fewer branches the less the mischief to be done."

of the Currency ("OCC"), and they were prohibited from having any branches.[8] Curiously, the first Comptroller of the Currency, Hugh McCulloch, had been president of the successor institution of the State Bank of Indiana during the crisis of 1857 when the bank was one of only a few in the country that did not need to suspend redemptions of specie, a result that some scholars attribute to the branch system in place. Rockoff (1989).

A purported advantage of the unit banking approach was that it kept banking activity local. Deposits would be raised from people in the surrounding city or county, and loans would be issued to locals. Consistent with the Jeffersonian ideal, most banks were quite small. A tipping point was the considerable growth of branch banking at the state level during the economic boom of the 1920s. With no movement at the federal level, the states had made use of their chartering power in the now firmly established "dual banking system" to experiment with branching outside the context of quasi-governmental banks, dividing into three regimes—(i) unit banking (no branches); (ii) county-wide branching; and (iii) full state branching. In 1924, Comptroller Henry Dawes captured the anti-branching arguments, writing to Congress that "branch banking is opposed to public policy as being in essence monopolistic. . . branch banking is absentee banking and is conducted for the sole purpose of earning dividends for the stockholders rather than of service to the community."[9] In the same section of the report that Dawes proclaims "[b]ranch banking. is particularly inconsistent with the American idea of local self-government", he notes that many large cities are left with few national banks as so many of them had converted their charters to become state banks. The supposed received wisdom opposed to branching was evidently confronting an economic reality. As the states demonstrated a growing acceptance of (at least intrastate) branching, Congress faced pressure to act. The result was the passage of the McFadden Act of 1927 which was a modest first step, permitting national banks in large cities to establish branches within the city, provided that the relevant state law permitted state banks to establish

[8] Although there was no statutory guidance, every Comptroller from the inception of the agency until 1922 agreed that national banks could not operate in more than one location. See Johnson and Rice (2008).

[9] Annual Report of the Comptroller of the Currency, 1924.

branches.[10] Bradford notes that this was a tiny victory for bankers, because the greatest benefits of branch banking come from entering new markets. However, a more substantive move toward branch banking soon arrived, during the New Deal, as the Banking Act of 1933 granted national banks the same permissions to branch as their state-chartered competitors, which meant that the ability of national banks to establish branches was now intimately tied to the regulatory regime of the state in which they were located.[11] As a historical curiosity, the third draft of the Banking Act of 1933 included a provision that would have permitted national banks, in any state, to establish branch offices through-out the state in which they were located *and* in neighboring states within fifty miles of the parent bank. That provision was never enacted into law due to a filibuster by populist Louisiana Senator Huey Long.

In the latter half of the twentieth century, technological innovations and regulatory loopholes put further pressure on the traditional aversion to branching. For example, the advent of Automated Teller machines ("ATMs") faced hurdles when courts held that they were branches under the McFadden Act. See, e.g. *Independent Bankers Association of America v. Smith*, 534 F.2d 921 (D.C. Cir 1976). More importantly, the long-standing cottage industry focused on getting around restrictive banking laws was finding increasing success. Since the 1890s, "chain banks" and "group banks" had existed as an unregulated precursor to the now familiar notion of a bank holding company, for the purpose of circumventing state laws, especially intrastate and interstate branching restrictions. As a creature of state corporation law, the holding company device could create what amounted to branches in the same state or out of state, by buying banks through the holding company. Since the holding company was not itself a bank, it was not subject to the regulators' demands to halt expansion. Even Federal Reserve Board chairman Marriner Eccles, himself a former banker, described the holding company form as an innovation born of necessity, since the supposed problems of

[10]The Act was unusually specific. National banks in a city with a population of at least 25,000 could establish one branch within the home city; national banks in cities of 50,000 to 100,000 residents could establish two branches; and national banks in cities with a population in excess of 100,000 could establish any number of branches with the approval of the Comptroller of the Currency.

[11]Some secondary sources, including Malloy and Lovett (2019), erroneously claim that this reform was part of the McFadden Act.

branch banking and bank holding companies were inextricably linked.[12]

When the Bank Holding Company Act of 1956 ("BHCA") came into effect, the regulatory evasion was over. The Act gave bank holding companies a regulator, the Federal Reserve Board, and ended the practice of making out-of-state bank acquisitions. In particular, the Douglas Amendment to the Act greatly limited bank holding company expansion by virtue of the requirement of affirmative authorization for interstate banking acquisitions by the acquired bank's state. As noted by Justice Rehnquist, "[f]rom 1956 to 1972, the Douglas Amendment had the effect of completely barring interstate bank acquisitions because no State had enacted the requisite authorizing statute." *Northeast Bancorp, Inc. v. Board of Governors of the Federal Reserve System*, 472 U.S. 159 (1985). But after 1972, the tide began to turn, as states passed statutes permitting interstate acquisitions.[13]

While the BHCA was largely intended to reduce the perceived anticompetitive excesses of chain banking (most notably the inclusion of non-banks such as insurance companies within the holding company structure), the Supreme Court and regulatory agencies took an increasingly liberal view of holding companies as time passed. In *United States v. Marine Bancorporation*, 418 U.S. 602 (1974), the Department of Justice ("DOJ") sought to block a merger between two banks in Washington state. The Court recognized the regulatory burden on banks under Washington's regulatory regime and affirmed the district court's judgment that the Seattle bank was not realistically a "potential competitor" with Spokane banks due to the state-level prohibitions on entry via branching and multi-bank holding companies and otherwise. The upshot of the Court's holding was that it became substantially more difficult for the DOJ to prevent bank holding companies from acquiring banks in new markets. As a consequence, if a state did not use its own lawmaking authority to limit bank

[12]See Grischkan (2026) for an extended discussion of Eccles' role in the Bank Holding Company Act, the pragmatic regulatory issues during this period and the history of bank holding company regulation in general.

[13]The *Northeast Bancorp.* decision has a nice discussion of various state laws of the period including Washington's authorization of the acquisition of failing banks by out-of-state bank holding companies, and Delaware's endorsement of the establishment of special purpose banks by out-of-state bank holding companies.

holding company expansion, large banks would face few obstacles to extending their banking operations within a state via acquisition of independent banks through the legal fiction of a holding company. Moreover, in *Northeast Bancorp.*, the Court upheld a challenge to a regional reciprocal agreement by states in New England to overcome the hurdle of the Douglas Amendment.

The major consequence of bank holding company regulation on branching restrictions was that by the year 1990, 46 states allowed interstate bank acquisitions, Mengle (1990), and therefore interstate branching was *possible* almost nationwide when an out-of-state bank holding company established a toehold in a new state via merger. As Johnson and Rice note, "[i]n contrast to the growth of interstate banking [via acquisition], prior to the passage of [Riegle-Neal], the vast majority of states did not permit interstate branching." By 1994, there existed an enormous patchwork of laws that governed interstate banking but only eight states allowed any form of interstate branching, and even with those laws on the books, very little interstate branching actually occurred. As a result, the means of branching across state lines was restricted to (i) chartering a new bank in the desired state, or (ii) acquisition of an out-of-state bank to convert to a subsidiary of the holding company. Perhaps the most plausible reading of the path of American bank branch regulation conclusion is one of slow acclimation. While branching was recognized early in US history to be desirable for governmental ends, and economists such as Chapman and Westerfield (1942) made the passionate case for the virtues of branch banking by diversification and scale, a structural preference by the public for small banks was not easily dislodged. All of this was to change dramatically with the passage of Riegle-Neal.

The Riegle-Neal Act

As the discussion above indicates, by the 1990s discontent with regulations on bank expansion in general, and branching restrictions in particular, had been brewing for decades. In 1991, comprehensive interstate banking reform was debated again when the U.S. Senate

passed a bill that would have permitted bank holding companies to acquire banks in *any* state and combine all of their subsidiary banks into a single bank with many branches in several states. Although that bill never made it into law, in 1993 a new Congress and a new President had the appetite to try again. The result was the Interstate Banking and Branching Efficiency Act, enacted on September 29, 1994.

While the final version of Act contained many tweaks to the Bank Holding Company Act and the Federal Deposit Insurance Act, the most succinct description of the major reforms of the Riegle-Neal Act comes from the introduction of the March 23, 1994 report of the Senate Committee on Banking, Housing, and Urban Affairs.

> "The Act would permit, after one year, adequately capitalized and managed bank holding companies to undertake the interstate acquisition or establishment of banks in any state. In addition, the Act would allow, after two years (unless a state elects earlier), bank holding companies with bank subsidiaries located in more than one state to combine the subsidiaries into interstate banks... *Under this bill, de novo interstate branching would be permitted only if a state law expressly allowed for such branching.*" Senate Report No. 103-240. (emphasis added).

The legislative history of the Act suggests a complicated cocktail of motivations, from the desire to harmonize the patchwork of state laws geared at permitting bank expansion to concerns about the underlying health of the banking system. The June 22, 1993 report of the House Subcommittee on Financial Institutions Supervision, Regulation and Deposit Insurance includes statements from Congressman Sam Johnson of Texas[14] and testimony from Federal Reserve Bank of Boston President Richard Syron[15] imploring Congress to

[14] "I believe reducing regulatory burden is an essential component to the passage of any Banking bill this year. And we must remove the Federal regulatory noose and provide our financial institutions with the ability to make loans and ease the credit crunch that is killing America's business"

[15] "Without nationwide banking and branching, regions of the economy experiencing severe regional shocks may be unable to attract additional bank capital when loan demand exceeds loan supply. Over a long course of time, markets will work and the capital will come in, but in the short run there are significant disruptions

act based on essentially the same reasoning articulated by Bradford in 1940, that the New England "credit crunch" of the early 1990s would have been substantially less severe if banks could have more easily diversified their portfolios. But another motive, which appears in both House and Senate Committee reports and remains familiar to contemporary discussions of bank regulation, was the declining share of credit assets held by banks, noting the presence of artificial restrictions on bank expansion increased the share of assets held by alternative entities—such as money market funds and mortgage companies—"at the expense of the banking industry." Senate Report no. 103-240.

Perhaps most importantly, the Act allowed interstate bank holding companies to acquire banks in any state starting in 1997. However, states were allowed to attach some strings to these transactions. In particular, states could (i) set limits on the acquisition of in-state banks that were less than five years old; (ii) set caps on deposit concentration; and (iii)—most importantly for this paper—restrict branching activities. Other prominent changes included the ability to conduct an interstate merger transaction that involves only the acquisition of a branch (or several branches) as opposed to the acquisition of the entire bank. 12 U.S.C. § 1831u(a)(4).

While interstate branching done through a merger was now permitted in every state, irrespective of state law, *de novo* branching, i.e. the establishment of a branch which did not previously exist, would be permitted only if a state explicitly "opted in" by passing a law to that effect. Johnson and Rice argue that small banking institutions could stand to benefit more from the availability of *de novo* branching than large institutions because they were less likely to be able to "buy their way" into new markets. However, lobbyists for small bankers such as the Independent Bankers Association of America exerted much effort in persuading state legislature to opt-out of Riegle-Neal's *de novo* branching provisions. The empirical results detailed below suggest that the fear of competition was likely warranted,

which are very difficult for an individual borrower. From their perspective, it is impossible to say that in the long run you will be OK, but in the short run you may go out of business because of the lack of credit. The credit crunch in New England is an example of a severe regional shock magnified by the impaired capital position of most New England depository institutions."

at least from the banks' perspective.

Ohio

Many states opted-in to Riegle-Neal's *de novo* branching provision shortly after the law's enactment. However, every state who opted in before Ohio had established some sort of additional barrier, the most common of which was a reciprocity requirement. A common example of the language is that of Massachusetts, whose legislature opted-in with a reciprocity requirement effective August 1996.

> "A[n]... out-of-state bank... if such bank does not operate a branch in the commonwealth, may, upon approval by the commissioner... establish and maintain a branch de novo in the commonwealth or may purchase a branch of a Massachusetts bank without purchasing the bank; *provided, however, that in each instance the laws of the jurisdiction in which such bank has its principal place of business expressly authorize, under conditions no more restrictive than those imposed by this chapter ... a Massachusetts bank to establish therein a branch de novo or to acquire a branch of a bank without acquiring the bank.*" M.G.L. c. 167 Section 39C. (emphasis added).

By contrast, the Ohio legislation to opt-in to *de novo* branching included no such requirement. Prior to the Riegle-Neal modifications, the section of the Ohio Revised Code on bank branching read, "[o]nly a bank with its principal place of business in this state may establish and maintain a banking office in this state." However, during the 1997 legislative session, Ohio revised § 1117.01(A) of its state code to read,

> "Subject to section 1115.05 and Chapter 1119 [o]f the Revised Code, a bank, *regardless of the location of* its principal place of business, may establish or acquire and maintain a baking office in this state." 1997 Ohio Laws 6332. (emphasis added).

As is typical with state governments, the legislative history for this statute is sparse, so it is difficult to formulate a coherent explanation for Ohio's departure from the behavior of other states. It is conceivable that Ohio's legislature took the opposite position of Henry Dawes, which is to say that the entry of out-of-state banks could be a boon to underbanked rural communities, or perhaps Ohio wanted to ensure in no uncertain terms that its law would allow Ohio banks to branch in any state with a reciprocity requirement.[16] Whatever the explanation, the law took effect in Ohio May 21, 1997 and Ohio became the first state in the union to embrace fully interstate branching.

The Dodd-Frank Act

The death knell for the Jeffersonian vision of small banks (at least in the context of branching) was the preemption of *all* interstate branching prohibitions by the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010. An enormous piece of legislation, the Dodd-Frank Act was passed in the wake of the 2008 financial crisis and contained a dizzying array of reforms addressing the systemic fragility of the financial system. Even observers who followed the passage of the law closely could be forgiven for not taking stock of Section 613 of the Act which amended the U.S.C. to allow states to impose branching restrictions only if those restrictions apply to state banks chartered by that state. In essence, discrimination in branching was no longer permitted against out-of-state banks.

Although it is difficult to the trace the immediate origins Section 613, it is known that the exact language which would become part of the statute appeared in the Obama Administration's Regulatory Reform Agenda in July of 2009. However, the Treasury Department's July 22, 2009 "Fact Sheet" on the legislative agenda does not highlight it at all. When H.R. 4173 was introduced in the House of Representatives on December 2, 2009, the language that

[16] As an aside, there was an issue of statutory interpretation such that 12 U.S.C. § 36(g) requires that "there is in effect in the host State a law that (i) applies equally to all banks" and whether or not a reciprocity requirement does in fact"appl[y] equally to all banks." However, by at least March 1997, the OCC had concluded that reciprocity requirements like the one enacted in Massachusetts were permissible. See OCC Corporate Decision #97-19.

would become Section 613 was not in the bill, although it was added along with a number of other amendments to what became the engrossed bill on December 11, 2009.

A simple explanation for the provision's presence in the Dodd-Frank Act is that the political compromise on *de novo* branching in Riegle-Neal had not been satisfactory for the banking industry and the issue remained on the back burner for 15 years. Perhaps similar to how the initial Riegle-Neal compromise was achieved following the New England credit crunch of the early 1990s, the final push to full interstate branching might have required another financial crisis for political cover. The previous sentence should be read with only a minuscule measure of cynicism because, after all, the branching advocates of the 1940s had extolled the benefits of diversified cash flows from bank branching in the aftermath of the Great Depression. What remains an empirical question is how much systemic risk reduction from additional commercial bank branching could plausibly be captured in 2010. That inquiry is beyond the scope of this paper. An alternative motivation (and one stated directly in the Obama administration's recommendations in "Financial Regulatory Reform: A New Foundation") is related to the Dodd-Frank Act's reorganization of thrifts under the OCC. An April 1992 administrative decision by the Office of Thrift Supervision (which was dissolved by Dodd-Frank) had allowed thrifts to branch nationwide without regard to state law. As a consequence, the language of Section 613 would simply bring commercial bank regulation into line with competitors. But no matter the impetus, after July 21, 2010, state laws that prohibited *de novo* entry by out-of-state banks[17] were now invalid.

2.3 Empirical Analysis

To measure the significance of interstate branching restrictions, I study two key events: the 1997 liberalization of branching restrictions in Ohio and the 2010 preemption of all state branching restrictions pursuant to the Dodd-Frank Act in 2010. The timing of Ohio's

[17]Such as Section 3824(b)(3) of California's Financial Code which stated "[t]his section constitutes: ... [a]n express prohibition against interstate branching through de novo establishment of California branch offices."

reform has the added benefit that it enables analysis of price effects in local banking markets, specifically the response of loan and deposit rates to the change in the law. In particular, the Cincinnati metropolitan area straddles the Ohio-Kentucky border, where the latter state retained its foreign branching prohibition and is therefore a suitable control state from which to infer the treatment effect of the Ohio reform on interest rates in the Cincinnati lending market.

By contrast, the Dodd-Frank Act had national impact as it brought all state branching laws into harmony. As a consequence, it is not possible to estimate the impact on loan and deposit rates because there no longer existed a suitable set of control states after the legislation came into effect. Nonetheless, the conclusions about entry of foreign banks following the Dodd-Frank Act reinforce the results of the Ohio exercise that branching restrictions were viewed by banks as a meaningful barrier to entry.

Data

The data used in the analysis of both events come from well-known and publicly available bank regulatory datasets. For data on bank branches, I rely on the Summary of Deposits ("SOD") database from the Federal Deposit Insurance Corporation ("FDIC"). The SOD contains comprehensive data on the branches of all depository institutions in the United States, including thrifts and credit unions, as measured on June 30th of every year since 1994. As this paper is concerned with regulatory changes to the commercial banking system, only branches of state and national banks are considered. One caveat with the SOD database is that there are known problems with the unique branch identifier—UNINUMBR—assigned by the FDIC. Although in theory the identifier should track branches when they are bought or sold, the accuracy is not perfect. However, for the purposes of this paper, only newly formed branches are studied (as measured by the establishment date in the SOD) since the goal is to measure *de novo* entrants as opposed to other forms of interstate entry such as by merging with an out-of-state bank or the purchase of a single branch. For a discussion of the difficulties

in tracking branch ownership over time using the SOD, see Benson et al. (2023). But beyond identifying newly established branches, the SOD also possesses detailed information on the ownership of the branches and importantly the location of the top regulatory bank or bank holding company which enables the construction of times series, by state, of out-of-state bank entry via *de novo* branching.

For the estimation of the impact of Ohio's reform on interest rates in local banking markets, I employ the Reports of Condition and Income (better known as the Call Reports) from the Federal Financial Institutions Examination Council ("FFIEC"), which contain quarterly balance sheet and income statement data for all FDIC-insured institutions. For simplicity I use a cleaned-up version of the data provided by the authors[18] of Drechsler et al. (2017) in their study of the deposits channel of monetary policy. The deposit and interest rate time series are constructed by dividing the relevant income statement line item (either interest income or interest expense for the loan and deposit categories respectively) by the relevant end of period balance sheet line item. An advantage of this relatively basic approach is that it reflects *ex post* realized interest rates rather than *ex ante* advertised rates, therefore the interest rate time series are immune to financial instruments whose rate might be renegotiated or are not actually transacted, yielding a more complete sense of the average interest rate charged on loans or paid on deposits. On the other hand, the approach stated above introduces the potential for measurement error if the Ohio and Kentucky banks in the sample sporadically issue/sell large loans or experience large deposit flows at the end of quarters. Such behavior would introduce noise into the time series because the stock of loans and deposits at the end of the period would not reflect the interest income or expenses over the period. However, there is no clear reason to conclude that the end of period movements in loans and deposits are likely to be correlated with treatment status. Thus to the extent that such statistical noise is present, the effect would be an increase in the standard errors of the estimated treatment effects rather than the introduction of bias to the estimated

[18] As of March 2026, the data are avaiiable on Philipp Schnabl's personal website.

coefficients themselves.

For more detailed information on the specific variables from each data source that are employed in the empirical exercises, see Appendix B.2.

The Ohio Experiment

The first pass at determining whether commercial banks reacted to the relaxing of *de novo* branch regulations compares Ohio's bank entry to the entire set of states that never opted-in to allowing *de novo* branching before the enactment of the Dodd-Frank Act. As explained *supra*, many states besides Ohio opted-in to *de novo* branching after Riegle-Neal, but they did so with significant qualifications, the most common of which was a reciprocity requirement. To evaluate the burden posed by the branching restrictions in as clean an environment as possible, I have opted to ignore these "qualified opt in" states because the resulting estimates would likely be attenuated by the effect of the other entry requirements.

In addition, the states who never opted-in after Riegle-Neal are an ideal control group for this exercise since there was arguably no influence on banks' branching decisions in these states from either minor restrictions on new branches or the anticipation of future regulatory changes, since these states never changed branching regulations until the preemption by Dodd-Frank. As demonstrated in Figure 2.1, the set of control states spans every region of the United States although coverage is more sparse in the North East where most states opted-in to *de novo* branching with a reciprocity requirement.

Within this setting, I employ a standard difference-in-differences design using the FDIC's data on bank branches to infer the change in *de novo* entry by out-of-state banks that can be attributed to Ohio's decision to opt in to interstate branching. The time period considered is July 1, 1993 to June 30, 1999, where a "year" is measured from July to June for the purpose of measuring branch entry to correspond with the timing of the FDIC's data collection. Accordingly, all observations before 1997 are untreated, and Ohio observations in 1999 are considered treated. The regression specification is standard but includes a control

for population as a proxy for economic activity, which would presumably impinge on an out-of-state bank's entry decision via a *de novo* branch,

$$y_{it} = \alpha_i + \lambda_t + \delta D_{it} + Pop_{it} + \epsilon_{it} \tag{2.1}$$

where y_{it} is a measure of branch concentration, α_i is a state fixed effect, λ_t is a year fixed effect, D_{it} is a binary variable that is equal to 1 for Ohio after the law change and 0 otherwise, and ϵ_{it} is a mean-zero disturbance term.

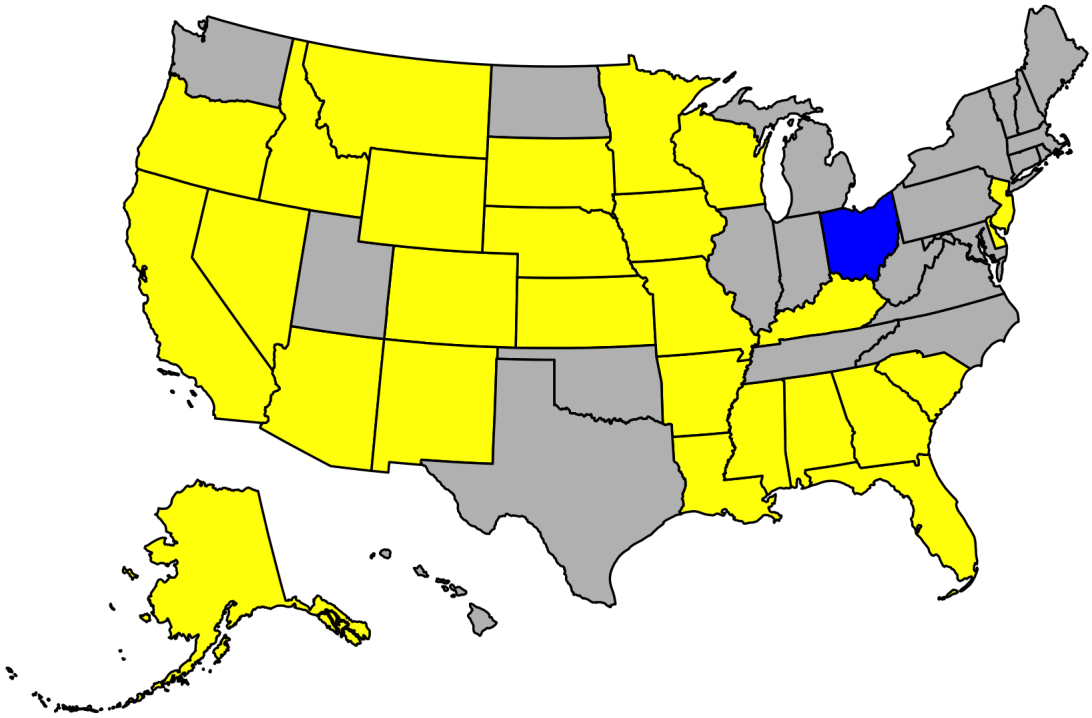


Figure 2.1: States Used in Riegle-Neal Act Exercises

Note: Ohio is the singular treated state and is shaded in blue, while the control states are those which had a total prohibition on *de novo* interstate branching prior to the Dodd-Frank Act and are shaded in yellow.

The specific choice of response variables is $y_{it} = \frac{b_{it}^F}{B_{it}}$ where B_{it} is the total number of bank branches established in state i in year t, and b_{it}^F is the number of those branches whose regulatory top holder is located in a state other than i. This specification was motivated by the increasing concentration of the banking system since the 1980s and the accompanied

decline in branch formation. Because I am interested in the entry of out-of-state banks, a response variable that captures the share of out-of-state branches is more closely related to the question of how banks responded to interstate branching restrictions than an alternative measure such as the total number of entrants or growth rate of entrants into a banking market.

The results of the estimation are presented in Table 2.1. The interpretation of the main result, i.e. the coefficient on D, is that if a state had previously seen 10% of its *de novo* branches originate from out-of-state corporate owners[19] who had a toehold in the state through merger, after the policy we would expect more than 40% of *de novo* branches to be owned by institutions in other states. Such a large rise in entry is strong *prima facie* evidence that, on average, commercial banks would have preferred entry into the Ohio market through *de novo* branches, but they were unable to exercise this option until the May 1997 reform. Note that the state population is measured in millions. Although the coefficient on population is not significant, the average treatment effect is larger when that variable is included, supporting the idea the branching restrictions were more important in larger states. Standard errors are clustered at the state level.

Dynamic Treatment Effects

While the average treatment effect computed above confirms that the branching restrictions had a meaningful effect on entry, it does not provide any information about the dynamics of entry after the policy change. A decision to enter a market by establishing a branch in a new state is not likely a casual decision since it involves an investment that is at least somewhat irreversible, and thus, there may be an incentive to delay entry to wait for additional information. See, e.g., Dixit and Pindyck (1994). Moreover, unless all banks were immediately ready to open a branch in Ohio after the reform went into effect, it is likely that the choice to open a *de novo* branch under the new regulatory regime would be

[19]This is approximately the figure for Ohio from 1994 to 1997.

Table 2.1: Difference-in-Differences Estimates

	Dependent variable:
	Fraction of *de novo* Branches from Out of State
Pop	0.0718
	(0.098)
D	0.3173***
	(0.055)
State Fixed Effects	Yes
Year Fixed Effects	Yes
Observations	139
Adj. R^2	0.610
Note:	*p<0.1; **p<0.05; ***p<0.01

administratively time-consuming, taking perhaps several years to enter the market. To study how allowing *de novo* branches by out-of-state banks affected entry over time, I estimate a regression specification of the form

$$y_{it} = \alpha_i + \lambda_t + \sum_{\tau} \delta_{\tau}(Treated_i \times d_{\tau}) + \epsilon_{it} \tag{2.2}$$

with α_i and λ_t as state and year fixed effects as before, but I now include a set of regressors where the treatment status of of each state is interacted with a dummy variable d_t that is equal to 1 if $t = \tau$. These interaction terms are defined relative to the timing of the treatment, $\tau \in \{-3, -2, 0, 1, 2, 3, 4, 5\}$, where $\tau = 0$ refers to the first year of treatment. Put differently, equation (2.2) is estimated on data from 1994-2002, using the same timing convention as in the previous exercise. Within this setup, the reference group for the dynamic treatment effects is the period before the law changed, i.e. 1996 is represented by $\tau = -1$ and is left out of the estimation. The same control states are used as in the previous exercises, and by plotting the values of δ_{τ}, we can examine the dynamic effect of Ohio's branching restriction liberalization. As before, standard errors are clustered at the state level.

There are two important takeaways from Figure 2.2. First, it is evident that the parallel

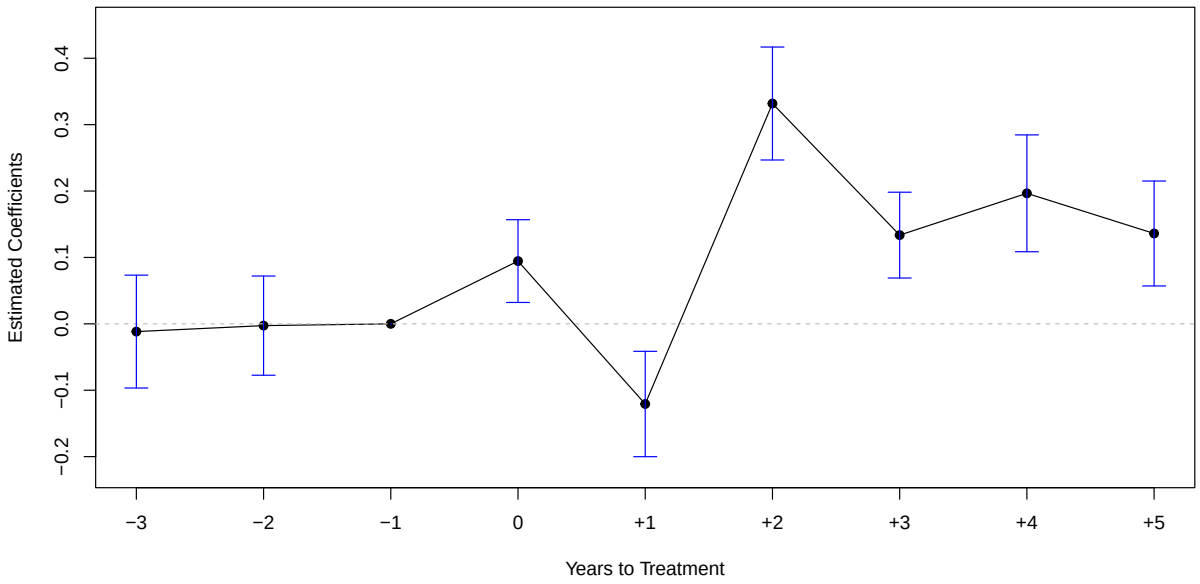


Figure 2.2: Dynamic Treatment Effects

trends assumption is likely to hold because the estimates for all pre-treatment periods are almost exactly zero, indicating that the trend of *de novo* branching by out-of-state banks in Ohio before 1997 was not meaningfully different from other states. Second, and most interestingly, the treatment effects are non-monotonic with the largest increase in interstate branching—relative to the control states—two years after treatment. One explanation of this path of dynamic treatment effects is purely an artifact of timing. Because the bank branch data is a census that occurs on June 30 of each year, and the Ohio law came into force in May, the coefficient for 1997 ($\tau = 0$) includes only one month of branches created under the new regulatory regime. The immediate and statistically significant uptick in *de novo* branches is likely attributed to banks who were immediately ready to establish new branches. It is possible that some out-of-state banks were waiting with bated breath for the law to change and jumped at the opportunity, but perhaps more likely, domestic banks or those with a toehold in the state through merger decided to establish new branches anticipating that other banks would find it much easier to enter in the future, taking advantage of the elimination of interstate branching restrictions.

It is also possible that the "first-mover advantage" of some banks is connected to lobbying efforts which resulted in the speedy passage of the Ohio reforms, and therefore the decline in 1998 is the result of a rush of branch creation that would otherwise have been spread out over multiple years. In addition, the significant rise in out-of-state *de novo* entry in 1999 is consistent with the hypothesis that administrative burdens in establishing a new bank branch are non-trivial and often time consuming. Moreover, it is noteworthy that the dynamic treatment effects reach a steady level of *de novo* entry three years after the treatment.

It should be noted that all of the estimates in both estimation exercises above are consistent with a naive evaluation of the effect of the Riegle-Neal Act in Ohio. As demonstrated in Figure 2.3, a simple time series of *de novo* branches in Ohio over the period 1994-2002 shows a marked increase in out-of-state branches in Ohio beginning in 1997 that remains higher than the pre-Riegle-Neal period even as the number of domestic branches falls below its pre-Riegle-Neal trend during the 2001 recession. The bottom figure plots the response variable used in the regression exercise, i.e. the fraction of *de novo* branches in Ohio from out-of-state institutions.

Effect of *de novo* Entry on Prices

Taken together, the previous two exercises show a significant increase in entry by out-of-state banks, which is strong evidence that pre-Riegle-Neal state branching restrictions meaningfully limited competition in banking markets. However, those exercises say nothing about the impact on consumers of Ohio's decision to opt in to Riegle-Neal. To address the question of consumer welfare, I now examine the effect of Ohio's liberalization of branching restrictions on loan and deposit rates. The approach taken is to consider the behavior of banks in the Cincinnati, Ohio metropolitan area. This market is especially convenient because (i) it includes eight counties of a state which did not opt in to Riegle-Neal (Kentucky) and (ii) it contains the six counties in Ohio where the plurality of new branches entered post-

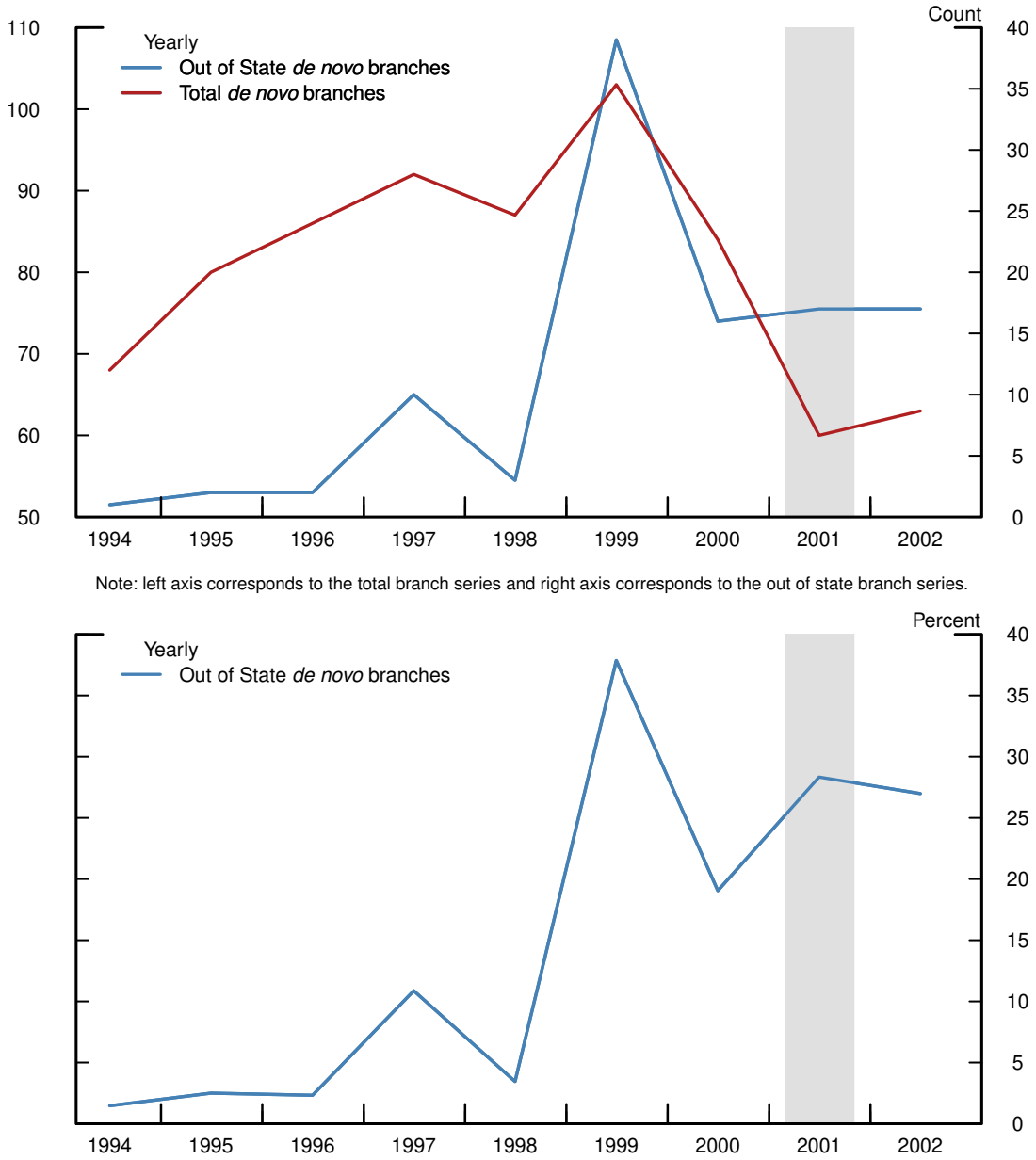


Figure 2.3: *De novo* Branching in Ohio 1994-2002

May 1997.

Because I am relying on the Call Reports to construct loan and deposit rates, I restrict attention to state banks whose entire operations were in a single state within the Cincinnati Metropolitan Statistical Area ("MSA"), as defined by the United States Census Bureau. The logic of this choice is that the Call Reports reflect asset holdings and income from the given bank's entire operations, so if a bank were operating in several states, the Call Report

line items would reflect the aggregation of loan income or deposit interest paid across all of those states. By limiting attention only to locally-operating institutions, it can be assumed that the computed interest rate times series reflect only the conditions of the Cincinnati banking market around the time of the branching legislation. With the set of banks that meet these conditions, I estimate the following relationship between deposit and loan rates and Ohio's decision to opt in,

$$r_{ijt} = \alpha_i + \gamma_j + \lambda_t + \delta D_{ijt} + Assets_{ijt} + \epsilon_{ijt} \tag{2.3}$$

where the new response variable, r_{ijt}, is the average deposit or loan rate (measured in percentage points) charged by bank j in state i in year t, α_i is a state fixed effect, λ_t is a year fixed effect, γ_j is a bank fixed effect, and $Assets_{ijt}$ (measured in millions of dollars) is a control for bank size as measured by year-end total assets. Analogous to the first exercise, this one is a simple difference-in-differences design using annual data for the entire period 1994 to 1999. As only two states and six years of data per bank are used, there are not enough "clusters" to justify the use of cluster robust standard errors, so heteroskedasticity robust standard errors are calculated instead.

As hypothesized, Tables 2.2 and 2.3 show that the state banks on the Ohio side of the Cincinnati MSA increased their deposit rates *and* decreased their lending rates in an economically and statistically meaningful way as a result of the change in the law.

It should be remarked first that the estimated treatment effect is economically large. The results suggest that the elimination of Ohio's branching restrictions caused a 41 basis point decrease in loan rates and a 30 basis point rise in deposit rates compared to the banks on the Kentucky side of the river. It is also notable that the response of loan rates appears to be somewhat stronger than the reaction of deposit rates, which is consistent with existing research on the downward flexibility but upward rigidity of deposit rates. See e.g., Driscoll and Judson (2013). Lastly, the estimated coefficients on total assets imply that the effect on deposit rates is more muted for larger banks, but the downward pressure on loan rates

Table 2.2: Change in Loan Rates

	Dependent variable:
	Average Loan Rate
Assets	-0.0049
	(0.0044)
D	-0.4103**
	(0.1850)
State Fixed Effects	Yes
Year Fixed Effects	Yes
Bank Fixed Effects	Yes
Observations	78
Adj. R^2	0.487
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 2.3: Change in Deposit Rates

	Dependent variable:
	Average Deposit Rates
Assets	-0.0046
	(0.0033)
D	0.3017**
	(0.1396)
State Fixed Effects	Yes
Year Fixed Effects	Yes
Bank Fixed Effects	Yes
Observations	78
Adj. R^2	0.676
Note:	*p<0.1; **p<0.05; ***p<0.01

is somewhat stronger for larger banks. Although the point estimates are not statistically significant, this result supports the idea that larger banks might exercise more market power in deposit market and compete more aggressively in lending markets.

Robustness

As the interest rate analysis relies on the data sample with the fewest observations, I consider several alternative specifications to test the sensitivity of the estimates in the previous subsection to the assumptions that led to the chosen sample. First, I run the same regression as equation (2.3) but now with addition of state banks located in the small part of the Cincinnati metropolitan area that lies in Indiana. I had originally excluded Indiana banks because, as shown in Figure 2.1, Indiana was among the states who opted-in to *de novo* branching via Riegle-Neal in June 1997 but with several qualifications including a reciprocity requirement. For this reason, while Ohio banks were prohibited from entering Kentucky over the entire 1994-1999 interval, they *were not* prohibited from entering Indiana from 1997 onward assuming that the other restrictions imposed by Indiana were satisfied. As a result, the inclusion of Indiana banks in the interest rate analysis would likely undermine the identification of the causal effect of Ohio's decision to opt-in to Riegle-Neal since Indiana was not a true control state.

However, while the inclusion of Indiana banks had the expected result of attenuating the estimated reduction in loan rates the inclusion strengthened the effect of the rise in deposit rates. The point estimate on loan rates changed from -0.41 (0.185) in the original exercise to -0.32 (0.182), standard errors in parentheses. Although the t-value dropped somewhat, the economic significance of the result remained. With respect to deposit rates, the point estimate increased from 0.302 (0.1396) to 0.366 (0.1418), suggesting that the effect of the new regulatory regime was strongest in deposit markets.

As a second check, I used the sample with Indiana banks to estimate the effect on a different definition of deposit rates. Here I defined the deposit rate as the bank's interest

expense normalized by total deposits, as opposed to only interest bearing deposits before. Because total deposits includes transaction accounts that might bear no interest as well as time deposits which cannot, by definition, be withdrawn immediately by bank customers, it is not clear whether increased competition in Ohio deposit markets would have a significant effect on these rates only two years after the intervention. Interestingly, the estimation based on equation (2.3) reveals that the point estimate for total deposits—0.307 (0.129)—is slightly larger while still statistically significant at the 5% level.

As a final assessment, I perform the original estimation with a sample that includes national banks (which are chartered by the OCC) that have branches only in the Cincinnati MSA.[20] I had originally excluded national banks because of their alternate regulatory regime, under the OCC and Federal Reserve Board, and typically larger operations within a multi-bank holding company.[21] The results of the estimation on the sample with national banks indicate that the effect on interest rates from competition via *de novo* entry was largely through state banks and especially in deposit markets. The point estimates for loan and deposits using the specification in equation (2.3) were insignificant in both cases although for loan rates, the estimated causal effect was economically meaningful at -0.2239 (0.2142). By contrast, the deposit rate point estimate was significantly smaller, 0.0575 (0.099).

To explain this dramatic reduction in the estimated causal effect on deposits, I considered a specification that replaced the bank fixed effect with an indicator variable for bank class, i.e. state or national bank.[22] The results are shown in Table 2.4.

What is striking about this alternate deposit rate specification is the high level of significance on bank class. Conditional on being a state bank, the causal effect of Ohio's intervention is a more than 60 basis point increase in deposit rates. The most likely conclu-

[20]To replicate these results, it is also necessary to remove the two national banks that had years of 0 interest income. It is unclear what was happening at these institutions but it is uncontroversial that they represent extreme outliers.

[21]Recall that state banks are not obligated to be members of the Federal Reserve System, and curiously all of the state banks in the interest rate analysis are non-members.

[22]Because bank class does not vary over time, it would be absorbed in the bank fixed effect if both variables were included.

Table 2.4: Change in Deposit Rates (with National Banks)

	Dependent variable:
	Average Deposit Rates
Assets	0.0005
	(0.0004)
D	0.0879
	(0.1314)
State Bank	0.5216***
	(0.0754)
State Fixed Effects	Yes
Year Fixed Effects	Yes
Bank Fixed Effects	No
Observations	132
Adj. R^2	0.466
Note:	*p<0.1; **p<0.05; ***p<0.01

sion to draw is that the increased competition in deposit markets reported earlier appears to be entirely through state banks. Prior to the removal of branching restrictions, state banks in Ohio did not need to compete as aggressively but post opt-in to Riegle-Neal rates rose dramatically. It should also be noted that that only seven national banks were added to the analysis, since very few national banks possessed branches only in the Cincinnati MSA. The attenuated point estimates can be attributed to (i) the lack of movement in the loan or deposit rates of the national banks in Ohio and (ii) the meaningful rise in deposit rate and slight fall in loan rates of the First National Bank of Brooksville, located near the eastern fringe of the metropolitan area in Kentucky. A relatively small bank, its return on assets (net income to asset ratio) declined over the sample period. In addition, the Brooksville bank faced an enforcement action by the OCC in July 1992 (a Formal Agreement) that was terminated in April 1994. It is not certain that the bank was significantly struggling from 1994-1999, but it is possible that the aggressive interest rate rise was part of new management policy following the enforcement action. But any rate, it is clear that the interest rate

impact of the branching reforms does not appear to have reached the cohort of national banks.

The Dodd-Frank Analysis

Shortly after the 2008 financial crisis, the advent of the Dodd-Frank Act rendered obsolete the choice to opt in to *de novo* branching. Thus, in one fell swoop, all of the control states from the Ohio experiment were compelled to accept *de novo* branches from out-of-state banks that conformed to the branching restrictions each state imposed on its own state banks. To measure the effect on *de novo* entry of this intervention, I implement a regression specification identical to that in equation (2.1), using the same variable definitions. The sample considered is the entire period July 2004 to June 2014. The results are presented in Table 2.5, and as with the Ohio estimates, standard errors are clustered at the state level.

The Dodd-Frank exercise uses branch data from every state in the union except New York, as illustrated in Figure 2.4. New York was excluded simply because its state legislature decided to opt in to *de novo* branching under Riegle-Neal effective July 21, 2008. As a consequence, New York was not subject to the 2010 preemption and using it as a control state would have required foregoing extra years of pre-treatment data in the estimation.

The immediate takeaway from this exercise is that the point estimate of the treatment effect is statistically significant although it is half the value of the Ohio case. There are likely three principal explanations for the more subdued effect. First, as briefly discussed in the Ohio analysis above, the exercise in this section includes states who had a reciprocity requirement as controls. What this means is that some of the control states—such as those in New England—were slightly "treated" because the reciprocity requirements for *de novo* branching were now invalidated. However, the degree of preemption is undoubtedly much larger for the states that never opted-in to Riegle-Neal.

The second explanation is simply the increasing adoption of and reliance on internet banking which reduces the need for physical branches. By 2010, consumers were becoming

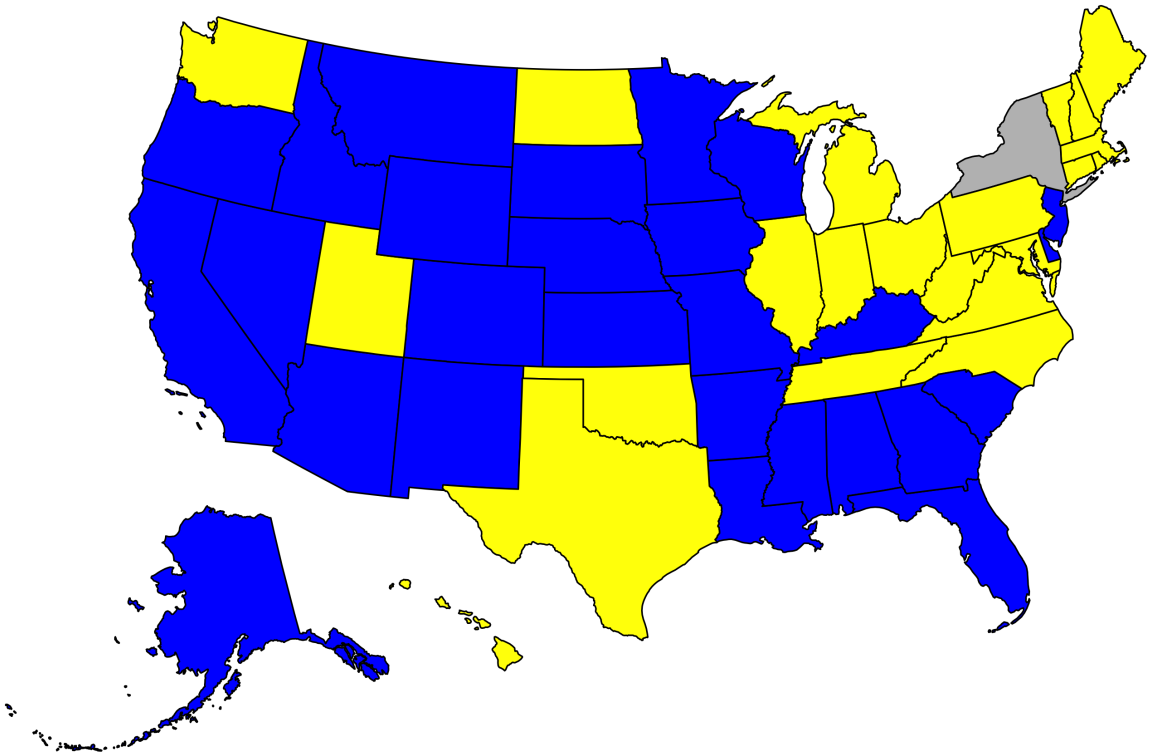


Figure 2.4: States Used in the Dodd-Frank Act Exercises

Note: states whose branching laws were preempted by the Dodd-Frank Act are shaded in blue, while the control states are shaded in yellow.

Table 2.5: Increase in Out of State *de novo* Entry after Dodd-Frank

	Dependent variable:
	Fraction of *de novo* Branches from Out of State
Pop	0.009
	(0.043)
D	0.121**
	(0.052)
State Fixed Effects	Yes
Year Fixed Effects	Yes
Observations	477
Adj. R^2	0.460
Note:	*p<0.1; **p<0.05; ***p<0.01

more comfortable with banking online, and the value of entering a market with a brick and mortar branch was simply not as high, which would explain a more tepid response of interstate branching decisions. And third, the Dodd-Frank Act was passed in the wake of the Great Financial Crisis, a period of significant stress on the banking system which further undermined aggressive competition by expanding into previously difficult to enter states.

But despite these conditions, the results of the difference-in-differences exercise paints a clear picture that bankers nevertheless reacted to the passage of the statute, and the states that had not opted-in to *de novo* branching before 2010 experienced an increase of 12.1 percentage points in the share of new branches organized under out-of-state banks. All considered, the experience of Ohio's banking market after 1997, as well as the experience of the set of states who never opted-in to Riegle-Neal after 2010, paints a picture that is difficult to deny. Although there existed mechanisms by which banks could enter states with branching restrictions, the revealed preference of bankers seems to be that *de novo* branching had important advantages over entry via merger or purchase of an existing branch.

2.4 Conclusion

The central argument of this paper is that historical restrictions on bank branching in the United States were economically meaningful restraints on entry into local banking markets. Although physical bank branches are a significantly less important form of bank competition now compared to the pre-internet era, the evidence from the statistical exercises presented here is unambiguous that at least some banks preferred *de novo* branching to entry via merger or acquisition. While the empirical findings suggest that removing branching restrictions was welfare-increasing for consumers via higher deposit rates and lower loan rates, the financial stability consequences are less clear. Future research should consider the macroprudential consequences of this type of entry, and whether states with branching restrictions experienced more or less stability during the Great Financial Crisis.

CHAPTER III

'Thou Shalt Not Let Debt/EBITDA exceed . . . ': Corporate Debt Covenants Over the Business Cycle

Abstract Contractual restrictions—such as financial maintenance covenants—are a commonly-used tool to mitigate the agency costs of debt. They also present a natural trade-off for firms as the inclusion of covenants increases the likelihood of repayment, lowering default risk and thus the credit spread on the loan, while reducing the firm's choice set of investment activities in some states of nature. But despite the ubiquity of covenants in lending agreements, most corporate finance models abstract from the institutional details of how covenants function in practice and thus do not capture the equilibrium process by which interest rates and covenant tightness are jointly negotiated. To fill this gap, I first present new empirical evidence that covenants become more strict following output contractions, and then I explain this phenomenon with a stylized model of a risky debt market under asymmetric information where the lender optimally chooses covenant tightness to screen borrowers. The model delivers a clear trade-off of covenant tightness for lower credit spreads and an endogenous shift to tighter covenants as market conditions deteriorate.

"In God we trust. All others pay cash."

— Early 20th century American proverb

3.1 Introduction

The vast majority of external corporate financing is debt. While debt financing carries certain advantages over equity—such as the interest tax shield—the presence of limited liability gives rise to well-known conflicts between stockholders and debtholders, e.g. Jensen and Meckling (1976), Myers (1977). A common solution to reduce the agency costs arising from these conflicts is the inclusion of loan "covenants" that restrict the actions of the firm in order to better align incentives. However, covenants are not simply state-contingent triggers with immediate consequences for borrowers. As noted in previous studies, Dichev and Skinner (2002) and Chodorow-Reich and Falato (2022), covenants are better thought of as embedded *options* which can be exercised for a variety of reasons such as preventing asset substitution by distressed firm or even shortening the maturity of a credit agreement with a relatively healthy borrower in order to strengthen the lender's balance sheet.

The existing theoretical literature that considers debt covenants has avoided modeling them explicitly, abstracting from their option-like properties, e.g. Gorton and Kahn (2000), Choi and Triantis (2013) and Acharya et al. (2021). In particular, those models are unable to explain the "tightness" of debt covenants across firms and lenders, as well as the average level of tightness over the business cycle.[1] The objective of this paper is to introduce a stylized model of risky debt subject to covenants that explains the "covenant tightness-interest rate" trade-off by explicitly modeling the lender's decision to waive a violation or exercise the option to accelerate the loan.

[1]The tightness of a financial maintenance covenant refers to the amount of financial weakening that the borrow can experience before the covenant is violated. A covenant that is negotiated such that the terms require a substantial level of deterioration is said to be "loose", which is roughly analogous to setting the strike price of a call option far out-of-the-money, because the covenant is less likely to be able to be exercised during the life of the loan. See Section 2 for a nuanced discussion of the institutional detail.

A theoretical treatment of debt covenants is especially important, because while better-aligned incentives have been associated with access to more favorable interest rates, Bradley and Roberts (2015), it is not possible to observe how the interest rate on a loan varies with different restrictions, so it remains an open question how much a typical firm benefits from accepting restrictive covenants. Moreover, unobserved heterogeneity among borrowers and inconsistent treatment of violations by creditors means that it is difficult to employ quasi-experimental methods to deduce the decline in firm value resulting from covenant enforcement.

Perhaps unsurprisingly, the restrictions that covenants impose are usually considered burdensome by borrowing firms and often feature prominently in annual reports and regulatory filings. Consider the 10-K filed by Protection One Alarm Monitoring in 2008 which emphasizes debts covenants in the discussion of risk factors currently affecting the company, writing

> "[the credit agreements] governing our unsecured term loan facility contain covenants that restrict our ability to finance future operations or capital needs, to respond to changing business and economic conditions or to engage in other... business activities that may be important to our growth."

As another example, the managers of the Rock-Tenn Company note in the Management's Discussion and Analysis section of their 2006 10-K that the firm has access to "revolving credit, swing, and term loan facilities in the aggregate principal amount of $700 million." However, "due to the covenants in the Senior Credit Facility, maximum available borrowings under this facility were approximately $126 million," significantly less than the headline figure. The concerns of these firms are paralleled by investment bankers of the 1980s who used the ability to evade covenants as a primary argument in persuading companies to eschew bank debt and issue high yield bonds instead, Drexel Burnham Lambert (1985). Despite these drawbacks, financial covenants in particular are extremely common and nearly

ubiquitous in the leveraged loan market, where agency conflicts are presumably most severe. Recent work by Berlin et al. (2020) suggests that the yearly incidence of syndicated loan packages *without covenants* has remained consistently under 2% for this market segment.

Given the considerable disadvantages, we would expect to see onerous restrictions in debt contracts only if they provide a benefit to the borrower as well as the lender, unless the bargaining power of the firm were truly negligible. The observation of an offsetting benefit to shareholders from the inclusion of covenants can be traced back at least to Smith and Warner (1979) who discuss the inclusion of dividend restrictions in exchange for longer maturity debt contracts. The research of Bradley and Roberts (2015) has provided empirical support for such a trade-off directly in the context of credit spreads. Using a large panel of syndicated loans, the authors find that the increase in an index of covenant intensity is associated with significantly lower yields on debt securities, all else equal. Of course, the lower cost of debt is accompanied by potentially binding constraints on the firm's future investment.

Unfortunately for financial economists, covenants differ markedly across credit agreements since they are the equilibrium outcome of idiosyncratic negotiations between borrowers and lenders. Accordingly, debt restrictions and interest rate spreads are determined *simultaneously*, and thus the relative restrictiveness of covenants is an important non-price component of debt contracts. Legal scholars contend that covenants are among the most fiercely negotiated parts of credit agreements as many other provisions lack malleability due to constraints of judicial interpretation, see Choi and Triantis (2013).

As mentioned earlier, the extent to which these covenants are truly "restrictive" is not a simple matter. While the violation of a debt covenant grants the lender the right to call in the loan, demand more collateral, increase the interest rate or impose other penalties, a significant minority of levered firms are in violation of their debt covenants at any given time. Chodorow-Reich and Falato (2022) find that on average around a quarter of syndicated loans are in violation of a covenant, rising to a third of loans during the 2008 financial crisis. In good times, the vast majority of these violations—on the order of 90%—are waived by

creditors, implying that the constraint usually does not bind at the contractually-stated level.[2]

To capture the features of real-world debt covenants described above, the model in this paper studies the covenant choice as the optimizing response of a lender to screening a class of *ex ante* identical borrowers who each possess a private signal of their own future profitability. The initial private signal is correlated with future signals of profitability that are observable to the lender during the life of the loan. Crucially, it is assumed that the borrower and lender are unable to contract around the realization of future signals and must instead rely on observable earnings' reports that are only weakly related to the firm's ultimate output. The lender's problem is then to set the interest rate and covenant tightness—defined as a debt to earnings threshold— to maximize lender profits given the information structure of the firms. If a covenant is triggered during the life of the loan, the lender is granted the option to liquidate the investment project.

The lender's choice of how tightly to set the debt covenant turns on how well the conditions screen out weak borrowers balanced against the dissuasion of strong borrowers due to the onerous terms. An important and novel feature is that during a recession, when the distribution of borrowing firms has deteriorated, equilibrium covenant tightness will endogenously rise, inducing more rationing consistent with the empirical exercises in the paper and comments by policymakers during the 2008 financial crisis.[3] The model also generates a realistic trade-off of tighter covenants for lower interest rates.

The alternative debt environment considered in this paper has important implications for

[2]Those authors go on to argue that a widespread motivation for lender enforcement of a covenant violation is not only concern about the profligacy of the borrower, but also that exercising the right to call in the loan is a mechanism for turning a long-dated syndicated loan into immediate liquidity. For simplicity, the model in this paper does not consider lender balance sheet issues and therefore does not speak to how this lender motivation impacts the covenant tightness-interest rate trade-off.

[3]For example, in reference to the August 5, 2008 FOMC meeting, "[i]n a particularly worrisome development, our quarterly survey of bank loan officers had revealed that banks were tightening the terms of their loans, especially loans to households, very sharply. The staff maintained its view... that the economy was either in or would soon enter recession", and in a speech at the Economic Club of New York, November 16, 2009, "many small businesses have seen their bank credit lines reduced or eliminated, or they have been able to obtain credit only on significantly more restrict terms."Bernanke (2015).

firms' optimal investment and debt policies as a result of state-contingent loan acceleration. In particular, the model in this paper can explain the stylized fact that that the intensity of debt restrictions is countercyclical. As shown below, as well as in Bradley and Roberts (2015) and Choi and Triantis (2013), when output contracts—or even equity prices fall—covenants become more restrictive on average, which is the expected response when firms face a trade-off of lower credit spreads in exchange for reduced managerial control in some states of nature.

The properties of the stylized model imply that, despite the ostensible irrelevance of restrictive covenants during macroeconomic expansions when the constraints are largely relaxed or violations not enforced, the costs and benefits to borrowers can be considerable. Using only information on the distribution of borrowers, the lender will exploit both the interest rate and the restrictiveness of the covenants to overcome the screening challenge posed by the private information of the borrowers. Depending on the parameterization of the model's primitives, the lender's policy function is characterized by "regimes" that vary in the reliance on the interest rate margin compared with the covenant tightness margin to screen borrowers, which massively affects the volume of credit issued.

Related Literature

The empirical results and theoretical model in this paper contribute to three different lines of research. First, there exists an extensive accounting literature on debt covenants beginning with the descriptive work of Leftwich (1983) followed by a deluge of research on managerial accounting choices and covenant violations, e.g. Chen and Wei (1993), Beneish and Press (1993), DeFond and Jiambalvo (1994). The culmination of this work was the seminal contribution of Dichev and Skinner (2002) which found persuasive evidence that corporate managers take explicit actions to avoid violating financial covenants when their firms are near the contractural thresholds. Secondly, the model in this paper provides a complement to the large empirical corporate finance literature on frictions in debt markets

and the role of covenants, e.g. Smith and Warner (1979), Chava and Roberts (2008), Nini et al. (2009), Bradley and Roberts (2015), Chodorow-Reich and Falato (2022), which has broadly found that covenants have a large influence on corporate investment. Lastly, the model of debt covenants introduced here is closely related to the theoretical work on asymmetric information in lending markets.[4] The model environment is motivated by the partial equilibrium bank profit maximization problem in Stiglitz and Weiss (1981) as well as Stiglitz and Weiss (1983) and Gorton and Kahn (2000), the latter of which extends the debt market analysis beyond two periods to study the termination of a lending relationship or renegotiation of loan terms in the face of moral hazard. However, none of these papers studies covenants explicitly as a result of equilibrium in the debt market.[5]

The following section provides additional background and empirical analysis of corporate debt covenants which guides the design of the debt market model described in Section 3.3 - 3.5. Section 3.6 discusses the economic properties, comparative statics and intuition of the model, and Section 3.7 concludes.

3.2 Empirical Motivation

The scope of activities that debt covenants may constrain is limited only by the imagination of the bankers and lawyers who draft the contracts. Common covenants include requiring the borrower to obtain insurance for collateral, forbidding the sale of certain assets, or letting agents of the lenders inspect borrower properties and financial records. But perhaps the most important restrictions—and certainly the most studied—are the previously alluded "financial covenants" also known as "maintenance covenants" or "financial condition covenants" which require the borrower to obey limits placed on the firm's accounting position, such as a maximum debt to EBITDA ratio, minimum quantity of liquid assets,

[4]For a general discussion of these types of models, see Tirole (2010).

[5]Gorton and Kahn (2000) remark that their Assumption 7 serves as a "a reduced form for sufficiently detailed covenants that when violated allow the bank to demand collateral", however this abstracts from the equilibrium determination of the covenant itself and how "tight" it is, which is the focus of this paper.

minimum tangible net worth or minimum interest expense to EBITDA. Often these limits will have a dynamic characterization, so instead of being a fixed value that must be met at all times, the threshold will rise or fall in a prescribed fashion over the life of the loan.

Examples of the most common financial covenants found in the Dealscan database of syndicated loan agreements are summarized by frequency in Table 3.1. A caveat of the underlying data is the incomplete coverage and uncertain quality of Dealscan's covenant information, a shortcoming also noted by Berlin et al. (2020). In particular, Dealscan appears to track only a small subset of possible debt covenants and ignores those that do not fit neatly into the categories in Table 3.1. An example is the January 14, 2019 credit agreement between General Motors Company and a banking syndicate led by JP Morgan Chase and Citibank. According to Dealscan, this loan has no covenants. However, inspection of the credit agreement shows the presence of at least two covenants, among other restrictions, that could plausibly be characterized as a financial covenant, notably a minimum liquidity covenant of $4 billion and a maximum indebtedness to tangible asset covenant of 7.5%. One explanation is that Dealscan captures only the restrictions explicitly labeled as "financial covenants" which is not the case for this loan, but another explanation is simplicity. Since debt covenants can be either boilerplate or highly tailored to the borrower, it is conceivable the data providers tabulate only the most common ones. Additionally, some covenants—like the one considered in this paragraph—include language governing complicated security interests in the collateral—e.g. if a second lien is established on an already pledged asset—which complicates interpretation of when a covenant based on an accounting ratio is or is not binding. The salient point is that while there exist many more restrictions in the loans that Dealscan covers than Table 3.1 suggests, leverage-based covenants are by far the most common, showing up in various guises as debt to cash flow, debt to tangible net worth, or debt to equity, and that is the type of contractual restriction I explore in the empirical exercise and theoretical model.

As a concrete example, consider once again the firm formerly known as Rock-Tenn,

Covenant	Percent of Loans
Max. Debt to Cash Flow	68.98
Min. Interest Coverage Ratio	44.74
Min. Fixed Charge Coverage Ratio	33.78
Max. Leverage Ratio	9.09
Max. Sr. Debt to Cash Flow	7.84
Min. Tangible Net Worth	6.42
Min. Net Worth	5.44
Max. Debt to Tangible Net Worth	3.12
Min. Debt Service Coverage Ratio	2.41
Min. Current Ratio	1.87
Min. Cash Interest Coverage Ratio	0.80
Max. Debt to Equity Ratio	0.36
Max. Loan to Value Ratio	0.09

Table 3.1: Financial Covenant Frequency

Note: syndicated loans of American manufacturing firms with at least one covenant listed, 2006-2019. Covenant names/categories are those of the database and were not chosen by the author.
Source: Thomson/Refinitiv Dealscan

a packaging and paperboard manufacturer based in Norcross, Georgia. The company's June, 2005 loan, which was referenced in the introduction, contained a covenant such that the leverage ratio was not to exceed 5.00 to 1 through June 30, 2006, with a schedule of declining values as the loan approached maturity in 2008. Even though I have claimed that the numerical value associated with a financial covenant is not a sharp characterization of the borrower's credit limit, it is nevertheless an informative signal of how much control the lender would like to have over the borrowing firm's cash flows. The lower the value of the leverage ratio covenant, the more likely the embedded option is "in the money" and the lender can exercise its rights to early repayment. Nevertheless, recent work in macro-finance by Greenwald (2019) and Drechsel (2023) has suggested that because the average values of financial covenant thresholds appear roughly stable over time when simply plotting the time series, covenant tightness is therefore invariant to the business cycle and must be interpreted as a structural parameter. If true, this would cast doubt on the economic significance of the option value for lenders since they do not appear to tighten covenant thresholds when macroeconomic conditions are most bleak and bank stress is presumably

highest. However, the analysis of those authors comes from a highly selected sample. During output contractions, the supply of credit contracts significantly so taking the median debt-to-EBITDA covenant value for loans issues during 2008 will include a disproportionate share of the most credit worthy borrowers, where covenant violations and enforcement are vanishingly rare. If there does exist a trade-off of lower credit spreads for tougher debt restrictions, it will manifest itself not among the highest quality borrowers, but among the lowest quality.

To test the claim that leverage-based financial covenants are invariant to the business cycle, I estimate the following relationship,

$$LR_{it} = \alpha + \beta_1 Recession_t + \beta_2 Size_{it} + \boldsymbol{\eta}^{\intercal}\boldsymbol{\Omega}_{it} + \epsilon_{it} \tag{3.1}$$

where *Recession* is a binary variable that takes on the value of 1 if the loan is negotiated during a recession, $Size_{it}$ is the dollar value of the loan i in year t, and $\boldsymbol{\Omega}$ is a vector of firm characteristics. LR is the threshold on the loan covenant, where I use only leverage ratio covenants defined as consolidated debt divided by consolidated EBITDA for the previous four quarters, which is the most common type of leverage ratio covenant, although many variations exist.[6] Since debt covenants are most meaningful in the leveraged loan market, I estimate equation (3.1) using Ordinary Least Squares with data from the sample collected by Berlin et al. (2020), which consists of syndicated loans issued by public borrowers between 2005 and 2014. From the raw text of these credit agreements, I manually gathered the information required to define the variables described above. As mentioned earlier, the large reduction in credit supply during the 2008 recession introduces bias into the analysis since many firms in the sample were not able to obtain credit during that period and I am thus unable to observe how tightly lenders would have set a leverage ratio covenant in the counterfactual where a loan were issued. The nature of the problem is nearly identical to

[6] An interesting feature of this set up is the autoregressive component. A single bad quarter will not affect the violation of the covenant when it is defined in terms of earnings over the "trailing twelve months", but the author found a handful of loans where the covenant was defined in terms of the most recent quarter's earnings multiplied by four, which exerts substantially more control on behalf of the lender. The latter type of covenant was not included in the regression of equation (3.1) to ensure consistency of interpretation.

the "composition bias" problem that plagued studies of the behavior of the real-wage rate over the business cycle. As articulated in Solon et al. (1994), the endogenous layoff behavior of firms means that the set of workers who are employed during a recession is *fundamentally different* than the set of workers employed during a period of macroeconomic growth.

Following Solon et al. (1994), to remedy the above concern, I consider only the the loans of firms who negotiated at least one credit agreement between 12/07 and 12/09 and at least one credit agreement outside that interval during the sample period. It should also be noted that not all of the credit agreements in the Berlin et al. (2020) sample contain a leverage ratio covenant, and some of the agreements that do are defined in ways markedly different from the standard, so I use only loans in which the debt-to-EBITDA covenant where EBITDA is defined in terms of the "trailing twelve months", the most commonly used definition. Lastly, I drop all observations where covenant or loan details are unclear as well as observations for firms I could not match with Compustat Fundamentals Annual data for the specifications with balance sheet and income statement controls.

Although the sample size is small, the results presented in Table 3.2 are clear that leverage ratio-based financial covenants were considerably tighter on average for loans issued during the 2008 recession vis-à-vis loans loans issued in other years. The point estimate for β_1 is both highly statistically significant as well as economically meaningful for all specifications considered. The interquartile range of the leverage ratio covenant in the sample is $[3.325, 5.00]$ with a median of 4.00. So for the median firm in my sample, the onset of the recession is estimated to be nearly equivalent to a reduction below the 25th percentile of leverage ratio covenants.

The simple correlational exercise above is intended to illustrate that the accounting ratio-based covenant values used in corporate debt contracts should be not interpreted as structural parameters that define the lending terms for the riskiest borrowers. They are better thought of as the result of idiosyncratic negotiations that also reflect the state of the business cycle, which supports the evidence of countercyclical covenant intensity in Zhang (2009). Since

Table 3.2: Covenant Intensity Regression Results

	Dependent variable:			
	LR			
	(1)	(2)	(3)	(4)
Recession	-0.857^{***}	-0.751^{***}	-0.696^{***}	-0.734^{***}
	(0.265)	(0.239)	(0.233)	(0.236)
Size	0.750	−0.897	−0.925	-1.035^{**}
	(0.579)	(0.656)	(0.649)	(0.512)
Assets		0.249	0.213^{***}	0.358^{***}
		(0.180)	(0.060)	(0.045)
EBITDA		0.001		
		(1.429)		
Free Cash Flow			0.985	
			(1.076)	
CAPX				-3.983^{***}
				(1.431)
Observations	110	83	83	83
R^2	0.118	0.307	0.325	0.362
Note:				*p<0.1; **p<0.05; ***p<0.01

Note: the units for loan size, total assets, EBITDA, free cash flow, and capital expenditures are in billions of US dollars. Robust standard errors for each point estimate are in parentheses.

lenders exhibit stricter control over new borrowers during output contractions, it may reasonably be inferred that lenders are also more likely to impose consequences on borrowers who violate covenants during business cycle downturns. The next section introduces a partial equilibrium investment model with covenant choice and enforcement, providing an environment in which data on corporate borrowing and investment can speak to whether covenants are in fact costly impediments to investment for firms trying to economize on interest expense or whether they are merely a necessary condition for marginal borrowers to access credit at all.

3.3 Model Environment

There exists a measure one continuum of risk-neutral firms that require external financing for a risky project. Each firm is endowed with equity E but must borrow I from a deep-pocketed, risk-neutral lender. The model proceeds over three periods.

At time $t = 0$, the firms observe a private, unverifiable signal α that is informative about the value of ultimate output y, which materializes at $t = 2$. The lender cannot distinguish firms and therefore seeks to design a loan contract that separates strong firms from weak ones. The private signal implies that all firms have the same $E[y]$ from the lender's perspective at $t = 0$.

In period $t = 1$, the firms receive contractable information about earnings $\pi \in \{\pi_\ell, \pi_h\}$ such that $\pi_h > \pi_\ell$, and a verifiable but uncontractable signal $z \in \{z_\ell, z_h\}$ that is correlated with y. At $t = 2$, y is revealed, the firms repay their debt bill, $(1 + r)I$, and distribute profits to shareholders. If $y < (1 + r)I$, the presence of limited liability allows shareholders to petition for bankruptcy protection, and the lender recovers the project's output.

It is assumed that z and π are uncorrelated, which means that π conveys no information about the ultimate success of the project. This is a strong assumption, but it is meant to capture the idea that real-life debt covenants are defined in terms of earnings because of their verifiability which can be communicated to a court to enforce the contract, even though accounting measures of earnings may be only weakly related to ultimate profitability, which is consistent with the empirical literature on debt covenants that has repeatedly found that earnings-based covenants are set tightly and banks waive most violations.

Stochastic Processes

Although lenders do not know each firm's type, the covariance structure of the economy is common knowledge. The private signal α is distributed uniformly on the unit interval. Each firm then has a base value of output indexed by α, $y_B = y_0 + k\alpha$, which cannot be credibly communicated to the lender.

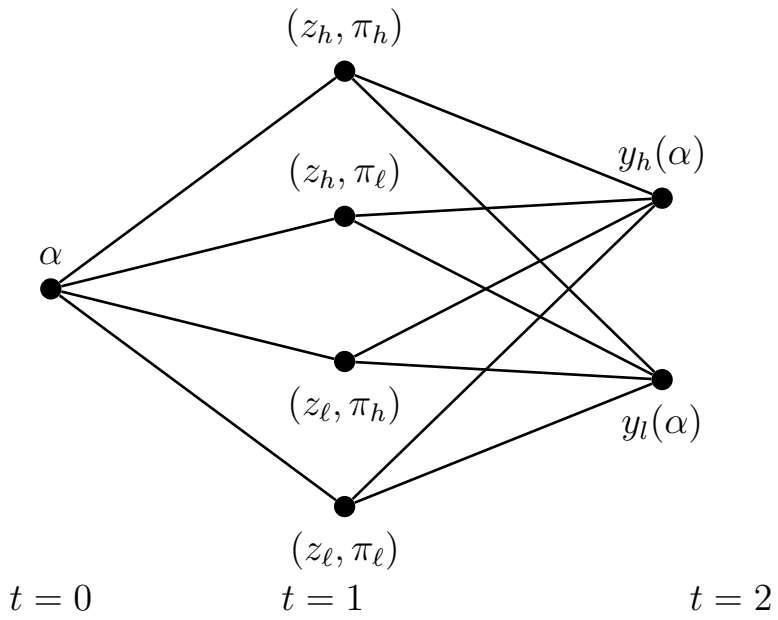
At $t = 1$, z is revealed for each firm where $\Pr(z = z_\ell) = p_z$ and $\Pr(z = z_h) = 1 - p_z$. The z signal does not change the ultimate firm output, but it alters the probability distribution of the final output. At $t = 2$, firms are hit by an additive profitability shock $D > 0$, such that final output will be

$$y(\alpha) = \begin{cases} y_h(\alpha) : y_0 + k\alpha + D \\ y_\ell(\alpha) : y_0 + k\alpha - D \end{cases} \tag{3.2}$$

and $\Pr(y = y_h | z_h) = q_h$, and $\Pr(y = y_h | z_\ell) = q_\ell$. I assume that $q_h > q_\ell$ so that the probability of a positive probability shock is higher for firms that receive the "good news" signal z_h at $t = 1$.

Lastly, the earnings signal is also distributed identically across firms, with $\Pr(\pi = \pi_\ell) = s$ and $\Pr(\pi = \pi_h) = 1 - s$.

Figure 3.1: Resolution of Stochastic Processes



3.4 No Covenant Contract

Before studying the properties of the equilibrium debt covenant, consider a simplified contracting environment where the lender can use only the interest rate to screen firms and maximize its profits. In this version of the model, the lender offers all firms a contract (r, I) that is not contingent on any of the information revealed at $t = 1$. Firms that accept the loan do not face any liquidation risk and must either repay the principal and interest, $(1 + r)I$, at $t = 2$ or default. The trade-off the lender faces is that choosing a higher interest rate increases the profit per loan but reduces the measure of firms who accept.

Note first that the two-step stochastic process for output can be summarized by a new variable

$$Q^N = p_z q_\ell + (1 - p_z) q_h$$

which is the unconditional probability of the high output state $y_h(\alpha)$ at $t = 0$, where the first term represents attaining $y_h(\alpha)$ after receiving the z_ℓ signal, and the second term reflects attaining $y_h(\alpha)$ after receiving the z_h signal. To simply notation, I will characterize the model's solution in terms of the repayment amount $R = (1 + r)I$, rather than the net interest rate, r. I also add the common assumption that in default, the lender can recoup only a fraction $\psi \in (0, 1)$ of the output, consistent with the findings of Zhang (2009) that tighter covenants are associated with higher recovery rates.

For tractability, I consider equilibria such that only firms that receive positive profitability shock are able to repay their debt, i.e. $y_h(\alpha) > R^N > y_\ell(\alpha)$ for all α, where R^N is the profit maximizing choice of the lender. As discussed further in Appendix C.3, the following assumption guarantees such a result. The economic intuition is that the profitability shock must be large enough so that the lender never finds it profitable to issue loans with an interest rate low enough such that they are risk free.

Assumption III.1. $y_0 + k - D < I$

Put differently, Assumption III.1 states that even the highest quality borrower, i.e. $\alpha = 1$, would be unable to repay an interest free loan in the adverse profitability state, which justifies the formulation of the firm's individual rationality constraint. At $t = 0$, a risk-neutral firm of type α faces the loan contract (r, I) and will accept the offer if and only if the expected profit from participation covers its initial equity investment. In other words, the firm's individual rationality condition is

$$Q^N(y_0 + k\alpha + D - R^N) > E$$

This condition may be manipulated to pin down the cutoff value $\alpha^N(R^N)$, such that given the lender's selected interest rate R^N, only firms of the type $\alpha > \alpha^N(R^N)$ will accept the contract,

$$\alpha^N(R^N) = \frac{\frac{E}{Q^N} + R^N - y_0 - D}{k} \tag{3.3}$$

where it is obvious by inspection that the threshold is increasing in R^N.

Lender's Problem

The lender seeks to pick R^N such that its expected profits are maximized. Although the lender cannot observe α, the expected value of a loan to a firm of type α is the probability-weighted average of (i) being repaid R^N if the firm receives a positive profitability shock and (ii) collecting $\psi y_\ell(\alpha)$ if the firm receives the adverse profitability shock. Integrating over all firms that accept the loan contract, the lender's expect profits as a function of R are

$$\Pi(R^N) = \int_{\alpha^N(R^N)}^{1} Q^N R^N + (1 - Q^N)\psi(y_0 + k\alpha - D) - I \, d\alpha \tag{3.4}$$

Since the cutoff for firm acceptance is a linear function of R, the lender's expected profit function is quadratic after integration, which guarantees the existence of a unique interior

maximum. The intuition of the lender's problem is more clear if you consider the first order necessary condition in a more general form, replacing the integrand with $g(R, \alpha^N(R))$ and then applying Leibniz's integral rule,

$$\frac{d\Pi}{dR^N} = \underbrace{\int_{\alpha^N(R^N)}^{1} \frac{\partial g(R^N)}{\partial R^N}\, d\alpha}_{\text{Increased profit per loan}} - \underbrace{g(R^N, \alpha^N(R^N))\frac{\partial \alpha^N(R^N)}{\partial R^N}}_{\text{Fewer loans issued}} \tag{3.5}$$

The solution of the lender's problem reveals a closed-form solution for the profit maximizing interest rate, whose full derivation is in Appendix C.1.

$$R^N = \frac{Q^N(y_0 + k + D) - E + I - (1 - Q^N)\psi\left(\frac{E}{Q^N} - 2D\right)}{2Q^N + (1 - Q^N)\psi} \tag{3.6}$$

The glaring issue with this model is that while the lender can use an interest-only screening device to maximize profits, it is not making use of the information revealed in period $t = 1$. In the next section, I turn to a contracting environment where the lender leverages the contractable earnings information π to increase expected profits.

3.5 Covenant Contract

The lender now offers firms a contract (r, I, κ) where r is the net interest rate on the loan, I is the principal of the loan—the same as before— and κ is an earnings-based debt covenant such that the lender has the option to call in the loan and recover γI at $t = 1$ if $\frac{I}{\pi} > \kappa$.[7] If the observed level of earnings is such that $\frac{I}{\pi} < \kappa$, then the lender cannot liquidate the loan and must wait until $t = 2$. This set up mirrors a max debt-to-EBITDA maintenance covenant which is the most common form of covenant observed in syndicated credit agreements.

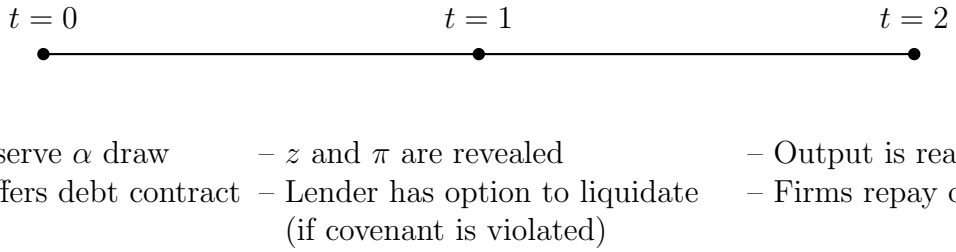
The model environment implies that the lender can choose one of three "covenant regimes":

[7]The assumptions surrounding the covenant are motivated by the idea that all the firms are investing in a similar project so recoverable assets are identical and the firms face idiosyncratic earnings shocks prior to completion of the project.

(i) a tight covenant regime such that $\kappa^* < \frac{I}{\pi_h}$ so that the lender may exercise its liquidation option with any earnings signal; (ii) an intermediate covenant regime such that $\frac{I}{\pi_h} < \kappa^* < \frac{I}{\pi_\ell}$ so that the lender may liquidate when π_ℓ materializes but not if π_h is observed; and (iii) a loose covenant regime where $\kappa^* > \frac{I}{\pi_\ell}$, which is isomorphic to the no covenant model because the the covenant will never be violated (as a result of the assumptions about the earnings process), and therefore the lender can never exercise its liquidation option.

The most interesting case is regime (ii) where the lender can liquidate its position in only some states of nature, i.e. when $\pi = \pi_\ell$. To guarantee that the lender will liquidate when $z = z_\ell$, it is necessary to make an additional assumption which reflects that the liquidation value must exceed the expected value of waiting for the project to finish when $z = z_\ell$. See Appendix C.2.

Figure 3.2: Timeline of the Loan Contract



The solution method of the lender's optimization problem for the contract with covenants is identical to that of the no covenant model, and the full derivations are available in Appendix C.2.

3.6 Analysis

The central claims of the paper are that the model described above (i) embeds a covenant-interest trade-off, and (ii) endogenously results in the lender's transition between regimes of covenant tightness when market conditions weaken.

To understand the mechanism that leads to the above results, consider that for a given

interest rate, as the covenant threshold rises, fewer firms will accept the lender's contract. However, the participation threshold endogenously falls as the interest rate declines. As a consequence, the lender has an incentive to reduce the interest rate it commands to induce greater participation as the presence of a covenant provides greater downside protection for the lender. The key assumption to ensure that the interest rate the lender charges will fall when the contract contains a covenant is that the option to exercise the covenant is valuable to the lender (otherwise the covenant is not economically meaningful), which means that γ must be sufficiently large.

Assumption III.2. $1 \geq \gamma > \frac{1+q_\ell}{2Q^N+(1-Q^N)\psi}$

As a preliminary matter, the probability that a firm makes it to the final stage of production is decreasing in covenant tightness.

Lemma III.3. *In equilibrium,* $Q^N > Q^I > Q^T$

Proof. The argument is straightforward. As well-defined probabilities, p_z, s, and q_ℓ are all positive.

$$1 > 1 - s \Rightarrow p_z q_\ell > p_z(1-s)q_\ell \Rightarrow \underbrace{p_z q_\ell + (1-p_z)q_h}_{Q^N} > \underbrace{p_z(1-s)q_\ell + (1-p_z)q_h}_{Q^I}$$

$$p_z(1-s)q_\ell > 0 \Rightarrow \underbrace{p_z(1-s)q_\ell + (1-p_z)q_h}_{Q^I} > \underbrace{(1-p_z)q_h}_{Q^T}$$

□

I next derive a technical result that will simplify the proofs of the theorems below, where Ω^N, Ω^I, and Ω^T refer to the denominators of the optimal interest rates in the no covenant, intermediate covenant and tight covenant contract respectively. Refer to Appendix C.2 for the full expressions of the equilibrium interest rates and profit functions for the contracts with covenants.

Lemma III.4. *(i)* $\Omega^I > \Omega^N(1-p_z s\gamma)$*, (ii)* $\Omega^T(1-p_z s\gamma) > \Omega^I(1-p_z\gamma)$

Proof. For (i), we can expand the expression as follows,

$$\begin{aligned}
&\Omega^I - \Omega^N(1 - p_z s\gamma) > 0 \\
\Rightarrow &1 + Q^I - p_z s - \Big(2Q^N + (1 - Q^N)\psi\Big)(1 - p_z s\gamma) > 0 \\
\Rightarrow &1 + p_z(1 - s)q_\ell + (1 - p_z)q_h - p_z s - \Big(2Q^N + (1 - Q^N)\psi\Big)(1 - p_z s\gamma) > 0 \\
\Rightarrow &(1 - \psi)(1 - Q^N) + p_z s\Big((2Q^N + (1 - Q^N)\psi)\gamma - q_\ell - 1\Big) > 0
\end{aligned}$$

where ψ and Q^N are known to be less than 1, so the entire expression will be positive so long as the second term in the large parentheses is greater than zero, which is ensured by a value of γ satisfying Assumption III.2.

For (ii) we can make a similar argument.

$$\begin{aligned}
&\Omega^T(1 - p_z s\gamma) - \Omega^I(1 - p_z\gamma) > 0 \\
\Rightarrow &(1 + Q^T - p_z)(1 - p_z s\gamma) - (1 + Q^I - p_z s)(1 - p_z\gamma) > 0 \\
\Rightarrow &(1 - p_z)(1 + q_h)(1 - p_z s\gamma) - (1 + p_z(1 - s)q_\ell + (1 - p_z)q_h - p_z s)(1 - p_z\gamma) > 0 \\
\Rightarrow &(1 - p_z)(1 + q_h) - (1 + p_z(1 - s)q_\ell + (1 - p_z)q_h - p_z s) + p_z\gamma\Big(1 + p_z(1 - s)q_\ell \\
&+ (1 - p_z)q_h - p_z s - (1 - p_z)(1 + q_h)s\Big) > 0 \\
\Rightarrow &p_z(s - 1)(1 + q_\ell) + p_z(1 - s)\Big(1 + p_z q_\ell + (1 - p_z)q_h\Big)\gamma > 0 \\
\Rightarrow &p_z(1 - s)\Big((1 + Q^N)\gamma - 1 - q_\ell\Big) > 0
\end{aligned}$$

The final inequality is guaranteed to be positive so long as $\gamma > \frac{1+q_\ell}{1+Q^N}$ which is a weaker requirement than Assumption III.2, therefore the proof is complete. □

Theorem III.5. ***(Covenant-Interest Trade-off I)*** *For a large enough level of borrowing, the lender's profit maximizing interest rate is decreasing in covenant tightness.*

Proof. The argument is constructive. The objective is to find a threshold I^* such that $I > I^*$

implies that $R^N > R^I > R^T$. Note that the interest rate for each covenant regime is linear in I. We can then compare the level of borrowing required to ensure that $R^N > R^I$ and $R^I > R^T$, which I will call I_1 and I_2 respectively. Substituting in the optimal interest rate expressions and rearranging yields the following.

$$I_1 > -\frac{1}{\Omega^I - \Omega^N(1-p_z s\gamma)}\Big[\Omega^I\big(Q^N(y_0+k+D) - E - (1-Q^N)\psi(\tfrac{E}{Q^N} - 2D)\big) \\ - \Omega^N\big(Q^I(y_0+k+D) - E - (1-Q^I-p_z s)(\tfrac{E}{Q^I} - 2D)\big)\Big]$$

$$I_2 > -\frac{1}{\Omega^T(1-p_z s\gamma) - \Omega^I(1-p_z\gamma)}\Big[\Omega^T\big(Q^I(y_0+k+D) - E - (1-Q^I-p_z s)(\tfrac{E}{Q^I} - 2D)\big) \\ - \Omega^I\big(Q^T(y_0+k+D) - E - (1-Q^T-p_z)(\tfrac{E}{Q^T} - 2D)\big)\Big]$$

The positivity of the denominators in both expressions is guaranteed by Lemma III.4. Therefore, any $I > I^* = \max\{I_1, I_2\}$ guarantees that the interest rate demanded by the lender is decreasing in covenant tightness.

□

Theorem III.5 is helpful in determining how a decreasing interest rate menu could exist among the contracts, however it does not give an easily interpretable sense of the required magnitude of I, and would lose its economic meaning if I^* were greater than the maximum possible payoff, $y_0 + k + D$, as no loans would be issued. I now introduce two technical assumptions that allow us to conclude that Theorem III.5 does not require a high level of borrowing to deliver the trade-off. As the next result shows, for economically reasonable parameter values, *any* positive level of borrowing ensures a covenant-interest trade-off.

Assumption III.6. $\frac{Q^N(1-Q^I-p_z s)}{Q^I(1-Q^N)} > \psi$

Assumption III.7. $y_0 + k > 3D$

Neither of these assumptions is strictly necessary for any result described in this paper, however they greatly simplify the proof of the next theorem. In the calibration considered

below, Assumption III.6 corresponds to the empirically plausible range of $\psi < 0.81$. Assumption III.7 merely ensures that the baseline level of output from production is not too small relative to the profitability shock. In the numerical exercises, this condition is violated yet there is nevertheless a significant reduction in the equilibrium credit spread as covenant tightness increases.

Lemma III.8. $\Omega^I Q^N > \Omega^N Q^I$

Proof. The result follows immediately after invoking the upper bound on ψ in Assumption III.6. □

Theorem III.9. ***(Covenant-Interest Trade-off II)*** *As the equity investment tends to zero, the lender's profit maximizing interest rate is lower in the contract with covenants for any positive level of borrowing.*

Proof. Consider the optimal interest rate under the no covenant and the intermediate covenant contracts. I desire to show that $R^N > R^I$. To complete the argument, it will be shown that the right hand side of the I_1 inequality (from the proof of Theorem III.5) is negative, and thus any $I > 0$ will lead to a declining interest rate schedule in covenant tightness. Recall that by Lemma III.4, the denominator is strictly positive. Therefore, the sign of the numerator will determine the sign of the complicated fraction. If the expression inside the outer parentheses is positive, we are done.

The relevant terms can be arranged into three expressions that are a function of Ω^N and Ω^I,

$$\begin{aligned}\mathbb{N} &= (y_0 + k + D)(\Omega^I Q^N - \Omega^N Q^I) + E(\Omega^N - \Omega^I) - \Omega^I(1 - Q^N)\psi(\frac{E}{Q^N} - 2D) \\ &\quad + \Omega^N(1 - Q^I - p_z s)(\frac{E}{Q^I} - 2D) \\ \lim_{E \to 0} \mathbb{N} &= (y_0 + k + D)(\Omega^I Q^N - \Omega^N Q^I) + \Omega^I(1 - Q^N)\psi 2D - \Omega^N(1 - Q^I - p_z s)2D\end{aligned}$$

The goal is to show that the last expression is strictly positive, which will hold so long as[8]

$$y_0 + k > \frac{2D\Big(\Omega^N(1 - Q^I - p_z s) - \Omega^I(1 - Q^N)\psi\Big)}{\Omega^I Q^N - \Omega^N Q^I} - D$$

To examine the numerator on the right-hand side, first note that $1 - Q^I - p_z s = \Omega^I - 2Q^I$ and that $(1 - Q^N)\psi = \Omega^N - 2Q^N$. After substitution into the expression above, we can simply the sufficient condition for positivity to

$$y_0 + k > \frac{2D\Big(\Omega^N(\Omega^I - 2Q^I) - \Omega^I(\Omega^N - 2Q^N)\Big)}{\Omega^I Q^N - \Omega^N Q^I} - D$$

$$y_0 + k > 3D$$

Therefore, under Assumption III.7, $R^N > R^I$. By identical reasoning, it is clear that Assumption III.7 also implies $R^I > R^T$, and the proof is complete. □

The significance of the previous result lies in its generality: any $I \in (y_0 + k - D, y_0 + k + D)$ will have the desired property. Under relatively weak assumptions, Theorem III.9 demonstrates that a basic lender's portfolio pricing problem, under asymmetric information about borrower quality, essentially carries with it a covenant-interest rate trade-off property. In other words, the fundamental trade-off captured by equation (3.5) extends to the inclusion of covenants. Recall that in the no covenant case, the lender balances the value of increasing the interest rate (which increases profit per loan while screening out worse quality borrowers) against the reduction in profits attributable to issuing fewer loans. Adding in a contractual feature that permits early liquidation, the modified lender's problem adds a trade-off of the benefit of downside protection against the decrease in lending, allowing the interest rate to work with the covenant in achieving the profit-maximizing balance.

[8]The division is legitimate by Lemma III.8.

The Effect of a Recession

I now consider the lender's optimal contract choice over the business cycle. The model is sufficiently rich that is it is challenging to characterize the comparative statics generally. Nevertheless, it is possible to show that there exists a threshold at which the optimal covenant choice changes when borrower quality deteriorates. I also demonstrate a numerical solution of the model, for an economically reasonable set of parameters, to illustrate how the lender's contract varies with the probability of a favorable output shock when $z = z_\ell$, i.e. q_ℓ.

Parameter	Value	Description
p_z	0.30	Probability of low state
q_h	0.80	Probability of favorable output shock in high state
s	0.38	Probability of low earnings
E	0.20	Equity investment
I	2.00	Principal borrowed
y_0	0.70	Output intercept
k	1.70	Output slope parameter
D	1.13	Profitability shock
γ	1.00	Recovery from covenant exercise
ψ	0.80	Recovery of assets in no covenant regime

Table 3.3: Parameters

The lender's endogenous switching between covenant regimes can be demonstrated with a straightforward application of the Intermediate Value Theorem. No additional assumptions are needed, although for ease of exposition I again employ the simplification from Theorem III.9 that the equity investment becomes arbitrarily small. The result does not depend on this assumption, but it avoids having to keep track of terms related to the marginal effect of q_ℓ on $\alpha(R)$, which affects lender profits through the lower bound of integration.

I first show that the lender's maximum profit (which is to say its value function) in the intermediate regime is increasing in the success probability of the adverse profitability state, q_ℓ, which provides the economically obvious result that the intermediate covenant regime becomes more valuable as borrowers in the adverse profitability state are less likely

to default.

Lemma III.10. $\Pi(R^{I*})$ *is monotonically increasing in* q_ℓ.

Proof. The proposition follows from a simple application of the Envelope Theorem, where R^{I*} is the optimally chosen interest rate, i.e.

$$\frac{\partial \Pi^I(R^{I*})}{\partial q_\ell} = \frac{\partial \Pi^I(R^I)}{\partial q_\ell}\bigg|_{R^I = R^{I*}} > 0$$

Since the value of equity tends to zero, $\alpha(R^I) = \frac{R^I - y_0 - D}{k}$ and therefore q_ℓ appears only in the integrand,

$$\frac{\partial \Pi^I}{\partial q_\ell} = \int_{\alpha(R^{I*})}^{1} \frac{\partial}{\partial q_\ell}\Big(Q^I R^{I*} + p_z s\gamma I + (1 - Q^I - p_z s)(y_0 + k\alpha - D) - I\Big)d\alpha$$

Note next that q_ℓ enters the expression only through Q^I and $\frac{\partial Q^I}{\partial q_\ell} = p_z(1-s)$, which implies that

$$\frac{\partial \Pi^I(R^{I*})}{\partial q_\ell} = p_z(1-s)\int_{\alpha(R^{I*})}^{1} \Big(R^{I*} - (y_0 + k\alpha - D)\Big)d\alpha$$

As both p_z and s are assumed to be positive, all that is required to complete the argument is that the interest rate charged by the lender is more than the recovery in default. By Assumption III.1 (as argued in Appendix C.3), that result is guaranteed to hold,[9] and the proof is complete. □

Theorem III.11. ***(Covenant Switching)*** *There exists a unique value* $\bar{q}_\ell \in (0,1)$ *such that the lender adjusts the contract it offers from the tight covenant to the intermediate covenant.*

Proof. Note first, that by construction, $\Pi^T(R^{T*})$ does not depend on q_ℓ and is therefore a fixed value. In addition, the intermediate covenant profit function is trivially continuous

[9] And the model would make no sense unless that were true.

in q_ℓ. If it can shown that for some value of q_ℓ, $\Pi^I(R^{I*}) < \Pi^T(R^{T*})$ and for a different value, $\Pi^I(R^{I*}) > \Pi^T(R^{T*})$, then we are done. By the invariance of $\Pi^T(R^{T*})$ to q_ℓ and the monotonicity of $\Pi^I(R^{I*})$ from Lemma III.10, the single crossing property is guaranteed.

For the first case, consider $q_\ell = 0$. It will be shown that $\Pi^I(R^{I*}) < \Pi^T(R^{T*})$. For convenience, I will work only with R^{I*}, since we know that R^{T*} is the unique optimal interest rate in the tight regime, and therefore $\Pi^T(R^{T*}) > \Pi^T(R^{I*})$. The result follows by transitivity if $\Pi^I(R^{I*}) < \Pi^T(R^{I*})$.

Note next that $q_\ell = 0 \Rightarrow Q^T = Q^I$, so we can write the difference of the regime profits, evaluated at R^{I*}, as

$$\Pi^I(R^{I*}) - \Pi^T(R^{I*}) = \int_{\alpha(R^{I*})}^{1} \big(p_z s\gamma I + Q^T R^{I*} + (1 - Q^T - p_z s)(y_0 + k\alpha - D) - I\big) - \big(p_z \gamma I + Q^T R^{I*} + (1 - Q^T - p_z)(y_0 + k\alpha - D) - I\big) d\alpha$$

After rearranging, the expression reduces to

$$p_z(1 - s) \int_{\alpha(R^{I*})}^{1} y_0 + k\alpha - D - \gamma I \, d\alpha$$

Since it is assumed that covenant exercise is valuable prior to default, it must necessarily be true that γI exceeds recovery in default, and the expression is negative, therefore $\Pi^I(R^{I*}) < \Pi^T(R^{T*})$ when $q_\ell = 0$.

For the next case, consider $q_\ell = 1$. I will use a variation on the argument above and show that $\Pi^I(R^{I*}) > \Pi^I(R^{T*}) > \Pi^T(R^{T*})$ which will complete the proof. Although the algebra is more complicated when $q_\ell = 1$, the difference in profits reduces to[10]

$$\Pi^I(R^{T*}) - \Pi^T(R^{T*}) = p_z(1 - s) \int_{\alpha(R^{T*})}^{1} R^{T*} - \gamma I \, d\alpha$$

[10]It should be remarked that $(1 - Q^I - p_z s) - (1 - Q^T - p_z) = 0$

Therefore, as long as repayment exceeds the value of early liquidation,[11] we know that for sufficiently large q_ℓ, the intermediate regime will be more profitable. Accordingly, $\bar{q}_\ell$ must exist on the interval $(0, 1)$ by the Intermediate Value Theorem.

□

The argument above relies on the definition of the profit functions under the standard assumptions on q_ℓ in the basic model. Nevertheless, the logic of the proof holds even though as $q_\ell \to 1$, it is not guaranteed that all of the model's assumptions will be satisfied. What must be independently verified is that $\bar{q}_\ell$ itself does not violate any assumptions of the model. Such a condition is met for the set of parameters in the numerical example.

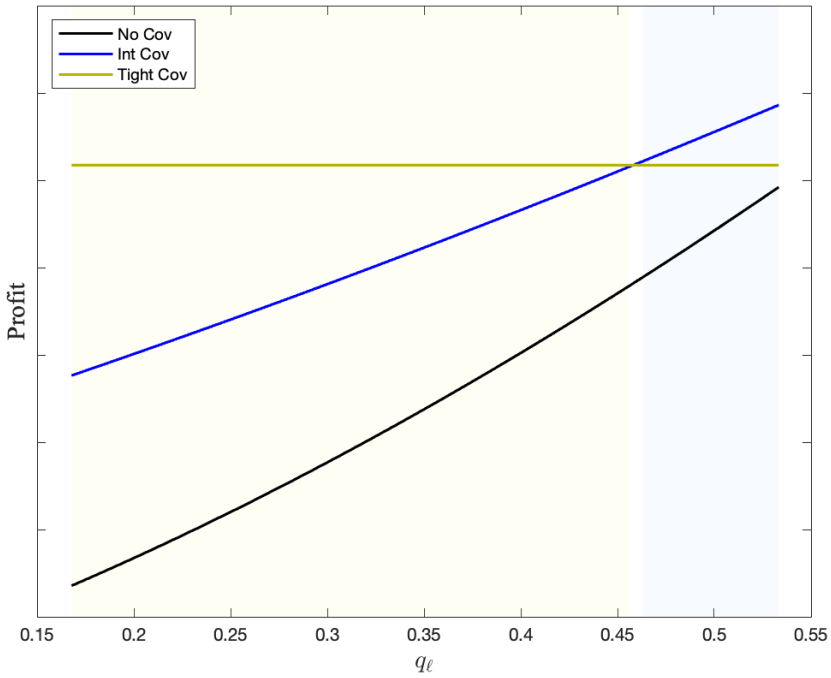


Figure 3.3: Lender Covenant Choice

As illustrated in Figure 3.3, the numerical exercise generates a separation into "covenant regimes" as guaranteed by Theorem III.11. For relatively high values of q_ℓ, represented by the light blue shaded area, the intermediate regime is most profitable, whereas for low values

[11] Which is true by construction, see Appendix C.3, otherwise the tight covenant profit maximization problem is ill-defined.

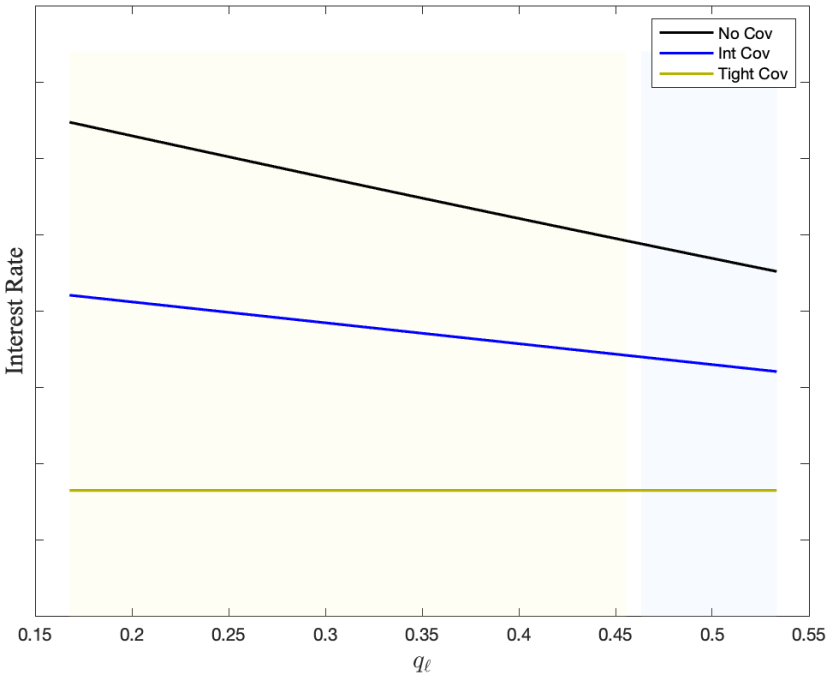


Figure 3.4: Interest Rate Schedule

of q_ℓ where borrower quality is significantly worse and thus early exercise is more valuable, the tight regime dominates.[12] It should be noted that, by construction, the lender's profit in the tight covenant regime is invariant to the level of q_ℓ, because it has committed to call in the loan in period $t = 1$ when z_ℓ is observed in exchange for a granting the borrower a more favorable interest rate, as shown in Figure 3.4. Taken together the two regimes result in a convex kink in the lender's value function (which is nothing more than the maximum of the profits from the three possible contracts).

Furthermore, despite the hairy algebraic expressions in the previous section, both the profit functions and the interest rate policy functions are roughly linear, and the magnitude of the slopes in absolute value is inversely related to covenant intensity. In other words, the fewer the restrictions on the loan, the faster the interest rate offered to the borrower falls faster as q_ℓ rises, which is nothing more than a restatement of the covenant-interest

[12]The lack of a regime for the "no covenant" contract is an artifact of the parameter choices. Under this parameterization, values of q_ℓ that would lead the lender to choose a no covenant contract would violate at least one of the essential model assumptions.

rate trade-off property. Lastly, the invariance of the interest rate in the tight covenant regime to the q_ℓ parameter embodies the result of a lower bound on market loan contracts during a recession, both of the rate of interest *and* the covenant tightness. As argued in the introduction, policymakers care enormously about lending standards, and one way to view the covenant regimes of this model is as a model of lending standards that varies over the business cycle.

3.7 Conclusion

While empirical corporate finance research has long appreciated the role of non-price elements of debt contracts, the theoretical literature has largely abstracted from the very features that make covenants so attractive to market participants. To fill that gap, this paper has presented new evidence of the variation in covenant intensity over the business cycle and introduced a tractable model of risky debt subject to realistic financial maintenance covenants. With a minimum of additional complexity, a simple three-period lender portfolio pricing problem generates an equilibrium trade-off of covenant tightness for lower credit spreads that varies endogenously over the business cycle. The environment studied is admittedly parsimonious, so future research should consider endogenizing the firm earnings process, making the covenant threshold choice continuous, and inserting this framework into existing workhorse dynamic corporate finance and general equilibrium macroeconomic models.

It would also be worthwhile to extend the basic model to consider a lending environment with capital and liquidity requirements to generate other motivations for setting covenants tightly that are unrelated to borrower quality, such as the liquidity preservation rationale studied in Chodorow-Reich and Falato (2022). Moreover, a more policy relevant setting would include different classes of borrowers who are screened differently. A major simplification of the environment studied here is that the representative lender faces a single set of observationally indistinguishable firms and therefore offers the same covenant tightness and

interest rate contract to every borrower. A more sophisticated extension could embed the covenant framework into a firm lifecycle model in which the borrower might move between levels of creditworthiness and hence exhibit time-varying covenant intensity at the firm level.

APPENDICES

APPENDIX A

Solution Methods and Welfare Calculations

A.1 Solution Methods

Baseline Model

1. Specify initial guess for $\begin{bmatrix} \pi_1, & \dots & , \pi_S \end{bmatrix}$
2. Calculate rental prices equilibrium rental prices $\{R^s\}_{s=1}^S$ using equation (1.9) and the stationary values for $\{N_s\}_{s=1}^S$, $N_s = \frac{\pi_s}{\pi_s + 2\gamma}$
3. Solve for the policy functions $\widehat{b'}(b, y, h^s_{-1}, e)$, $\widehat{h}(b, y, h^s_{-1}, e)$ and the indicator function $DEF(b, y, h^s_{-1}, e)$ which marks whether an agent defaults on their rental agreement in each state
4. Use policy functions to compute the stationary distribution $\lambda(b, y, h^s_{-1}, e)$
5. Calculate the implied default probability for each unit type using this distribution,

$$\delta^s = \frac{\sum_{b \in \mathcal{B}} \sum_{y \in \mathcal{Y}} DEF(b, y, h^s_{-1} = h^s, e = 0) \cdot \lambda(b, y, h^s_{-1} = h^s, e = 0)}{\sum_{b \in \mathcal{B}} \sum_{y \in \mathcal{Y}} \lambda(b, y, h^s_{-1} = h^s, e = 0)}$$

6. If $\pi_s \approx \delta^s \ \forall s \in S$ then stop, otherwise update π_s in the direction of δ_s and return to **2.**

In the model solved in Section 1.4, the algorithm iterates only over π_1 as it is assumed that agents in h^2 cannot default.

Model with Nonpayment Insurance

1. Specify an initial guess for τ

2. Calculate equilibrium rental prices $\{R^s\}_{s=1}^S$ using equation (1.13)

3. Solve for the policy functions $\widehat{b'}(b, y, h^s_{-1}, e)$, $\widehat{h}(b, y, h^s_{-1}, e)$ and the indicator function $DEF(b, y, h^s_{-1}, e)$ which marks whether an agent defaults on their rental agreement in each state

4. Use policy functions to compute the stationary distribution $\lambda(b, y, h^s_{-1}, e)$

5. Calculate implied excess insurance payments. Let Ω^s_0 represent the measure of households in unit s,

$$\Omega^s_0 = \sum_{b\in\mathcal{B}} \sum_{y\in\mathcal{Y}} \sum_{e\in\mathcal{E}} \lambda(b, y, h^s_{-1} = h^s, e)$$

and Ω^s_1 represent the measure of households that are newly defaulting,

$$\Omega^s_1 = \sum_{b\in\mathcal{B}} \sum_{y\in\mathcal{Y}} DEF(b, y, h^s_{-1} = h^s, e = 0) \cdot \lambda(b, y, h^s_{-1} = h^s, e = 0)$$

and Ω^s_2 represent the measure of households that are in eviction proceedings and awaiting ejection,

$$\Omega^s_2 = \sum_{b\in\mathcal{B}} \sum_{y\in\mathcal{Y}} \lambda(b, y, h^s_{-1} = h^s, e = 1)$$

The insurance payments are then τR^s for all occupied units and insurance payouts are

E for each household newly defaulting plus R^s for all nonpaying households.

$$\xi = \left(\sum_{s \in S} \tau R^s \, \Omega_0^s \right) - \left(\sum_{s \in S} E \, \Omega_1^s + R^s \, (\Omega_1^s + \Omega_2^s) \right)$$

6. If $\xi \approx 0$ then stop, otherwise increase τ if $\xi < 0$, or decrease τ if $\xi > 0$, then return to step **2.**

A.2 Welfare Analysis

To derive the compensating variation, begin by invoking the definition of the value function for the household at state $\mathcal{S} = \Big[b, y, h_{-1}^s, e \Big]$, where $V_B(\mathcal{S})$ is the value in the baseline economy and $V_I(\mathcal{S})$ is the value in the economy with landlord insurance, and $\widehat{c}_i$ and $\widehat{h}_i$ refer to the optimal policy functions in each regime.

$$V_B(\mathcal{S}) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{\left((\widehat{c}_{B,t})^{\alpha} (\widehat{h}_{B,t})^{1-\alpha} \right)^{1-\sigma} - 1}{1-\sigma} \right)$$

$$V_I(\mathcal{S}) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{\left((\widehat{c}_{I,t})^{\alpha} (\widehat{h}_{I,t})^{1-\alpha} \right)^{1-\sigma} - 1}{1-\sigma} \right)$$

The goal is to find a value $\mu(\mathcal{S})$ that represents the change in consumption needed to make the household indifferent between living in the baseline economy and the economy with the landlord insurance scheme, i.e. solving the equation

$$V_I(\mathcal{S}) = \sum_{t=0}^{\infty} \beta^t \left(\frac{\left(\left((1+\mu(\mathcal{S})) \widehat{c}_B \right)^{\alpha} (\widehat{h}_B)^{1-\alpha} \right)^{1-\sigma} - 1}{1-\sigma} \right) \tag{A.1}$$

The value is state-contingent since households in different states of nature might require distinct adjustments to their consumption stream to remain indifferent. As written, a value of $\mu(\mathcal{S}) > 0$ implies the household prefers the economy with insurance and requires addi-

tional consumption in the baseline economy to be indifferent, whereas $\mu(\mathcal{S}) < 0$ indicates the consumer prefers the baseline economy and would need to reduce their consumption over time in order to be indifferent.

Rearranging equation (A.1) and invoking the definitions of the value functions we get,

$$V_I(\mathcal{S}) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{(1+\mu(\mathcal{S}))^{\alpha(1-\sigma)} \left(\left(\widehat{c}_B\right)^{\alpha} (\widehat{h}_B)^{1-\alpha} \right)^{1-\sigma} - 1}{1-\sigma} \right)$$

$$V_I(\mathcal{S}) = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{(1+\mu(\mathcal{S}))^{\alpha(1-\sigma)} \left(\left(\widehat{c}_B\right)^{\alpha} (\widehat{h}_B)^{1-\alpha} \right)^{1-\sigma}}{1-\sigma} \right) - \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma}$$

$$V_I(\mathcal{S}) = (1+\mu(\mathcal{S}))^{\alpha(1-\sigma)} \sum_{t=0}^{\infty} \beta^t \left(\frac{\left(\left(\widehat{c}_B\right)^{\alpha} (\widehat{h}_B)^{1-\alpha} \right)^{1-\sigma} - 1}{1-\sigma} \right) + \sum_{t=0}^{\infty} \beta^t \frac{(1+\mu(\mathcal{S}))^{\alpha(1-\sigma)}}{1-\sigma} - \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma}$$

$$V_I(\mathcal{S}) = (1+\mu(\mathcal{S}))^{\alpha(1-\sigma)} \left(V_B(\mathcal{S}) + \frac{1}{(1-\sigma)(1-\beta)} \right) - \frac{1}{(1-\sigma)(1-\beta)}$$

$$\mu(\mathcal{S}) = \left(\frac{V_I(\mathcal{S}) + \frac{1}{(1-\sigma)(1-\beta)}}{V_B(\mathcal{S}) + \frac{1}{(1-\sigma)(1-\beta)}} \right)^{\frac{1}{\alpha(1-\sigma)}} - 1$$

APPENDIX B

Bank Branch Data: Variable Definitions and Construction

B.1 Data Construction

Entry Exercises

The empirical exercises that measure entry of out-of-state banks rely on counts of newly established branches, identified by the SIMS_Established_Date variable for each year of the Summary of Deposits data. First, all new branches in a state opened in the previous twelve months[1] are counted, B_{it}, and then the branches for which STALPBR is not the same as STALPHCR are counted as out-of-state (or foreign) branches, b_{it}^F. The counts are recomputed each year reflecting that the response variable, $y_{it} = \frac{b_{it}^F}{B_{it}}$, measures only entry in a given year, so if a branch were to close within a year it is still counted as entry in the year in which it opened.

[1] To account for the timing of the census, entry is measured from the date of the FDIC survey, June 30, so a year is measured between July 1 of the previous year and June 30 of the current year.

Interest Rate Exercises

In the analysis of the response to loan and deposit rates after Ohio's intervention, I restrict attention to banks that meet three criteria: (i) exist in both 1994 and 1999 (to ensure continuous operation through the treatment period); (ii) operate branches only in the Cincinnati metropolitan area (so that loan and deposit income on their balance sheets is a function of only local banking competition rather than operations in other markets); and (iii) are charted by the state in which their branches are located under a charter type of "state member" or "state non-member" bank (to avoid including national banks who are chartered by the OCC and thus operate under an additinoal federal regulatory regime).[2]

The interest rate time series are computed using the end of year values for the income statement and balance sheet values. As the data are quarterly, the realized interest rate values used in equation (2.3) are annualized in the usual fashion by assuming that the income (expenses) were earned (paid) at a constant rate over the year, so the time series are computed as follows, using the Call Report variables described in Table (B.1), for bank j in state i in year t,

$$loan_rate_{ijt} = \frac{\text{Intincloans}_{ijt} \times 4}{\text{Loans}_{ijt}}$$
$$deposit_rate_{ijt} = \frac{\text{Intexp}_{ijt} \times 4}{\text{Intbeardep}_{ijt}}$$

[2]Due to the small sample size, this exercise also includes banks whose regulatory top holder (STALPHCR) is empty, under the assumptions that if the bank has no branches outside the states, it is highly likely that its corporate form is not organized as a bank holding company which explains the empty entry.

B.2 Raw Data

Variable	Definition	Dataset	Empirical Exercise
SIMS_Established_Date	The date the branch location was established	Summary of Deposits	All
STALPBR	State of the physical location of the branch	Summary of Deposits	All
STALPHCR	State of the headquarters of the branch's regulatory top holder	Summary of Deposits	All
BKCLASS	Code that indicates the type of depository institution based on charter type and Federal Reserve membership status and country.	Summary of Deposits	All
MSANAMB	Metropolitan Statistical Area in which the branch is physically located.	Summary of Deposits	Ohio (Interest Rates)
POP	Resident population of a state by year. Each state series is of the form OHPOP, MIPOP, etc., ultimate source is the U.S. Census Bureau	FRED	Ohio (Entry), Dodd-Frank (Entry)
Assets	Total assets	Call Reports	Ohio (Interest Rates)
Intincloans	Interest income on loans, corresponds to RIAD4010 in the call reports	Call Reports	Ohio (Interest Rates)
Loans	Total loans and leases, corresponds to RCFD1400 in the call reports	Call Reports	Ohio (Interest Rates)
Intexp	Interest expense, corresponds to RIAD4073 in the call reports	Call Reports	Ohio (Interest Rates)
Intbeardep	Total interest bearing deposits, corresponds to RCON6636 in the call reports	Call Reports	Ohio (Interest Rates)
Deposits	Total deposits, corresponds to RCON2200 in the call reports	Call Reports	Ohio (Interest Rates)

Table B.1: Underlying Variables Used in the Analysis

APPENDIX C

Derivations and Sufficient Conditions

C.1 Derivation of Optimal Interest Rate in the No Covenant Model

For clarity, the work below evaluates the integral before differentiation, however using Leibniz's rule greatly simplifies the algebra.

$$\begin{aligned}
\Pi(R^N) &= \int_{\alpha^N(R^N)}^{1} Q^N R^N + (1-Q^N)\psi(y_0 + k\alpha - D) - I \, d\alpha \\
&= (Q^N R^N - I) \int_{\alpha^N(R^N)}^{1} d\alpha + (1-Q^N)\psi \int_{\alpha^N(R^N)}^{1} (y_0 + k\alpha - D) \, d\alpha \\
&= (Q^N R^N - I)(1-\alpha^N(R^N)) + (1-Q^N)\psi\left((y_0 - D)(1-\alpha^N(R^N)) + \frac{k}{2}(1-\alpha^N(R^N)^2)\right) \\
&= \left(Q^N R^N + (1-Q^N)\psi(y_0 - D) + (1-Q^N)\psi\frac{k}{2} - I\right) \\
&\quad - \left(Q^N R^N + (1-Q^N)\psi(y_0 - D) - I\right)\alpha^N - \frac{k}{2}(1-Q^N)\psi(\alpha^N)^2
\end{aligned}$$

The first order necessary condition for R^N is then,[1]

$$\frac{d\Pi}{dR^N} = Q^N - \left(Q^N + (1-Q^N)\psi(y_0 - D) - I\right)\frac{1}{k} - Q^N\alpha^N - (1-Q^N)\psi\alpha^N = 0$$

$$0 = \frac{1}{k}\Bigg[kQ^N - \left(Q^N R^N + (1-Q^N)\psi(y_0 - D) - I\right) - Q^N\left(\frac{E}{Q^N} + R^N - y_0 - D\right) - (1-Q^N)\psi\left(\frac{E}{Q^N} + R^N - y_0 - D\right)\Bigg]$$

$$\Rightarrow R^N\left(2Q^N + (1-Q^N)\psi\right) = kQ^N - (1-Q^N)\psi(y_0 - D) + I - E + Q^N y_0 + Q^N D - (1-Q^N)\psi\left(\frac{E}{Q^N} - y_0 - D\right)$$

$$R^N = \frac{Q^N(y_0 + k + D) - E + I - (1-Q^N)\psi\left(\frac{E}{Q^N} - 2D\right)}{2Q^N + (1-Q^N)\psi}$$

C.2 Optimal Covenant Choice

In this appendix, I derive the optimal interest rate and profits for the lender in the "tight covenant" and "intermediate covenant" regimes. Recall that the "loose covenant" regime is isomorphic to the no covenant model since the lender is unable to liquidate its positions no matter the value of π that is observed.

Intermediate Covenant Regime

Under the intermediate covenant regime, the firm's individual rationality constraint is still that expected profits are greater than or equal to the initial equity investment, which can be rearranged for the participation threshold $\alpha^I(R)$.[2] Each term refers to a possible

[1] Note that $\frac{d^2\Pi}{dR^2} = -\left(\frac{2Q^N + (1-Q^N)\psi}{k}\right)$ which is everywhere negative for positive values of k and $Q^N \in (0,1)$, so we conclude that R^N corresponds to a maximum.

[2] Note that Q^I simplifies to $p_z(1-s)q_\ell + (1-p_z)q_h$

path to y_h, i.e. (z_ℓ, π_h), (z_h, π_ℓ), and (z_h, π_h).

$$(y_h - R^I) \underbrace{\Big(p_z(1-s)q_\ell + (1-p_z)sq_h + (1-p_z)(1-s)q_h \Big)}_{Q^I} \geq E$$

$$\Rightarrow (y_0 + k\alpha + D - R^I)Q^I \geq E$$

$$\Rightarrow \alpha^I(R^I) = \frac{\frac{E}{Q^I} + R^I - y_0 - D}{k}$$

The lender's profit function is this regime is

$$\Pi(R^I) = \int_{\alpha^I(R)}^{1} p_z s\gamma I + Q^I R^I + (1 - Q^I - p_z s)(y_0 + k\alpha - D) - I \, d\alpha \tag{C.1}$$

where the first term under the integral reflects the cash flow from liquidation (which occurs in this regime when both π_ℓ and z_ℓ are revealed), the second term reflects repayment in period $t = 2$, and the third term is the cash flow from default.

Using the shortcut of Leibniz's rule, the first order condition is

$$\frac{d\Pi}{dR} = \int_{\alpha^I(R)}^{1} Q^I d\alpha - \left(p_z s\gamma I + Q^I R + (1 - Q^I - p_z s)(y_0 + k\alpha^I(R) - D) - I \right) \frac{1}{k} = 0$$

$$\Rightarrow Q^I - Q^I \left(\frac{\frac{E}{Q^I} + R - y_0 - D}{k} \right)$$

$$= \left(p_z s\gamma I + Q^I R + (1 - Q^I - p_z s) \left\{ y_0 + k \left(\frac{\frac{E}{Q^I} + R - y_0 - D}{k} \right) - D \right\} - I \right) \frac{1}{k}$$

$$\Rightarrow -2RQ^I - (1 - Q^I - p_z s)R$$

$$= p_z s\gamma I + (1 - Q^I - p_z s) \left(\frac{E}{Q^I} - 2D \right) - I - Q^I k + E - y_0 Q^I - DQ^I$$

$$R^I = \frac{Q^I(y_0 + k + D) - E + (1 - p_z s\gamma)I - (1 - Q^I - p_z s) \left(\frac{E}{Q^I} - 2D \right)}{1 + Q^I - p_z s}$$

Tight Covenant Regime

The solution to the lender's problem under the "tight covenant" is analogous to that under the intermediate regime. We start from the firm's individual rationality constraint $\alpha^T(R)$,[3] but now there are only two possible paths for a firm to make it to $t = 2$ as the lender will exercise its option to liquidate whenever it observes z_ℓ, no matter the earnings signal that appears.

$$
\begin{aligned}
&(y_h - R)\underbrace{\Big((1-p_z)sq_h + (1-p_z)(1-s)q_h\Big)}_{Q^T} \geq E \\
\Rightarrow &(y_0 + k\alpha + D - R)Q^T \geq E \\
\Rightarrow &\alpha^T(R) = \frac{\frac{E}{Q^T} + R - y_0 - D}{k}
\end{aligned}
$$

The lender's profit function is this regime is

$$
\Pi(R) = \int_{\alpha^T(R)}^{1} p_z\gamma I + Q^T R + (1 - Q^T - p_z)(y_0 + k\alpha - D) - I \, d\alpha \tag{C.2}
$$

where the first term under the integral reflects the cash flow from liquidation (which occurs in this regime when z_ℓ is revealed, independent of the realized value of π), the second term reflects repayment in period $t = 2$, and the third term is the cash flow from default.

Once again employing the shortcut of Leibniz's rule, the first order condition is

$$
\begin{aligned}
&\frac{d\Pi}{dR} = \int_{\alpha^T(R)}^{1} Q^T d\alpha - \Big(p_z\gamma I + Q^T R + (1 - Q^T - p_z)(y_0 + k\alpha^T(R) - D) - I\Big)\frac{1}{k} = 0 \\
&\Rightarrow Q^T - Q^T\left(\frac{\frac{E}{Q^T} + R - y_0 - D}{k}\right)
\end{aligned}
$$

[3]Note that in this case the probability reduces to $(1-p_z)q_h$ as only the firms that observe z_h will be able to continue to production.

$$= \left(p_z\gamma I + Q^T R + (1 - Q^T - p_z) \left\{ y_0 + k \left(\frac{\frac{E}{Q^T} + R - y_0 - D}{k} \right) - D \right\} - I \right)$$

$$\Rightarrow -2RQ^T - (1 - Q^T - p_z)R$$
$$= p_z\gamma I + (1 - Q^T - p_z) \left(\frac{E}{Q^T} - 2D \right) - I - Q^T k + E - y_0 Q^T - DQ^T$$

$$R^T = \frac{Q^T(y_0 + k + D) - E + (1 - p_z\gamma)I - (1 - Q^T - p_z) \left(\frac{E}{Q^T} - 2D \right)}{1 + Q^T - p_z}$$

Interest Rate Comparison

Across the three regimes, the equilibrium interest rates are

$$R^N = \frac{Q^N(y_0 + k + D) - E + I - (1 - Q^N)\psi\left(\frac{E}{Q^N} - 2D\right)}{2Q^N + (1 - Q^N)\psi}$$
$$R^I = \frac{Q^I(y_0 + k + D) - E + (1 - p_z s\gamma)I - (1 - Q^I - p_z s)(\frac{E}{Q^I} - 2D)}{1 + Q^I - p_z s}$$
$$R^T = \frac{Q^T(y_0 + k + D) - E + (1 - p_z\gamma)I - (1 - Q^T - p_z)(\frac{E}{Q^T} - 2D)}{1 + Q^T - p_z}$$

Covenant Model Profit Functions

Here are the optimized profit functions after integration but before substitution of the acceptance thresholds,

$$\Pi^N(R^N) = \left(Q^N R^N + (1 - Q^N)\psi(y_0 - D) + (1 - Q^N)\psi\frac{k}{2} - I\right)$$
$$- \left(Q^N R^N + (1 - Q^N)\psi(y_0 - D) - I\right)\alpha^N - \frac{k}{2}(1 - Q^N)\psi(\alpha^N)^2$$
$$\Pi^I(R^I) = \left(p_z s\gamma I + Q^I R^I + (1 - Q^I - p_z s)(y_0 - D) + (1 - Q^I - p_z s)\frac{k}{2} - I\right)$$
$$- \left(p_z s\gamma I + Q^I R^I + (1 - Q^I - p_z s)(y_0 - D) - I\right)\alpha^I - \frac{k}{2}(1 - Q^I - p_z s)\,(\alpha^I)^2$$
$$\Pi^T(R^T) = \left(p_z\gamma I + Q^T R^T + (1 - Q^T - p_z)(y_0 - D) + (1 - Q^T - p_z)\frac{k}{2} - I\right)$$
$$- \left(p_z\gamma I + Q^T R^T + (1 - Q^T - p_z)(y_0 - D) - I\right)\alpha^T - \frac{k}{2}(1 - Q^T - p_z)\,(\alpha^T)^2$$

C.3 Sufficient Conditions

Sufficiency for $y_h > R > y_\ell$

For the validity of the profit and interest rate expressions derived above, it must be the case that—in all regimes—the optimally chosen interest rate falls between the two possible levels of output for all firms that accept the contract, so that firms who receive a positive profitability shock may repay the loan, while those that receive the adverse shock will default.

At the lower bound, such a condition requires that even the highest quality borrower (i.e. $\alpha = 1$) cannot repay the loan when y_ℓ materializes. Assumption III.1 ensures that this is the case, because if it were not true, then it must be that $R < I$, which implies a negative expected return on the loan. Such an action cannot be profit maximizing for the lender given that it has the option to earn a return of zero by not issuing the loan. Therefore, $y_0 + k - D < I \leq R$ for all borrowers.

Next, consider the marginal borrower who is indifferent between accepting and rejecting the loan and whose high state income would be

$$\begin{aligned} y_h(\alpha(R)) &= y_0 + k\alpha(R) + D \\ &= y_0 + \frac{E}{Q} + R - y_0 - D + D \\ &= \frac{E}{Q} + R \\ \Rightarrow y_h(\alpha(R)) - R &= \frac{E}{Q} \geq 0 \end{aligned}$$

So the marginal borrower thus generates profits at least as large as the debt owed. And because every other firm who accepts the contract must make strictly greater profits in the positive profitable shock state than the marginal borrower, and E must be non-negative, it follows that all firms who accept the contract are certain to be able to repay, and therefore

$y_h \geq R$ for all borrowers. Note that the argument is general, as it applies symmetrically to all covenant regimes.

Sufficiency for liquidation when $z = z_\ell$

Additionally, the contracts with covenants are predicated on the idea that the lender finds it profitable to liquidate when the observed shock z is at its low value, z_ℓ. Such a condition is satisfied when the inequality below holds, which corresponds to the situation where the expected return at $t = 1$ (when $z = z_\ell$) of waiting until $t = 2$ is less than the value of exercising the liquidation option, i.e.

$$\gamma I > q_\ell R + (1 - q_\ell)(y_0 + k\mathbb{E}[\alpha] - D)$$

Observe that the expectation operator over α is with respect to the set of firms who accept the contract, not the entire unit interval.

Liquidation does not dominate the interest rate

Lastly, for the optionality of the covenant to be meaningful, the lender must desire to waive a violation when $z = z_h$. A sufficient condition is that, in the model with covenants, $R > \gamma I$. In principle this could be weakened to a condition analogous to the above in which the expected return in the good state is greater than γI, however the math is more straightforward under this approach. The following two assumptions guarantee that conclusion.

Assumption C.1. $2D > I$

Assumption C.2. $y_0 + k > D$

Under these assumptions, and using the result from Theorem III.9 that $R^I > R^T$ (which does not depend on either assumption), I need only show that $R^T > \gamma I$. Invoking the value

of R^T derived above, and letting $E \to 0$, we must confirm that

$$\frac{Q^T(y_0 + k + D) + I - p_z\gamma I + 2D(1 - Q^T - p_z)}{1 + Q^T - p_z} > \gamma I$$

$$Q^T(y_0 + k + D) + I - p_z\gamma I + 2D(1 - Q^T - p_z) > \gamma I(1 + Q^T - p_z)$$

$$Q^T(y_0 + k + D) + I + 2D - 2DQ^T - 2Dp_z > \gamma I + \gamma IQ^T$$

$$Q^T(y_0 + k - D) + I + 2D(1 - p_z) > \gamma I(1 + Q^T)$$

By Assumption III.2, γ is at most 1, therefore the inequality will hold if we assume γ is at its maximum, i.e. $Q^T(y_0 + k - D) + 2D(1 - p_z) > IQ^T$.

By Assumption C.2, the first term on the left hand side is positive, so it suffices to show that $2D(1 - p_z) > IQ^T$. Recall that $Q^T = (1 - p_z)q_h \Rightarrow 1 - p_z > Q^T$, thus combined with Assumption C.1, we may conclude that the inequality holds, and therefore, even in the tight covenant regime, there is no value in exercising the liquidation option when $z = z_h$.

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