Internal Capital Markets in the Great Depression[†]

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Abstract

We study the functioning of internal capital markets during the Great Depression. To do this, we construct a plant-level dataset from the Census of Manufactures for a select set of industries and link the plants into their parent companies. We examine the sensitivity of plant-level employment to changes in local demand and financial conditions across single and multi-plant firms. We find that employment in plants that are a part of a multi-plant firm is more highly correlated with demand than that of a single-plant. At the same time, employment at multi-plant firms is less correlated with financial conditions. We interpret this as evidence for the efficacy of internal capital markets to substitute for breakdowns in external capital markets and channel resources to the most productive locations. We also show a related claim that shocks to plants in one particular region spillover to plants that are part of the same firm but located in a different region.

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1 Introduction

How productive and financial resources are allocated across time and space is a central question in economics. In particular, to what extent resources are allocated through markets as opposed to inside of firms has been a key question going back to Coase (1937). As elucidated by a long tradition Williamson (1981), firms face a tradeoff in their choice between external and internal finance acting as substitutes for one another. A literature in finance has searched for this tradeoff in the cross-section but has instead only been able to identify the negative effects e.g., Scharfstein and Stein (2000). Rather than allocating resources efficiently, internal capital markets appear to put resources in low productivity projects particularly when the company operates a diverse set of product lines Rajan, Servaes, and Zingales (2000)

Rather than attempting to identify the efficacy of internal capital markets in the cross-section, where omitted variables may blur relationships, we take a different approach using time series variation in the functioning of *external* capital markets. The particular variation we consider is that of the Great Depression. This was a time of unprecedented disruptions in *external* capital markets, from rolling bank failures to plummeting stock prices matched with a stark decline in output. Now a long line of economists from Friedman and Schwartz (1971) to Bernanke (1983) have focused on these external capital market shocks.[1] However, none of this work has attempted to address the possible connections between shocks to external capital and the response of internal ones.

Recently and closest to our work, Matvos and Seru (2013) and Kuppuswamy and Villalonga (2010) used the financial crisis of 2007-2009 to examine IC markets under strained external credit markets. Kuppuswamy and Villalonga (2010) document a fall in the di-

[1] Still to this day, the debate between those who place large portion of the decline on the banking crisis versus those who see the banking crisis as an epiphenomena such as Cole and Ohanian (2000) rages on.

versification discount, as evidence of an increase in efficiency of IC markets. Matvos and Seru (2013) estimate a structural model to account for how IC markets can be a substitute for external ones. A limitation of all this work and much of the empirical literature is the reliance on Compustat segment data to identify the extent of a particular firm's operations. As pointed out by Villalonga (2004), these self-reported "segments" not infrequently conflict with segments as categorized by the Census Bureau.

We provide a cleaner setup by building a micro-level dataset from the Census of Manufacturers with establishments linked to their parent companies. With this, we zoom in to the establishment level to understand, in particular, how *multiplant* firms channel resources, financial or otherwise, between their various operations. Hence, rather than having to rely on self-reported by the firm information on segments, we use geographic diversification like the work of Giroud and Mueller (2012). Furthermore, we consider a set of industries that are particularly simple in that the product produced is relatively undifferentiated and firms are not vertically integrated. This is an important point of distinction from Giroud and Mueller (2012) as reallocation in their dataset may be not only between plants of the same firm that produce the same good but also plants of the same firm that produce particular inputs for one another.[2] Note as well that the firms in our sample include not only the biggest firms listed on the stock exchange but the whole universe of firms and plants in a particular industry.

Our empirical approach estimates the difference between multiplant (MP) firms' and single plant (SP) firms' employment response in reaction to changes in the local economic environment. Most empirical work, on the other hand, has taken investment as the dependent variable. We consider variation in demand conditions and changes in the cost of external capital as measured by the relevant regional Federal Reserve's discount rate. The

[2] To the best of our knowledge, almost all of the literature has focused on firms with horizontal differentiation. Vertical differentiation introduces a whole other set of bargaining and hold-up issues.

focus on these shocks is also in contrast to Giroud and Mueller (2012) that focus on events that might improve firm reorganization. We do not attempt to separate these changes into shocks or anticipated changes. The employment data are at a monthly frequency allowing us to study this process of reallocation at a much higher frequency than previous empirical work.

Now before discussing the main results, one might fairly wonder whether SP firms are a fair comparison group. We provide empirical evidence that the only consistent difference between the two is in terms of size not in terms of the production process. With this in place, we find that employment at MP firms is more correlated with demand conditions than for SP firms as proxied by a measure of local retail sales. The point estimates range from a doubling of the sensitivity of SP firms to a 50% greater sensitivity. On the other hand response to what we identify as a change to the discount rate are dampened in MP firms with respect to the SP ones. Here the point estimates suggest a reduction in the sensitivity by around 20%. We interpret this first result on demand as supportive evidence for the bright side of internal capital markets where internal funds are channeled towards plants that need it most be that need in terms high demand or lack of credit. We would emphasize that these results stand in contrast to much of the empirical literature which finds the opposite with resources allocated on IC markets flowing in the "wrong" direction. We discuss some possible explanations for the differences.

In our second set of results, we look at the effect of internal fund allocation for the propagation of shocks across regions. If firms reallocate funds across their plants in response to local conditions, this should be reflected in spillover effects (unless the firm's supply of funds is perfectly elastic). Take for example a firm with plants in two separate regions with one of those plants subject to a local demand spike. Then given our previous results, the plant in the region with relatively lower demand should see its employment fall. We document precisely this effect for changes in demand. The effect of “other” demand shocks is of roughly the same magnitude as the direct effect. We do not find strong evidence for spillovers in response to credit shocks which may be a function of the smaller direct effect in the first place. We interpret our empirical results as evidence of spillover effects that are present in MP firms.

It is important to keep in mind that while not quite as “granular” as the modern US economy, big firms with multiple plants still dominated during this period. Taking two examples from our sample: in the cement industry, the average number of plants of the the three largest firms to operate was more than ten. In the automobile industry, that average was eighteen for the “Big Three”. Hence, understanding how these firms allocated their resources geographically has particularly important implications for the geographic scope of the Depression. In particular, our results suggest that IC markets played a role in propagating shocks during the Great Depression acting as a substitute for the breakdown in external capital markets. We do not make any pronouncements on the potential welfare benefits or costs of IC markets as the insurance provided against adverse shocks comes at the cost of propagation of local shocks at a more aggregate scale.

Related Literature

Our paper relates to an extensive literature theoretically and empirically about the costs (so called “dark side”) and benefits (so-called “bright side”) of MP firms and IC markets. Theoretical models have been developed for both a bright side (see Stein (1997) and a dark side (Scharfstein and Stein (2000)) of IC markets. The benefits are usually thought of as coming from being able to engage in “winner picking” allowing for particularly productive projects to receive outsized amounts of resources. The costs are usually thought of in terms of rent seeking in the process of allocating resources on the part of managers. We remark that "conditions" for the bright side are fulfilled by our sample: we study fairly homogeneous plants within an industry in times of large stress to external capital markets.

Empirically an ample literature attempts to identify costs and benefits of MP firms (or conglomerates), investigating the trade-off between benefits of diversification and its costs; the literature goes back to Lamont (1997); Rajan, Servaes, and Zingales (2000); Shin and Stulz (1998), and more recently, notably Maksimovic and Phillips (2002); Schoar (2002) and Gomes and Livdan (2004). This work has tended to be reduced form in nature though Gomes and Livdan (2004) and Matvos and Seru (2013) are notable exceptions.[3]

2 Data

We collect data from the Census of Manufactures for 10 industries: ice, macaroni, agricultural implements, sugar refining, cement, malt, bone black, cane sugar, concrete,[4] and radio. The source as a whole is discussed in greater detail in Ziebarth (2013). This is an incredibly rich source to study the Depression at an unprecedented degree of disaggregation. The important limitations to this data are that it lacks information on investment (or the value of capital) and any information on the financial position of the plants or their parent firms. The first limitation makes the focus of this paper in terms of the outcome variable different than much of the literature. We will focus on monthly plant-level employment instead of on investment.

While collected ostensibly for other purposes, the industries provide a nice cross-section of the manufacturing sector as a whole. Ice, sugar, and macaroni are consumer, non-durable products while both cement and agricultural implements are capital goods purchased by other businesses. The industries also differ to what extent they sell locally or to national

[3]See Stein (2003) Phillips and Maksimovic (2007) and paper therein for a thorough literature review.
[4]We thank Miguel Morin.

markets. Because of high shipping costs, both ice and cement plants have limited geographic scope, while the others such as automobiles and radios ship across the country. Furthermore, there are differences in the degree of competition. The tacit collusion in the sugar and cement industries has been suspected by many authors.[5] Finally, the industries differ quite strikingly with regards to the importance of labor in production. The fraction of wages to revenue (gross output), a rough measure of the elasticity of production with respect to labor, ranges from .04 in sugar to .22 in agricultural implements. The diversity of the industries lends credence to the claim that the results reported below apply generally to the manufacturing sector.

We also note that the industries differ in their degree of "aggregation." The CoM did not use things like 4 digit SIC codes to organize plants into industry groups. Instead they had categories that changed over time tending to become more narrowly defined. For example, the radio industry starts out in 1929 as also including phonograph producers before splitting these plants into a separate category Scott and Ziebarth (2013). At the same time, the industries of ice, macaroni, cement, sugar refining, malt, bone black, and cane sugar are very narrowly defined with plants tending to make only one product with little product differentiation. On the other hand, the remaining industries are closer 3 digit SIC codes with many plants producing a variety of products. This is particularly true for agricultural implements where plants made reapers, tractors, thrashers among other things. The concrete industry, while tending to have a particular plant only producing one product, covers all things made with concrete from concrete blocks to statues. The question of industry groupings is not particularly pressing for us since we are not interested questions of competition between these plants.

Besides the cement industry where directories from the Cement Institute were em-

[5]For sugar, see Genesove and Mullin (1998). For cement, see Chicu, Vickers, and Ziebarth (2013) and the FTC's court case in 1931, *FTC v. Cement Institute*.

ployed, we link by hand plants into their parent firm using the name of the parent company. This can be a fraught process when firms change their names over the years. The process of linking particular plants over time, by way of comparison is much easier since we can use name of the plant as well as the location of the plants. There is no reason to think that the errors in matching plants to firms and the same firm over time are anything but random. That being said, almost surely the errors in the process of matching lead us to underestimate of the fraction of plants that are part of multi-plant firms. The reason for this is that it is much more likely to not find a match in error than in matching a plant that should not be. This will generate the usual attenuation bias. We should be clear that due to the fact that we do not have the whole universe of manufacturing establishments, we are not able to identify plants owned by a particular firm that fall outside of our industries of interest. In that way, it makes sense to think of this as a "conditional" analysis where the internal capital market operates at two levels, first allocating resources between different lines the business is in and second between plants in that particular line.

3 Empirical Specification and Results

In this section we first some document differences between single-plant (SP) and multi-plant (MP) firms. However, we suggest that the disparities with regards to the relative sizes of the plants is not related to differences in production technologies. Then using data on local demand and credit conditions at the Fed regional level, we examine the differential response between SP and MP plants and the spillover across plants belonging to MP firms.

3.1 Comparing MP versus SP Plants

One might fairly wonder whether the comparison between these two types of firms is a fair one. The summary statistics across our set of industries as reported in Table 1 does bear this out. MP plants are just bigger in terms of revenue and employment. For output (revenue), even for the smallest case of cement, difference between single and MP plant amount to a move up the distribution from the 47th to the 53rd percentile. That difference is most striking for sugar where the disparity reflects moving from the 41st to 59th percentile. Unsurprisingly the differences are similar for wage earners, MP plant firms have larger workforces.

We could be tempted to interpret these statistics as evidence for profound differences between SP and MP plants. However, comparing MP plants along dimensions other dimensions such as geographic locations or the organization of their production paints a slightly different picture. First, in Figure 1, we plot the marginal distribution of plants across the 13 Federal Reserve districts for SP and MP plants. These distributions do not appear to be significantly different to us. If there are many MP plants in a region, there also tends to many SP plants as well. This will allow us to identify the effects of changes in demand and credit conditions using within region variation rather than having to compare SP plants in one region with, say, high demand to MP plants in a different region with, say, low demand.

Second, we compare MP plants and single plants in terms of capital intensity —their labor shares of revenue. We report the results in two ways, first we compute the raw statistics aforementioned reported in Table 1. We also report a test of equality of the variables once demeaned and scaled by their standard deviation in Table 2. This industry adjustment of plant level variable follows other literature e.g. Giroud and Mueller (2012) This procedure attempts at erasing most differences we can control for and place all plants on a similar scale. Finally we keep in mind that labor inputs only captures wage earners, leaving salaried workers or any adjustment of labor at the intensive margin.

However along this labor share dimension, SP and MP plants do not appear that dissimilar across industries. MP plants may have a smaller ratio of wages to revenue, but the difference is neither large in the statistical nor economic sense. This suggests MP plants are not different in terms of technology, relative to single plants in their industry. There is more direct evidence on this for some industries. For example, in cement and ice, differences between plants were not due to fundamentally different production processes. It was simply a function of the scale of the machinery employed. In cement, it was the size of the kiln. For ice, the horse power of the compressors. Instead in the spirit of Foster, Haltiwanger, and Syverson (2008), we would argue MP plants are larger simply because they are more productive. Given this, we are comfortable making the comparisons between these two groups.

While our industry coverage is not exhaustive of the manufacturing sector, we should note again the rich heterogeneity in terms of the importance of MP plants. On one end the macaroni industry is solely composed of SP plants, whereas 60% of cement plants are part of a MP firms. Note furthermore that MP plants and firms control a larger fraction of total revenue than the share of plants. This should not be surprising given the previous evidence that MP plants are larger on average than SP plants. What this means is that MP firms and plants play an outsized role in these industries and understanding how they operate is much more important than understanding how some "representative" firm or plant behaves.

3.2 Empirical Specification

Our empirical strategy uses geographic and temporal differences in demand and credit conditions to identify the effects of internal capital markets by comparing the behavior of MP plants with respect to SP plants. Besides the work of Giroud and Mueller (2012) who also emphasize the geographic dimension, most of the literature on IC markets considered another dimension of diversification, the variety of industry segments within a MP firm. The benefit of this is geographic approach is not minor. As pointed out by Phillips and Maksimovic (2007), the measurement error due to the self reporting of Compustat segments can severly bias studies of internal capital markets.

Our set of firms (and data limitations) also lead us to restrict attention to "horizontal" internal capital markets meaning allocating resources between plants producing horizontally differentiated products. This is in line with most theoretical work though this literature has tended to have the idea of conglomerate produces many types of products in mind rather than a geographically dispersed firm. The problem is that this restriction to a particular type of conglomerate has been lost in empirical literature. There work has not differentiated between conglomerates who produce a horizontally differentiated set of products and those that are arranged more vertically. That vertical dimension could be in terms of demand such as the relationship between Microsoft Office and Windows. It could also be in terms of production such as in automobile companies before they divested many of their part suppliers. We would argue that these vertical IC markets introduces a whole other set of theoretical issues that have not been, to our knowledge, adequately addressed. This is not a problem solved by the using some non-Compustat datasource. Our setup hues closer to the original theoretical framework as we have industries with plants arranged horizontally in the main.

By focusing on these horizontal firms allows for a cleaner interpretation of the results. In geographically arranged industries, the only reason why shocks to a particular MP plant in one region should spill over to a plant part of the same firm in another region is through the internal capital market. In contrast, for vertically arranged firms, shocks to one plant may *directly* affect another plant through demand or production complementarities. assume that we could identify a shock to demand for Windows, because of compatibility issues between Windows and Office, this would induce a demand increase for Office clouding the interpretation of any results.

With this geographic focus, we consider regional economic conditions at the Federal Reserve district level. It would be preferred to have more narrowly defined regions or regions that more closely reflect a particular plant's market. The broad range of these regions also leads to cases where all plants of a MP firms are contained in a single district, a question for how to handle these in the estimation. We rely on the district level data simply due to data availability constraints. The conditions we consider are the discount rate for the respective regional Fed and regional demand as proxied by the retail sales index collected by the Federal Reserve. With regards to the first variable, recall that this was time before authority over discount policy had been centralized at the Federal Reserve Board. This led to variation in discount rate policy across different regions and more generally discount lending. We should emphasize that we view the effect of changes in the discount rate as not directly falling on the plants themselves but on credit for their wholesalers. So the question is whether the producers we study are able to substitute their own trade credit for these changes in availability of credit from the regional Fed.

The details regarding the second shock, the retail sales data, are discussed in Park and Richardson (2011). These measures of retail sales were collected by the Federal Reserve at the time. As noted before, not all of these industries sold completely locally so to what extent this shock is a demand shock matters by industry. We will attempt to control for this by interacting demand with industry fixed effects. Finally, we aggregate the monthly employment and retail sales data to the quarterly level since this is the frequency of the discount rates.

We test for the "efficient" functioning of IC markets when firms might face external constraints along two dimensions:[6]

(a) Employment in MP plants is more sensitive to demand than SP plants since they are able to tap internal resources.

(b) Employment in MP plants is less sensitive to demand than SP plants s since IC markets act as a substitute for external markets.

These are both bright sides of IC markets. Note that the test here for efficiency is simply for a qualitative effect in these directions. We use this less stringent standard since most of the rest of the literature has found evidence for clearly inefficient IC markets with resources moving going in the wrong direction. Our choice of the word "sensitivity" is intentional since we do not mean to ascribe causality to the estimates.

We can go further by using temporal variation over the years of the Census to estimate the value of these IC markets as conditions in external capital markets collapse starting in 1931 and slowly begin to recover in 1935. This type of year by year analysis is similar in spirit to the exercise in Matvos and Seru (2013). A large part of the value of IC markets is derived from the presence of binding borrowing constraints. If firms are free to borrow as much as they like, then there is very little incentive to pool financial resources as in IC markets. We can test at least indirectly for these borrowing constraints by examining to what extent conditions in one region where an MP plant is located spillover to an MP plant part of the same firm in a different region. If the pool of internal resources is constrained by external credit, then increasing employment at one plant in response to demand, say, should come at the cost of lower employment at the plant with relatively lower demand. A similar effect should be present for changes in discount rates. The magnitude of this spillover can also be examined over time for evidence on the value of IC markets in the face of external credit collapses.

[6]See Maksimovic and Phillips (2002) for a typical neoclassical model of IC markets.

In terms of a specific regression specification, we will follow the setup of Giroud and Mueller (2012) as close as possible for the sake of comparability. So in particular, the dependent variable will be the "centered" log employment at the plant-level centered by the industry-month median. This sweeps out industry specific seasonal variation but not industry year differences. Abusing notation slightly, denote this by $\log E_{it}$. This makes it transparent that we will not be using industry-specific time trends to identify any effect and the choice of the median is to limit the influence of outliers. For now, we choose to not trim tails of any variable though results are relatively robust to the choice here. Finally, we cluster the standard errors at the firm-year level following precisely the choices in Giroud and Mueller (2012).

We estimate the following specification

$$\log E_{it} = \alpha_1 + \alpha_2 MP_{it} + \alpha_3 R_{it} + \tilde{\alpha}_3 MP_{it} R_{it} + \alpha_4 I_{it} + \tilde{\alpha}_4 MP_{it} * I_{it} + \varepsilon_{it} \tag{3.1}$$

This equation will be estimated using the within estimator to difference out plant fixed effects. The actual level effect of MP is identified off of plants that change firms. The baseline specification will also include Fed district specific yearly time trends. We also experiment with specifications where we drop all MP firms where all of the plants are located in the same Federal Reserve district. We do this mainly for comparability for some later regressions where we look for spillovers from plants in other districts. This simply cannot be done when all the plants are in the same district. This is one point where more disaggregated data would be very welcome.

3.3 Estimates of Sensitivity to Local Shocks in MP versus non-MP Firms and Plants

Table 3 reports the results across 3 different specifications depending on the set of industry-year fixed effects included. We first note that the baseline correlations between employment with the retail index and the discount rate have the "right" signs. Employment is positively correlated with higher retail sales and negatively correlated with discount rates. We go further and find that employment at MP plants is much more correlated with demand conditions. In fact, in the first specification, the sensitivity is more than double the baseline effect and at a minimum is almost 50% larger. In the case of local discount rate, as hypothesized, sensitivity is lower for MP plants though the relative effect is not as large as that for demand with a decline in magnitude of around 16% to 20%. Note that this still leaves employment at MP plants sensitive to changes in discount rates.

The results also still apply when we restrict attention to a different comparison group. These results are reported in Table 4. Besides MP firms that span multiple Fed districts, there is a group of firms and plants that are concentrated in one Fed region. One may think that this group is not a fair comparison since for this group, a shock in the local region affects all the plants at the same time independent of any internal capital market effects. So in this specification, we drop all of these plants and firms. Still even with this restriction of the sample, the same patterns are present with only minor effects on the magnitudes. These results seem to favor the potential bright side of IC markets during the Great Depression.

In Table 5, we disaggregate this relationship by year. Though the results are more noisy, there appears to be evidence that the value of these IC markets increases as external credit markets collapse. In particular, we find that the largest increase in sensitivity to demand conditions are in the later years of 1933 when credit markets are the most stressed.

In fact, in 1929 before the Depression had even arrived, MP plants are *less* sensitive to demand conditions, the opposite of what we noted in the full sample. When we turn to differences in sensitivity to discount rates over the years, we find a roughly similar picture picture with the largest declines in sensitivity coming during the Depression though unlike for demand, it does not appear to be present in 1933 (at least statistically).

Again we have tried to avoid using causal language, but one may wonder about the possibility of reverse causality here where changes in employment drive changes in retail demand or changes in discount rates. While this is plausible though manufacturing is only part of a local economy, the difficulty is still how that would explain these *differences* between MP and SP plants. It does not matter with regards to the effect on demand whether a person is employed by a MP or SP plant. So while reverse causality is clearly a question in ascribing causal meaning to the baseline effects, we do not think it limits what we can say about the differences between these two type of plants.

Now the question is whether this additional correlation is driven by reallocation of resources within the firm or that plants in an MP firm are simply able to tap additional resources because of, say, slack borrowing constraints. To answer this, we look for evidence of spillovers of local shocks across plants part of the same MP firm following the exercise of Giroud and Mueller (2012).

3.4 Response to Other Local Economic Shocks in MP vs. non-MP plants

Here we examine possible spillover effects of regional shocks to a plant not located in that region but linked through internal capital markets. Start by taking a concrete example. Consider the Alpha Portland Cement Company and two of its constituent plants: one located in Alabama and another located in Illinois. During the Depression, there are region-specific shocks like say the banking panic in Chicago of July 1931, which presumably would affect directly the Alpha plant located in the state of Illinois. The question is will those Illinois specific events propagate all the way to Alabama through the internal capital markets linking this plant in Illinois to the one in Alabama? Now if all MP firms had solely two plants, this would be relatively simple to operationalize by including the other plant's shock in the regression from before. The problem is what to do when there are more than 2. For example, the Alpha Portland Cement Company actually has 9 plants total.

With more than 2 plants, we have to decide on how to weight the local conditions at the various plants. For each measure, we construct a revenue-weighted average of the measure for regions where other plants part of the same firm are located. To spell this variable out in more detail, let w_{jt}^k denote share of total revenue for firm j at time t from region k. For simplicity, let me suppress the dependence on the firm subscript j. Also denote the rescaled weights excluding region k as

$$\tilde{w}_t^k = \frac{w_t^k}{\sum_{\tilde{k} \neq k} w_t^{\tilde{k}}}.$$

By construction $\sum_{\tilde{k} \neq k} w_t^{\tilde{k}} = 1$. Then for plant i in region k, we calculate for the demand index $\tilde{I}_{it}$

$$\tilde{I}_{it} = \sum_{\tilde{k} \neq k} \tilde{w}_t^k I_t^k$$

We do the same process to construct a weighted-average of discount rates, $\tilde{R}_{it}$.

There is no particular reason for weighting by revenue. One could imagine weighting by distance to the other plants. One could also consider more flexible approaches where the weights were estimated inside of the model. For the discount rate, one might consider using the minimum discount rate over all regions since if firms could borrow freely, then it would choose the least costly region to borrow in to fund all their operations. We leave these other possibilities for future work.

The next question is how should SP plants or an MP firm will all of its plants in the same region be handled. We choose to set both of these variables to 0 though any value would work. It is not literally the case that these plants have an average other discount rate of 0. In some sense, this information is missing. However, we do not want to drop this group of plants since they still provide useful information for identifying effect of own discount rate and retail index. Let $\tilde{M}P_{it}$ be an indicator for the group of plants that do have plants in other regions, then what we will estimate is the interaction between this indicator and the other discount rate and retail index variables. Note that $\tilde{M}P_{it}$ is not exactly the indicator for being a multi-plant firm since it also requires the plants to be located in separate Fed districts. We consider some regressions where we only use $\tilde{M}P$ plants for later.

The basic idea of the regression we estimate is similar in spirit to the specification of Giroud and Mueller (2012). They do not look at the effects of local shocks to economic conditions instead focusing on the plausibly exogenous introduction of an airline route to study the role of information in internal capital markets. So their paper is not interested in business cycles at all and the role of internal capital markets thereof. This comes with the benefit of having a clear causal interpretation. Like before, we refrain from using this causal language.

Now we estimate for plant i at time t

$$\log E_{it} = \alpha_0 + \alpha_1 MP_{it} + \alpha_2 I_{it} + \tilde{\alpha}_2 MP_{it} * I_{it} + \beta_1 MP_{it} * \tilde{I}_{it} + \alpha_3 R_{it} + \tilde{\alpha}_3 MP_{it} * R_{it} + \beta_2 MP_{it} * \tilde{R}_{it} + \varepsilon_{it} \tag{3.2}$$

Industry by year fixed effects are also included in the regressions. We consider various ways to decompose the error ε_{it} such as estimating firm-level fixed effects. Again by including the $\tilde{M}P_{it}$ terms means that we will not be using the information for non-$\tilde{M}P$ firms to identify the spillover effects. In the regression where we restrict attention to $\tilde{M}P$ plants, then the relevant variables are excluded.

Table 6 reports the results of this regression. We find that a plant in a particular location responds to conditions of plants in other locations that are part of the same firm. In particular, the response is the opposite of the response to a shock in its own region. If demand is relatively high for other plants, employment is lower. Similar results hold for discount rates. This is further evidence the firms are actually shuffling resources across areas in the face of some constraint on the amount of resources at their disposal. In other words, it is not the case that firms "keep their powder dry" whereby they could give more resources to one particular plant without affecting another plant. These spillover effects are not small. It is difficult to directly interpret the magnitude, but relative to the direct effects, these spillovers appear meaningful with almost equal magnitude for the retail index and about one fifth for the discount rate. Table 7 reports the results when we drop all the firms with all of its plants in a single Fed region. Results are basically unaffected.

Finally, we examine the effects across time. These provide further insights into how internal capital markets function in the presence of external credit market distress. One would expect that with limited outside credit opportunities, the spillover effects would be larger as firms would not be able to substitute using external finance. Table 8 reports results to that effect. We find in particular for the retail index that the spillover effects are much larger during the Depression with basically no negative spillovers in 1929 before the Depression begins. The results for the discount rate are more nuanced. Unlike for the retail index, we still find positive spillover effects in 1929, but for most of the Depression years not only disappear but become negative with higher discount rates for other plants negatively affecting a plant's own employment as well. Our interpretation is that for these years, credit contractions were so severe that all plants were forced to reduce their employment to accommodate the changes.

Overall, taken together the results show that firms faced binding credit constraints and, hence, had to reshuffle resources between plants in response to changes in external conditions. This became even more extreme with the Depression with less ability to offset the necessary reshuffling with external credit and further declines in credit forcing all plants to reduce employment. Still this is a story where internal capital markets are playing an essential role in mitigating these shocks in an efficient manner rather than in a distorted manner, seemingly implied by much of the previous empirical literature.

4 Conclusion

We have studied how resources are allocated inside of firms during a time of great stress in external capital markets. We collected a plant-level dataset from the Census of Manufactures and linked plants to their parent firms. We then documented that employment at MP firms was more correlated with local "demand" conditions as proxied by a retail sales index but less so with regional Fed discount rates. We argued that this implicated differences in access to credit as the explanation for this "double difference." In addition, we found that shocks tended to spillover between plants part of the same firm located in different regions. We would emphasize again that these results contrast with much of the literature which has strained to find any positive effects from internal capital markets with Matvos and Seru (2013) being the one exception.

For future work, it would be interesting to collect data on the financial position of these firms. There is the possibility for the largest firms who were covered by Moody's and were on the NYSE. There is also the possibility of collecting limited financial data for the smallest firms from Dun and Bradstreet. This was a credit rating agency at the time and they reported some estimate of a firm's net worth as well as a subjective credit rating like Moody's and S&P do today. This information would allow for a better sense of how dependent the firms are on external finance and to what extent the structure of a firm's balance sheet affects reallocation between its units.

Another possible extension would be to use the differential behavior of multi plant versus single plant firms in a given region to infer whether particular banking panics are based on insolvency or illiquidity. This is a reoccurring debate in the literature going back to Friedman and Schwartz (1971) through Wicker (2000) and to the present in Calomiris and Mason (2003). All of this work has, not surprisingly, used sources on banks in various degrees of disaggregation to address this question. The idea here would be to do something like the reverse. Instead of attempting to play the role of bank examiner, one could use the observed behavior of multi-plant firms in particular region to infer the beliefs of actual economic actors at the time. The intuition would be as follows. If bank failures are driven by illiquidity, then resources should flow into multi-plant firms to take advantage of the high shadow value of funds in that region. If instead bank failures reflect poor fundamentals in the region, then would expect to see multi-plant firms move resources away from that area. We leave this suggestion for future work.

Table 1

Summary Statistics by Industry for MP and SP firms. All variables are untransformed.

Industry	Revenue Fraction of MP (%)	Labor Share (%) MP	Labor Share (%) SP	Labor Share (%) Δ	Revenue MP	Revenue SP	Revenue Δ	Wage Earners MP	Wage Earners SP	Wage Earners Δ	Number MP	Number SP	Number Δ
Macaroni	.	.	13.560	0.000	.	10.724	0.000	.	1.981	0.000	0	1159	1181
				(0.000)			(0.000)			(0.000)			
Cement	65.902	18.437	19.129	-0.692	13.611	13.460	0.151	4.754	4.596	0.158	358	222	578
				(0.718)			(0.068)			(0.071)			
Sugar Refining	52.993	3.595	3.607	-0.012	16.846	16.538	0.308	6.508	6.224	0.284	36	41	77
				(0.216)			(0.157)			(0.127)			
Ice	52.773	26.633	147.490	-120.857	10.312	9.902	0.410	1.495	1.403	0.093	4777	6476	11581
				(30.884)			(0.019)			(0.016)			
Malt	86.241	5.681	5.480	0.201	13.250	12.936	0.315	2.837	2.650	0.187	107	23	108
				(1.263)			(0.309)			(0.198)			
Boneblack	71.206	15.910	154.433	-138.522	12.300	11.525	0.775	3.149	2.654	0.495	42	26	67
				(105.177)			(0.339)			(0.238)			
Cane Sugar	23.918	9.266	8.794	0.472	12.208	11.968	0.240	3.667	3.201	0.465	47	232	278
				(0.721)			(0.179)			(0.189)			
Concrete	17.019	21.893	25.106	-3.213	10.370	9.766	0.605	2.024	1.419	0.605	563	4782	5655
				(0.561)			(0.043)			(0.039)			
Radio	35.400	29.258	35.066	-5.807	14.033	12.160	1.873	5.703	3.528	2.175	73	681	750
				(21.496)			(0.225)			(0.230)			

	Revenue	Wage Earners	Labor Share
Cement	0.190**	0.190**	-0.0825
	(0.0847)	(0.0845)	(0.0875)
Sugar Refining	0.441*	0.496**	-0.0128
	(0.226)	(0.221)	(0.230)
Ice	0.398***	0.114***	-0.0738***
	(0.0184)	(0.0194)	(0.0162)
Malt	0.235	0.216	0.0376
	(0.197)	(0.208)	(0.146)
Bone Black	0.553**	0.508*	-0.331
	(0.267)	(0.259)	(0.326)
Cane Sugar	0.214	0.390**	0.105
	(0.192)	(0.170)	(0.174)
Concrete	0.606***	0.670***	-0.251***
	(0.0473)	(0.0466)	(0.0391)
Radios	0.949***	1.101***	-0.0335
	(0.116)	(0.117)	(0.0491)

Table 2

Comparing MP plants to non-MP plants. The respective variable is demeaned and scaled by the standard deviation for the respective industry. This allows for direct comparability across industries. The table reports the mean difference in the variable between MP and non-MP plants. Both output and wage earners are in terms of logs. The labor fraction is the ratio of total wage bill to total revenue. The data is missing for macaroni since there are no multi-plant firms. Numbers in parenthesis are standard error of the difference. $*$ difference significant at 10%. $**$ difference significant at 5%. $***$ difference significant at 1%.

	Centered Log Wage Earners		
	(1)	(2)	(3)
Retail Index	0.0607***	0.0745***	0.192***
	(0.0193)	(0.0193)	(0.0201)
(Multiplant=1)*Retail Index	0.0860***	0.0854***	0.0979***
	(0.0166)	(0.0168)	(0.0174)
Discount Rate	-0.112***	-0.112***	-0.0620***
	(0.0120)	(0.0116)	(0.0108)
(Multiplant=1)*Discount Rate	0.0220**	0.0201**	0.0133
	(0.0100)	(0.00999)	(0.0101)
Fixed effects?	Industry * Year	Industry, Year	None
Observations	209596	209596	209596
Adjusted R^2	0.093	0.090	0.067

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3

Sensitivity to local demand conditions and regional Federal Reserve discount rates for MP versus non-MP plants. The dependent variable is the centered log employment where we center by the median industry employment for that month-year. All regressions use the within estimator to difference out plant fixed effects. Standard errors are clustered at the plant-level.

	Centered Log Wage Earners		
	(1)	(2)	(3)
Retail Index	0.0582***	0.0752***	0.192***
	(0.0193)	(0.0193)	(0.0201)
(Multiplant=1)*Retail Index	0.0675***	0.0648***	0.0770***
	(0.0206)	(0.0206)	(0.0214)
Discount Rate	-0.0995***	-0.102***	-0.0620***
	(0.0119)	(0.0116)	(0.0108)
(Multiplant=1)*Discount Rate	0.0283**	0.0291**	0.0216*
	(0.0121)	(0.0121)	(0.0121)
Fixed effects?	Industry * Year	Industry, Year	None
Observations	173558	173558	173558
Adjusted R^2	0.054	0.050	0.028

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4

Sensitivity to local demand conditions and regional Federal Reserve discount rate for MP versus non-MP plants. Here we drop firms that have all their plants in one Fed district. Standard errors are clustered at the plant-level.

	(1)	(2)	(3)	(4)
	1929	1931	1933	1935
(Multiplant==1)*Retail Index	-0.0491***	-0.0248	0.102***	0.0120
	(0.0149)	(0.0230)	(0.0244)	(0.0208)
	(0.00932)	(0.00737)	(0.0101)	(0.0332)
(Multiplant==1)*Discount Rate	0.0159	0.0366**	0.0104	0.141***
	(0.0304)	(0.0182)	(0.0287)	(0.0433)
Observations	61735	52386	42537	52938
Adjusted R^2	0.013	0.021	0.012	0.005

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5

Sensitivity to local demand conditions and regional Federal Reserve discount rate for MP versus non-MP plants year by year. Standard errors are clustered at the plant-level.

	Centered Log Wage Earners		
	(1)	(2)	(3)
Other Retail Index	-0.0513*	-0.0615**	-0.0747**
	(0.0280)	(0.0280)	(0.0301)
Other Discount Rate	0.0202*	0.0244**	0.0248**
	(0.0111)	(0.0111)	(0.0111)
Retail Index	0.0607***	0.0743***	0.192***
	(0.0193)	(0.0193)	(0.0201)
(Multiplant=1)*Retail Index	0.111***	0.116***	0.135***
	(0.0227)	(0.0228)	(0.0244)
Discount Rate	-0.111***	-0.111***	-0.0620***
	(0.0120)	(0.0116)	(0.0108)
(Multiplant=1)*Discount Rate	0.0113	0.00740	0.000424
	(0.0116)	(0.0115)	(0.0115)
Fixed effects?	Industry * Year	Industry, Year	None
Observations	209596	209596	209596
Adjusted R^2	0.093	0.090	0.067

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6

Sensitivity to local demand conditions and regional Federal Reserve discount rate as well as conditions in other regions where plants of same firm are located. Standard errors are clustered at the plant-level.

	Centered Log Wage Earners		
	(1)	(2)	(3)
Other Retail Index	-0.143**	-0.140**	-0.0669
	(0.0599)	(0.0601)	(0.0674)
Other Discount Rate	-0.00514	-0.00194	0.0377*
	(0.0209)	(0.0209)	(0.0209)
Retail Index	0.0580***	0.0745***	0.192***
	(0.0193)	(0.0193)	(0.0201)
(Multiplant==1)* Retail Index	0.198***	0.193***	0.135*
	(0.0627)	(0.0628)	(0.0706)
Discount Rate	-0.0997***	-0.102***	-0.0620***
	(0.0119)	(0.0117)	(0.0108)
(Multiplant==1)*Discount Rate	0.0342	0.0321	-0.0125
	(0.0219)	(0.0218)	(0.0217)
Observations	173558	173558	173558
Adjusted R^2	0.054	0.050	0.028

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7
Sensitivity to local demand conditions and regional Federal Reserve discount rate as well as conditions in other regions where plants of same firm are located. Standard errors are clustered at the plant-level. Here we drop firms that have all their plants in one Fed district.

	Centered Log Wage Earners			
	(1)	(2)	(3)	(4)
	1929	1931	1933	1935
Other Retail Index	-0.000823	-0.0602*	-0.110***	-0.120***
	(0.0236)	(0.0333)	(0.0356)	(0.0300)
Other Discount Rate	0.236***	-0.0664***	0.000712	-0.158***
	(0.0379)	(0.0245)	(0.0346)	(0.0514)
Observations	61735	52386	42537	52938
Adjusted R^2	0.015	0.022	0.012	0.007

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 8

Sensitivity to local demand conditions and regional Federal Reserve discount rate as well as conditions in other regions where plants of same firm are located year by year. Standard errors are clustered at the plant-level.

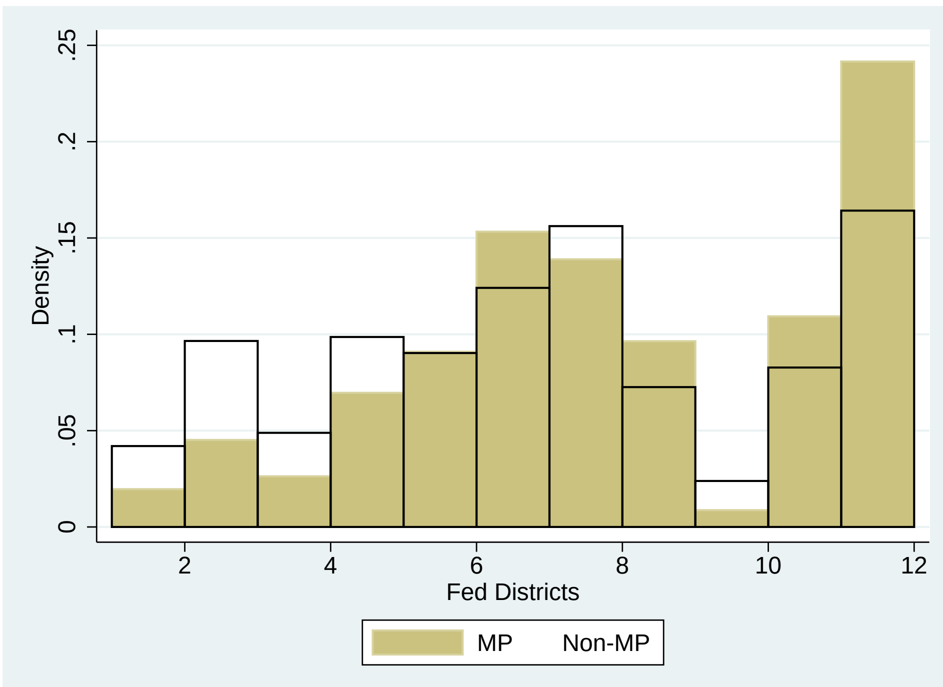

Figure 1
Histogram of plant locations by Federal Reserve District for MP and non-MP plants.

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