Statement of Professional Activities

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Part I

Research

Economies grow, in part, through the accumulation of productive capital — that is, investment in physical assets, like machines and structures, and more recently in intangible assets, like patents and trademarks. Yet for all its importance, our understanding of what drives aggregate investment remains surprisingly fragmented. There is no lack of theories and evidence on how individual firms make investment choices, highlighting factors ranging from technology, to market structure, to financing. But what is missing is a clear understanding of which of these theories are of practical relevance in aggregate. My research, which lies at the intersection of macroeconomics and corporate finance, is mainly concerned with answering this question.

One strand of my research studies the investment effects of specific market imperfections, in particular financing frictions. The second strand studies how the rise of intangible capital has changed investment, returns to capital, and the distribution of economic activity across firms.

There are two distinguishing features of my work. First, I analyze novel sources of data on firm-level investment and financing. My goal is both to improve measurement of firms that are under-represented in existing sources (such as private firms), and to shed light on poorly understood aspects of investment (such as intangibles). Second, I combine these data with structural models. The combination of these two approaches enables me to connect my empirical findings with salient macroeconomic trends, and to quantify the aggregate impact of the micro-level patterns I uncover.

At a broad level, two main insights emerge from my work. First, drivers of investment that appear salient for individual firms can turn out to have limited aggregate effects (a fallacy of composition). This problem is particularly severe for investment because of how unevenly distributed it is across firms. My first strand of research, on financing frictions, illustrates this in several ways, highlighting for instance how constraints on access to credit for small firms may only have a limited impact short-run fluctuations in aggregate investment.

Second, trying to infer from aggregate data the economic forces that drive investment at the level of individual firms can be misleading (a fallacy of division). This problem is also particularly severe for investment because of the considerable differences in the technological and financial environments that different firms face. For instance, while aggregate trends in investment, profitability and valuations may suggest that a particular form of structural change is at work across all sectors in the economy — say, a rise in market power —, a more disaggregated view of the data might contradict this, and highlight other factors — say, rising intangibles — instead.

Both insights matter not only for understanding how the economy works, but also for figuring

out which levers are available to policymakers. Disaggregated data should be a crucial part of the effort to measure the investment and financing choices of firms. And models designed to understand the heterogeneous effects of policies across firms should be an input into the evaluation of policies, as they can help correctly figure out their aggregate effects — i.e. avoiding fallacies of composition —, while limiting unintended consequences on specific firms — i.e. avoiding fallacies of division.

The first part of my research agenda focuses on the investment effects of market imperfections, in particular financing frictions. Extensive work in corporate finance shows how various frictions (such as agency conflicts or information asymmetries) might impact firm-level decisions. Yet we have a more limited understanding of which frictions matter most in aggregate. My research tackles this question, both by expanding the measurement of financing patterns to new groups of firms, and by using models to trace the link from firm-level frictions to aggregate investment.

This strand of my work has produces several important results. On one hand, the extreme degree of skewness of the distribution of investment across firms means that even if certain financing frictions might appear to be widespread in the cross-section, they may not cause significant distortions in aggregate. In fact, even commonly accepted empirical measures, such as firm size, may not be accurate proxies for the severity of financing frictions. On the other hand, among firms that may appear to have good access to credit, such as firms with access to bond markets, financing distortions may remain first-order. For instance, the gradual shift of corporate credit toward market-based financing in the US since the early 1990s may have had the unintended consequence of reducing large borrowers' flexibility in times of financial distress.

The second part of my research agenda studies the aggregate effects of the rise in intangible capital. Intangible capital consists of corporate assets that do not have a physical presence. Some — such as software, databases, software, patents, and brands — can readily be identified, while others — such as customer and supplier relationships, or managerial competencies — are harder to measure. Macroeconomic data indicate that these assets have become core to the aggregate capital stock. Microeconomic data confirm this, as firms increasingly describe expenditures on research and development, information technology, and workforce training as their most important investments, even when these expenditures do not create recognizable assets on their balance sheets.[1]

The first main result from this strand of my work is that the shift to intangibles interacted with, and reinforced, the changing degree of firm market power, a key concern for economists in recent years. An implication is that considering either mechanism in isolation produces incorrect estimates of their respective importance. The second main result is that there is considerable heterogeneity

[1]For instance, approximately 20% of operating expenses reported on Amazon's 2017 10-K consisted of investments in its online sales platform,cloud computing services, and general purpose R&D. Amazon describes these items not as variable costs, but as "investments we make in order to offer a wide variety of products and services to our customers."

(both across and within industries) in the degree to which intangible intensity and market power has changed. This suggests caution when making normative statements based on aggregate data.

My current work on intangibles proposes a new formal approach to describe the economic properties of intangibles, highlighting their non-rivalry as an input, but also the challenges involved in excluding other firms from using them. Both properties sharply distinguish intangibles from traditional, physical assets. Ultimately, my hope is that this new approach will shed light on the forces that link intangible intensity to the distribution of economic activity across firms.

1 Investment effects of market imperfections

This part of my agenda studies how specific market imperfections shape the aggregate dynamics of investment. My work is primarily focused on the effects of financing frictions ([4], [5], [7], [18], [12], [15], [16] and [17]), but also studies coordination failures ([1]), and imperfect information aggregation ([6] and [8]).

1.1 Financing frictions

Extensive theoretical work in corporate finance shows how financing frictions might impact investment. Yet empirical work face two important challenges: measurement, and aggregation. On the measurement side, data on financing has largely been limited to public businesses, which may not accurately reflect the choices of all firms. On the aggregation side, the extreme degree of cross-sectional dispersion of investment means that going from firm-level frictions to aggregate effects is non-trivial, because firms might not all be equally exposed to the same frictions.

My research in this area explores both of these questions. First, I leverage new micro data sources to improve the measurement of financing and investment patterns of firms in the entire cross-section. Second, I build structural models that embed key financing frictions highlighted in the corporate finance literature, and use the micro data to discipline them and clarify the conditions under which these frictions can have large aggregate effects.

Aggregate implications of firm-level financing frictions ([5], [16], [12], [15])

These papers study the conditions under which standard capital market imperfections affecting firm-level access to financing might have a substantial impact on aggregate investment.

In **"Small and Large Firms Over the Business Cycle"** (Crouzet and Mehrotra [5], *American Economic Review*, 2020), we revisit a key piece of evidence in support of the view that financing frictions have large aggregate effects: the behavior of small firms. Because small firms are generally

thought to face constraints in their access to financing, their behavior over the cycle or in response to shocks has often been used as a litmus test for theories of financial frictions. However, a lack of micro data has made it difficult to tie together their investment and financing decisions.

We tackle this challenge by constructing a new firm-level data source. Relative to existing sources, this data covers a large sample of small, private businesses, over a long period of time, at the quarterly frequency. The data come from the micro records of a Census survey, the Quarterly Financial Report (QFR), which contains detailed information on balance sheets. These records had not been formatted for research purposes; doing so is a key contribution of the paper. The resulting dataset has two main advantages. First, it allows to measure more precisely the "excess sensitivity" of small firms — that is, whether they respond more to shocks than large firms. Most important, it allows us to directly tie the effect of size to financing variables, and thus test financial theories of the excess sensitivity of small firms.

The new data provide two important insights into these questions. First, consistent with the prior literature (Gertler and Gilchrist, 1994), the excess sensitivity of small firms is statistically significant; however, it is economically small. For instance, revenue growth among the bottom 90% of firms is only about one-fifth more sensitive to changes in GDP than among the top 0.5% of firms (the very largest US businesses). Combined with an extreme degree of concentration, this estimate implies that excess sensitivity of small firms has moderate aggregate effects.

Second, using a variety of empirical approaches, we find limited support for the view that the excess sensitivity of small firms is a manifestation of tighter financial constrains. In models of costly external financing, after a shock to the supply of credit, net borrowing by constrained firms responds more than net borrowing by unconstrained firms; after a shock to the marginal return on investment, it responds less. By contrast, in the data, after monetary policy shocks, or after the start of a downturn, changes in net borrowing flows are not statistically different between small and large firms. Thus, viewed through the lens of these models, the data indicate that size is not a good proxy for whether firms are financially constrained.

Instead, we propose an alternative interpretation of the size effect. Using establishment-level data, we show that the size effect is explained by sectoral diversification — how many different sectors a firm's establishments belong to. This finding can be rationalized by a non-financial mechanism, economies of scope across sectors (Panzar and Willig, 1981), which predicts that firms that enjoy greater economies of scope tend to be both larger and less responsive to aggregate shocks.

These findings have several broad implications, both for research on financing frictions, and for understanding what explains differences in firm size. The paper suggests caution in interpreting size effects solely through the lens of financing frictions, and questions whether theories where financing

frictions are a key determinant of firm size can give a complete account of the data. It also highlights the outsize contribution of the very largest firms to investment fluctuations, suggesting that understanding the frictions these firms face should also be an important area of focus.

This paper has been taught in several graduate-level courses on macroeconomics and corporate finance, including at Princeton, and MIT. Additionally, the underlying work on the construction of a panel from the QFR is currently being used by other researchers with Census data access at various institutions, including Harvard and Wharton, for further projects.

Though our findings in [5] suggest that size may not be the most accurate gauge of financial constraints, data on firms' choices of capital structure may provide better information on their financial conditions. In ongoing work, **"Private Ownership, Capital Structure, and Investment"** (Crouzet and Mehrotra [5], 2022), we leverage the same data to study the effects of access to public equity markets on firms' financing and investment choices. Going public helps firms diversify funding sources, but also increases separation between ownership and control, possibly worsening agency problems. Direct evidence on the net costs of private ownership is however limited, because transitions between private and public ownership are poorly observed. The goal of this project is to use the panel of private firms in the QFR to address this gap. The main difficulty is to systematically identify the history of public and private ownership of each firm in the QFR; this requires a merge to historical sources on US listings, on which we are currently working.

Another link I have explored between financial conditions and firm investment is the potential effects of debt overhang, which has long been emphasized by an influential literature in corporate finance as creating conflicts between debt holders and shareholders, leading to sub-optimal firm-level investment choices (Myers, 1977; DeMarzo and He, 2021). In **"Can the Cure Kill the Patient?"** (Crouzet and Tourre [12], R&R, first round, *Journal of Finance*, 2021), we study the *aggregate* effects of debt overhang. While the firm-level distortions it creates are well-understood, it is less well understood whether debt overhang has a large impact on investment at a macroeconomic level. This issue came into particular focus over the past two years, as fiscal and monetary authorities attempted to provide emergency lending to firms through various programs, potentially magnifying debt overhang through the incremental debt associated with the programs.

We tackle this question by constructing and estimating a structural model within which we quantify the aggregate effects of debt overhang, both in normal times, and in the context of government credit support programs. We start from a firm-level model in which debt overhang is particularly severe (DeMarzo and He, 2021), which we embed in a simple growth model with heterogeneous firms. We then estimate the model using firm-level data on the relationship between leverage and investment to discipline the key structural parameters of the model.

Our findings provide a simple but fairly surprising insight. At the estimated parameter values, the *average* effect of debt overhang is large — steady-state aggregate growth is half of what it would be absent agency frictions. However, the *marginal* effect of debt overhang is small: the *median* firm's investment is relatively insensitive to leverage, so that increasing it has limited aggregate effects. As a result, policies inducing higher leverage — including corporate credit support programs — create small aggregate distortions, particularly when weighed against their potential short-term benefits, such as reducing deadweight losses from liquidations during downturns. In related work, **"Default, Debt Maturity, and Investment Dynamics"** (Crouzet [15], working paper, 2017), I show that shortening debt maturities substantially tempers the underinvestment problem, suggesting an avenue for further attenuating the distortions induced by credit support policies.

This paper is currently being taught as part of graduate-level courses in macroeconomics and corporate finance in various institutions, including Stanford, and has also spurred work by researchers at central banks, who have replicated our analysis using local datasets on financing and investment, in particular the Fed Board and the Bank of Italy.

A general lesson from this part of my work is that financing frictions might be severe at the firm level and yet have limited aggregate implications, either because micro measurement indicates these frictions are not sufficiently widespread ([5]), or because they primarily affect firms that have a small aggregate weightinvestment ([12]). This suggests that, to have large aggregate real effects, theories of financing frictions must both closely reflect the microeconomic details of financing arrangements, and affect larger firms. The second part of my work on financing frictions explores one such set of theories: frictions in bank financing and its main alternative, public debt markets.

The role of banks in financing investment ([7], [4], [17], [18])

The second group of papers in my work on financing frictions focuses specifically on the frictions involved in bank financing, and the trade-offs between using bank and non-bank sources of finance.

A widely held view is that non-bank sources of debt — such as the corporate bond market — act as a "spare wheel" for firms in times of stress in the banking sector, and are thus a source of financial and macroeconomic stability. My work shows the limits of this logic. The development of non-bank financing may have unintended a number of unintended consequences, ranging from limited financial flexibility when firms are in distress ([7],[17]), to a limited ability for policymakers to stimulate corporate investment ([4]), to a more fragile intermediary sector ([18]).

In **"Aggregate Implications of Corporate Debt Choices"** (Crouzet [7], *Review of Economic Studies*, 2018), I first study frictions between non-bank intermediaries (NBIs) and the firms that borrow from them. Bonds account for the majority of the funding provided by NBIs to firms,

and a growing share of overall corporate debt. The corporate finance literature has shown that bonds are more difficult to restructure than loans, because bond ownership is dispersed, leading to free-rider problems in the restructuring process. As a result, bonds offer less flexibility to borrowers in times of financial distress. While the theoretical foundations for this friction have been extensively studied (Bolton and Scharfstein, 1996), the implications of lower flexibility for firm-level and aggregate investment are less well understood.

I contribute by constructing and analyzing a structural model that sheds light on the real effects of this friction. In the model, firms optimally choose their debt structure — the mix of loans and bonds — by trading off the lower flexibility of bonds in times of financial distress, with the higher costs of loans in normal times. The latter costs are meant to capture the information-intensive nature of banking relationships, which involve the regular maintenance of covenants, as well as potential penalties related to their violation (Chava and Roberts, 2008). Building on corporate finance theory, I explicitly model renegotiations between banks, NBIs, and borrowers; but I also embed this process into a dynamic investment model with heterogeneous firms.

I use micro evidence on the debt structure of public firms (Rauh and Sufi, 2010) to validate the predictions of the model. Depending on credit risk, firms in the model sort into two types of debt structure: a mixed debt structure, that combines bank loans and bonds; or a specialized debt structure, that only uses bonds. This lines up well with the firm-level evidence, which suggests that only the safest firms used specialized debt structures.

The model has rich and surprising predictions for the effects of shocks that affect the relative cost of loans versus bonds, such as shocks to bank balance sheets. These shocks induce low credit risk firms to switch from a mixed to a specialized debt structure — in line with the commonly held view that bond markets act as a "spare wheel" in times of financial stress. However, this switch is not neutral for investment; instead, investment for switching firms declines. This result has a precautionary intuition: firms deleverage as an endogenous response to losing the flexibility offered by loans. Quantitatively, because these switching firms are large, the mechanism can have a meaningful impact on aggregate investment. An implication is that, by reducing financial flexibility in times of borrower distress, a shift toward non-bank debt may induce a precautionary response that will eventually lead to underinvestment.

In **"Credit Disintermediation and Monetary Policy"** (Crouzet [4], *IMF Economic Review*, 2021), I build on the model developed in [7] to study more specifically the effects of monetary policy shocks on investment. In the 1990s, the share of loans in total corporate debt was 55%; it had fallen to 30% by 2015. My paper explores whether this change in the aggregate composition of corporate debt is relevant to monetary policy transmission.

The paper makes both empirical and theoretical contributions. On the empirical front, I provide comprehensive evidence on the rising importance of non-bank forms of financing for public firms, both in aggregate and at the firm level. Additionally, I show that the firm-level bond share is an important determinant of the sensitivity of investment to monetary shocks. On the theoretical front, I study whether the model in [7] can generate a pass-through of monetary shocks comparable to the data, and I use counterfactuals to assess the effects of a further rise in the bond share.

The core result of the paper is that the rising bond share — a phenomenon which I show happened not only in aggregate, but also at the firm level — likely contributed to a smaller pass-through of monetary policy to investment rates, in part because of the precautionary effects highlighted above. This adds to the broader insight from [7] that the shift toward non-bank sources of finance may not necessarily be a positive development; in this instance, it reduces the levers available to policymakers to stimulate investment.

In both [7] and [4], a key assumption is that loans guarantee a degree of flexibility to borrowers, which is manifested through renegotiation in times of distress. In ongoing work, **"Debt Flexibility"** (Crouzet et al. [17], 2022), we use loan-level data to provide further evidence on this topic. Existing empirical work on loan renegotiation (Roberts and Sufi, 2009; Roberts, 2015) has shown that loan modifications are pervasive in the syndication market, offering a degree of state-dependence and flexibiliy consistent with the theory. Using the Y14, a regulatory dataset on corporate loans gathered by the Fed from commercial bank for stress-testing purposes, we study loan modifications beyond the syndicated market. While this work is still ongoing, we find that in contrast to syndications, single-lender loans — which tend to be to smaller, private firms — are very seldom modified, regardless of whether the borrower in distress. Flexibility appears to be a hallmark of larger loans, calling into question whether banks use soft or private information to offer more state-contingency to firms with which they have an established relationship.

Finally, in ongoing work, **"The Non-Bank Credit Channel"** (Crouzet and Darmouni [18], 2022), we study the growth in non-bank debt from the perspective of the frictions between households and non-bank intermediaries (NBIs). The Diamond and Dybvig (1983) view is that banks engage in liquidity transformation: they issue demandable short-term debt to households in order to fund illiquid loans. This can create incentives for households to run on banks. Historically, the largest NBIs, pension funds and insurers, did not engage in liquidity transformation, and were thus seen as stable intermediaries. More recently, the fastest-growing NBIs have been mutual funds, which issue redeemable shares to fund debt purchases. Frictions in the valuation of these shares imply that they may not immediately incorporate liquidation costs, restoring the liquidity mismatch problem, and potentially casting these NBIs as sources of financial fragility.

Our main contribution is to introduce these alternative intermediary funding structures in a macroeconomic model with a financial sector (Gertler and Kiyotaki, 2010; He and Krishnamurthy, 2012; Brunnermeier and Sannikov, 2014). We then compare the positive and normative implications of the model when intermediaries use two different funding structures, one mimicking banks (deposits) and the other mimicking mutual funds (redeemable shares). While estimation of the model is still ongoing, it already offers a number of insights; for instance, the model suggests that regulation of NBIs should follow a "pecking order": first encouraging NBIs to hold capital buffers against redemptions, and only then using redemption limits.

1.2 Coordination problems

Firm-level decisions to invest in new technologies are a crucial component linking innovation to aggregate productivity growth. Yet firms often appear to be slow to adopt new technologies, even in contexts where new technologies offer a clear improvement over existing ones, and where other frictions — such as financial constraints — do not obviously bind (Hall, 2004).

In **"Shocks and Technology Adoption: Evidence from Electronic Payment Systems"** (Crouzet et al. [1], accepted, *Journal of Political Economy*), we study whether coordination problems can explain slow technology adoption by firms. We analyze a situation where an individual firm's decision to undertake an investment is influenced by how many other firms also undertake it. When the decisions are complements — for instance, investment in network technologies, as in (Katz and Shapiro, 1985) — equilibria with self-fulfilling expectations of low investment can arise.

Our contribution is to use a quasi-natural experiment, combined with a structural model, to quantify the effect of these externalities on investment. The technology we study is a mobile-based electronic payment system. This payment system was adopted en masse by Indian retailers following the Demonetization of 2016, which temporarily reduced cash in circulation.

Our analysis uses detailed retailer-level data on payments using the mobile-based technology. Due to the structure of local banking markets, certain regions in India were more exposed to the currency shortage than others. This local exposure was plausibly unrelated to other determinants of payment adoption, and can be used to estimate the causal effect of the shortage on retailers' payment technology choices. We find that, in highly exposed regions, adoption continues to grow even long after currency in circulation has gone back to normal. Additionally, adoption is state-dependent: in localities with a large pre-shock user base, the long-term response was stronger.

In our structural model, these qualitative patterns arise naturally when returns to the payments technology increase with the size of the user base — that is, when there are investment externalities. But the model helps us go a step beyond, and quantify exactly their contribution. We show that

without externalities, cumulative adoption two quarters after demonetization would have been 45% lower. Thus, in our empirical setup, externalities are a quantitatively large obstacle to investment.

When investment involves externalities, policy interventions to address them become potentially important. Here, the model offers some unexpected and useful insights. Situations with both externalities *and* ex-ante heterogeneity in adoption create a policy trade-off, between *aggregate* investment in the new technology, and the *dispersion* of investment across firms. Untargeted interventions (say, investment subsidies) may improve aggregate adoption, relative to laissez-faire, but will also exacerbate initial differences in adoption, favoring primarily sectors or regions where pre-shock investment in the technology was already high.

1.3 Imperfect information

Firm investment decisions are forward-looking, and therefore driven by information regarding future economic fundamentals. But how accurate is this information? That is, is investment driven by actual news, or by noise? I tackle this question in two related papers, first from a positive perspective [8], then from a normative perspective [6].

Macroeconomists have long argued that "animal spirits" — changes in expectations unrelated to economic fundamentals — could be important drivers of fluctuations in investment (Beaudry and Portier, 2006). In **"What Do Inventories Tell Us About News-Driven Business Cycles?"** (Crouzet and Oh [8], 2016, *Journal of Monetary Economics*), we propose a way to test this theory using data on a particular type of investment: inventory accumulation.

The main insight of the paper is that *current* inventory investment should be particularly sensitive to news about *future* productivity, even if these news do not eventually materialize, as the animal spirits hypothesis postulates. When such news arrive, wealth effects imply that sales should increase. However, firms also expect marginal cost to fall, as a result of future productivity improvements. Instead of increasing output, they will therefore seek to meet the increase in demand by selling out of inventory. The inventory stock will thus fall when news arrive, generating negative comovement between inventory investment and sales in response to the shock.

The paper formalizes this intuition in a real business cycle model augmented to include inventory investment and "animal spirits" shocks. We then apply it to the data, using a sign-restricted vector autoregression that allows us to identify shocks that simultaneously increase sales and reduce inventory. The theory says that "animal spirits" shocks should be a subset of the identified shocks. We find that the identified shocks contribute little to overall fluctuations; intuitively, it is rare to see inventory investment comove negatively with sales at business-cycle frequencies. The paper thus casts doubt on whether non-fundamental changes in expectations about future productivity are a

big contributor to business-cycle fluctuations in investment. More generally, it provides an example of how investment behavior can be used to elicit changes in expectations about fundamentals.

Besides investment decisions, information about future economic fundamentals is also embedded in capital prices. Do regulatory constraints in financial markets change the informativeness of these prices? We study this normative question in **"On the Effects of Restricting Short-Rerm Investment"** (Crouzet et al. [6], 2020, *Review of Financial Studies*). We explore restrictions to the frequency with which investors are allowed to change the exposure of their portfolios to fundamentals. These restrictions are of direct real-world relevance; index funds are constrained to hold essentially fixed exposures to fundamentals, while trading desks have risk exposures that are required to be zero by the end of each day, but may vary at higher frequencies.

We use a variant of the noisy rational expectations model (Grossman and Stiglitz, 1980) in which investors trade a claim to future dividends, and can choose to become differentially informed about the dividends process across dates. The first contribution of the paper is to show that the asset market equilibrium, which generally has a complicated expression, can be arbitrarily well approximated by a series of mean-variance portfolio choice problems, one for each frequency. These problems have orthogonal solutions, giving the (approximate) equilibrium a "factor"-like structure, in which factors are portfolios of futures whose return fluctuate at specific frequencies.

We then leverage this insight to study the effects of shutting down trade at certain frequencies. The main result is that this restrictions makes prices uninformative about high-frequency changes in fundamentals, but does nothing to the informativeness of prices about fundamentals at lower frequencies. A corollary is that while restrictions to high-frequency trade make prices more noisy at particular *dates*, they do not affect the information conveyed by prices about slow-moving components of economic fundamentals.

2 The macroeconomic impact of rising intangibles

The second part of my research agenda is focused on the economic effects of the rise in intangible capital. Over the past four decades, intangible assets have become core to the productive capital stock of firms (Corrado et al., 2009). This shift creates two challenges for economists interested in the connection between firms, investment, and growth. The first is empirical: investment in intangibles is seldom fully captured in macro or micro data, which can bias investment rates and returns to capital, and lead to misguided interpretations of the relationship between the two. The second is theoretical: intangibles can have different economic properties from physical assets — for instance, different returns to scale, or different degrees of pledgeability.

My research tackles these two challenges in turn. In [11], [10], [3] and [2], I first study whether, within existing production and investment models, accounting more systematically for intangibles can help shed light on some of the key trends that have characterized the US business landscape over the last three decades. In [9], [14] and [13], I propose a new model of intangible capital, which takes into account two economic properties of intangibles that elude most existing models: their non-rivalry, and the difficulty to exclude others from their use. I then explore the implications of these two properties and contrast them with existing approaches to modeling intangibles.

2.1 Intangibles and the changing US business landscape

Over the last three decades, US businesses have experienced three simultaneous changes. First, investment rates have declined (Gutiérrez and Philippon, 2017). Second, capital's share of aggregate income, and rates of returns on capital, have increased (Karabarbounis and Neiman, 2014; Farhi and Gourio, 2018). Third, measures of market concentrations have increased (Autor et al., 2020).

Two main explanations have been advanced. The first one is that competition among US businesses has declined. Firms with higher market power enjoy higher rates of profits, and have less incentive to increase capacity at the margin, leading to higher rates of returns and lower investment (Gutiérrez and Philippon, 2017; De Loecker et al., 2020). Additionally, declining competitiveness may lead to less entry and more concentration.

The second explanation is the rise in intangible investment. In this view, measures of firms' capital stock fail to comprehensively include their intangibles, leading to biased estimates of the relationship between investment, profits, and valuations. Additionally, because intangibles allow firms to enjoy scale economies, they may also increase concentration.

These two explanations provide starkly different views of the root cause of recent changes in the US business landscape: one driven by market or regulatory failures, and the other driven by a change in the structure of production. Disentangling them is a first-order question, both from a positive and a normative standpoint. This is the goal of my first group of papers on intangibles.

Documenting the facts ([11], [10])

In **"Intangibles, Investment, and Efficiency"** (Crouzet and Eberly [11], *American Economic Review, Papers and Proceedings*, 2018), we start by focusing on the US retail sector. In the 1990s and 200s, retail underwent a substantial transformation, as sector leaders invested in the inventory management and distribution systems that allowed for the "big-box store" revolution (Foster et al., 2006). Retail thus potentially provides a prime example of the effects of intangible investment on industry structure, competitiveness, and rates of return.

In order to study the sector, we combine firm-level data from 10-K filings, with productivity estimates from sectoral accounts. Our work reveals three important facts. First, firms in this sector display the patterns of falling *physical* investment, rising valuations, and rising concentration as in the rest of the economy. Second, across subsectors of retail, falling *physical* investment and rising concentration closely correlates with rising intangible intensity. Third, measures of the markup of price over marginal cost did not change, while labor and multi-factor productivity increased and inventory-to-sales ratios fell. Taken together, these facts suggests a more propitious interpretation of the rise in concentration: instead of being driven by increased market power, it may reflect economies of scale made possible investments in intangibles related to logistics and distribution.

In **"Understanding Weak Investment: The Role of Market Power and Intangibles"** (Crouzet and Eberly [10], *Proceedings of the Jackson Hole Symposium*, 2019), we extend our analysis to other sectors of the US economy. The main empirical challenge is to construct and compare systematically measures of the intangible capital stock of US firms. Our primary data source are 10-K filings, and we build on existing work, in particular Eisfeldt and Papanikolaou (2013), to estimate flow investment in R&D and in organization capital. We also show how to adjust measures of corporate profits and of the markup of price over marginal cost for the fact that these investment expenditures are generally misclassified as operating expenses.

Our work has three core results. First, in reduced-form regressions, intangible intensity can account for about one-third of the change in the gap between investment and valuations over the last three decades. Second, changes in intangible intensity strongly and positively predicts changes in the markup of price over marginal cost, in rates of return to capital, in valuation ratios, and in concentration. However, intangible intensity also predicts changes in both labor and multifactor productivity. Third, and perhaps most important, aggregate trends mask a substantial amount of sectoral heterogeneity. Some sectors such as high-tech and healthcare, underwent much larger increases in both intangible intensity and profits or rates returns, while others, such as manufacturing, in fact experienced slight declines in those data moments.

These results add at least two important insights to the debate on the causes and consequences of declining investment, rising returns, and rising concentration. First, the pervasive empirical importance of intangibles suggests that any account of how rising market power affects investment, returns and concentration is incomplete unless one also, and jointly, accounts for the effects rising intangible intensity. Second, heterogeneity in sectoral trends suggests that care is needed when drawing conclusions — particularly normative ones — from the aggregate data.

Quantifying the contribution of intangibles ([2], [3])

The second step in our work is to provide a structural interpretation of the reduced-form correlations described in [11] and [10]. We do this in two separate papers, [2] and [3], whose common theme is to provide a framework that accounts for the *joint* impact of intangibles and market power on growth, investment, valuations, and returns.

In **"Rents and Intangible Capital: a Q+ Framework"** (Crouzet and Eberly [2], *Journal of Finance*, forthcoming), we focus on investment and valuations. Tobin's Q — the ratio of enterprise value to the stock of physical capital — has been rising over the last three decades, suggesting that returns to physical investment are rising. Yet physical investment has been declining. We ask: to what extent do rents and intangibles explain this divergence?

This question requires a framework with more dimensions than previous models allowed for; firms must simultaneously earn rents, and invest in mismeasured intangibles. We construct this framework and then estimate it using a combination of national and firm-level data.

In the model, marginal q, the incremental enterprise value associated with an incremental unit of capital, is a sufficient statistic for investment. With rents and intangibles, marginal q will be below average Q — generating the 'gap' between investment and Q observed in the data. But the model allows us to be more specific. We show that the gap between Q and q can be decomposed into three terms. The first two capture the direct effects of mismeasured intangibles and of rents; each would exist even if the other mechanism were shut down. The third term is new, and appears only when the two mechanisms are combined. Intuitively, it represents the additional enterprise value associated with the rents generated by the unmeasured stock of intangible capital. Crucially, this term is positive; the presence of intangibles amplifies the effects of rents, and vice-versa. This decomposition is very general, and requires few assumptions beyond relatively standard ones.

We then show how each of the three terms in this decomposition can be estimated using data on Tobin's average Q, investment rates, rates of average return to physical capital, and estimates of the size of the intangible capital stock. Doing so leads to three main empirical findings.

First, the term capturing the direct effect of intangibles, plus the term capturing the interaction with rents, account for between 33% and 69% of the aggregate investment gap. The range between these estimates depends on how broad our measure of the stock of intangibles is. The lower bound is obtained when using only R&D expenditures as a proxy for intangible investment; the upper bound is obtained when also including a comprehensive measure of investment in organization capital obtained from firm-level accounting data. Thus intangibles appear to play a substantial role in the divergence between investment rates and valuations.

Second, our approach provides new estimates of the pure profit share. The pure profit share refers to revenue generated by firms in excess of the competitive cost of capital and labor; it has

been a central focus of the debate on the importance of rising market power in among US businesses. We find that the pure profit share increased, by less than half of what earlier work had estimated, illustrating the importance of including intangibles in the analysis.

Finally, the firm-level data allows us to produce sector-level decompositions of the gap between average Q and marginal q. These decompositions exhibit substantial heterogeneity, even across broadly defined sectors. This reinforces and sheds new light on the reduced-form results in [10]. For instance, in healthcare and high-tech, the gap is primarily driven by rents to intangible capital, while for the consumer sector, rents to physical assets are more important (though this result substantially depends on the measure of intangible capital used).

Interestingly, while our structural model imposes no relationship between intangible intensity and the pure profit share, the estimates we obtain are strongly positively correlated among subsectors of the healthcare, high-tech and manufacturing sectors, while they are sometimes *negatively* correlated in the services and consumer sectors. Thus, there appears to be a link between intangibles and market power, though not a homogeneous one. While in some industries, the creation of new intangible assets may lead to efficiency gains (as [11] also suggests), in others, intangibles may help firms entrench their dominant positions.

Broadly, these results suggest that interpretations of the gap between investment and valuations that only emphasize rents should be handled with caution. Accounting for intangibles reduces the gap, as well as estimates of rents. Moreover, aggregate trends mask substantial sectoral heterogeneity; no single story fits all, suggesting that broad normative conclusions might be misguided. This paper has been taught in graduate-level corporate finance courses at Princeton and Columbia.

In **"Intangibles, Markups, and the Measurement of Productivity Growth"** (Crouzet and Eberly [3], *Journal of Monetary Economics*, 2021), we study the causes of the slowdown in US productivity growth. Between 1947-1996 and 1997-2018, measured TFP growth fell by almost half, from 1.1% to 0.6% p.a. We ask whether rising intangibles and rising rents can explain this drop.

Either mechanism alone can bias measured TFP growth. Rents will generally bias it downward, by overstating the capital share. The effects of mismeasured intangibles are more complex. In national accounts, mismeasured intangible investment will be classified as intermediate rather final spending, making measured GDP too low. Prior work had shown that the effects of this bias GDP growth are likely small (Corrado et al., 2009). But it had overlooked the fact that mismeasurement of intangibles will also bias the capital share and the growth rate of capital prices.

The contribution of the paper is twofold. First, we characterize analytically these biases in a neoclassical growth model where firms earn rents and use mismeasured intangibles. Echoing the findings in [2], the biases created by rents and by mismeasured intangibles can reinforce each other.

Rents bias the capital share upwards. Mismeasured capital prices can bias real capital growth upward. In isolation, either channel has a small effect; in combination, they amplify each other.

Second, we combine model and data to estimate the size of the overall bias. We adjust national accounts data for the misclassification of certain intangible investments, such as spending on consulting, design, or marketing. Crucially, price deflators for these inputs have been growing faster than those of measured capital. This faster price growth, combined with rising rents, leads us to infer a downward bias in measured TFP growth of about half of the decline observed since 1997.

The implication is that the contribution of TFP to the growth slowdown may have been overstated. Instead, our results indicate that *real* capital grew at a slower pace, because firms became increasingly reliant on (mismeasured) intangibles, whose prices grew faster than those of measured capital inputs — a form of *negative* investment-specific technical change (Greenwood et al., 1997). I hope to provide further evidence on the issue, and explore its causes, in future research.

2.2 A new framework for intangibles

Existing work on intangibles tends to study them within a standard neo-classical production framework. This approach produces important insights, but does not explicitly consider the fact that, because intangibles do not have a physical presence, some of their economic properties might radically differ from physical capital. My current research proposes a new framework that helps explore these differences, and their macroeconomic and financial implications.

In **"The Economics of Intangible Capital"** (Crouzet et al. [9], *Journal of Economic Perspectives*, 2022), and its companion paper, **"A Model of Intangible Capital"** (Crouzet et al. [14], working paper, 2022), we sketch the basic elements of this framework. We propose to define intangibles as information that can be used as an input in production, but must be stored before doing so. Both the storage technology and the property rights environment then determine the two key economic properties of the intangible: its non-rivalry within the firm (that is, the extent to which a firm can use multiple instances of it simultaneously); and its excludability.[2]

Some examples may be useful. Consider a patent for high strength steel tubing. It consists of information describing the alloy used in the tubes. The patent is stored digitally, making it easy to copy, and therefore non-rival within the firm — the firm can use it simultaneously in different steel plants. Excludability from use by other firms will depend on the property rights environment.

Consider instead an inventory management system. It consists of information on how to organize production within a plant. Its primary method of storage is the know-how of managers overseeing

[2] In this framework, physical assets can be represented as those that are fully rival within the firm, and are generally easier to exclude from use by other firms, though this may still depend on the property rights environment.

production. If the time of these managers is scarce, improving inventory management in one plant may negatively impact others. The intangible is therefore only partially non-rival within the firm. It may also be difficult to exclude other firms from using it, since managers can leave the firm.

In [9] and [14], we formalize these two properties. Partial non-rivalry within the firm is represented by allowing the marginal rate of substitution of the intangible across a firm's production facilities to be less than one. Limits to excludability are represented as a negative relationship between a firm's scope (the number of different production facilities), and the amount of intangibles that it retains cash flow and control rights over. The two may interact; for instance, the returns to scale associated with high non-rivalry may not be attractive when limits to excludability are severe.

In **"Intangible Capital, Non-Rivalry, and Growth"** (Crouzet et al. [13], working paper, 2022), we study how these economic properties affect long-term growth. We are particularly interested in situations where, due to innovations in information storage and processing technologies, the degree of non-rivalry of intangibles within the firm increases. To answer this question, we augment a standard growth model with the framework developed in [9] and [14]. In the resulting model, intangibles are different from "ideas" in the endogenous growth literature, because they need not be fully non-rival and public capital goods. The standard Romer (1990) model is however a special case (when intangibles are fully non-rival), while the real business-cycle model with no growth is another (when intangibles are fully rival, and thus identical to physical capital).

Contrary to what intuition might suggest, we show that equilibrium growth is a non-monotonic function of the degree of non-rivalry of intangibles. That is, an improvement in technologies for storing and replicating intangibles may eventually depress growth. The intuition is that, if limits to excludability are imperfect, a higher degree of non-rivalry of intangibles means that the surplus from their creation accrues more rapidly to outside imitators, weakening the incentive to create the intangible in the first place. This suggests a potential mechanism through which the shift toward intangibles could lead to a slowdown in economic growth.

In future work, we plan to explore the implications of the framework of [9] and [14] for capital structure and the assignment of control and cash-flow rights. As suggested above, the framework indeed implies that financial and technological choices will be mutually dependent, which could help shed light on the joint variation in capital structure and intangible intensity across industries.

3 Bibliography

Refereed publications

[1] Crouzet, N., A. Gupta, and F. Mezzanotti (2022). Shocks and Technology Adoption: Evidence from Electronic Payment Systems. *Journal of Political Economy, accepted.* [Link to latest version].

[2] Crouzet, N. and J. Eberly (2022). Rents and Intangible Capital: A Q+ Framework. *The Journal of Finance, forthcoming.* [Link to latest version].

[3] Crouzet, N. and J. Eberly (2021). Intangibles, Markups, and the Measurement of Productivity Growth. *Journal of Monetary Economics 124*, S92–S109. [Link to published version].

[4] Crouzet, N. (2021). Credit Disintermediation and Monetary Policy. *IMF Economic Review 69*(1), 23–89. [Link to working paper version] [Link to published version].

[5] Crouzet, N. and N. R. Mehrotra (2020). Small and Large Firms Over the Business Cycle. *American Economic Review 110*(11), 3549–3601. [Link to published version].

[6] Crouzet, N., I. Dew-Becker, and C. G. Nathanson (2020). On the Effects of Restricting Short-Rerm Investment. *The Review of Financial Studies 33*(1), 1–43. [Link to published version].

[7] Crouzet, N. (2018). Aggregate Implications of Corporate Debt Choices. *The Review of Economic Studies 85*(3), 1635–1682. [Link to published version].

[8] Crouzet, N. and H. Oh (2016). What Do Inventories Tell Us About News-Driven Business Cycles? *Journal of Monetary Economics 79*, 49–66. [Link to published version].

Non-refereed publications

[9] Crouzet, N., J. Eberly, A. L. Eisfeldt, and D. Papanikolaou (2022). The Economics of Intangible Capital. *Journal of Economic Perspectives 36*(3), 29–52. [Link to published version].

[10] Crouzet, N. and J. Eberly (2019). Understanding weak capital investment: the role of market power and intangibles. *2018 Jackson Hole Symposium, Federal Reserve Bank of Kansas City*. [Link to working paper version] [Link to published version].

[11] Crouzet, N. and J. Eberly (2018). Intangibles, Investment, and Efficiency. *American Economic Review, Papers and Proceedings 108*, 426–31. [Link to published version].

Working papers

[12] Crouzet, N. and F. Tourre (2021). Can the Cure Kill the Patient? Corporate Credit Interventions and Debt Overhang. *Revise and resubmit (first round), Journal of Finance*. [Link to latest version].

[13] Crouzet, N., J. Eberly, A. L. Eisfeldt, and D. Papanikolaou (2022a). Intangible Capital, Non-Rivalry, and Growth. *Working paper, Northwestern University*. [Link to latest version].

[14] Crouzet, N., J. Eberly, A. L. Eisfeldt, and D. Papanikolaou (2022b). A Model of Intangible Capital. *NBER working paper*. [Link to latest version].

[15] Crouzet, N. (2017). Default, Debt Maturity, and Investment Dynamics. *Working paper, Northwestern University*. [Link to latest version].

Work in progress

[16] Crouzet, N. and N. Mehrotra (2022). Private Ownership, Capital Structure, and Investment.

[17] Crouzet, N., R. Bidder, M. Jacobson, and M. Siemer (2022). Debt Flexibility.

[18] Crouzet, N. and O. Darmouni (2022). The Non-Bank Credit Channel. [Preliminary and incomplete draft available upon request].

References

Autor, D., D. Dorn, L. F. Katz, C. Patterson, and J. Van Reenen (2020). The Fall of the Labor Share and the Rise of Superstar Firms. *The Quarterly Journal of Economics 135*(2), 645–709.

Beaudry, P. and F. Portier (2006). Stock Prices, News, and Economic Fluctuations. *American Economic Review 96*(4), 1293–1307.

Bolton, P. and D. S. Scharfstein (1996). Optimal Debt Structure and the Number of Creditors. *Journal of political economy 104*(1), 1–25.

Brunnermeier, M. K. and Y. Sannikov (2014). A Macroeconomic Model with a Financial Sector. *American Economic Review 104*(2), 379–421.

Chava, S. and M. R. Roberts (2008). How Does Financing Impact Investment? The Role of Debt Covenants. *The journal of finance 63*(5), 2085–2121.

Corrado, C., C. Hulten, and D. Sichel (2009). Intangible Capital and US Economic Growth. *Review of income and wealth 55*(3), 661–685.

De Loecker, J., J. Eeckhout, and G. Unger (2020). The Rise of Market Power and the Macroeconomic Implications. *The Quarterly Journal of Economics 135*(2), 561–644.

DeMarzo, P. M. and Z. He (2021). Leverage Dynamics Without Commitment. *The Journal of Finance 76*(3), 1195–1250.

Diamond, D. W. and P. H. Dybvig (1983). Bank Runs, Deposit Insurance, and Liquidity. *Journal of political economy 91*(3), 401–419.

Eisfeldt, A. L. and D. Papanikolaou (2013). Organization Capital and the Cross-Section of Expected Returns. *The Journal of Finance 68*(4), 1365–1406.

Farhi, E. and F. Gourio (2018). Accounting for Macro-Finance Trends: Market Power, Intangibles, and Risk Premia. *Brookings Papers on Economic Activity, Fall*, 147–250.

Foster, L., J. Haltiwanger, and C. J. Krizan (2006). Market Selection, Reallocation, and Restructuring in the US Retail Trade Sector in the 1990s. *The Review of Economics and Statistics 88*(4), 748–758.

Gertler, M. and S. Gilchrist (1994). Monetary Policy, Business Cycles, and the Behavior of Small Manufacturing Firms. *The Quarterly Journal of Economics 109*(2), 309–340.

Gertler, M. and N. Kiyotaki (2010). Financial Intermediation and Credit Policy in Business Cycle Analysis. In *Handbook of monetary economics*, Volume 3, pp. 547–599. Elsevier.

Greenwood, J., Z. Hercowitz, and P. Krusell (1997). Long-Run Implications of Investment-Specific Technological Change. *The American economic review*, 342–362.

Grossman, S. J. and J. E. Stiglitz (1980). On the Impossibility of Informationally Efficient Markets. *The American economic review 70*(3), 393–408.

Gutiérrez, G. and T. Philippon (2017). Investmentless Growth: An Empirical Investigation. *Brookings Papers on Economic Activity*, 89.

Hall, B. H. (2004). Innovation and Diffusion. *The Oxford Handbook of Innovation*.

He, Z. and A. Krishnamurthy (2012). A Model of Capital and Crises. *The Review of Economic Studies 79*(2), 735–777.

Karabarbounis, L. and B. Neiman (2014). The Global Decline of the Labor Share. *The Quarterly journal of economics 129*(1), 61–103.

Katz, M. L. and C. Shapiro (1985). Network Externalities, Competition, and Compatibility. *The American economic review 75*(3), 424–440.

Myers, S. C. (1977). Determinants of Corporate Borrowing. *Journal of financial economics 5*(2), 147–175.

Panzar, J. C. and R. D. Willig (1981). Economies of Scope. *The American Economic Review 71*(2), 268–272.

Rauh, J. D. and A. Sufi (2010). Capital Structure and Debt Structure. *The Review of Financial Studies 23*(12), 4242–4280.

Roberts, M. R. (2015). The Role of Dynamic Renegotiation and Asymmetric Information in Financial Contracting. *Journal of Financial Economics 116*(1), 61–81.

Roberts, M. R. and A. Sufi (2009). Renegotiation of Financial Contracts: Evidence from Private Credit Agreements. *Journal of Financial Economics 93*(2), 159–184.

Romer, P. M. (1990). Endogenous Technological Change. *Journal of political Economy 98*(5, Part 2), S71–S102.

Part II

Teaching

Since I joined Kellogg, I have taught the Global Capital Markets and Macroeconomic Policy course. This course is an elective designed primarily for MBA who major in Finance. Its goal is to introduce students to key concepts in macroeconomics, and to develop their ability to think autonomously about how the broad macroeconomic environment affects specific industries, sector, or countries.

The course lasts ten weeks and is structured around seven main topics: macroeconomic measurement; long-run growth; inequality and labor markets; the macroeconomic effects of financial crises; monetary policy; fiscal policy; and trade and capital flows. Each topic introduces students to simple analytical models to help think through the key concepts, and then teaches the students how to apply these models to real-world examples.

Between 2015 and 2016, Janice Eberly and I worked on updating the course, with two ideas in mind: first, to emphasize facts and evidence in the exposition of the main topics of the course; second, to conduct as much teaching as possible through examples. In order to achieve this goal, we introduced "discussion sets" — a shorter and somewhat more analytical version of case studies. Discussion sets are group assignments in which the students are asked to first think through the impact of a recent macroeconomic event on the situation of particular business our individuals, and then analyze the approach of policymakers to the event.

One concrete example is a discussion set on mortgage finance, which first gives the students background on the mortgage market in the run-up to the Great Recession, then asks them to work through the re-financing decision of an underwater household, and finally has them discuss some policy proposals to alleviate housing debt overhang. Most of the environments for our case studies are chosen from recent macroeconomic events; for instance, the module on long-run growth focuses on the growth performance of India and China, and the fiscal policy module focuses on the European sovereign debt crisis and the long-run fiscal outlook for the US government budget.

Additionally, because the macroeconomic environment is continuously evolving, the class is updated with new material annually. For instance, during 2020 and 2021, I placed a heavy focus on understanding the components of the monetary and fiscal response to the Covid-19 crisis, displacing some of the material on the Global Financial Crisis which I had previously used. The continuous updating of the class requires some work, but is a good way to keep students engaged and responsive.

Over the course of 7 years, my teaching grades risen steadily, along with enrollment in the class; the grade average for the course is 4.7/6, and my grade average as an instructor is 4.9/6. A link to my teaching evaluations is available on my professional webpage.

Part III

Professional service

4 Internal service

As part of my service to Kellogg, I have been involved in supervising graduate students. Additionally, I have been an organizer and a participant in the Finance Seminar, as well as a participant in the Macroeconomics Seminar. Finally, I have participated in various internal committees.

4.1 Student advising

I have been a dissertation committee member for three students at Kellogg:

1. Apoorv Gupta, a Finance student, who graduated in 2020, and is now an assistant professor in the Economics Department at Darmouth;
2. Adriana Troiana, a Finance Student, who graduated in 2022 and is now at Uber;
3. Jingxiong (Tony) Hu, a Finance student, who is graduating in 2023.

Additionally, I have served as a regular advisor to a number of other graduate students, both from the Finance and the Economics department, including Brittany Lewis (Finance student, graduated in 2020, first placement at Indiana University, now at Washington University), Ricciardo Bianchi-Vimercati (Finance student, graduated in 2022, now at Pimco), and Federico Puglisi (Economics student, graduating in 2023).

4.2 Other internal service

My service to the school to date is as follows:

2016-2019, 2021	Reading Committee (Junior Recruiting)
2018-2019	Personnel Committee (Junior Observer)
2017-2019, 2021	Reading Committee (PhD Admissions)
2021	First-year PhD Advising (advisee: Tim Seida)
2014, 2015, 2019	PhD Admit Day Presentation
2016-2017, 2020-2021	Finance Seminar (with Filippo Mezzanotti, Sean Higgins)

5 External service

As part of my external service to the profession, I have been invited to discuss work by leading researchers at a variety of conferences. I have also been called on to referee for many top academic publications, and served on various conference committees. Finally, as part of my work [5] and [16], I have created material for future researchers to use the QFR panel data created for these projects, as well as for Census economists to potentially improve on the data collection and organization methods underlying the QFR.

5.1 Invited presentations

Part IV contains three tables, listing, respectively, invited seminars, invited conferences, and invited discussions that I have given up to this point, including scheduled presentations for the academic year 2022-2023. I have only included co-author presentations (indicated with a *) in two cases: for NBER meetings, as well as for the Jackson Hole Symposium of the Federal Reserve Bank of Kansas City, for which [10] was written.

5.2 Referee

I have been a referee for the following journals: *American Economic Review, Journal of Political Economy, Review of Economic Studies, Quarterly Journal of Economics, Econometrica, Journal of Finance, Review of Financial Studies, Journal of Financial Economics, Journal of Monetary Economics, American Economic Journal: Macro, Review of Economic Dynamics, Review of Economics and Statistics, European Economic Review, Economic Journal, American Economic Review: Insights, Journal of the European Economic Association, Journal of Money, Credit and Banking, Journal of Banking and Finance, Review of Corporate Finance Studies, Management Science, Journal of Financial and Quantitative Analysis.* I have also served on the reviewing committee grants for the Social Sciences and Humanities Research Council of Canada.

5.3 Conference committees

Program committees

1. Financial Intermediation Research Society Meetings, 2019-2023
2. European Finance Association Meetings, 2021-2022
3. Society for Financial Studies Cavalcade, 2023

Session chair

1. American Economic Association Meetings, International Society for Inventory Research Session, 2020-2021

5.4 Other external service

In [5] and [16], a core contribution was to create a long panel dataset from the micro data records underlying the QFR, as well as merge these data with various external datasets, so as to improve researchers and Census economists' understanding of the representativeness and coverage of the sample.

This process was involved: the underlying data had not been recorded using a homogeneous set of balance sheet variables; there were substantial changes in the sampling frame over time; some sampling weights were missing from the data and had to be estimated from other sources; and some identifier variables were missing in certain years.

The code underlying this data cleaning effort, as well as newly created data dictionaries for the resulting dataset, new sampling weights, and consistent ID variables, have now all been made available to Census-affiliated researchers who wish to use the QFR data in the panel data format which was created for [5] and [16]. Additionally, I have been in regular interaction with Census researchers to better understand the micro data underlying the QFR as well as the sampling methodologies used to collect it, and disseminate information on this to Census-affiliated researchers. In particular, I gave an internal presentation to the QFR Census team on the results of my research using this data, as well as ideas for additions to the micro data underlying the survey which would facilitate its widespread use by other researchers.[3] In the long-run, I hope to maintain this close collaboration with Census, since I think it provides a useful external service to the profession, given the limited existing data on the financing patterns of private firms in the US.

5.5 Awards, Fellowships and Scholarships

1. AAII Prize for Best Paper, Midwest Finance Association Meetings, 2021
2. Donald P. Jacobs Scholar, Kellogg School of Management, 2014-2015
3. Wueller Award for best graduate teaching assistant, Columbia University, 2011
4. Harris Prize for Best Second Year Paper, Columbia University, 2010
5. Doctoral Fellowship, Columbia University, 2008-2014

[3] This discussion was internal to Census and is not available on my website.

Part IV

Invited presentations

Tables include scheduled presentations. For conferences, * indicates co-author presentation.

Seminars

Academic year	Seminar	Paper
2022-2023	Imperial College London (Finance)	[12]
	Shanghai Advanced Institute of Finance	[13]
	MIT Sloan (Finance)	[13]
	HEC Paris (Finance)	[18]
	Stanford GSB (Macroeconomics)	[13]
	Halle Institute for Economic Research	[18]
	European Central Bank	[18]
	University of Luxemburg	[18]
	Dartmouth (Finance)	[13]
	Philadelphia Fed	[18]
2021-2022	London School of Economics (Macroeconomics)	[1]
	Bundesbank	[12]
	Virtual Corporate Finance Seminar	[12]
	Swiss Finance Institute, Lausanne	[12]
	Michigan State (Finance)	[12]
	London School of Economics (Finance)	[12]
	EDHEC (Finance)	[12]
	Boston Fed	[12]
	Columbia Business School (Macro-Finance)	[12]
	University of Bonn (Finance)	[12]
2020-2021	St Louis Fed	[12]
	Université Laval	[12]
	INSEAD	[12]
	USC Marshall School of Business (Finance)	[2]
	European Central Bank	[12], [4]
	Boston College (Macroeconomics)	[2]
	University of Amsterdam (Finance)	[2]

	Bank of Canada	[12]
2019-2020	Central Bank of Denmark	[2]
	University of Toronto (Finance)	[1]
	NYU Stern (Finance)	[1]
	Richmond Fed	[2]
	Chicago Fed	[1]
	Chicago Booth (Finance)	[2]
	University of Maryland (Finance)	[2]
2018-2019	London Business School (Finance)	[5]
	Ohio State (Economics)	[5]
	Boston Fed	[5]
	London School of Economics (Economics)	[5]
	International Monetary Fund	[10]
	University of Wisconsin-Madison (Finance)	[5]
2017-2018	UNC Chapel Hill (Finance)	[5]
	Carnegie / University of Pittsburgh (Macroeconomics)	[5]
	Imperial College London (Finance)	[5]
	Duke (Finance)	[5]
	Notre Dame (Macroeconomics)	[5]
	Chicago Booth (Finance)	[5]
	University of Bonn (Macroeconomics)	[5]
	Goethe University (Economics)	[5]
2016-2017	University of Minnesota (Finance)	[15]
	National University of Singapore	[15]
	Federal Reserve Board	[5]
	Inter-American Development Bank	[5]
2015-2016	Chicago Fed	[7]
	Wharton (Finance)	[8]
2014-2015	University of Maryland (Macroeconomics)	[7]
	Federal Reserve Board	[7]
	European Central Bank	[7]
	USC Marshall School of Business (Economics)	[7]
2013-2014	Paris-Dauphine	[7]
	Bank of England	[7]

CREI and Pompeu Fabra (Economics)	[7]
University College London (Economics)	[7]
Stanford GSB (Finance)	[7]
Harvard Business School (Finance)	[7]
Notre Dame (Economics)	[7]
Bocconi (Economics)	[7]
University of Geneva (Finance)	[7]
Chicago Booth (Finance)	[7]
Kellogg School of Management (Finance)	[7]
Bank for International Settlements	[7]

Conferences

Academic year	Conference	Paper
2022-2023	MIT Sloan Junior Finance conference	[12]
2021-2022	Bank of Italy Workshop on Covid-19 and Firms	[12]
	Booth Workshop on Advances in Macro-Finance	[2],[3]
	University of Mannheim Workshop on Firm Heterogeneity	[12]
	Society of Economic Dynamics Meetings	[1]
	Workshop on Inclusive Growth, University of Amsterdam	[2]
	European Finance Association Meetings	[12]
2020-2021	Macro-Finance Society Meetings	[12]
	JME-SNB-SCG Conference at Gerzensee	[3]
	American Economic Association Meetings	[4]
	Midwest Finance Association Meetings	[1]
	NBER Economics of Digitization Meeting*	[1]
	SED Meetings	[2]
	Adam Smith Conference	[1]
	NBER Conference on Research on Income and Wealth Summer Meeting	[3]
	9th Workshop on Production-Based Asset Pricing, Norwegian Business School	[2]
	European Finance Association Meetings	[2]
2019-2020	Yale Junior Finance Conference	[2]
	Jacques Polak Conference, IMF	[4]

	American Finance Association Meetings	[1]
	Jackson Hole Finance Conference	[2]
	Midwest Finance Association Meetings	[2]
	Western Finance Association Meetings	[2]
	NBER Corporate Finance Summer Meeting	[2]
	Princeton Conference on Corporate and the Macroeconomy under Covid-19	[12]
2018-2019	NBER Impulse and Propagation Mechanisms	[5]
	Boston University TPRI competition conference	[10]
	Banque de France Workshop on Investment in the New Monetary and Financial Environment	[5]
	Jackson Hole Symposium*	[10]
	San Francisco Fed Conference on Advances in Financial Research	[5]
	NBER Productivity and Entrepreneurship Meeting*	[1]
	NY Fed Conference on Fintech	[1]
	Financial Intermediation Research Society Meetings	[5]
2017-2018	Red Rock Finance Conference	[6]
	UCLA Junior Macro Conference	[5]
	NBER Monetary Economics Meeting	[5]
	American Economic Association Meetings	[5]
2016-2017	Philadelphia Fed Debt and Banking Conference	[15]
	Adam Smith Workshop	[6]
	Society for Financial Studies Cavalcade	[15]
	Society for Economic Dynamics Meetings	[5]
	Barcelona GSE Summer Workshop	[5]
	NBER Capital Markets Summer Meeting	[5]
	Minnesota Macro Meeting	[5]
2015-2016	American Finance Association Meetings	[7]
	Society for Economic Dynamics Meetings	[15]
	Macroeconomics of Financial Frictions Mini-Conference, Cambridge University	[7]
2014-2015	Boston Macro-Finance Conference	[7]
	6th Conference on Financial Stability, Tilburg University	[7]

	Tsinghua Macro Conference	[7]
2013-2014	European Economic Association Meetings	[7]
	Conference on Expectations in Dynamic Macroeconomic Models, San Francisco Fed	[8]
2012-2013	Society for Economic Dynamics Meetings	[8]
	Midwest Macroeconomics Meetings	[8]

Discussions

Academic year	Conference	Paper
2022-2023	American Finance Association Meetings	*Growth Through Diversity*, by Heyerdahl-Larsen, Illeditsch, and Kung
2021-2022	NBER Capital Markets Summer Meeting	*Cross-Sectional Financial Conditions, Business Cycles and The Lending Channel*, by Ferreira
	Midwest Finance Association Meetings	*The Ownership Structure of US Corporations*, by Lewellen and Lewellen
	Midwest Finance Association Meetings	*Firm Quality Dynamics and the Slippery Slope of Credit Intervention*, by Li and Li
2020-2021	China International Conference in Finance	*Bond Finance, Bank Finance, and Bank Regulation*, by Huang
	Financial Intermediation Research Society Meetings	*Firm-bank linkages and optimal monetary policy in a lockdown*, by Segura and Villacorta
	Society for Financial Studies Cavalcade	*Knowledge Cycles and Corporate Investment*, by Bustamante, Cujean, and Frésard

	Midwest Finance Association Meetings	*Monetary Surprises, Debt Structure, and Credit Misallocation*, by Chen
	American Economic Association Meetings	*Volatility and Financial Structure of Firms*, by Dinlersoz, Kalemli-Ozcam, Penciakova and Quadrini
2019-2020	Midwest Finance Meetings	*Financing Corporate Growth*, by Frank and Sanati
	NBER Economics Fluctuations and Growth Winter Meeting	*How EU Markets Became More Competitive Than US Markets: A Study of Institutional Drift*, by Gutiérrez and Philippon
	American Finance Association Meetings	*The Rise of Star Firms: Intangible Capital and Competition*, by Ayyagari, Demirguc-Kunt and Maksimovic
2018-2019	2nd IMF Macro-Finance Conference	*On the Cost of Financial Intermediation*, by De Nicolo, Presbitero, Rebucci, and Zhang
	Western Finance Association Meetings	*Time Inconsistency and Financial Covenants*, by Xiang
	8th ITAM Finance Conference	*Q: Risks, Rents or Growth?*, by Corhay, Kung and Schmid
	Financial Intermediation Research Society Meetings	*News Shocks and Asset Prices*, by Bretscher, Malkhozov and Tamoni
	NBER Monetary Economics Fall Meeting	*Borrowing to Save and Investment Dynamics*, by Xiao

2017-2018	NBER Capital Markets Summer Meeting	*Leverage Over the Life-Cycle and Implications for Firm Growth and Shock Responsiveness*, by Dinlersoz, Kalemli-Ozcan, Hyatt and Penciakova
	HEC-McGill Winter Finance Conference	*Demand Disagreement*, by Heyerdahl-Larsen and Illedistch
	Northwern Finance Association Meetings	*Government Guarantees and Bank Liquidity Creation*, by Berger, Li, and Saheruddin
2016-2017	Midwest Finance Association Meetings	*The Finance-Uncertainty Multiplier*, by Alfaro, Bloom and Lin
	Midwest Finance Association Meetings	*The Interplay Between Financial Conditions and Monetary Policy Shocks*, by Bassetto, Benzoni and Serrao