Private Firms: Friends or Foes of Public Firms?

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Abstract

We examine the impact of positive private firm innovation shocks and private firm liquidity shocks on existing public firm peers using an extensive dynamic textual network of roughly a half million public and private product market peers from 2000 to 2021. We document that state-level shocks to the incentives of private firms to invest in R&D have positive effects on related public firms. These innovation incentive results are consistent with substitution and private firms developing products that are complementary to public firms. We also find that after these innovation shocks, related public firms increase acquisitions of private firms and have improved profitability, sales growth, and investments, including R&D. Measures of competition and competitive threats also decline following private firm innovation shocks. In contrast, we find that state-level liquidity shocks, which can instead relax financing constraints of private firms located in these states, negatively impact related public firms, consistent with private firms increasing the competitive pressure on public firms. These results suggest that non-innovation demand or liquidity shocks enable private firms to challenge public firms as competitors, while innovation shocks increase private firm complementarities to public firms thus benefiting both public and private firms.

1 Introduction

A large number of studies in economic disciplines focus on publicly traded firms both because data is easy to obtain and because these firms are "important". Yet the majority of firms in developed economies such as the U.S. are private firms, and due to their sheer numbers, their impact can be large. Smaller businesses also potentially can be more important than large public firms on several dimensions policymakers care about, such as (A) the opportunities they offer to less wealthy citizens, (B) their hypothesized role as drivers of novel innovation, and (C) the countervailing force they offer against domination by the largest firms.[1] The void in private firm research is particularly large regarding the dynamics of their impact on market structure and how shocks (either policy-driven or unintended consequences of events such as real estate price increases) affect large firms.[2]

Understanding how small and large firms interact, and how policy shocks can impact these interactions, has elevated importance given the evidence of increasing large firm dominance and indications of increased market power. For example, Kwon et al. (2024) find that U.S. concentration has been rising steadily over the past 100 years and Grullon et al. (2019) also find increasing concentration among public firms. Our study develops a dynamic spatial model of the product market with public and private firms represented in the same model, which along with the geography of policy initiatives, can test how small firm shocks propagate (or not) to large public firms. The framework can inform policymakers regarding potential broader impacts of their initiatives. Our findings underscore how even policies targeted at boosting small private firms can, in fact, further increase the success and growth of the largest public firms.

We use a comprehensive database of U.S. private and public firms in time series from 2000 to 2021 that we build using webpages from the Internet Archive's WayBack Machine.[3]

[1]Related policy focus on small business span decades, including the creation of the U.S. Small Business Administration in 1953, the Jumpstart Our Business Startups Act of 2012 (JOBS Act), and the strong focus on small businesses during the Covid pandemic through the Paycheck Protection Program and the Small Business Debt Relief Program.

[2]Noteworthy exceptions are a number of studies including Becker and Ivashina (2023) and Farre-Mensa et al. (2020) that study private VC backed firms. Yet the majority of smaller private firms are neither VC-backed nor publicly traded and do not have the benefits of institutional support.

[3]This work was made possible by research funded by the National Science Foundation developing scalable and informative natural language processing techniques customized to websites as summarized in Hoberg et al. (2024)

This database is a dynamic, annually-updated spatial model of a large fraction of the U.S. economy that jointly covers approximately 500,000 private firms and 5,000 public firms per year from 2000 to 2021. We refer to this resource as the Web-based Textual Network Industry Classification (WTNIC) database. It is updated annually and covers the product markets of both public and private firms, enabling us to follow these firms over time using a spatial structure that measures how firms are related to each other over time. We thus are able to assess how public and private firms are related to each other and how they interact at a relatively high annual frequency. Hoberg and Phillips (2016) provides a more detailed summary of the benefits of dynamic spatial modeling of industry classifications.

This paper uses this WTNIC database to assess the impact of state-level positive shocks to small private firms on public firms in related product markets. We examine the impact specifically on public firms that have high product similarity to the shocked private firms. We exclude private firms in the same state as the focal public firm from this analysis to ensure exogenous treatment. Understanding this relationship can help us understand the economy-wide impact of policies such as state-level R&D tax credits that are aimed at bolstering small businesses. We test central hypotheses motivated by the extent to which private firms either position themselves as competitors to related public firms (their products are at least partial substitutes), or whether private firms instead tend to develop products that are complementary to related public firms. The former would predict wide ranging negative spillovers to public firms and the latter wide-ranging positive spillovers.

The first economic shock we examine is shocks to the incentives for conducting R&D that occur after states pass tax credits for R&D. We focus on small private firms that operate in these states. Under the complementarity (substitution) hypothesis, we expect these positive shocks to private firms to be positive (negative) for the related public firms. Our results strongly favor the complementarity thesis for R&D shocks (innovation inspires complementary investment), and we explore two potential channels for these effects.

The first channel is public firms can acquire the shocked private firms, who increase the development of synergistic products or features. The public firms would subsequently rapidly commercialize these complementary products "at scale" given their large size. This channel is consistent with the view that public firms optimally outsource their R&D and initial new product development to private firms, and then buy them to commercialize the products. Public firm acquisitions of private firms would then increase as in Phillips and Zhdanov (2013).

The second channel is the shocked private firms might develop more innovative products that complement public firms' products directly (without the need for acquisitions). For example, private firms might not have the depth to fully compete with large public firm products, and instead offer products that consumers purchase to enhance the consumption of the public firm's product.[4] If complementary products are highly prevalent among smaller private firms, then we would expect positive shocks to smaller private firms will create positive spillovers for larger public firms in the form of increased sales, higher profits, and increased investment as public firms benefit from increased demand arising from the complementary products of the private firms.

We next examine the response of public firms to state-level real estate shocks that impact the private firms operating in these states. Real estate price shocks may relax private firms' financial constraints as studied by Adelino et al. (2015). These real estate price shocks could then enable private firms to expand by relaxing their financial constraints. We examine if these real-estate shocks, which positively impact small private firms, affect the larger public firms in their markets.

Our results for this non-innovation shock favor substitution and not complementarity. These liquidity-focused shocks are thus consistent with the shocked private firms becoming stronger competitors to the public firms in their markets. Under substitution, we expect lower sales, lower profits, and reduced levels of investment for public firms. This would result if private firm competitors essentially crowd out market share from the public firms. While these crowd-out effects are the most direct prediction under substitution, a theoretical alternative is the "escape the competition hypothesis" of Aghion et al. (2005), which predicts public firms might increase their investments in the face of the competitive threats (even as their accounting performance declines in the short run) in order to escape the competition through product differentiation and increased quality.

Ultimately, whether private firms act as competitive substitutes or complements might

[4]An example is Jibbitz, a smaller private company that produced charms that could be attached to the well-known Crocs shoes (Crocs was publicly traded). These products can be strong complements as the success of one leads to more sales of the other. Another example would be a small software developer creating apps that run on the Apple platform, making Apple's products more attractive and vice-versa.

thus depend on the type of shock to the small private firms, or the characteristics of the focal public firms being evaluated. For example, a shock specifically targeting incentives to innovate might stimulate more exploratory innovation, whereas more generic non-innovation positive shocks might instead incentivize investments such as advertising or increasing the scale of existing operations. As a result, the impact of different positive shocks to private firms on public firm peers can be quite different. This impact might also vary with firm characteristics such as size or age, as larger firms might be better positioned to internalize technological gains at scale through acquisitions.

The identification challenge we face is that both public and private firms may benefit from increasing demand in an industry, and thus, any interactions or changes we document may be based on their reactions to these shocks. We use two plausibly exogenous *local* positive shocks that impact groups of private firms operating in product markets. The first is based on state-level R&D tax credits as studied in Bloom et al. (2013), and is a positive innovation-specific shock to private firms in treated states. The second is based on state-year real estate price appreciation rates from the Federal Housing Finance Authority and is a non-innovation-focused shock to private firms. From the perspective of private firms in a given state, this second shock identifies either local demand shocks (which pushed up real estate prices) or improved liquidity via borrowing by founders (from higher valued real estate collateral), neither of which is a primitive shifter of innovation. Thus, we can compare the impact of a definitive positive innovation shock to the impact of a more general positive non-innovation shock. Because private firms might invest in different ways following these shocks, we do not expect similar treatment effects.

We find that positive innovation shocks to private firms' innovation incentives generate positive complementarities for public firm peers in many ways. Public firms increase investments both in the form of R&D and acquisitions, and they realize sales growth as predicted by the complementarities hypothesis. These results are particularly strong for larger public firms, which specifically increase acquisitions more than R&D, consistent with our second hypothesis and the possibility of large gains through public firms scaling new technologies produced by small private firms. These firms also experience improved profits and lower competition as overall product similarity with public rivals decreases. These gains for large firms are consistent with the innovation-outsourcing theory of Phillips and Zhdanov (2013), which predicts acquisitions by public firms of smaller firms after smaller firms initially increase innovation. Smaller public firms are different and increase R&D investment instead of acquisitions, and they realize smaller gains in real performance, consistent with smaller and less scalable spillovers. Regarding competitive intensity, we find stronger results for firms in more competitive markets, consistent with the need for more dynamic strategies when competition is high, and also consistent with the escape competition thesis of Aghion et al. (2005).

We find diametrically opposite results for non-innovation-focused positive shocks that impact private firm demand and relax their financial constraints, as these shocks enable private firms to expand and increase their competitiveness. Affected public firms experience declines in both acquisitions and R&D along with lower profits and increased competition in the form of total similarity to rivals. These findings are consistent with the predictions of increased competition from private firms. The impact of these non-innovation-focused shocks is more uniform across subsamples, as large, small, tech and non-tech public firms have reduced investment, and decreases in profits and increased competition.

Our findings of positive effects for public firms following positive innovation shocks that directly impact private firms indicate a positive economic "multiplier effect" when policies increase small firm innovation incentives. However, our findings for non-innovation-focused shocks show a negative impact on public firms, consistent with increased competition and substitution effects as predicted by our first hypothesis. A simple explanation based on the characteristics of growth options might explain these opposing results. The net present values of exploratory innovation growth options might have a very diffuse distribution and a high-risk profile, and only shocks targeting innovation directly are strong enough to materially shift the likelihood of exercising such growth options. On the other hand, the value of growth options aimed at "emulating successful peers" likely have a tighter distribution around zero and a lower risk profile. Thus, general shocks to demand and liquidity are adequate to shift these growth options into ones that can be exercised, but these shocks are not impactful enough on innovation incentives to shift exploratory innovation specifically.

We find additional results that confirm our interpretation of the R&D shock as an innovation-focused shock and the real estate values shock as a non-innovation-focused shock. In particular, we examine a validation test where we predict growth in the size of private firm websites as a way to measure private firm product innovation. We find strong results that only the R&D tax credits shock strongly shifts growth in private firm website size. The non-innovation real estate shock only has a weak impact on the growth of private firm websites. Economically, the impact of the R&D tax credit shock is 15x more important than the non-innovation real estate shock in predicting the growth of private firm websites.

Although our study makes significant progress regarding joint market structure analysis of public and private firms, some limitations remain for future research to address. First, although we study hundreds of thousands of private firms, our study only includes those in popular private firm databases such as Capital IQ and Orbis. Extending the sample could be fruitful. Future studies might nevertheless consider ultra-small "mom and pop" enterprises or sole proprietorships, although the impact of such operations on public firms is likely smaller and plays out over longer horizons. Second, our data only goes back to 2000 given the limitations of the Wayback Machine. Finally, gains in artificial intelligence tools, although currently costly to implement given the trillions of pairwise comparisons needed to construct the WTNIC database, should become more scalable in the coming years. Finally, while our evidence suggests important considerations policymakers might examine when assisting small enterprises, more research is needed to refine how policies might be optimized further.

2 Theoretical Predictions

We use our large webpage text-based network industry classification (WTNIC) database to assess the impact of positive shocks to private firms on the public firms operating in related product markets. We start by noting that theoretical predictions crucially hinge upon whether the positive shocks induce the private firms to expand in ways that are complements or substitutes to the existing public firms in their markets.

The first economic shock we examine is local shocks to R&D incentives following state passage of R&D tax credits specifically in the markets where the private firms operate. Our thesis is that these shocks are positive for the private firms operating in these states. We then expect these shocks to impact related public firms indirectly through private firms in two ways. The first channel is that the private firms will have stronger incentives to develop complementary products that will positively influence the performance of the larger public firms. A wide array of positive effects could follow including sales growth, more investment as growth options increase in value, and reduced competition as the investment generates differentiation and increased quality.

A second channel is these positive innovation shocks might also result in more public firm acquisitions of private firms. The central idea is that public firms will be more likely to acquire these private firms after the private firms develop new products from their R&D. These acquisitions take place as larger public firms can use their larger resources to more rapidly commercialize the private firms' products. This result would be consistent with the prediction that public firms optimally outsource their R&D and initial new product development to private firms and then buy them to commercialize and advertise the products. Public firm acquisitions of these private firms would increase as predicted by Phillips and Zhdanov (2013). An example would be video games developed by private firms that use Microsoft's X-box platform. Microsoft has subsequently purchased many small game producers, including the private companies that developed Halo, Doom, Redfall, and Gears of War.[5]

This discussion motivates our first hypothesis based on complementarity. We also discuss the alternative substitution hypothesis below.

Hypothesis 1 [Complementarity]: Positive shocks to the private firms will have two primary effects on public firms.

Hypothesis 1a: Sales, profits, and organic investment of public firms will increase as private firms develop more complementary products.

Hypothesis 1b: Acquisitions by public firms of private firms will increase after the private firm innovation shocks.

The second economic shock we examine is local positive shocks in the form of state-level real estate price changes in the markets where the small private firms are located. As noted in the existing literature, increases in local real estate prices are particularly favorable to smaller firms and, in particular, to private firms (see Adelino et al. (2015)). These demand shocks

[5]For a list of the 13 game developer companies that Microsoft has purchased see: https://www.pcgamer.com/every-game-and-studio-microsoft-now-owns/

enable private firms to expand by relaxing their financial constraints, and we thus predict they will be stronger competitors. If private firms become more significant competitors for public firms, we would expect a negative impact of the public firms. We thus examine whether public firm sales, profits, and investment are negatively impacted following these positive shocks to the related private firms.[6] Regarding investment, the main idea is that the relative value of growth options will decrease for the public firms, as private firm competitors become more likely to take market share from them. An alternative view to this hypothesis for investment, in particular, is the "escape the competition hypothesis" of Aghion et al. (2005). This hypothesis predicts that public firms may increase their investments in the face of competitive threats even as their accounting performance declines.

This discussion motivates our second hypothesis based on substitution:

Hypothesis 2 [Substitution]: Demand or liquidity shocks that are favorable to private firms will negatively affect larger public firms in related product markets. Public firm sales, profits, and investment will decrease as the relative value of their growth options declines. This results because private-firm competitors have reduced financial constraints will be more likely to take market share from the public firms.

As noted earlier, little is known regarding the potential validity of these hypotheses on average in a complete panel data setting. The consequences are policy relevant given the plethora of policy initiatives to support smaller private firms, and the dearth of knowledge of their impact on the larger public firms in the economy. We note that H1 and H2 are general, and it is an empirical question whether any specific shock favors complementary or substitute impacts on public firms.

3 Data and Methods

3.1 Web-based Product Market Peers: Using Doc2Vec website Embeddings

We use and extend the foundational network of web-based private firm peers that was developed by Hoberg et al. (2024) (henceforth HKP24). In this expanded network, we include all

[6] To compute the private firm shock that impacts the public firm through the private firm channel, we remove the shocks of private firms that operate in the same state as the headquarters of the public firm.

firms with 25 employees or more, including firms that expand to 25 employees in their earlier years. We extend this database by expanding its time series to include years from 2000 to 2021. We also expand its cross-sectional coverage of URLs to include all URLs from Compustat, Capital IQ, and Orbis (original database) and also include private firms from Venture Expert and Preqin.[7] We refer to this extended database as the WTNIC database (Web-based Textual Network Industry Classification). We briefly summarize the methodology here but refer readers to the above study for details.

WNTIC is constructed by following five steps. The first is to gather the universe of URLs from all of the above databases, clean them to only include the root domain (the first part of any URL that does not include any forward slashes). The second step is to query the Wayback Machine once per URL x year, and extract each website's latest snapshot in each calendar year. This step is completed by then downloading all verbal content from these website snapshots up to three levels of depth (sub-URLs with no more than 3 forward slashes). The website text is then purged of html tags and images to only include verbal content using Beautiful Soup.

The third step is to train a doc2vec embedding model separately for each year, where the websites from the universe of public firms plus 32,000 private firms are used for training. We use a Doc2vec dimensionality of 300, with each website in each year is represented spatially as a 300-element vector. The pairwise similarity between the two firms in a given pair is then the cosine similarity between the two vectors of the two firms. Because websites contain much content that is not about the products the firm sells, and because such website content has a strong "verbal factor structure", a fourth step is required to purge the resulting similarity scores of non-product content. This is done by first fitting an LDA model over all websites separately for each year and using a pairwise regression-based approach to purge the pairwise scores of the non-product content, resulting in a higher-quality network (see HKP24 for detailed documentation). The result is a set of pairwise similarity scores purged of non-product content for every permutation of public and private firms in our sample of URLs in each year.

The fifth and final step is to condense the resulting trillions of pairwise similarities over

[7] Firms with fewer than 25 employees are unlikely to be on a growth path and including more would result in scalability challenges as the existing sample already requires trillions of pairwise similarity calculations and adjustments that take months to run even with parallel processing on a well-equipped University server.

the 22-year sample. There are three types of pairwise similarities: public-to-public, public-to-private, and private-to-private. This study focuses on the public-to-private similarities. Due to the large number of these observations, we sort the pairwise similarities in each year and take only the top 1%. This level of granularity is similar to that of four-digit SIC codes. We classify the resulting 1% of pairs as "product market peers," and this constitutes the public-to-private WTNIC database. The database consists of a gvkey for the public firm in the pair, a URL for the given private firm in the pair, and a pairwise similarity score. The private firms can then be linked back to the underlying databases (Capital IQ, ORBIS, Venture Expert, or Prequin) by using the URL as the crosswalk.

3.2 Private Firm Innovation Shocks and Non-Innovation Shocks

We measure private firm innovation and non-innovation shocks at the state-year level. For innovation shocks, we first obtain measures of the user-cost of R&D from Bloom et al. (2013).[8] The core variation in this measure relates to R&D tax credits, which experience significant variation throughout our sample and that are plausibly exogenous from the perspective of a public firm that is not in the same state as the private firms being "treated" by time-varying tax breaks for R&D spending. We invert the sign of this variable for ease of interpretation, making its intuition as a form of plausibly exogenous variation in private firm incentives to conduct R&D (as noted later, we avoid contamination to the public firm in each public-private pair by only considering private firms that are located in a different state than the focal public firm). For each state in each year, we thus have a measure of R&D incentives for private firms operating in the state.

We measure positive non-innovation-focused shocks using state-level annual real estate price changes from the Federal Housing Finance Authority (FHFA), which are available at the state-year level during our entire sample from 2000 to 2021. The primary impact of high residential real estate price appreciation on a private firm is likely to manifest through either (or both) of two specific channels. First, higher real estate prices in a region can improve liquidity as the firm's owners can raise additional capital using their home as collateral. Second, higher real estate price appreciation can affect private firms due to the existence of local state-wide demand shocks (or local economic booms that increase both home prices

[8] We thank the authors for sharing an extended version of this database through 2016 on their websites.

and local product demand). Our thesis incorporates either view, as we label this shock as a non-innovation-focused positive shock, i.e., it benefits private firms in a region primarily via primitive gains that are not directly tied to innovation as was the case for the R&D shock noted above. To the extent that increased collateral or cashflows from higher demand can facilitate innovation, this too would be part of the treatment effect of such shocks that we will examine. Yet our own thesis goes the other way, as primarily non-innovation positive shocks (to either cashflows or liquidity) can empower the private firm peers to become more aggressive in the product market, moving their products closer to becoming substitutes to the existing public firm products. Our results support this negative view and are not consistent with real estate shocks primarily acting as exploratory innovation shocks.

For both shocks, we only assess the impact of private firm peers located in different states than where the focal public firm is headquartered. This helps to ensure these shocks are plausibly exogenous from the perspective of the focal public firms in our sample, which are in different states and not directly impacted by these shocks.

As our goal is to assess the impact of private firms on public firm investment and outcomes, we next aggregate these shocks over the set of private firms operating in related markets for each focal public firm. To do so, we simply average both shocks (which exist at the private firm-year level) over all of the private firm peers that are 1% granularity peers to the focal public firm (excluding private firms located in the same state as the focal public firm). Because 1% granularity is fine (similar to 4-digit SIC codes), we next compute a "broader version" of these shocks by averaging this quantity over the 5% granularity public firm WTNIC peers for each focal public firm.[9] The granularity of the resulting broader measure is thus similar to 2-digit SIC codes, which have approximately 5% granularity (the odds that two randomly drawn firms are in the same 2-digit SIC code). While our results are robust to using either the narrow definition (which skips the second step) or the broad definition of these shocks, they are considerably stronger using the broad measure. This indicates that greater complementarities are present across a broader set of peers. Overall,

[9]We alternatively could have just used the 5% granularity private firm peers and skip the second average over public peers. However, we were unable to compute this data structure due to its unwieldy size. For example, just computing and extracting the 1% private peers for each public firm takes months to run on a high-end server with parallel processing capabilities. This reflects the fact that the number of observations increases quadratically when computing peer networks and we note that many years have almost a quarter million private firms in our final sample.

we focus on the broader shocks in our main analysis but also report results for the narrow definition in the Online Appendix (discussed in the results section).

4 Descriptive Information and Validation

Table 1 displays the top ten most related domestic private firms for 20 well-known public firms.

Insert Table 1 here

The examples in Table 1 are intuitive and well-illustrate the sometimes-competitive and sometimes-complementary nature of smaller public firms that are similar to these large public firms and also why many might be relevant acquisition candidates when they receive positive innovation shocks through R&D tax credits providing incentives for them to increase innovation. For example, the most similar private firm to Apple is elgato.com, which primarily produces complementary products to Apple. Elgato is a company that sells a collection of hardware devices such as computer cams, a light that can be attached to a computer, wire devices, and teleprompters. These devices do not directly compete with Apple's offerings but are generally seen as complementary devices that make the experience of using Apple's products better.

Another example of a purely complementary relationship is General Dynamics' nearest private peer firm, aerosimulation.com. This company provides flight simulation services to train pilots, whereas General Dynamics manufactures airplanes through the Gulfstream brand. Carnival Cruise's most similar peer is also complementary as it is a travel agency focused on cruises, a business that is likely built around the potentially lucrative market of marketing cruises to various audiences. This relationship is also unambiguously complementary, as both parties benefit when there are positive shocks to travel agencies. As with the prior examples, any significant innovation on the part of this company could make it an acquisition candidate for Carnival, which might be able to quickly scale up the business (or public firms in this situation might simply copy the new technology if it is not protected). Blackrock's nearest peer, Numerix, is also complimentary as it provides risk management technology to investment firms.

Yet, not all peers are complementary. Boeing's nearest peer, boomsupersonic.com, produces supersonic aircraft, a product that is arguably more of a substitute than a complement to Boeing's aircraft offerings. Similarly, CVS' closest private peer is Maxor, a competing pharmacy company. Also, Markel Group's nearest peer is allrisks.com, and both are insurance companies. Yet, although these companies are generally positioned as substitutes, they nevertheless could become relevant acquisition candidates should any of these companies increase their innovativeness. The public firms might acquire them or simply adopt the new technologies without acquisition if the technology is not protected. Both mechanisms are elements of our thesis. Overall, the relative size between the large public firm and the average private firm in our sample is substantial, and thus, the public firm in such pairs can generate significant synergies by scaling up any innovation produced by its smaller private peers, making these complementarities valuable. The intellectual foundation behind this kind of innovation synergy, as is the case for the complementary peers noted above, obtains from Phillips and Zhdanov 2013's theoretical model, suggesting that larger firms can benefit from outsourcing some innovation to smaller private firms, which might be more agile. They later become acquisition candidates.

The examples also illustrate that, in rare cases, unintended peers entered our database. For example, airbus.com appears as a peer to Boeing. This company is neither private nor a U.S. domestic company. Yet Airbus does have locations in the U.S. including manufacturing facilities, indicating why it might appear in the Capital IQ or Orbis databases with a U.S. address (as is required to be in our sample). It was also not filtered out as a public firm because airbus.com does not appear as a public firm URL in the Compustat database. We note that we simply chose 20 intuitive examples to display in Table 1 as we wish to document both strengths and weaknesses in our approach. Yet, in reviewing the list of peers in this table, we believe that the error rate is very low.

Insert Table 2 here

Table 2 summarizes the total number of private firm peers in the full extended WTNIC database. The first column shows the number of URLs with a valid snapshot present on the WayBack Machine each year. Counts range from a quarter of a million in the early years of our sample to over a half-million peers in the middle of our sample. The second column reports the number of peers for which we have a valid U.S. state address, a necessary condition to be included in our final sample as we use state information to compute our key innovation and non-innovation shock variables. The third column summarizes the fraction with state information, and this ranges from 35% to just over 50%, with a higher fraction earlier in our sample. These trends are consistent with less important peers having somewhat lower coverage in earlier years, a pattern seen in many financial databases. We note that our results are robust if we run our analysis in the first half or second half of our sample, indicating that it is unlikely to produce bias.

Insert Table 3 here

Table 3 documents the cross-sectional coverage of our final WTNIC database, which we use to construct our main shock variables. It reports the average number of both private peers and public firms for each Fama-French-12 sector in our final sample. The third column reports the ratio between the two and indicates that our final sample of private peers is roughly 30x to 40x larger than the sample of public firms itself, indicating that we should have high power to test our hypotheses and that our coverage is quite uniformly strong across sectors.

4.1 Public Firm Investment and Outcomes Database

We start with all public firms in the Compustat database from 2000 to 2021. We drop observations with missing assets or assets less than $1 million and retain those that are in the WTNIC database (they have a valid URL and an available WayBack Machine snapshot) in year $t-1$ (we lag all RHS variables). 80,273 observations pass these filters. We also exclude firms that do not have a valid CRSP permno in the merged CRSP Compustat database and that are not in the TNIC database of Hoberg and Phillips (2016), these last steps ensure that we focus on firms that are definitively publicly traded and that are domestic U.S. firms (our results are fully robust if we skip this last step). There are 78,287 observations in our final sample. Table 4 displays summary statistics for our key variables.

Insert Table 4 here

Panel A of Table 4 presents summary statistics for our WTNIC variables, including our innovation-focused R&D Shock and our non-innovation-focused Real Estate Shock. We also report the average log of each focal firm's private firm peer website size (we use this variable in a two-stage IV regression later) and the total similarity of each firm's private rivals as measured in the WTNIC database. All variables have minimum and maximum values that are not extreme relative to the mean and standard deviation, indicating an absence of outliers and there is no need to winsorize these variables.

Panel B displays summary statistics for our standard firm-year corporate and investment variables widely used in the existing literature. All financial ratio variables are winsorized at the 1/99% level. The number of acquisitions and divestitures are from the SDC Platinum database and are also winsorized. The average firm year in our sample has 0.65 acquisitions and 0.241 divestitures. We identify the number of patents for each firm in each year from Kogan et al. (2017). Finally, we compute 10-K Non-Compete agreements as the total number of 10-K paragraphs mentioning these agreements scaled by the total number of paragraphs in the firm's 10-K (implemented using the metaHeuristica software platform).

Table 5 displays Pearson correlation coefficients for our key variables.

Insert Table 5 here

Table 5 shows that our two shock variables, *Private Rivals R&D Shock* and *R.E. Shock*, are just 20.6% correlated, indicating an absence of multicollinearity when we include both as RHS variables in our regressions. We also note that the R&D Shock is positively correlated with sales growth and negatively correlated with TNIC-3 total similarity, which foreshadows some of our main results regarding the positive influence of private firms on public firms when they experience innovation-focused shocks. We also find very little correlation between acquisitions and sales growth, which is in contrast to the strong positive results we find for both (although mainly in the sample of large firms). However, we note that Table 5 correlations are only univariate associations, and our later results are formal as they control for firm and year fixed effects and controls.

4.2 Validation of Private Firm Tests

We construct two plausibly exogenous variables that measure shocks to the private firm peers of focal publicly traded firms. The first is based on R&D tax credits and is a shock specifically to the innovation incentives of these private firms. The second is based on home price appreciation, and we view this shock as a non-innovation-based shock to these private peers (this shock is rooted either in liquidity or demand, as discussed earlier).

We consider an important validation test in this section. If our interpretation of these shocks as primarily innovation-based and non-innovation based is correct, we should observe that the first shock specifically shifts the treated private firms to increase their innovation. The second shock, being non-innovation-based at its roots, should have a much smaller effect on these private firms' innovation. Note that we do not expect zero impact on these private firms' innovation levels because liquidity or demand shocks can also stimulate some increased investment in innovation through the alleviation of financial constraints channel or the demand-induced growth-option to innovate channel. In conclusion, crucial for this validation is that the first shock should strongly and positively predict innovation, and the second should much more weakly positively predict innovation.

Although we do not observe the actual spending on innovation for these private firms, we do observe the number of words in their websites. Because growth in a specific firm's website is likely a direct indicator of innovation (Hoberg and Phillips (2010) use this approach for 10-Ks to model innovation in the form of mergers synergies), we consider a regression of the average website size of the focal firm's private peers on the key RHS variables (the two shocks). We also include firm and year fixed effects and controls for size and age. We display the results in Table 6.

Insert Table 6 here

The table shows that the ex ante Private Rivals R&D shock very strongly predicts the ex post average size of the private peer's websites. The t-statistic is 22.8, indicating that the R&D tax credit shock indeed is a strong shifter of innovation investment by the treated private firms. The table also shows that the ex ante Private Rivals Real Estate Shock only weakly predicts ex post private firm website size. Here the t-statistic is only 3.11. Because we standardize the RHS variables in this regression prior to running the regression, we can also compare the coefficient magnitudes. The table shows that the R&D shock's coefficient (0.031) is 15 times larger than the Real Estate shock's coefficient (0.002). This confirms that not only is the R&D shock statistically far more important to innovation, but it is also economically much larger. We conclude that our interpretation of these two shocks as being innovation-based and non-innovation-based is validated.

5 Economic Results

5.1 Regression Methodology

In this section, we directly examine the impact of positive innovation-focused and non-innovation focused private firm shocks on their public firm peers. As discussed earlier, we construct these shocks using plausibly exogenous variation relating to R&D tax credits and the price appreciation of residential real estate, both measured in the states where private firms are located. To further ensure the variation is plausibly exogenous, for each focal public firm in our sample, we ensure that these shocks are measured only using private firms located in states other than the state where the public firm is headquarted. In addition, we lag all RHS variables including these two shock variables to ensure all are measurable by year t, and predict ex-post outcomes in year $t+1$. In all of our regressions, the dependent variable is the focal public firm's investment or outcome variable and the panel is a pubic-firm x year panel. We include firm and year fixed effects in all regressions as well as controls for log size and log age.

5.2 Baseline Results

Our first test examines the unconditional impact of both shocks on public firm investment and outcomes. The results are displayed in Table 7.

Insert Table 7 here

We first focus on the innovation-focused shock represented by the variable "Priv Rivals R&D Shock". Panel A displays results for investments, and the first column shows that ex-ante shocks to the innovation incentives of private firm peers result in significantly more acquisitions for the focal public firm but do not impact the number of divestitures. We also observe higher levels of organic investment in the form of R&D/assets and also higher patents/assets. These results indicate significant and positive innovation spillovers. The results are particularly strong for R&D as the t-statistic is 7.21. Finally, the last column in Panel A shows that public firms in markets where private firms realize innovation shocks also increase their use of non-compete agreements. This result suggests that these spillovers are not without competitive threats, but overall, the results indicate strong and consistent positive spillovers.

Panel B of Table 7 displays performance outcomes for both shocks. We find that innovation-focused shocks to private peers result in higher ex post sales growth and asset growth for related public firms, although we also observe some significant reduction in profits in the form of return on assets. The lower ROA is likely related to the adjustment costs associated with the much more significant increase in R&D (our later results will further support this as the lower ROA is unique to smaller firms, which increase R&D the most). The table also shows that these public firms have a very significant reduction in total TNIC similarity, indicating a large improvement in product differentiation and, thus, lower competition. The results in Panel B overall show that the results for private firm innovation shocks bring consistent and material improvements not only in investment for related public firms but also in their performance and improved competitive positioning. Yet we note, as above, that these gains are not without some evidence of increased competitive threats, as the last column shows positive and significant increases in product market fluidity (indicating higher competitive threats as noted in Hoberg et al. (2014)).

The second row in both panels of Table 7 displays results for the non-innovation focused private firm shock. We find essentially diametric-opposite findings. Because these variables are only modestly correlated, we note that these results are robust to including each in the regression separately. The non-innovation shock leads to fewer acquisitions by the focal public firms, no effect on R&D, and these public firms receive fewer patents. We find no significant results for non-compete agreements. From an investment perspective, these non-innovation shocks are generally opposite those the innovation-focused shock as we find public firms overall scale back. Panel B reinforces this negative interpretation as these public firms experience lower ROA, lower asset growth, and increased competition in the form of total TNIC similarity. Moreover, we find higher levels of competitive threats in the form of product market fluidity. Not only do these results point to negative outcomes, but the increased competition in the form of total similarity and fluidity are furthermore consistent with the substitution hypothesis as increased total similarity is direct evidence of increased substitution.

Overall our baseline findings support the conclusion that innovation-focused shocks to private firms lead to positive complementarities along many dimensions for peer public firms. This suggests that policies aimed at improving small firm incentives to innovate should have positive multiplier effects as they also stimulate significant increases in innovation for (not-directly-treated) larger public firms. On the other hand, positive non-innovation-focused shocks have the opposite effects and lead to increased substitution between public and private firms. Policies aimed at improving non-innovation gains for smaller private firms are thus less likely to result in multiplier effects and improved overall growth. To further understand the mechanisms behind these effects and understand where complementarities versus substitution arises, we next explore a number of theoretically motivated subsamples including large versus small firms, young versus old firms, tech versus non-tech firms, and firms facing high versus low competition.

5.3 Large versus Small Firms

We next explore the impact of these shocks on smaller versus larger publicly traded firms. In each year, we sort our sample of public firms by lagged assets and define large (small) firms as those with above (below) median assets in the given year. We then rerun our baseline model in Table 7 after adding interactions between the large and small firm dummies and the two private firm shocks. The results are presented in Table 8.

Insert Table 8 here

Panel A shows that the impact of the private firm innovation shock is quite different for large versus small public firms. Large public firms make significantly more acquisitions (t-statistic near 5.0) and increase R&D modestly (t-statistic 2.1). In contrast, small firms do not significantly acquire more but instead dramatically increase their R&D (t-statistic 8.5). Both firms patent more frequently, and large public firms increase their use of non-compete agreements, whereas smaller firms do not. These findings are consistent with our third hypothesis.

The results suggest that large firms internalize the significant innovation complementarities primarily through acquisition, and they protect these gains using non-compete agreements, which seems important following some acquisitions where important personnel is involved. These results are consistent with Phillips and Zhdanov (2013) and the intuition that large firms can benefit most from acquisitions and can pay more for targets as they are capable of scaling up any acquired innovation more than smaller public firms. Panel B shows that this strategy is highly successful as these large public firms experience highly significant sales growth and asset growth, as well as weakly significant increases in ROA. Moreover, they experience very large gains in product differentiation from other public rivals, indicating improved competitive positioning. These uniform and significant gains are counterbalanced by an increase in product market fluidity, indicating some increased competitive threat. This result illustrates why the increased use of non-compete agreements is likely optimal.

Small public firms, because they do not acquire more, internalize the innovation complementarities in an entirely different way. The investment results suggest their reaction is primarily to ramp up organic R&D, which also facilitates increased patenting and thus some improvements in barriers to entry. Panel B shows that this strategy is less effective than that of the larger public firms. Yet these firms still experience gains in sales growth and asset growth although they are somewhat smaller and less significant than those for the larger public firms. Yet the small firms experience significant declines in ROA (t-statistic -4.8), while the larger firms experienced an increase. This likely reflects the increased adjustment costs of the increased R&D. Because these firms also experience significant reductions in total similarity, their competitive positioning is improved following these innovation shocks and the overall evidence suggests that the organic strategy of smaller firms generates gains, but the gains are somewhat smaller, and also more risky than are the unambiguous gains realized by larger public firms.

Regarding the non-innovation-focused shock to private firms, Panel A of Table 8 suggests that the reduced investments and lower patenting activity documented in our baseline results are felt roughly equally by small and large public firms. Panel B indicates that the impact of this shock on performance is significantly worse for large public firms, which experience significant losses in ROA, lower asset growth, and higher competition in the form of total similarity. As our results indicate that the non-innovation-focused shock primarily increases substitution, these results suggest that larger public firms are the primary target and, thus, the biggest losers. This suggests that policies delivering benefits to small firms through liquidity or increased demand rather than through innovation incentives will likely result in a transfer of business and market share from larger public firms to smaller private firms. Smaller private firms are in the middle and are less exposed.

5.4 Old versus Young Firms

We next explore the impact of these shocks on younger versus older publicly traded firms. In each year, we thus sort our sample of public firms by firm age and define old (young) firms as those with above (below) median age in the given year. We then rerun our baseline model in Table 7 after adding interactions between the old and young firm dummies and the two private firm shocks. The results are presented in Table 9.

Insert Table 9 here

Our motivation for considering these tests is rooted in the hypothesis that younger firms are potentially more agile than older firms and might better internalize gains from complementarities. Their agility may also help them to escape competition better when shocks imply increased substitution.

Our results on this prediction are somewhat mixed. Panel A shows that the private firm innovation shock leads both old and young firms to increase acquisitions, R&D and patents. Consistent with the agility thesis, the younger firms are able to increase R&D and patents more than the older firms, but the differences are modest. However, regarding the non-innovation-focused shock, younger firms reduce patenting activity, whereas older firms do not significantly decrease patents, suggesting that older firms are better at preserving barriers to entry.

The outcomes in Panel B also suggest that results for old versus young firms are not strongly different. Young firms experience reduced ROA for the innovation shock whereas old firms experience losses in ROA for the non-innovation shock. Both old and young experience similar outcome results for sales growth, asset growth and total similarity. Yet smaller firms appear to realize economically larger reductions in total similarity following the innovation shock, illustrating some modest evidence of their having better agility. Yet we conclude that firm age is not as important as firm size as a moderator of these results.

5.5 Firms in Innovative vs non-Innovative Markets

We hypothesize that tech-oriented firms in innovative markets might react differently to our primary innovation and non-innovation shocks. Yet predictions could go either way, as more innovative private firms could be seen as particularly complementary (stronger positive effects) or their innovation itself might be a threat when the shock is specifically about innovation (substitution effects). As this is an empirical question, we analyze whether firms in innovative industries or non-innovative industries experience similar effects.

We define firms in innovative industries as those where the average lagged R&D/assets of TNIC peers is above (below) median. We then rerun our baseline model in Table 7 after adding interactions between the innovative and non-innovative industry dummies and the two private firm shocks. The results are presented in Table 10.

Insert Table 10 here

The investment results in Panel A show that results are overall quite similar across the two groups with only modest differences. Both innovative and non-innovative firms experience more acquisitions following private firm peer innovation shocks, although only the more innovative firms experience reduced M&A following non-innovation real estate shocks. This suggests that substitution shocks from improved peer liquidity are more important in innovative markets. We continue to find only weak results for divestitures, and intuitively find that innovative industry firms are more responsive in their R&D policies although non-innovative industry firms also increase R&D following peer innovation shocks.

The performance results in Panel B are also intuitive as less innovative firms realize gains in profitability rather quickly following innovation shocks as they can incorporate new technology features more quickly into their products. More innovative firms experience declines in profitability, likely relating to their rather sharp increases in R&D, thus consistent with high adjustment costs. Both types of firms experience increased sales growth, although this is only significant for firms in non-innovative industries. Both types of firms experience asset growth (consistent with the acquisitions) and significant reductions in total similarity, suggesting that the technology spillovers help these firms succeed in differentiating themselves from their rivals. Both types also observe higher fluidity as the new technology permeates the market. Regarding non-innovation shocks, we continue to find substitution effects in the form of lower profits and some increases in total similarity and fluidity, all consistent with increased competition and some losses in market position.

We conclude that the impact of innovation-focused policies favoring smaller private firms is quite consistent across firms in innovative industries versus those in less innovative industries with only modest differences across these groups.

5.6 Firms Facing High versus Low Competition

We next explore the impact of these shocks on firms facing high versus low competition. In each year, we thus sort our sample of public firms by TNIC-3 total similarity and define high (low) competition firms as those with above (below) median total similarity in the given year. We then rerun our baseline model in Table 7 after adding interactions between the high and low competition dummies and the two private firm shocks.

The motivation for these tests is multifaceted and we expect results to be stronger for firms in competitive markets. First, these firms face more competitors, and major shocks to them should create stronger complementarities or substitution effects. Second, these firms stand to benefit more than firms facing less competition if they can improve their competitive position. In particular, innovation can create value-adding product differentiation and escape from the most intense competition. The results are presented in Table 11.

Insert Table 11 here

Panel A of Table 11 strongly supports our predictions as the increases in acquisitions, R&D and patenting are notably stronger for high competition public firms. Yet one interesting twist is that non-compete agreements is the only variable that is stronger for low competition firms. This suggests that the primary concern of low competition firms when innovation shocks come is to maintain their barriers to entry but otherwise continue the "quiet life" with only modest increases in innovation.

The performance results in Panel B then confirm the intuitive consequences of the Panel A findings. Indeed the public firms facing high competition experience the sharpest gains in the form of sales and asset growth, as well as lower competition (less total similarity). Both firm types experience lower ROA likely due to adjustment costs or limit pricing to reinforce barriers to entry.

Regarding the non-innovation private firm shock, where our baseline results indicate substitution, Table 11 shows that the losses due to substitution are overwhelmingly born by the public firms facing high competition. These firms experience lower ROA, less asset growth, and more intense competition. Yet the low competition public firms do not realize any significant losses, as their barriers to entry are likely robust to shocks to these smaller private firms.

6 Robustness and Two-Stage Tests

Our main results indicate strong evidence that private firm peer innovation shocks result in strong complementarities for public firm peers, especially larger firms operating in non-technology markets and firms in more competitive markets. In contrast, non-innovation-focused shocks lead to substitution effects and poor performance by public firm peers. In this section, we examine the robustness of these findings.

6.1 Public Website Peers

One important question is whether our results are "special" to small private firms, or whether having more public firm peers generates similar findings. We thus use the public-to-public WTNIC similarities database and first identify the peers associated with a 5% granularity classification. For each focal public firm, we then compute the total similarity relative to its peers as the sum of the pairwise similarities. This approach is the same as that used by Hoberg and Phillips (2016) to compute the TNIC-2 classification but applied to website similarities instead of 10-K text similarities. As is the case with our private firm peers, this 5% granularity is consistent with two-digit SIC codes. In this section, we examine if our results are robust to controlling for the website total similarity of public peers. This would ensure that information from the public peers is unique.

Insert Table IA1 here

Table IA1 displays the results of adding the control for the public peer total similarity to the baseline results in Table 7. Both regarding investments in Panel A and performance in Panel B, we find that our results are highly robust.

6.2 Narrow Peers

As noted in our methods Section 3, our baseline tests define the private firm peers for each public firm based on a 5% granularity. This level of granularity is relatively broad, and in line with two-digit SIC codes. In this section, we consider a more narrow 1% granularity definition of private firm peers. There are two primary consequences of doing so. First, the number of peers will be substantially fewer, resulting in lower power. Second, the peers remaining under this narrow definition are “more similar” to the focal public firms. A consequence is that substitution effects are more likely.

Insert Table IA2 here

We present the results of this test in Table IA2. Regarding investments in Panel A, we see significantly weaker results. For example, for the innovation-focused shock, we find no significant results for acquisitions, and moreover, the coefficient flips to negative. This is consistent both with less power (predicts the insignificance) and with more substitution (predicts the sign flip). Regarding R&D and patents, we observe some increases by public firms following this shock although they are significantly weaker than our baseline results. This finding also fits the predictions as R&D and patents are predicted to increase both under the complementarities hypothesis but also under the substitution hypothesis if the innovation is being conducted to escape competition and the patents are being issued to build stronger barriers to entry.

Regarding performance in Panel B, the results for the innovation-focused shock generally favor the complementary interpretation but are weaker than our baseline results in Table 7. We do observe significant sales and asset growth and reduced competition. The non-innovation-focused shock produces results indicating substitution as is the case in the baseline tests, although they are not as strong as the baseline.

We conclude that our results are most definitive when we define private firm peers using the more broad 5% granularity. When using a more narrow definition, many but not all results are robust, and overall, the results shift somewhat toward substitution for the narrow peers.

6.3 Two-Stage Models

Our main tests in Table 7 and the corresponding subsamples utilize plausibly exogenous shocks, and we find strong results regarding complementarity and substitution, as noted above. These tests are done using a reduced-form one-stage model. In this section, we explore whether we can draw similar conclusions using a two-stage variables model.

In order to do so, we first need to clarify that, at least from the perspective of our innovation-focused private firm shock, this plausibly exogenous shock is a shifter of private firm innovative output. In particular, our mechanism posits that the private firms increase their exploratory innovation following the R&D tax credits being increased, and in turn, this induces complementarities on the related public firms. In order to build the two-stage model, we thus need a measure of the endogenous innovative output of the private firms that are treated by the shock.

We measure exploratory innovation using the number of words in the private firm websites. Intuitively, a private firm investing in innovation will develop new products or features, and a consequence is that its website will increase in size and richness. To aggregate website size over the private peers of each public firm, we simply average the website size over the given private peers of each focal firm (following the same methods as used to build our shock variables).[10] We then take the natural logarithm of the resulting average to reduce the impact of outliers.

[10]For example, we also exclude private firms in the same state as the focal public firm).

In our two-stage model, the first stage regresses the log average website size on the private peer innovation-focused shock variable. The precise specification is column (2) of our validation Table 6. This table shows that the innovation-focused shock is a very strong shifter of website size with a t-statistic of 22.8, indicating a strong effect.

Insert Table 12 here

Table 12 displays the second stage results where we regress our investment and additional outcome dependent variables on the instrumented private firm rival website size. The results in Panel A for investment variables and in Panel B for operating income and growth variables show similar results as our reduced form evidence presented earlier.

7 Conclusions

We use a large dynamic spatial network of over 500,000 public and private firms to examine how private firms impact publicly traded firms. This network captures inter-firm relatedness for both private and public firms. We examine how shocks to the private firms in this network impact public firm investment, profitability, growth, and acquisitions of private firms by public firms.

The spatial network is based on the newly introduced WTNIC website-based industry classification database. The database provides a dynamic spatial model of market structure covering the U.S. economy, and that includes all publicly traded companies with available website URLs along with over 500,000 private firms with valid URLs in each year.

We use the spatial model to examine two plausibly exogenous shocks to the private firm peers in the same markets as each focal public firm. The first is based on R&D tax credits and is an innovation shock, and the second is based on real estate price appreciation and is a non-innovation-based shock. These shocks are calculated using shocks to related private firms that operate in states outside where the public firm headquarters is located. They are more likely to impact the private firms who concentrate their operations in specific states. We use regressions predicting growth in the size of these private firm websites to validate our interpretation of these shocks as innovation-based and non-innovation-based.

We document that private firm innovation shocks benefit public peers when the private firm states introduce R&D tax credits. The impact on the public firms is improved profitability, sales growth, and investments including R&D. These results are stronger for large public firms that also engage in more acquisitions of private firms as predicted by Phillips and Zhdanov (2013). Measures of competition and competitive threats also decline following private firm innovation shocks. Small public firms do not increase acquisitions but instead strongly increase R&D to organically benefit from the complementarities. These firms also perform well, but overall, large firms are the primary beneficiaries. These results suggest that complementarities and positive spillovers arise in multiple forms following private firm innovation shocks. Although we find uniform effects for young versus old firms, we also find that results are stronger when firms are in more competitive markets.

In contrast, state-level positive real estate shocks, which improve the liquidity of private firms, negatively impact related public firms. Public firms decrease investments and perform poorly when private peers receive positive real-estate shocks. These results are consistent with increased competition for public firms from private firms as these shocks improve the liquidity and demand of the private firms and thus increase the competitive intensity of treated private firms. We also directly observe increasing levels of competition for public firms from private peers (measured as total product market similarity with peers).

Overall, these results suggest that innovation shocks increase private firm complementarity, whereas non-innovation demand or liquidity shocks enable private firms to challenge public firms as competitors. These results should prove useful to policymakers regarding policies aimed at increasing the incentives for small private firms to grow. The results suggest that improving the incentives to innovate will create significant positive complementarities to the public peers of these firms, suggesting a positive economic multiplier effect to such policies, further suggesting that such policies could stimulate more economic growth in addition to assisting these small firms. In contrast, policies that target small firm liquidity or that increase demand (such as economic stimulus) do not create analogous positive spillovers for public firms. Rather, these shocks increase competition for public firms.

We believe more research on how these shocks propagate through firm networks is needed and should prove fruitful, as well as more research exploring the efficacy of small-business policy initiatives.

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Table 1: Examples of top ten most similar websites to U.S. public firms (pg 1 of 4)

The table first reports the top ten most similar websites in 2021 to example well-known public firms.

Company Name	Company Website	Rank	Peer Website	Similarity
Apple Inc	apple.com	1	elgato.com	0.429
Apple Inc	apple.com	2	dashlane.com	0.427
Apple Inc	apple.com	3	intego.com	0.413
Apple Inc	apple.com	4	terracycle.com	0.410
Apple Inc	apple.com	5	moto.com	0.406
Apple Inc	apple.com	6	bittorrent.com	0.399
Apple Inc	apple.com	7	universalclimate.com	0.399
Apple Inc	apple.com	8	storedvalue.com	0.396
Apple Inc	apple.com	9	beatsbydre.com	0.392
Apple Inc	apple.com	10	revent.com	0.390
Barrick Gold Corp	barrick.com	1	apollogold.com	0.417
Barrick Gold Corp	barrick.com	2	twin-metals.com	0.373
Barrick Gold Corp	barrick.com	3	doerun.com	0.371
Barrick Gold Corp	barrick.com	4	aquilaresources.com	0.365
Barrick Gold Corp	barrick.com	5	sedgman.com	0.355
Barrick Gold Corp	barrick.com	6	easternresourcesinc.com	0.344
Barrick Gold Corp	barrick.com	7	hatch.com	0.338
Barrick Gold Corp	barrick.com	8	gsr.com	0.330
Barrick Gold Corp	barrick.com	9	vitgoldcorp.com	0.319
Barrick Gold Corp	barrick.com	10	theaureport.com	0.302
Blackrock Inc	blackrock.com	1	numerix.com	0.410
Blackrock Inc	blackrock.com	2	causewaycap.com	0.397
Blackrock Inc	blackrock.com	3	eqderivatives.com	0.386
Blackrock Inc	blackrock.com	4	kingstreet.com	0.364
Blackrock Inc	blackrock.com	5	smartstream-stp.com	0.353
Blackrock Inc	blackrock.com	6	fxcm.com	0.348
Blackrock Inc	blackrock.com	7	circleci.com	0.341
Blackrock Inc	blackrock.com	8	gatescap.com	0.332
Blackrock Inc	blackrock.com	9	kurtosys.com	0.331
Blackrock Inc	blackrock.com	10	liquidplanner.com	0.330
Boeing Co	boeing.com	1	boomsupersonic.com	0.582
Boeing Co	boeing.com	2	airbus.com	0.514
Boeing Co	boeing.com	3	airwaysmag.com	0.487
Boeing Co	boeing.com	4	motoart.com	0.486
Boeing Co	boeing.com	5	propilotmag.com	0.471
Boeing Co	boeing.com	6	speednews.com	0.466
Boeing Co	boeing.com	7	syberjet.com	0.461
Boeing Co	boeing.com	8	elitetraveler.com	0.451
Boeing Co	boeing.com	9	nextantaerospace.com	0.446
Boeing Co	boeing.com	10	evertsair.com	0.446
Carnival Corporation Plc	carnivalcorp.com	1	cruises-n-more.com	0.392
Carnival Corporation Plc	carnivalcorp.com	2	sailami.com	0.349
Carnival Corporation Plc	carnivalcorp.com	3	vacationstogo.com	0.341
Carnival Corporation Plc	carnivalcorp.com	4	islandwindjammers.com	0.326
Carnival Corporation Plc	carnivalcorp.com	5	gatewaytrvl.com	0.326
Carnival Corporation Plc	carnivalcorp.com	6	northsails.com	0.315
Carnival Corporation Plc	carnivalcorp.com	7	monroetravel.com	0.314
Carnival Corporation Plc	carnivalcorp.com	8	faredeals.com	0.312
Carnival Corporation Plc	carnivalcorp.com	9	prestigecruises.com	0.309
Carnival Corporation Plc	carnivalcorp.com	10	pathfinderstravel.net	0.308

Table 1: Examples of top ten most similar websites to U.S. public firms (pg 2 of 4)

The table first reports the top ten most similar websites to sample well-known public firms.

Company Name	Company Website	Rank	Peer Website	Similarity
Cvs Health Corp	cvshealth.com	1	maxor.com	0.485
Cvs Health Corp	cvshealth.com	2	optum.com	0.427
Cvs Health Corp	cvshealth.com	3	serve-you-rx.com	0.424
Cvs Health Corp	cvshealth.com	4	americanhealthcare.com	0.419
Cvs Health Corp	cvshealth.com	5	carecentrix.com	0.416
Cvs Health Corp	cvshealth.com	6	valuedrugco.com	0.404
Cvs Health Corp	cvshealth.com	7	worldcongress.com	0.399
Cvs Health Corp	cvshealth.com	8	aetna.com	0.396
Cvs Health Corp	cvshealth.com	9	cvs.com	0.394
Cvs Health Corp	cvshealth.com	10	medimpact.com	0.385
Dell Technologies Inc	delltechnologies.com	1	tig.com	0.475
Dell Technologies Inc	delltechnologies.com	2	cimasg.com	0.433
Dell Technologies Inc	delltechnologies.com	3	madeit.com	0.425
Dell Technologies Inc	delltechnologies.com	4	workspot.com	0.422
Dell Technologies Inc	delltechnologies.com	5	greenpages.com	0.421
Dell Technologies Inc	delltechnologies.com	6	redapt.com	0.420
Dell Technologies Inc	delltechnologies.com	7	inxero.com	0.420
Dell Technologies Inc	delltechnologies.com	8	allinestech.com	0.419
Dell Technologies Inc	delltechnologies.com	9	ndm.net	0.413
Dell Technologies Inc	delltechnologies.com	10	involta.com	0.413
Dish Network Corp	dish.com	1	sling.com	0.495
Dish Network Corp	dish.com	2	directv.com	0.471
Dish Network Corp	dish.com	3	directstartv.com	0.412
Dish Network Corp	dish.com	4	mlgc.com	0.403
Dish Network Corp	dish.com	5	xfinity.com	0.399
Dish Network Corp	dish.com	6	allconnect.com	0.397
Dish Network Corp	dish.com	7	etex.net	0.392
Dish Network Corp	dish.com	8	bctelco.com	0.389
Dish Network Corp	dish.com	9	secv.com	0.378
Dish Network Corp	dish.com	10	godish.com	0.372
Disney (Walt) Co	thewaltdisneycompany.com	1	vreg.com	0.483
Disney (Walt) Co	thewaltdisneycompany.com	2	nbcuniversal.com	0.475
Disney (Walt) Co	thewaltdisneycompany.com	3	unifiedpictures.com	0.436
Disney (Walt) Co	thewaltdisneycompany.com	4	henson.com	0.431
Disney (Walt) Co	thewaltdisneycompany.com	5	entertainmentbenefits.com	0.424
Disney (Walt) Co	thewaltdisneycompany.com	6	rsafilms.com	0.417
Disney (Walt) Co	thewaltdisneycompany.com	7	digitaldomain.com	0.415
Disney (Walt) Co	thewaltdisneycompany.com	8	alkemy-x.com	0.415
Disney (Walt) Co	thewaltdisneycompany.com	9	paragontheaters.com	0.413
Disney (Walt) Co	thewaltdisneycompany.com	10	swank.com	0.410
General Dynamics Corp	gd.com	1	aerosimulation.com	0.438
General Dynamics Corp	gd.com	2	gdmissionsystems.com	0.437
General Dynamics Corp	gd.com	3	elbitsystems-us.com	0.418
General Dynamics Corp	gd.com	4	dynetics.com	0.417
General Dynamics Corp	gd.com	5	ltc-ltc.com	0.416
General Dynamics Corp	gd.com	6	i3-corps.com	0.405
General Dynamics Corp	gd.com	7	pesystems.com	0.399
General Dynamics Corp	gd.com	8	ndieng.com	0.390
General Dynamics Corp	gd.com	9	linquest.com	0.386
General Dynamics Corp	gd.com	10	clearedconnections.com	0.383

Table 1: Examples of top ten most similar websites to U.S. public firms (pg 3 of 4)

The table first reports the top ten most similar websites to sample well-known public firms.

Company Name	Company Website	Rank	Peer Website	Similarity
Kraft Heinz Co	kraftheinzcompany.com	1	brfoods.com	0.281
Kraft Heinz Co	kraftheinzcompany.com	2	sfrindustries.com	0.278
Kraft Heinz Co	kraftheinzcompany.com	3	gehls.com	0.275
Kraft Heinz Co	kraftheinzcompany.com	4	frischs.com	0.275
Kraft Heinz Co	kraftheinzcompany.com	5	eggstrategy.com	0.273
Kraft Heinz Co	kraftheinzcompany.com	6	kerry.com	0.270
Kraft Heinz Co	kraftheinzcompany.com	7	nestleusa.com	0.263
Kraft Heinz Co	kraftheinzcompany.com	8	dennisexpress.com	0.262
Kraft Heinz Co	kraftheinzcompany.com	9	purestrategies.com	0.259
Kraft Heinz Co	kraftheinzcompany.com	10	qualitydairy.com	0.259
Lowes Cos Inc	lowes.com	1	keimlumber.com	0.481
Lowes Cos Inc	lowes.com	2	shadesoflight.com	0.481
Lowes Cos Inc	lowes.com	3	hollywoodhillsrehab.com	0.479
Lowes Cos Inc	lowes.com	4	alvarezhomes.com	0.479
Lowes Cos Inc	lowes.com	5	marvinsbuildingmaterials.com	0.473
Lowes Cos Inc	lowes.com	6	doityourself.com	0.454
Lowes Cos Inc	lowes.com	7	sterlingenergy.info	0.441
Lowes Cos Inc	lowes.com	8	madseninc.com	0.440
Lowes Cos Inc	lowes.com	9	kitchens.com	0.433
Lowes Cos Inc	lowes.com	10	ccair.com	0.432
Markel Group Inc	markel.com	1	allrisks.com	0.415
Markel Group Inc	markel.com	2	propertyandcasualty.com	0.366
Markel Group Inc	markel.com	3	seibels.com	0.362
Markel Group Inc	markel.com	4	amwins.com	0.356
Markel Group Inc	markel.com	5	jmwilson.com	0.354
Markel Group Inc	markel.com	6	hudsoninsgroup.com	0.352
Markel Group Inc	markel.com	7	stonepoint.com	0.352
Markel Group Inc	markel.com	8	westernlitigation.com	0.348
Markel Group Inc	markel.com	9	hilbgroup.com	0.341
Markel Group Inc	markel.com	10	thewrcgroup.com	0.337
Merck Co	merck.com	1	merck-animal-health-usa.com	0.371
Merck Co	merck.com	2	bioplusrx.com	0.359
Merck Co	merck.com	3	targethealth.com	0.356
Merck Co	merck.com	4	gumberg.com	0.336
Merck Co	merck.com	5	biospace.com	0.334
Merck Co	merck.com	6	decisionresourcesgroup.com	0.330
Merck Co	merck.com	7	prahs.com	0.326
Merck Co	merck.com	8	us.sandoz.com	0.316
Merck Co	merck.com	9	inventprise.com	0.315
Merck Co	merck.com	10	spectrumscience.com	0.312
Microsoft Corp	microsoft.com	1	aschereenergy.com	0.257
Microsoft Corp	microsoft.com	2	kensington.com	0.257
Microsoft Corp	microsoft.com	3	winzip.com	0.249
Microsoft Corp	microsoft.com	4	thinksmartinc.com	0.247
Microsoft Corp	microsoft.com	5	munters.com	0.245
Microsoft Corp	microsoft.com	6	smartavi.com	0.241
Microsoft Corp	microsoft.com	7	hafeezcontractor.com	0.236
Microsoft Corp	microsoft.com	8	mhi.com	0.234
Microsoft Corp	microsoft.com	9	lacomputercompany.com	0.231
Microsoft Corp	microsoft.com	10	haascnc.com	0.230

Table 1: Examples of top ten most similar websites to U.S. public firms (pg 4 of 4)

The table first reports the top ten most similar websites to sample well-known public firms.

Company Name	Company Website	Rank	Peer Website	Similarity
Salesforce Inc	salesforce.com	1	technologyadvice.com	0.403
Salesforce Inc	salesforce.com	2	demandgen.com	0.389
Salesforce Inc	salesforce.com	3	simplus.com	0.380
Salesforce Inc	salesforce.com	4	ismsystems.com	0.377
Salesforce Inc	salesforce.com	5	sigstr.com	0.376
Salesforce Inc	salesforce.com	6	immediatelyapp.com	0.375
Salesforce Inc	salesforce.com	7	mothernode.com	0.369
Salesforce Inc	salesforce.com	8	improveit360.com	0.367
Salesforce Inc	salesforce.com	9	financialforce.com	0.364
Salesforce Inc	salesforce.com	10	redargyle.com	0.362
Starbucks Corp	starbucks.com	1	crimsoncup.com	0.379
Starbucks Corp	starbucks.com	2	scooterscoffee.com	0.355
Starbucks Corp	starbucks.com	3	ipsento.com	0.349
Starbucks Corp	starbucks.com	4	gavina.com	0.347
Starbucks Corp	starbucks.com	5	cdccoffee.com	0.341
Starbucks Corp	starbucks.com	6	newenglandcoffee.com	0.335
Starbucks Corp	starbucks.com	7	dunkindonuts.com	0.320
Starbucks Corp	starbucks.com	8	badasscoffee.com	0.309
Starbucks Corp	starbucks.com	9	victrolacoffee.com	0.308
Starbucks Corp	starbucks.com	10	moustachecoffeeclub.com	0.307
Tesla Inc	tesla.com	1	arm.com	0.325
Tesla Inc	tesla.com	2	spacex.com	0.315
Tesla Inc	tesla.com	3	getcruise.com	0.311
Tesla Inc	tesla.com	4	mbrdna.com	0.306
Tesla Inc	tesla.com	5	ultracell-llc.com	0.305
Tesla Inc	tesla.com	6	commutercars.com	0.300
Tesla Inc	tesla.com	7	transphormusa.com	0.297
Tesla Inc	tesla.com	8	listentech.com	0.296
Tesla Inc	tesla.com	9	herasys.com	0.295
Tesla Inc	tesla.com	10	in.mathworks.com	0.295
Uber Technologies Inc	uber.com	1	firsttransit.com	0.288
Uber Technologies Inc	uber.com	2	honkforhelp.com	0.286
Uber Technologies Inc	uber.com	3	motolingo.com	0.276
Uber Technologies Inc	uber.com	4	drivemode.com	0.274
Uber Technologies Inc	uber.com	5	tripactions.com	0.263
Uber Technologies Inc	uber.com	6	spothero.com	0.261
Uber Technologies Inc	uber.com	7	all-startransportation.com	0.259
Uber Technologies Inc	uber.com	8	deem.com	0.257
Uber Technologies Inc	uber.com	9	flycorona.com	0.254
Uber Technologies Inc	uber.com	10	carvertise.com	0.248
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	1	valuedrugco.com	0.375
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	2	burnsgroupnyc.com	0.306
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	3	astrupdrug.com	0.303
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	4	rangeme.com	0.300
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	5	maxor.com	0.296
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	6	acosta.com	0.295
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	7	knipper.com	0.295
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	8	pharmacarehawaii.com	0.290
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	9	medicalpharmacyct.com	0.287
Walgreens Boots Alliance Inc	walgreensbootsalliance.com	10	kohlberg.com	0.286

Table 2: Private Firm Website Coverage Over Time

The table first reports the total number of private firms in our sample of websites in each year in the first two columns. The third column indicates how many of these website-year observations have available headquarter state data from Orbis or Capital IQ.The final column indicates the fraction of observations that have information on HQ location in the given year.

Year	Total # Private Firms	# Private FIrms w/ State Data	Fraction Covered
2000	128,814	67,450	0.524
2001	224,651	115,552	0.514
2002	253,200	129,017	0.510
2003	284,619	143,252	0.503
2004	321,762	159,015	0.494
2005	308,165	153,427	0.498
2006	286,951	144,067	0.502
2007	298,420	147,961	0.496
2008	353,979	172,109	0.486
2009	353,465	169,716	0.480
2010	362,302	171,669	0.474
2011	390,945	182,081	0.466
2012	419,655	193,397	0.461
2013	507,914	225,227	0.443
2014	478,383	208,656	0.436
2015	554,184	233,727	0.422
2016	554,662	226,675	0.409
2017	452,830	184,474	0.407
2018	406,182	159,914	0.394
2019	377,458	147,715	0.391
2020	415,398	150,879	0.363
2021	426,827	150,441	0.352

Table 3: Private Firm Website Coverage by Fama-French-12 Sectors

The table first reports the average number of public rivals and private rivals each firm has during our sample for each of the Fama-French-12 industry sectors. Both calculations are done at the 5% granularity level, which is similar to how coarse 2-digit SIC codes are.

Fama-French-12 Sector	Average # Private Peers	Average # Public Peers	Ratio: Public to Private
Chemicals	8,269	264	31.3x
Cons Durables	8,600	284	30.3x
Cons NonDurables	9,521	253	37.6x
Energy	5,637	293	19.2x
Finance	12,088	311	38.9x
Health	7,958	308	25.8x
Manufacturing	10,005	269	37.1x
Misc	11,449	270	42.4x
Retail/Wholesale	9,855	301	32.8x
Tech + Bus Equp	11,679	307	38.1x
Telecom	9,876	312	31.6x
Utilities	6,627	239	27.8x

Table 4: Summary statistics

Summary statistics are reported for our sample based on annual firm observations from 2000 to 2021. Panel A summarizes three characteristics of the private firms operating in a public firm's product market including their tax-credit-based R&D incentives and the non-innovation positive shock implied by real estate gains in the states the private firms operate in (multiplied by 1000 for reporting purposes). We also report the average number of words in private peer websites. Finally, our fourth WTNIC variable is the total similarity of the public peers operating in the given firm's product market (public peer total similarity). Panel B reports summary statistics for various investment and outcome variables from Compustat, the SDC Platinum database, and the HP2016 TNIC data repository. See Section 3 for more details on how variables are constructed.

Panel A: WTNIC Website Variables	Mean (1)	SD (2)	Min (3)	Median (4)	Max (5)	Obs (6)
Priv Rivals RnD Shock	-0.092	0.902	-3.826	-0.101	2.661	66,147
Priv Rivals R.E. Shock	0.125	3.266	-17.716	0.012	18.281	78,827
Log Priv Rivals Avg WebSize	9.081	0.257	8.323	9.038	10.524	78,827
Public Peer Total Simil.	0.354	0.362	0.010	0.220	2.420	73,288

Panel B: Corporate Finance Variables	Mean (1)	SD (2)	Min (3)	Median (4)	Max (5)	Obs (6)
Log(Assets)	6.460	2.211	0.703	6.476	15.136	78,827
Log(Age)	2.716	0.801	0.693	2.773	4.277	78,827
Operting Income/Assets	0.015	0.265	-2.108	0.075	0.454	76,011
Log Asset Growth	0.055	0.331	-7.022	0.044	4.881	73,887
Log Sales Growth	0.063	0.466	-9.508	0.060	9.453	71,952
Product Market Fluidity	0.071	0.037	0.001	0.064	0.301	78,344
TNIC-3 Total Similarity	0.107	0.196	0.010	0.021	1.279	78,827
# Acquisitions	0.605	1.235	0.000	0.000	9.000	72,313
# Divestitures	0.241	0.647	0.000	0.000	5.000	72,313
RnD/Assets	0.058	0.131	0.000	0.000	1.200	78,827
# Patents/Assets	0.004	0.015	0.000	0.000	0.174	78,821
10-K Non-Compete/Doc Size	0.591	1.575	0.000	0.000	10.204	72,155
Life Cycle State 1	0.243	0.138	0.000	0.221	1.000	78,162
Life Cycle State 2	0.412	0.169	0.000	0.393	1.000	78,162
Life Cycle State 3	0.279	0.134	0.000	0.268	1.000	78,162
Life Cycle State 4	0.066	0.094	0.000	0.028	0.820	78,162

Table 5: Pearson Correlation Coefficients

Pearson Correlation Coefficients are reported for our sample of public firm-years from 2000 to 2021. The first three variables are characteristics of the private firms operating in a public firm's product market including their tax-credit-based R&D incentives, the non-innovation positive shock implied by real estate gains in the states the private firms operate, and the average number of words in their websites. We report correlations with various investment and outcome variables from Compustat, the SDC Platinum database, and the HP2016 TNIC data repository. See Section 3 for more details on how variables are constructed.

Variable	Private Rivals R&D Shock	Private Rivals R.E. Shock	Private Rivals Avg Web-site Size	Log Assets	Log Age	Oper-ating Income /Assets	Log Sales Growth	Product Market Fluidity	TNIC-3 Total Similar.	# Acqui-sitions
Priv Rivals RnD Shock	1.000	0.206	0.358	-0.357	-0.082	-0.261	0.023	0.012	-0.286	-0.027
Priv Rivals R.E. Shock	0.206	1.000	0.078	-0.106	-0.032	-0.089	-0.003	0.079	-0.143	-0.009
Log Priv Rivals Avg WebSize	0.358	0.078	1.000	0.066	0.021	-0.058	0.046	-0.095	-0.066	0.062
Log(Assets)	-0.357	-0.106	0.066	1.000	0.318	0.414	-0.000	-0.008	0.058	0.325
Log(Age)	-0.082	-0.032	0.021	0.318	1.000	0.246	-0.070	-0.305	-0.228	0.107
Operting Income/Assets	-0.261	-0.089	-0.058	0.414	0.246	1.000	-0.055	-0.311	-0.232	0.140
Log Sales Growth	0.023	-0.003	0.046	-0.000	-0.070	-0.055	1.000	0.035	0.015	0.058
Product Market Fluidity	0.012	0.079	-0.095	-0.008	-0.305	-0.311	0.035	1.000	0.538	-0.057
TNIC-3 Total Similarity	-0.286	-0.143	-0.066	0.058	-0.228	-0.232	0.015	0.538	1.000	-0.096
# Acquisitions	-0.027	-0.009	0.062	0.325	0.107	0.140	0.058	-0.057	-0.096	1.000

Table 6: Private Peer Website Size vs Shocks

The table reports OLS regressions with plausibly exogenous shifters of related-private-firm innovation and non-innovation positive shocks, and where the dependent variable is the natural logarithm of the number of words in the websites of a given focal public firm's private peers. This is a measure of implicit innovation undertaken by these private peers. Our key RHS variables of interest are the "Rivals Priv R&D Shock" and "Rivals Priv R.E. Shock". Both are computed by, for each public firm in each year, identifying the set of private firms from the WTNIC database that operate in the same product markets as the focal firm (1% granularity). As we have the state each private firm is located in, we then average the user cost of R&D (from Bloom, Schankerman, and Van Reenen 2013) across these private firms to generate the user cost of R&D for a given public firm's peers. We then average the result over a given focal public firm's public firm peers (5% granularity using public firm website peers) to generate the Rivals Private Firm R&D user cost of R&D. We flip the sign on the result to make it a positive shifter of innovation, and the result is the "Rivals Priv R&D Shock," and this variable indicates a plausibly exogenous (esp. from the perspective of the focal public firm) positive innovation shock for these private peers. The "Rivals Priv R. E. Shock" is the average price appreciation averaged over these same private firm peers, and hence a higher value indicates a plausibly exogenous positive non-innovation shock for these peers. We also include controls for size, age, and all regressions include firm and year fixed effects. All right-hand side variables are standardized for comparison and computed in year $t-1$, and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	Priv Peer Web Size (1)	Priv Peer Web Size (2)	Priv Peer Web Size (3)
Priv Rivals R&D Shock	0.031***	0.031***	
	(22.82)	(22.70)	
Priv Rivals R.E. Shock	0.002***		0.002***
	(3.11)		(3.06)
Log Assets	-0.007**	-0.007**	-0.007**
	(-2.12)	(-2.04)	(-2.29)
Log Age	-0.007**	-0.008**	-0.010***
	(-2.17)	(-2.24)	(-3.05)
Firm + Year F.E.	Yes	Yes	Yes
Observations	71,493	71,493	77,700

Table 7: Baseline Reduced Form w/ Shocks (Broad)

The table reports OLS regressions with plausibly exogenous shifters of related-private-firm innovation and non-innovation positive shocks, and where the dependent variable is a firm investment policy or outcome variable such as acquisitions, divestitures, R&D/assets, ROA, sales growth etc, as specified in the column headers. Our key RHS variables of interest are the "Rivals Priv R&D Shock" and "Rivals Priv R.E. Shock". Both are computed by, for each public firm in each year, identifying the set of private firms from the WTNIC database that operate in the same product markets as the focal firm (1% granularity). As we have the state each private firm is located in, we then average the user cost of R&D (from Bloom, Schankerman, and Van Reenen 2013) across these private firms to generate the user cost of R&D for a given public firm's peers. We then average the result over a given focal public firm's public firm peers (5% granularity using public firm website peers) to generate the Rivals Private Firm R&D user cost of R&D. We flip the sign on the result to make it a positive shifter of innovation, and the result is the "Rivals Priv R&D Shock," and this variable indicates a plausibly exogenous (esp. from the perspective of the focal public firm) positive innovation shock for these private peers. The "Rivals Priv R. E. Shock" is the average price appreciation averaged over these same private firm peers, and hence a higher value indicates a plausibly exogenous positive non-innovation shock for these peers. We also include controls for size, age, and all regressions include firm and year fixed effects. All right-hand side variables are computed in year $t-1$ and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	# Acq-uisitions (1)	# Div-estitures (2)	R&D /Assets (3)	# Patents /Assets (4)	Non-Compete (5)
Priv Rivals R&D Shock	56.016***	-7.346	7.036***	1.569***	39.267**
	(4.08)	(-0.86)	(7.21)	(11.46)	(2.20)
Priv Rivals R.E. Shock	-2.682**	0.385	-0.151	-0.080***	-1.856
	(-2.25)	(0.54)	(-1.42)	(-4.13)	(-1.08)
Log Assets	0.056***	0.057***	-0.008***	-0.000**	0.074***
	(4.62)	(9.39)	(-7.40)	(-2.35)	(4.33)
Log Age	0.036	0.082***	0.006***	0.002***	-0.106**
	(1.00)	(4.28)	(2.75)	(7.60)	(-2.28)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	65,120	65,120	71,493	71,487	64,972
Panel B: Outcomes	**OI/Assets (1)**	**Sales Growth (2)**	**Asset Growth (3)**	**Total Similarity (4)**	**Prod Mkt Fluidity (5)**
Priv Rivals R&D Shock	-5.651***	25.554***	20.622***	-26.613***	2.732***
	(-2.58)	(4.63)	(5.83)	(-19.91)	(8.57)
Priv Rivals R.E. Shock	-0.845***	-0.002	-1.098***	0.501***	0.852***
	(-3.66)	(-0.00)	(-2.88)	(3.96)	(24.26)
Log Assets	0.007***	-0.117***	-0.153***	0.007***	0.002***
	(2.89)	(-20.31)	(-39.86)	(7.01)	(8.17)
Log Age	0.006	-0.075***	-0.008	0.000	-0.008***
	(1.21)	(-7.28)	(-1.00)	(0.03)	(-11.03)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	68,957	65,245	66,907	71,493	71,042

Table 8: Big vs Small Reduced Form w/ Shocks

The table presents results using OLS regressions with plausibly exogenous shifters of related-private-firm innovation and non-innovation positive shocks analogous to those in Table 7 with the following changes. We first sort firms in each year into Small and Large groups using firm assets from year $t-1$. Small (Large) firms are those with below (above) median in the given year. We then include interactions between "Rivals Priv R&D Shock" and "Rivals Priv R.E. Shock," and both the Small and Large firm dummies. We also include the Small firm dummy itself in the regression. All other aspects of these regressions are as defined in Table 7. All right-hand side variables are computed in year $t-1$ and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	# Acq-uisitions (1)	# Div-estitures (2)	R&D /Assets (3)	# Patents /Assets (4)	Non-Compete (5)
Small x Priv Rivals R&D Shock	15.227	5.439	12.797***	2.310***	21.096
	(1.15)	(0.74)	(8.51)	(10.89)	(0.86)
Big x Priv Rivals R&D Shock	91.357***	-18.922	1.549**	0.855***	54.381***
	(4.98)	(-1.62)	(2.05)	(5.84)	(2.90)
Small x Priv Rivals R.E. Shock	-2.132	-0.962	-0.294	-0.115***	-3.530
	(-1.60)	(-1.31)	(-1.43)	(-3.26)	(-1.23)
Big x Priv Rivals R.E. Shock	-3.256*	1.519	-0.021	-0.050***	-0.529
	(-1.66)	(1.30)	(-0.36)	(-3.52)	(-0.27)
Small	-0.015	0.011	0.004**	0.001***	-0.030
	(-0.60)	(0.85)	(2.35)	(3.33)	(-0.70)
Log Assets	0.055***	0.058***	-0.008***	-0.000	0.070***
	(4.31)	(8.83)	(-6.51)	(-1.33)	(3.95)
Log Age	0.037	0.082***	0.006***	0.003***	-0.107**
	(1.02)	(4.24)	(2.83)	(7.68)	(-2.29)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	65,120	65,120	71,493	71,487	64,972

Panel B: Outcomes	OI/Assets (1)	Sales Growth (2)	Asset Growth (3)	Total Similarity (4)	Prod Mkt Fluidity (5)
Small x Priv Rivals R&D Shock	-15.392***	20.267**	19.577***	-28.612***	3.341***
	(-4.73)	(2.35)	(3.86)	(-15.76)	(8.00)
Big x Priv Rivals R&D Shock	3.558*	29.847***	21.732***	-24.840***	2.098***
	(1.77)	(5.92)	(5.68)	(-18.99)	(5.80)
Small x Priv Rivals R.E. Shock	-0.504	0.825	-0.945	0.032	0.646***
	(-1.15)	(0.71)	(-1.38)	(0.21)	(14.33)
Big x Priv Rivals R.E. Shock	-1.166***	-0.657	-1.218***	0.881***	1.021***
	(-7.02)	(-1.39)	(-3.08)	(4.68)	(20.12)
Small	0.016***	0.020**	-0.008	-0.002	0.001
	(4.48)	(1.99)	(-1.21)	(-1.29)	(1.38)
Log Assets	0.010***	-0.114***	-0.154***	0.006***	0.002***
	(3.57)	(-17.79)	(-37.16)	(6.30)	(8.10)
Log Age	0.006	-0.074***	-0.008	-0.000	-0.008***
	(1.17)	(-7.27)	(-1.00)	(-0.05)	(-11.10)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	68,957	65,245	66,907	71,493	71,042

Table 9: Young vs Old Reduced Form w/ Shocks

The table presents results using OLS regressions with plausibly exogenous shifters of related-private-firm innovation and non-innovation positive shocks analogous to those in Table 7 with the following changes. We first sort firms in each year into Young and Old groups using firm age in year $t-1$. Young (Old) firms are those with below (above) median age in the given year. We then include interactions between "Rivals Priv R&D Shock" and "Rivals Priv R.E. Shock," and both the Young and Old firm dummies. We also include the Young firm dummy itself in the regression. All other aspects of these regressions are as defined in Table 7. All right-hand side variables are computed in year $t-1$ and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	# Acq-uisitions (1)	# Div-estitures (2)	R&D /Assets (3)	# Patents /Assets (4)	Non-Compete (5)
Young x Priv Rivals R&D Shock	46.235***	1.510	8.617***	1.999***	2.251
	(2.88)	(0.18)	(5.68)	(9.14)	(0.10)
Old x Priv Rivals R&D Shock	63.435***	-14.107	5.416***	1.138***	67.648***
	(3.65)	(-1.21)	(4.71)	(6.26)	(3.00)
Young x Priv Rivals R.E. Shock	-2.297	1.271	-0.261	-0.138***	-0.880
	(-1.56)	(1.62)	(-1.64)	(-5.20)	(-0.43)
Old x Priv Rivals R.E. Shock	-2.951	-0.883	-0.056	-0.020	-2.291
	(-1.53)	(-0.71)	(-0.46)	(-0.78)	(-0.81)
Young	-0.009	0.007	-0.001	0.001**	-0.009
	(-0.27)	(0.47)	(-0.59)	(2.35)	(-0.19)
Log Assets	0.056***	0.057***	-0.008***	-0.000**	0.075***
	(4.64)	(9.36)	(-7.43)	(-2.42)	(4.39)
Log Age	0.034	0.084***	0.006***	0.003***	-0.115**
	(0.93)	(4.40)	(2.75)	(7.88)	(-2.45)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	65,120	65,120	71,493	71,487	64,972

Panel B: Outcomes	OI/Assets (1)	Sales Growth (2)	Asset Growth (3)	Total Similarity (4)	Prod Mkt Fluidity (5)
Young x Priv Rivals R&D Shock	-13.645***	28.637***	26.118***	-38.733***	4.414***
	(-4.33)	(3.44)	(5.26)	(-19.65)	(10.56)
Old x Priv Rivals R&D Shock	2.514	22.655***	15.194***	-14.112***	0.983**
	(1.00)	(3.93)	(3.79)	(-10.72)	(2.52)
Young x Priv Rivals R.E. Shock	-0.550*	0.027	-1.580***	0.488***	0.926***
	(-1.66)	(0.03)	(-2.81)	(2.67)	(19.54)
Old x Priv Rivals R.E. Shock	-1.007***	-0.112	-0.653	0.822***	0.716***
	(-3.40)	(-0.15)	(-1.38)	(4.79)	(14.13)
Young	-0.004	0.000	-0.005	0.004*	0.002**
	(-0.97)	(0.01)	(-0.68)	(1.84)	(2.39)
Log Assets	0.007***	-0.117***	-0.153***	0.007***	0.002***
	(2.96)	(-20.30)	(-39.86)	(7.44)	(8.02)
Log Age	0.005	-0.074***	-0.008	-0.001	-0.008***
	(0.95)	(-7.16)	(-0.97)	(-0.24)	(-10.78)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	68,957	65,245	66,907	71,493	71,042

Table 10: Firms in Innovative vs Non-Innovative Industries, Reduced Form w/ Shocks

The table presents results using OLS regressions with plausibly exogenous shifters of related-private-firm innovation and non-innovation positive shocks analogous to those in Table 7 with the following changes. We first define firms in innovative industries as those having TNIC peers with above-median R&D/assets. Non-innovative industry firms are those with below median values. We then include interactions between "Rivals Priv R&D Shock" and "Rivals Priv R.E. Shock," and both the Tech and Non-Tech firm dummies. We do not include the Tech and Non-Tech firm dummies in the regression because they are subsumed by the firm fixed effects. All other aspects of these regressions are as defined in Table 7. All right-hand side variables are computed in year $t-1$ and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	# Acquisitions (1)	# Divestitures (2)	R&D /Assets (3)	# Patents /Assets (4)	Non-Compete (5)
Non-Innov Industry x Priv Rivals R&D Shock	70.982***	-22.153*	3.637***	0.760***	50.410**
	(3.69)	(-1.74)	(7.51)	(10.43)	(2.23)
Innov Industry x Priv Rivals R&D Shock	42.492**	12.686	11.386***	2.628***	24.314
	(2.42)	(1.28)	(5.99)	(9.25)	(0.93)
Non-Innov Industry x Priv Rivals R.E. Shock	1.285	1.952*	0.050	-0.012	-2.916
	(0.68)	(1.72)	(1.14)	(-1.54)	(-1.31)
Innov Industry x Priv Rivals R.E. Shock	-8.349***	-2.348*	-0.549**	-0.205***	0.019
	(-3.48)	(-1.79)	(-2.01)	(-4.38)	(0.00)
Log Assets	0.057***	0.057***	-0.008***	-0.000**	0.074***
	(4.66)	(9.35)	(-7.45)	(-2.42)	(4.34)
Log Age	0.033	0.080***	0.006***	0.002***	-0.105**
	(0.90)	(4.15)	(2.77)	(7.61)	(-2.25)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	65,120	65,120	71,493	71,487	64,972

Panel B: Outcomes	OI/Assets (1)	Sales Growth (2)	Asset Growth (3)	Total Similarity (4)	Prod Mkt Fluidity (5)
Non-Innov Industry x Priv Rivals R&D Shock	9.156***	34.734***	26.726***	-22.795***	2.571***
	(3.63)	(5.85)	(5.75)	(-18.43)	(6.01)
Innov Industry x Priv Rivals R&D Shock	-22.801***	11.799	12.515**	-30.784***	3.099***
	(-6.41)	(1.22)	(2.31)	(-14.83)	(7.44)
Non-Innov Industry x Priv Rivals R.E. Shock	-0.350	-1.824***	-1.726***	0.923***	1.007***
	(-1.61)	(-2.70)	(-3.69)	(4.80)	(19.53)
Innov Industry x Priv Rivals R.E. Shock	-1.204**	3.097**	0.024	-0.040	0.613***
	(-2.27)	(2.25)	(0.03)	(-0.29)	(12.32)
Log Assets	0.007***	-0.117***	-0.153***	0.007***	0.002***
	(2.98)	(-20.27)	(-39.86)	(7.07)	(8.16)
Log Age	0.005	-0.073***	-0.008	-0.000	-0.008***
	(0.98)	(-7.16)	(-0.97)	(-0.17)	(-11.20)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	68,957	65,245	66,907	71,493	71,042

Table 11: High vs Low Public Total Similarity Reduced Form w/ Shocks

The table presents results using OLS regressions with plausibly exogenous shifters of related-private-firm innovation and non-innovation positive shocks analogous to those in Table 7 with the following changes. We first sort firms in each year into Low and High groups based on TNIC-3 total similarity from year $t-1$ (Hoberg and Phillips 2016). Low (High) public firm competition firms (LoPubSimm and HiPubSimm, respectively) are those with below (above) median total similarity in the given year. We then include interactions between "Rivals Priv R&D Shock" and "Rivals Priv R.E. Shock," and both the Low and High public total similarity firm dummies. We also include the Low public firm total similarity firm dummy itself (LoPubSimm) in the regression. All other aspects of these regressions are as defined in Table 7. All right-hand side variables are computed in year $t-1$ and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	# Acq-uisitions (1)	# Div-estitures (2)	R&D /Assets (3)	# Patents /Assets (4)	Non-Compete (5)
LoPubSimm x Priv Rivals R&D Shock	19.434	-1.981	4.411***	1.373***	65.911***
	(1.25)	(-0.21)	(5.13)	(7.03)	(2.70)
HiPubSimm x Priv Rivals R&D Shock	46.078***	-15.768**	13.496***	2.244***	15.097
	(3.42)	(-1.97)	(10.70)	(12.95)	(0.98)
LoPubSimm x Priv Rivals R.E. Shock	-0.596	-2.312*	-0.033	0.007	-3.503
	(-0.24)	(-1.87)	(-0.31)	(0.24)	(-0.92)
HiPubSimm x Priv Rivals R.E. Shock	-3.702***	1.510*	0.030	-0.093***	-1.161
	(-2.68)	(1.69)	(0.20)	(-3.67)	(-0.64)
LoPubSimm	0.046**	-0.007	-0.003***	-0.000	0.048
	(2.14)	(-0.70)	(-2.96)	(-0.22)	(1.58)
Log Assets	0.056***	0.057***	-0.009***	-0.000***	0.075***
	(4.55)	(9.37)	(-7.74)	(-2.64)	(4.37)
Log Age	0.028	0.083***	0.008***	0.003***	-0.119**
	(0.77)	(4.24)	(3.39)	(7.95)	(-2.54)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	65,120	65,120	71,493	71,487	64,972

Panel B: Outcomes	OI/Assets (1)	Sales Growth (2)	Asset Growth (3)	Total Similarity (4)	Prod Mkt Fluidity (5)
LoPubSimm x Priv Rivals R&D Shock	-7.299***	16.421***	10.078**	-5.129***	1.123***
	(-3.06)	(2.61)	(2.26)	(-6.40)	(3.37)
HiPubSimm x Priv Rivals R&D Shock	-11.812***	24.318***	26.571***	-25.138***	2.059***
	(-4.18)	(3.37)	(6.13)	(-16.96)	(5.78)
LoPubSimm x Priv Rivals R.E. Shock	-0.276	1.857**	0.724	0.089	0.287***
	(-0.75)	(2.01)	(1.10)	(0.97)	(6.77)
HiPubSimm x Priv Rivals R.E. Shock	-1.203***	-0.391	-1.518***	0.742***	1.082***
	(-4.20)	(-0.51)	(-3.18)	(4.38)	(24.56)
LoPubSimm	0.005	0.005	-0.001	-0.015***	-0.008***
	(1.51)	(0.78)	(-0.25)	(-11.94)	(-18.69)
Log Assets	0.008***	-0.118***	-0.154***	0.007***	0.002***
	(3.01)	(-20.38)	(-39.93)	(7.57)	(7.42)
Log Age	0.005	-0.074***	-0.007	0.003	-0.007***
	(0.88)	(-7.06)	(-0.81)	(0.90)	(-8.84)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	68,957	65,245	66,907	71,493	71,042

Table 12: Baseline Reduced Form w/ Shocks (IV Method)

The table reports two-stage IV regressions where the first stage uses our plausibly exogenous shifter of related-private-firm innovation based on R&D tax credits and the first stage dependent variable is the private firm peers' average website length. The instrumented length of the peer websites is then used in the second stage. The second stage dependent variables are public firm investment policy or outcome variables such as acquisitions, divestitures, R&D/assets, ROA, sales growth etc, as specified in the column headers. Our instrument "Rivals Priv R&D Shock" is computed by first identifying the set of private firms from the WTNIC database that operate in the same product markets as the focal firm (1% granularity). As we have the state each private firm is located in, we then average the user cost of R&D (from Bloom, Schankerman, and Van Reenen 2013) across these private firms to generate the user cost of R&D for a given public firm's peers. We exclude private firms (and their shocks) that are located in the state of focal public firm's headquarters. We then average the result over a given focal public firm's public firm peers (5% granularity using public firm website peers) to generate the Rivals Private Firm R&D user cost of R&D. We flip the sign on the result to make it a positive shifter of innovation, and the result is the "Rivals Priv R&D Shock," and this variable indicates a plausibly exogenous (esp. from the perspective of the focal public firm) positive innovation shock for these private peers. All right-hand side variables are computed in year $t-1$ and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	# Acq-uisitions (1)	# Div-estitures (2)	R&D /Assets (3)	# Patents /Assets (4)	Non-Compete (5)
Instrum Rival Avg Website Size	1.020***	-0.134	0.198***	0.044***	0.715**
	(4.17)	(-0.88)	(6.76)	(9.98)	(2.26)
Log Assets	0.062***	0.056***	-0.008***	-0.000	0.078***
	(4.97)	(9.22)	(-6.82)	(-1.43)	(4.49)
Log Age	0.053	0.080***	0.008***	0.003***	-0.094**
	(1.46)	(4.11)	(3.44)	(7.49)	(-2.02)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	65,120	65,120	71,493	71,487	64,972
Panel B: Outcomes	**OI/Assets (1)**	**Sales Growth (2)**	**Asset Growth (3)**	**Total Similarity (4)**	**Prod Mkt Fluidity (5)**
Instrum Rival Avg Website Size	-0.152**	0.671***	0.585***	-0.748***	0.070***
	(-2.42)	(4.56)	(5.71)	(-13.79)	(6.93)
Log Assets	0.007***	-0.114***	-0.152***	0.005***	0.003***
	(2.60)	(-19.31)	(-38.44)	(3.38)	(8.67)
Log Age	0.005	-0.070***	-0.002	-0.007*	-0.008***
	(1.01)	(-6.63)	(-0.24)	(-1.81)	(-9.62)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	68,957	65,245	66,907	71,493	71,042

Online Appendix:
Small Private Firms:
Friend or Foe of Larger Public Firms?

Gerard Hoberg and Gordon M. Phillips

(not for publication)

Table IA1: Baseline Reduced Form w/ Shocks (Broad, Add Public Peers)

The table presents results using OLS regressions with plausibly exogenous shifters of related-private-firm innovation and non-innovation positive shocks analogous to those in Table 7 except that we add one additional variable. The added variable is the total public firm similarity from year $t-1$ (measured using WTNIC website similarities for public firms only and a 2% granularity following Hoberg and Phillips 2016). We also include controls for size, age, and all regressions include firm and year fixed effects. All right-hand side variables are computed in year $t-1$ and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	# Acq-uisitions (1)	# Div-estitures (2)	R&D /Assets (3)	# Patents /Assets (4)	Non-Compete (5)
Priv Rivals R&D Shock	47.563***	-6.690	6.529***	1.555***	41.666**
	(3.28)	(-0.72)	(6.52)	(10.84)	(2.19)
Priv Rivals R.E. Shock	-3.253***	0.291	-0.155	-0.083***	-2.111
	(-2.58)	(0.39)	(-1.39)	(-4.10)	(-1.18)
Public Peer Total Simil.	0.001	0.005	0.004*	-0.000	-0.019
	(0.04)	(0.32)	(1.89)	(-1.53)	(-0.73)
Log Assets	0.062***	0.060***	-0.008***	-0.000**	0.076***
	(4.86)	(9.11)	(-7.12)	(-2.32)	(4.17)
Log Age	0.018	0.085***	0.006**	0.003***	-0.097*
	(0.46)	(4.11)	(2.28)	(7.29)	(-1.92)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	60,607	60,607	66,422	66,417	60,462

Panel B: Outcomes	OI/Assets (1)	Sales Growth (2)	Asset Growth (3)	Total Similarity (4)	Prod Mkt Fluidity (5)
Priv Rivals R&D Shock	-4.814**	28.011***	21.962***	-25.886***	2.669***
	(-2.11)	(4.95)	(5.97)	(-18.88)	(8.09)
Priv Rivals R.E. Shock	-0.847***	0.010	-1.165***	0.487***	0.840***
	(-3.50)	(0.02)	(-2.91)	(3.64)	(22.59)
Public Peer Total Simil.	-0.008*	0.036***	0.002	0.021***	0.001**
	(-1.86)	(2.92)	(0.28)	(6.62)	(2.10)
Log Assets	0.007***	-0.112***	-0.153***	0.007***	0.002***
	(2.61)	(-18.95)	(-37.77)	(6.65)	(7.99)
Log Age	0.010*	-0.071***	-0.008	0.001	-0.009***
	(1.71)	(-6.56)	(-0.92)	(0.32)	(-11.53)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	64,120	60,624	62,122	66,422	66,011

Table IA2: Baseline Reduced Form w/ Shocks (Narrow)

The table presents results using OLS regressions with plausibly exogenous shifters of related-private-firm innovation and non-innovation positive shocks analogous to those in Table 7 with one key change. In particular, we measure the key variables "Rivals Priv R&D Shock" and "Rivals Priv R.E. Shock" using only the private firms with websites that are most similar of all to the given focal public firm (a "narrower" definition of private firm peers). We start by, for each public firm in each year, identifying the set of private firms from the WTNIC database that operate in the same product markets as the focal firm (1% granularity). As we have the state each private firm is located in, we then average the user cost of R&D (from Bloom, Schankerman, and Van Reenen 2013) across these private firms to generate the user cost of R&D for a given public firm's peers. We then skip the step of averaging the result over a given focal public firm's public firm peers (hence we use only the 1% most similar private firms). All right-hand side variables are computed in year $t-1$ and the dependent variables are computed in year t to ensure no look-ahead bias. t-statistics are clustered by firm.

Panel A: Investment	# Acq-uisitions (1)	# Div-estitures (2)	R&D /Assets (3)	# Patents /Assets (4)	Non-Compete (5)
Priv Rivals R&D Shock	-5.654	-0.763	0.533*	0.219***	1.078
	(-1.09)	(-0.26)	(1.71)	(3.75)	(0.18)
Priv Rivals R.E. Shock	0.186	0.440	-0.051	-0.017*	-1.891**
	(0.36)	(1.41)	(-1.15)	(-1.89)	(-2.50)
Log Assets	0.059***	0.059***	-0.009***	-0.000***	0.077***
	(4.58)	(9.02)	(-7.42)	(-2.80)	(4.18)
Log Age	0.021	0.087***	0.005**	0.003***	-0.094*
	(0.53)	(4.20)	(1.98)	(7.10)	(-1.85)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	60,211	60,211	66,024	66,019	60,066
Panel B: Outcomes	**OI/Assets (1)**	**Sales Growth (2)**	**Asset Growth (3)**	**Total Similarity (4)**	**Prod Mkt Fluidity (5)**
Priv Rivals R&D Shock	-0.237	7.082***	3.948***	-4.697***	0.284***
	(-0.30)	(3.80)	(2.98)	(-11.21)	(2.63)
Priv Rivals R.E. Shock	-0.228**	-0.103	-0.019	0.171***	0.170***
	(-2.21)	(-0.38)	(-0.11)	(4.25)	(12.94)
Log Assets	0.007**	-0.113***	-0.154***	0.008***	0.002***
	(2.49)	(-19.00)	(-37.54)	(7.68)	(8.17)
Log Age	0.011**	-0.071***	-0.010	0.000	-0.010***
	(1.99)	(-6.55)	(-1.08)	(0.13)	(-12.03)
Firm + Year F.E.	Yes	Yes	Yes	Yes	Yes
Observations	63,724	60,284	61,748	66,024	65,613