The Great Startup Sellout and the Rise of Oligopoly

By Florian Ederer and Bruno Pellegrino*

Acquisitions of startups by incumbent firms constitute a significant trend in recent years, with numerous high-profile examples making headlines. However, these acquisitions have also been the subject of much policy scrutiny and academic debate, with some arguing that they contribute to the entrenchment of dominant incumbent firms (Cunningham, Ederer and Ma, 2021; Pellegrino, 2019). Rather than allowing for the creation of synergies acquisitions may serve to protect the dominant position of incumbent firms by limiting the ability of acquired startups to challenge their existing business models.

Using a model in which granular firms produce differentiated products and compete in a network game of Cournot oligopoly, we present evidence that the progressive shift of VC-backed startups from initial public offerings (IPOs) to acquisitions has contributed to the aggregate increase in oligopoly power.

First, we show that the number of IPOs declined dramatically compared to the number of acquisitions since the mid-1990s. Second, incumbent firms, especially those with a high product similarity to VC-backed startups have become more insulated from competition in the last two decades. Third, large technology companies such as Google, Amazon, Facebook, Apple, and Microsoft (GAFAM) which have been particularly aggressive in their acquisition strategies have greatly reduced the competitive pressures they face from other companies over the same period, both compared to other firms in the technology sector and public firms more generally. Finally, the increase in acquisitions has not been matched by an increase in firm-level product market dynamism which declined significantly for all public firms and particularly for GAFAM.

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I. Theory

We employ the general equilibrium model of Pellegrino (2019) in which n single-product granular firms produce differentiated products and compete in a network game of Cournot oligopoly. Each firm i produces a differentiated good consisting of common characteristics $\mathbf{a}_i$ and idiosyncratic characteristics. A representative agent with quadratic utility over product characteristics consumes all the goods produced in the economy, supplies labor as a production input, and receives income from owning shares of the firms in the economy. This setup yields the following linear demand system

$$\mathbf{p} = \mathbf{b} - (\mathbf{I} + \mathbf{\Sigma})\,\mathbf{q}. \tag{1}$$

where $\mathbf{p}$ and $\mathbf{q}$ are the price and quantity vectors of all the products in the economy, $\mathbf{b}$ is the vector of demand intercepts which can be interpreted as measures of product quality, and $\mathbf{\Sigma}$ is the $n \times n$ matrix of price-quantity derivatives for all pairs of products. $\mathbf{\Sigma}$ depends on the weight α the consumer attaches to idiosyncratic characteristics and on the matrix $\mathbf{A}'\mathbf{A}$ containing the dot products (or cosine similarities) $\mathbf{a}_i'\mathbf{a}_j$ based on the common characteristics between firms.

Each firm i produces output q_i at a fixed cost f_i and a constant marginal c_i^0. The Cournot equilibrium quantity allocation $\mathbf{q}^\Phi$ in which each firm i maximizes profit π_i is given by

$$\mathbf{q}^\Phi = (2\mathbf{I} + \mathbf{\Sigma})^{-1}\left(\mathbf{b} - \mathbf{c}^0\right) \tag{2}$$

where $\mathbf{c}^0$ denotes the vector of marginal costs. To express the equilibrium markup

in terms of productivity and centrality, we can rewrite equation (2) in scalar notation

$$q_i^{\Phi} = \frac{1}{2}\left[\gamma_{ii} + \sum_{j\neq i}\gamma_{ij}\frac{b_j - c_j}{b_i - c_i}\right](b_i - c_i) \tag{3}$$

where γ_{ij} is the ijth element of the matrix $\mathbf{\Gamma} \equiv \left(\mathbf{I} + \frac{1}{2}\mathbf{\Sigma}\right)^{-1}$.

The term in square brackets is a measure of (inverse) centrality that captures how far firm i is from every other rival j in the space of product characteristics, weighting each rival j by its competitiveness $(b_j - c_j)$ relative to i. The product market centrality of firm i is χ_i and is defined as

$$1 - \chi_i \equiv \gamma_{ii} + \sum_{j\neq i}\gamma_{ij}\frac{b_j - c_j}{b_i - c_i}.$$

χ_i ranges from zero to one and is a measure of centrality because it summarizes the entire matrix of cross-price derivatives into an n-dimensional vector. Loosely speaking, we replaced $\left(\mathbf{I} + \frac{1}{2}\mathbf{\Sigma}\right)^{-1}$ with a diagonal matrix that has $(1 - \chi_i)$ along the diagonal, to obtain a new characterization of firm i's output based on its centrality χ_i, its demand intercept b_i and its marginal cost c_i

$$q_i^{\Phi} = \frac{1 - \chi_i}{2}(b_i - c_i). \tag{4}$$

χ_i provides a measure of centrality as a function of exogenous objects coming from the matrix of product similarities, the demand intercepts, and the firm's costs. It determines how close the firm i's actual equilibrium markup μ_i is to the competitive markup which is equal to 1 and the monopolistic markup $\bar{\mu}_i$

$$\mu_i = \chi_i + (1 - \chi_i)\,\bar{\mu}_i \tag{5}$$

This characterization of the markup μ_i links the topology of the product market rivalry network to the firm's ability to influence prices. A firm that is very central (i.e., $\chi_i \to 1$) has many rivals that supply products similar to its own, and thus behaves like an atomistic firm which does not affect prices. In contrast, a firm that is highly peripheral (i.e., $\chi_i \to 0$) supplies a product with characteristics that are not produced by other firms, and thus behaves like a monopolist. A firm has maximum ability to influence prices when its centrality χ_i is zero (i.e., it has no competitors). Armed with this characterization we are now able to describe how startups and incumbents are related and how these relationships have changed over the last three decades.

II. Data

We employ two data sources to estimate the markup and centrality measures presented in Section I: firm financials and text-based product similarity.

We measure revenues, variable costs, and fixed costs in our model by using data from Compustat. These variables correspond to accounting revenues, Costs of Goods Sold (COGS), and Selling General and Administrative (SGA) costs, respectively.

Hoberg and Phillips (2016) provide a time-varying empirical estimate of the matrix of product-based cosine similarities $\mathbf{A}'\mathbf{A}$ between firms by text-mining the business description section of 10-K forms of all publicly-listed U.S. firms. Pellegrino (2019) shows how to identify the matrix $\mathbf{\Sigma}$ from the Hoberg and Phillips (2016) cosine similarity data.

III. Results

Figure 1 shows that initial public offerings (IPOs) have become a dwindlingly small share of corporate transactions compared to acquisitions. While IPOs greatly outnumbered acquisitions in in the late 1980s and early 1990s, this pattern has entirely reversed. By 2019 there were only just over 100 IPOs compared to over 1,000 acquisitions. However, this relative decline of the importance of IPOs as an exit mechanism appears to be unrelated to the decline of the startup rate that has been measured in the broader economy (Decker et al., 2014). In fact, rather than declining the number of startups that are backed by venture capital (VC), which constitute the majority of startups that eventually become public companies, has radically increased

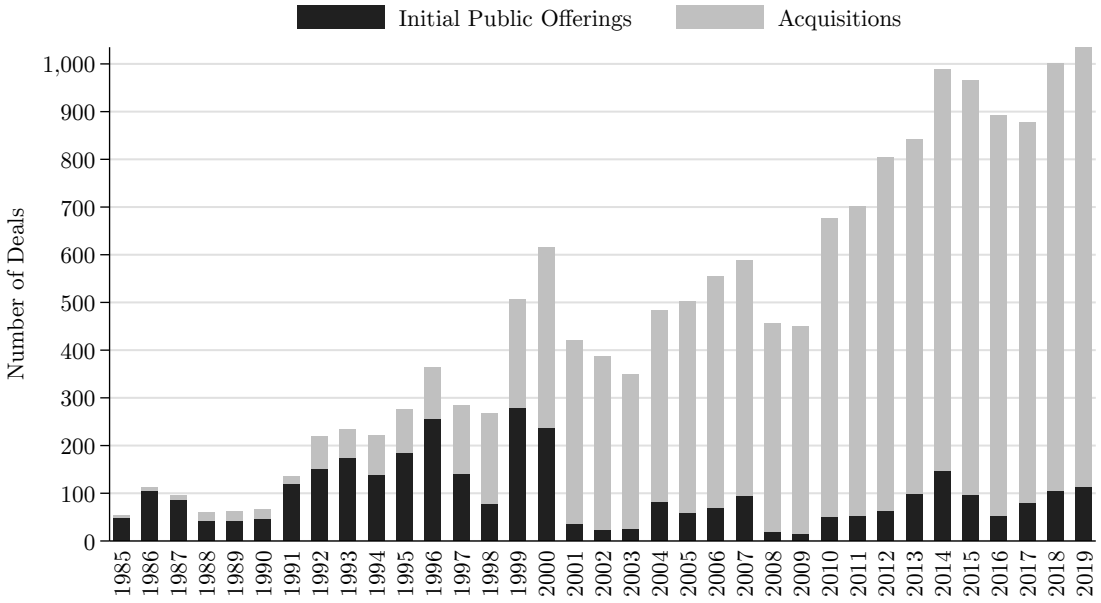

FIGURE 1. INITIAL PUBLIC OFFERINGS AND ACQUISITIONS

Note: Number of initial public offerings (black) and acquisitions (gray) by year.

over this period. Thus, the reason behind the decline in IPOs is not a dearth of startups, but rather the fact that most VC-backed startups nowadays choose to be acquired by incumbents instead.

(Pellegrino, 2019) documents that over the same time period the entire distribution of firm product market centralities decreased suggesting that the typical public firm faces less competition from substitute products than it did in the past. While profits and value added increased with nominal GDP, economic activity is now concentrated among a much smaller number of firms. Kahle and Stulz (2017) argues that underlying this decline in the overall number of firms is a secular decline in the rate of IPOs which has not been counterbalanced by a decrease in the rate of exit of incumbent firms.

Figure 2 displays a balanced panel of continuing public firms. Hoberg and Phillips (2018) provide a cosine similarity score for each of the continuing public firms relative to startups backed by venture capital. We sort continuing firms according to whether they were above or below the median in terms of similarity to VC-backed startups in 2000. Firms above the median are more similar to VC-backed startups. Importantly, similarity in this case is not to startups who actually enter in Compustat, but to all startups that were previously funded by venture capital firms. We match the two subsamples so that they have the same exact distribution of centrality in 2000 and then plot the average centrality of the two samples.

We would expect firms with high similarity to VC-backed startups to increase their centrality over time compared to firms with low similarity because the former are in a portion of the product space that experiences a lot of startup entry. Surprisingly, we find the opposite result. Firms that are more similar to startups are becoming less central (i.e., are facing increasingly less competition) overall and also significantly less central than firms with low similarity to startups.

Acquisitions appear to be a key explanation for this trend. If all the startups went

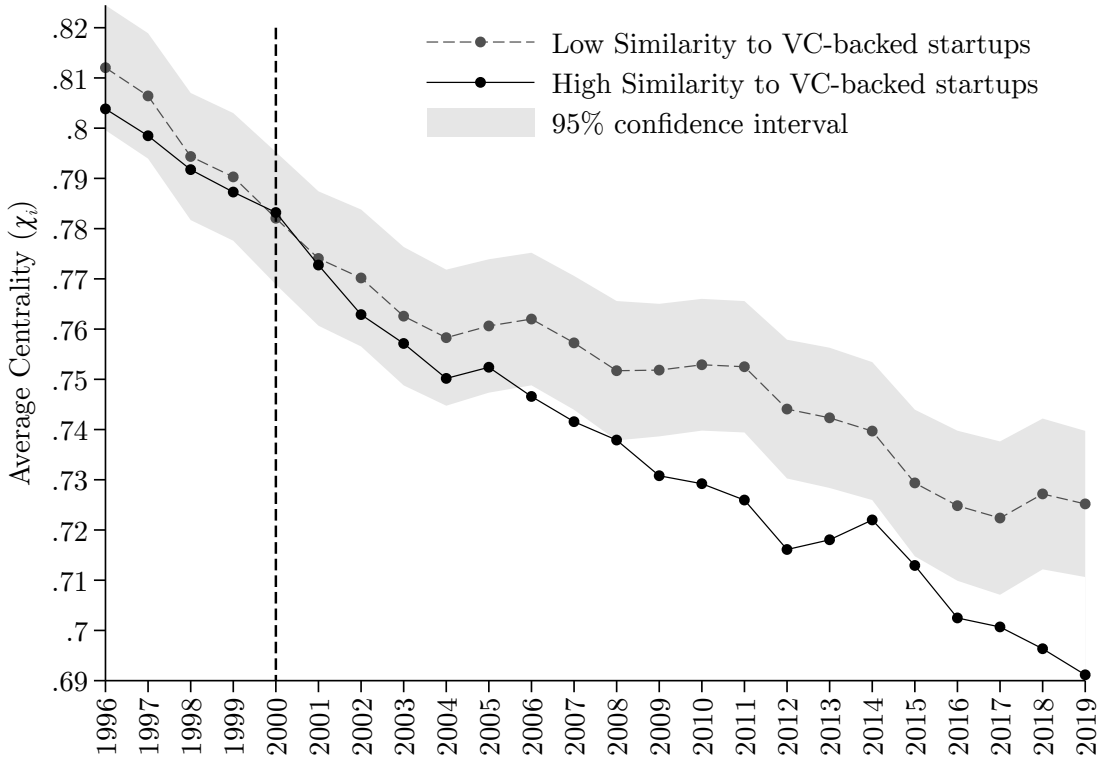

Figure 2. Product Market Centrality of Continuing Firms

Note: Average product market centrality χ_i of continuing firms in Compustat with high similarity (solid black line) and low similarity (dashed gray line) to VC-backed startups over time.

public, the centrality of high-similarity firms would mechanically increase. But because many of these startups which would exert competitive pressure on existing firms with similar products, are getting acquired the high-similarity firms are less and less central.

Figure 3 investigates how product market centrality χ_i has changed for different firms and sectors in the economy over time. In particular, it shows that the average product market centrality of the tech giants Google, Amazon, Facebook, Apple, and Microsoft (GAFAM) has decreased significantly. These five firms are now collectively much less central in the network of product market rivalry than they were a quarter century ago. This trend is not typical for the rest of Compustat or even the remaining technology sector. As can be seen in Figure 3 the average product market centralities for the technology sector and the rest of Compustat only slightly decreased from 1999 to 2019. Thus, relative to the rest of the economy GAFAM have become much more insulated from competitive forces.

Once again, an explanation for this stark trend appears to be the increasing use of acquisitions. GAFAM have acquired hundreds of companies in the last decade, outpacing other groups of top acquirers (Jin, Leccese and Wagman, 2022). Many of these acquisitions also occurred without pre-closing antitrust review or antitrust challenge prompting congressional and academic critics of past antitrust policy to suggest the companies' acquisition activity is competitively harmful because it eliminates future competitive threats and deters future entry into markets dominated by GAFAM.

One potential objection to our results

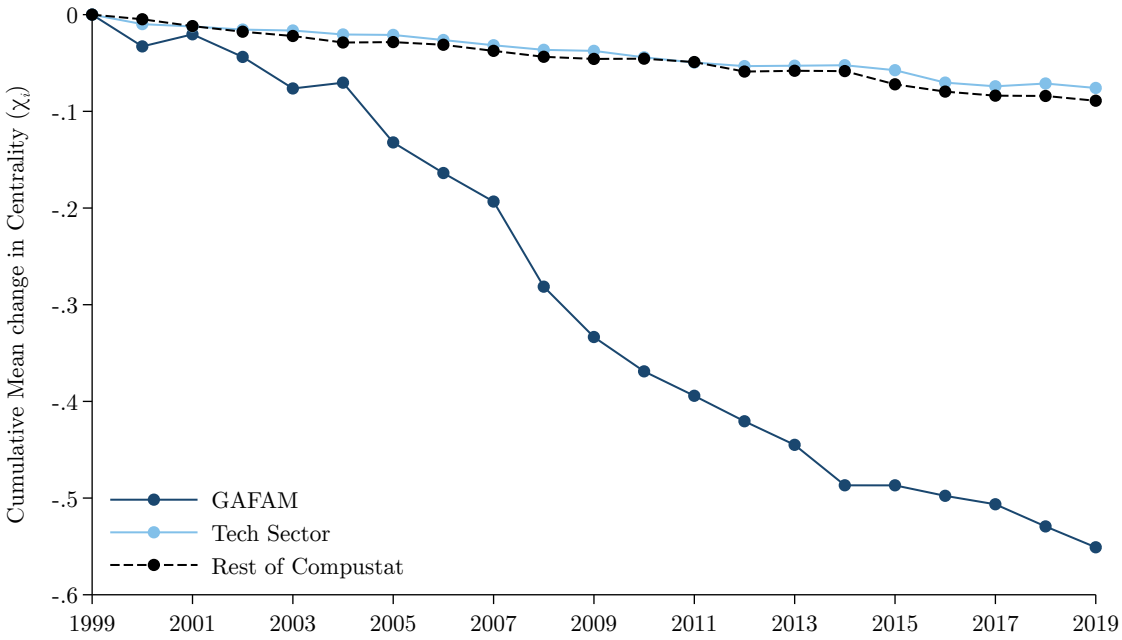

FIGURE 3. SECTORAL EVOLUTION OF PRODUCT MARKET CENTRALITY

Note: Cumulative mean change in product market centrality χ_i of GAFAM firms (dark blue line), other tech firms (light blue line), and the rest of Compustat (dashed black line) over time.

is that firms, particularly in the tech industry, acquire startups to gain ownership of valuable technology and human capital. Preventing startups from being acquired could limit the innovation ability of larger firms. However, there is evidence that the increased rate of startups acquisitions was not associated with more product innovation and that innovation decreased particularly sharply for GAFAM. One measure of product market dynamism at the firm-level is

$$AngularVelocity_{it} = \text{acos}(a'_{it} a_{it-1}) \quad (6)$$

which captures the year-to-year variation in 10-K product description. Although the average velocity for Compustat firms decreased by nearly 20% since 1997 the decrease for GAFAM is even larger, amounting to nearly 45%. These trends cast doubt on the hypothesis that the intense startup acquisition activity of large tech companies was driven by a product innovation motive.

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