Supplementary Appendix to "The Monetization of Innovation"*

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*The views expressed are those of the author and should not be interpreted as reflecting the views of the European Central Bank, the Eurosystem, the Board of Governors of the Federal Reserve System, or their staff.

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SA.1 Additional results and robustness

SA.1.1 Inspecting firms along innovation or monetization progress

Table SA.1 investigates the characteristics of firms at different stages of their monetization and innovation progress by inspecting firms by quartiles of service quality q (top panel) and monetization stock M (bottom panel).

Not surprisingly, sales rise across increasing quartiles of both q and M. In turn, SG&A expenditures decline (as a fraction of sales) across ascending M quartiles and q quartiles. As gross profit margins are generally healthy across bins, losses appear to be fueled by SG&A expenditures.[1] Firms are more likely to make losses in bins with the largest SG&A-to-sales[2]—yet, these firms also exhibit the highest firm value-to-sales, capturing the growth potential associated with such expenditures. Our simulated panel then captures the coexistence of unprofitability and high valuations, pointing to SG&A investment as a common driver (largely driven by monetization expenditures).

SA.1.2 Further assessing the role of direct monetization

This Appendix complements the counterfactual analysis in Section 4.1 of the paper, which assesses how the degree of direct monetization φ affects firm choices and outcomes.

Namely, we inspect firm dynamics upon incurring losses (Figures SA.1) when increasing the parameter φ beyond its baseline value, then reproducing the analysis conducted in Figure 4 in the main text under our calibrated value of φ. Notably, Figure SA.1 shows that dynamics do not change much when increasing φ beyond our calibrated value.

[1] Consistently, as per Table 4, the net profit margin exhibits a negative sensitivity to lagged SG&A, both in the actual and simulated data.

[2] Table SA.1 also reveals that the frequency of losses is very sensitive to M: It goes from about 77% to less than 2% from the lowest to the highest M quartile.

SA.1.3 The impact of monetization uncertainty

Monetization and monetization uncertainty set digital service firms apart from pure R&D-intensive firms. First, investment in monetization implies that digital service firms deflect some resources from innovation to monetization (this being the case even when allowing for direct monetization of customers). Second, monetization expenditures translate into uncertain increases in the monetization stock.

In this section, we isolate the effect of monetization uncertainty by designing a counterfactual setup in which, for a given monetization expenditure S, the ensuing increase in the monetization stock is deterministic. Specifically, we modify Equation (4) to: $M' = M(1-\phi) + SE[Y] = M(1-\phi) + S\nu^{-1}$. I.e., for a given S, the increase in M is equal to the expected increase in the baseline model with monetization uncertainty.

Table SA.2 compares selected moments from our baseline setup featuring monetization uncertainty with those associated with this counterfactual with no monetization uncertainty. We start by observing that, without uncertainty, the gross profit margin is more sensitive to SG&A expenditures, and the sensitivity of the net profit margin to SG&A goes from negative with uncertainty (as it is in the actual data, see Table 4) to positive without uncertainty (see the last two rows of Table SA.2). The reason is that, absent uncertainty, monetization expenditures directly map into known increases in the monetization stock—thus, net profits become positively sensitive to such expenditures.

Without monetization uncertainty, firms exhibit higher monetization and R&D expenditures in *absolute* magnitude, leading to a larger monetization stock and service quality, on average. However, looking at expenditures normalized by sales, firms on average spend a *lower* share of their sales on monetization and R&D. As a result, these investments erode the net profit margin by a lower extent absent uncertainty, and the frequency of losses decreases. Whereas absolute firm value decreases on average due to uncertainty, the valuation ratio (firm value to sales) slightly increases as, with uncertainty, the upside potential from monetization is uncapped (whereas it is so absent uncertainty). This result lends further support to the idea that the high valuation ratios of DS firms are largely driven by the upside potential

associated with monetization breakthroughs.

SA.1.4 Alternative modeling of financing frictions

The model extension in Section 5.1 of the main text assumes the existence of frictions associated with the financing of intangible capital such as monetization and R&D expenditures, resulting in additional costs upon incurring such expenditures. In this section, we test the robustness of our results by adopting a different modeling approach—namely, in the spirit of Whited (1992), we capture financing costs by increasing the firm discount rate.[3]

Table SA.3 shows the associated results. Namely, we continue to find that tighter financing frictions (going from left to right in the columns of this table, associated with a greater discount rate and, thus, a lower β) lead firms to reduce their SG&A investment as a fraction of sales. The decrease is driven by a decline in both monetization-to-sales and R&D-to-sales. Lower SG&A expenditures lead to a decrease in the frequency of losses, yet they also lead to a reduction in valuations on average, as seen from the lower firm value-to-sales. Overall, the main takeaways are confirmed under this alternative modeling.

SA.2 Monetization: Anecdotal evidence

Digital service firms have distinctive features that set them apart from other R&D-intensive firms: (1) Revenues are associated with the accumulation of a monetization stock via risky monetization expenditures, but monetization has uncertain outcomes; (2) Monetization is easier if the firm has a large customer base (gathered through success in the innovation dimension), but having a large customer base need not bring revenues; (3) Continued investment in innovation is necessary to maintain and expand their customer base; (4) Unprofitability

[3] As per page 1433 of Whited (1992): "Compared to an unconstrained firm, a firm facing a binding liquidity constraint [...] incurs a higher marginal opportunity cost of investment today versus delaying it until tomorrow; that is, it behaves as if it has a higher discount rate since, as discussed above, the value of proceeds from an extra unit of investment are forced to be higher today than tomorrow in the face of a binding constraints." Relatedly, Zucchi (2024) studies the relation between financing frictions in primary markets and trading frictions in secondary markets, showing that they are related through a higher discount rate.

often goes hand in hand with large valuations. Below we provide anecdotal evidence and practical examples of these key features, by reporting excerpts from the financial press. Interestingly, the growing significance of monetization is well exemplified in Figure SA.2, showing the count of the word "monetize" in the ten major U.S. newspapers.[4] The figure shows a steep increase starting in 2005, with the word count having increased manifold since then.

Digital service firms' difficult path to profitability in spite of a broad customer base are exemplified by the article "Tumblr and the Death of the Old Internet" (August 17, 2019, *Wall Street Journal*). The article reports:

"On the business side, it [Tumblr] operated under the assumption that it could make money off its users the same way people had since the invention of the banner ad: Build a big enough audience, and "monetization" will take care of itself. Alas, Tumblr was inherently ill-suited to advertising [...]. Its impenetrability was a challenge to advertisers."

This article emphasizes how R&D is also important for these firms (as in our model). It highlights that the service was "never a very polished or particularly reliable service to begin with, had a hard time going mobile." The article then concludes:

"the real scandal of Tumblr isn't that it's now worth a fraction of its former selling price. The scandal is that Tumblr was ever valued so highly at all. [...] Having a very popular product and only the vaguest idea how to make money on it doesn't, it turns out, a world-changing business model make."

The same article also reports the case of Yahoo. It notes that:

"[Yahoo] hemorrhaged talent throughout the 2010s at both the engineering and executive level, couldn't attract and retain the sort of people that could help its revenue-generating engine, that is its ailing ad network, to compete. More or less the same thing occurred once Yahoo joined AOL, sorry Oath—oh wait, I mean Verizon Media—whose parent company essentially wrote down its entire value to zero in late 2018. Eyeballs, which this combined network had plenty of, weren't enough in a climate in which advertisers had moved beyond the kind of cut-rate programmatic display advertising its sites were running."

These lines illustrate that building a large customer base is not sufficient for digital service firms—monetization is also required, but the outcome is largely uncertain.

Similarly, the article "Snapchat must hit more angles with advertisers" (September 19,

[4] A similar approach is adopted, for instance, by Baker et al. (2016).

2019, *Wall Street Journal*) illustrates that having a large customer/user base does not imply that advertisers flock to the firm. Talking about Snapchat, the article reports:

"Because the largest segment of Snap's users are young, older brand executives don't necessarily use Snapchat frequently, [...] if ever. This can mean that they don't understand the platform and, therefore, may not see the value in advertising there. Snap has been working to combat friction between its platform and advertisers to boost sales. [...] Earlier this year, Snap rolled out Instant Create, which enables advertisers to make ads in three steps. In April, Snap announced a partnership with e-commerce tech company Shopify allowing merchants to purchase Snapchat ads directly through Shopify's platform. [...] This is evident in recent results. Snap grew overall sales in the second quarter by 48% year-over-year—its best growth since the first quarter of 2018."

These all can be seen as examples of monetization efforts, which have a highly uncertain outcome. In a subsequent article ("Snap posts gains in Users, Revenue" *Wall Street Journal*, October 22, 2019), it is reported:

"Adding more users is critical for Snap as it looks to attract more advertisers and, in turn, generate more revenue. [...] Snap, whose Snapchat app turned eight years old in September, has yet to turn a profit as a public company."

This article reflects the difficulty of firms in attaining profitability. Similarly, talking about Slack technologies, the article "Slack Shares Jump in Trading Debut" (June 20, 2019, *Wall Street Journal*) reports:

"instant-messaging software has supplanted email as the main method of communication for some office workers" and emphasizes the firm's large customer base. The article also depicts the firm by noting the key characteristics of digital service firms: "fast-growing revenue but significant net losses as the company seeks scale by pouring money into sales and marketing."

While not sufficient to attain profitability, having a broad customer base is a necessary condition, as exemplified by the article "Instagram is breaking hearts" (*Wall Street Journal*, August 17, 2019):

"Instagram says it doesn't receive compensation directly for the sales it enables through hosting influencers' posts. Instead, it basks in the traffic they bring. The more people engage on their platform, the greater its value to advertisers. [...] Popularity begets popularity."

The importance of continued monetization expenditures (to maintain the firm's moneti-

zation stock) is exemplified by the article "Twitter Shares Plunge as Ad-Business Troubles Weigh on Growth" (*Wall Street Journal*, October 24, 2019). The article reports:

"Technical glitches in Twitter Inc.'s advertising software roiled the social-media company in the third quarter, as a pullback in spending from some buyers and weaker pricing for ads also cut into revenue and profit even though it added millions of new users. [...] Twitter, similar to other social-media and Internet firms, has been jockeying to increase its share of the growing digital-advertising business, albeit one that is dominated by larger players such as Alphabet Inc.'s Google and Facebook Inc. The company said malfunctions in ad-targeting software as well as weaker-than-expected spending in July and August hurt its performance. The software problems meant that Twitter couldn't serve ads to users with the same level of precision as it normally does, prompting some advertisers to pause or reduce spending. For example, a burger restaurant's ads might have been delivered to a wide swath of users, including vegetarians and people who live long distances away, making them less effective than if they were sent to meat lovers who live near the restaurant. [...] Advertising is very high-margin revenue, so when your advertising isn't growing as fast, your profitability will be impacted by a greater amount,"

Similarly, the article "Etsy updates advertising offerings" (*Wall Street Journal*, February 26, 2020) exemplifies how digital service firms continue to try and refine their ad platforms, which is one of the most prominent way digital service firms make profits:

"Etsy, Inc. (Nasdaq: ETSY), which operates two-sided online marketplaces [...], announced today that it is evolving its advertising offering to help sellers more effectively drive traffic to their listings. Etsy is introducing a new advertising service, called Offsite Ads. Etsy will pay the upfront costs to promote sellers' listings on multiple internet platforms without any upfront costs for sellers."

Finally, SG&A expenditures can weigh on firm profitability, see "Airbnb Swings to a Loss as Costs Climb Ahead of IPO" (*The Wall Street Journal*, February 11, 2020):

"Investors have grown increasingly suspicious of companies with losses and no clear path to profitability. [...] Airbnb's drooping profitability is causing concern within the firm, according to people close to the company. The board in recent weeks grilled executives on why expenses are outpacing revenue, the people said. Airbnb increased its revenue to $1.65 billion in the third quarter, up almost $400 million from a year earlier, one of the people said. But costs rose faster. Net profit for the quarter was $266 million less than the $337 million profit for the same period in 2018, and not enough to cover losses for the first six months of the year, the person added. Costs are likely to increase further, as a result of Airbnb's recent move to spend more on safety issues affecting its platform. Airbnb is also spending heavily on upgrading the technology of its platform, with costs running at more than $100 million a

year, a person close to the company said. One category of costs that has grown particularly fast is general and administrative expenses, which more than doubled year-over-year to total $175 million in the third quarter [...]"

SA.3 Additional evidence

Growth of DS firms along the intensive and extensive margin We complement Figure 1 in the main text—showing the growth in market capitalization and sales of DS firms—by zooming on different cohorts of firms. Specifically, Figure SA.3 shows the grow in inflation-adjusted market capitalization and sales when partitioning firms into three different cohorts: those that entered from 1995 up to 2004, those that entered between 2005 and 2014, and those that entered after 2014. Irrespective of the cohort, we see that the relative contribution to aggregate sales and market capitalization is low at entry and gradually grows over time. Thus, whereas entry continues to occur till the end of our sample, we see growth in both sales and market capitalization for the different cohorts.

Further comparing DS and non-DS firms This section deepens the empirical comparison between DS and non-DS firms.

We further investigate the profit margins and the expenditures of the different groups of firms in Table 1 of the paper (i.e., DS, non-DS, R&D, and New firms) when calculating averages weighted by inflation-adjusted sales. Table SA.4 shows such weighted averages. We observe that weighted averages deviate most notably from equally-weighted averages for the net profit margin, the loss-making frequency, and the SG&A-to-sales of DS firms. Specifically, the table shows that the weighted-average net profit margin of DS firms is positive. This result is expected and captures the idea that larger DS firms enjoy generous net profit margins—by contrast, small firms disproportionately bear losses, being heavily investing in SG&A expenditures. Consistently, we find that the weighted average of SG&A-

to-sales of DS firms is much smaller than the simple average. This result supports the idea that smaller firms exhibit much larger SG&A expenditures (because they have not attained monetization yet).

Further comparing non-DS and DS firms, Table SA.5 reproduces Table 3 for the sample of Non-DS firms. Comparing these two tables reveals that whereas SG&A-to-sales increase and then decline over a loss-making interval for non-DS firms too, the magnitude of the changes is more dramatic for DS than for non-DS firms. At the same time, as for DS firms, the increase and decline in R&D expenditures is less pronounced.

References

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Whited, T. (1992). Debt, liquidity constraints, and corporate investment: Evidence from panel data. *Journal of Financial Economics 47*, 1425—1460.

Zucchi, F. (2024). The real effects of financing and trading frictions. *Journal of Financial and Quantitative Analysis 59*, 3835—3870.

Service quality, q	1st	2nd	3rd	4th
Sales	0.577	1.032	1.496	2.267
SG&A expenditures to sales	0.557	0.540	0.518	0.467
Monetization exp to sales	0.506	0.495	0.481	0.443
R&D exp to sales	0.051	0.045	0.038	0.025
Monetization stock	0.990	1.751	2.509	3.613
Gross profit margin	0.567	0.569	0.583	0.595
Loss-making frequency	0.433	0.441	0.392	0.329
Firm value to sales	4.571	4.554	4.468	4.321

Monetization stock M	1st	2nd	3rd	4th
Sales	0.483	0.920	1.428	2.507
SG&A expenditures to sales	0.793	0.589	0.448	0.258
Monetization exp to sales	0.746	0.548	0.410	0.224
R&D exp to sales	0.047	0.041	0.037	0.034
Service quality	0.312	0.475	0.587	0.712
Gross profit margin	0.407	0.536	0.631	0.737
Loss-making frequency	0.766	0.552	0.260	0.019
Firm value to sales	5.090	4.649	4.300	3.896

Table SA.1: Success along innovation and monetization. This table studies firms sorted into quartiles of service quality q (top panel) and of monetization stock M (bottom panel). The quantities reported are conditional means from our simulated model.

Moment	With uncertainty	Without uncertainty
Sales	1.335	1.448
SG&A expenditures to sales	0.522	0.458
Monetization exp. to sales	0.482	0.419
Monetization expenditures	0.580	0.611
R&D exp. to sales	0.040	0.039
R&D expenditures	0.055	0.060
Monetization stock	2.212	2.340
Service quality	0.521	0.554
Gross profit margin	0.578	0.571
Loss-making frequency	0.399	0.352
Firm value to sales	4.484	4.366
Firm value	5.361	5.629
Sensitivity of gross profit margin to lagged SG&A	0.042	0.170
Sensitivity of net profit margin to lagged SG&A	-0.309	0.223

Table SA.2: The effect of monetization uncertainty. This table compares means of selected quantities from our simulated data from the baseline version of the model (labeled as "With uncertainty") with those from the counterfactual environment in which monetization increases are deterministic (labeled as "Without uncertainty").

	$\beta = 1/1.065$ (Baseline)	$\beta = 1/1.07$	$\beta = 1/1.075$
Sales	1.335	0.585	0.235
SG&A expenditures to sales	0.522	0.496	0.415
Monetization expenditures to sales	0.482	0.465	0.392
R&D expenditures to sales	0.040	0.031	0.024
Innovation rate	0.243	0.209	0.169
Service quality	0.521	0.226	0.091
Monetization stock	2.212	0.975	0.392
Gross profit margin	0.578	0.573	0.573
Loss-making frequency	0.399	0.377	0.301
Firm value to sales	4.484	4.123	3.736

Table SA.3: Robustness: Alternative modeling of financing costs. This table reports means from our simulated data under our baseline parameterization (column "Baseline" with $\beta = 1/1.065$) and when increasing the discount rate ($\beta = 1/1.07$ in the second column and $\beta = 1/1.075$ in the third).

	DS	Non DS	R&D	New
Gross profit margin	0.678	0.328	0.452	0.313
Net profit margin	0.260	0.149	0.203	0.130
Loss-making frequency	0.077	0.016	0.029	0.033
SG&A to sales	0.420	0.179	0.249	0.183
R&D to sales	0.121	0.024	0.073	0.024
Number of observations	2338	83127	18921	36463

Table SA.4: WEIGHTED AVERAGES. The table shows averages of selected variables weighted by inflation-adjusted sales for DS, Non-DS, R&D, and New firms. Variable construction and additional details are reported in Appendix A.

# Subsequent years	Change in SG&A-to-sales	Change in R&D-to-sales
1	+10.66%	+2.29%
2	-3.17%	-0.88%
3	-3.42%	-0.89%
4	-2.93%	-0.73%
5	-1.70%	-0.43 %

Table SA.5: EXPENDITURES OVER A LOSS SPELL FOR NON-DS FIRMS. The table reports the year-on-year difference in SG&A-to-sales (second column) and R&D-to-sales (third column) for non-DS firms in the years following a firm first incurs operating losses.

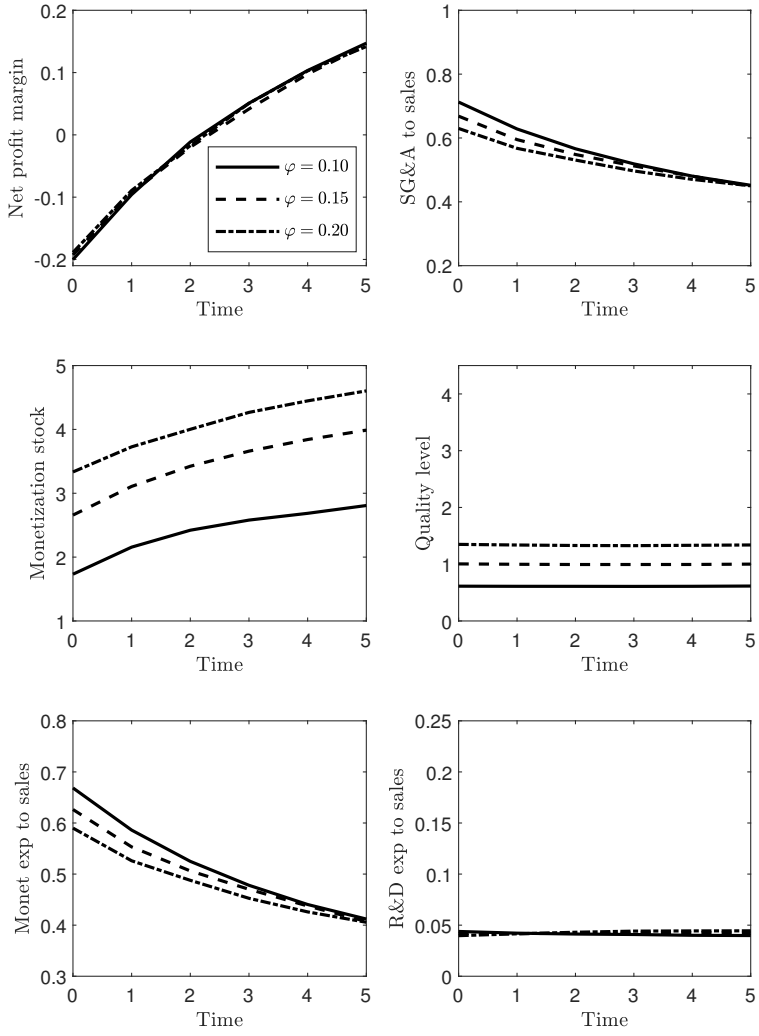

Figure SA.1: Firm dynamics upon incurring losses and direct monetization. The figure shows the dynamics of the net profit margin, SG&A to sales, monetization stock, quality level, monetization expenditures to sales, and R&D to sales over the years following the onset of losses (marked as time 0 on the horizontal axis) for increasing value of the degree of direct monetization φ, as described in the legend. Quantities are means conditioning on the year following the shock.

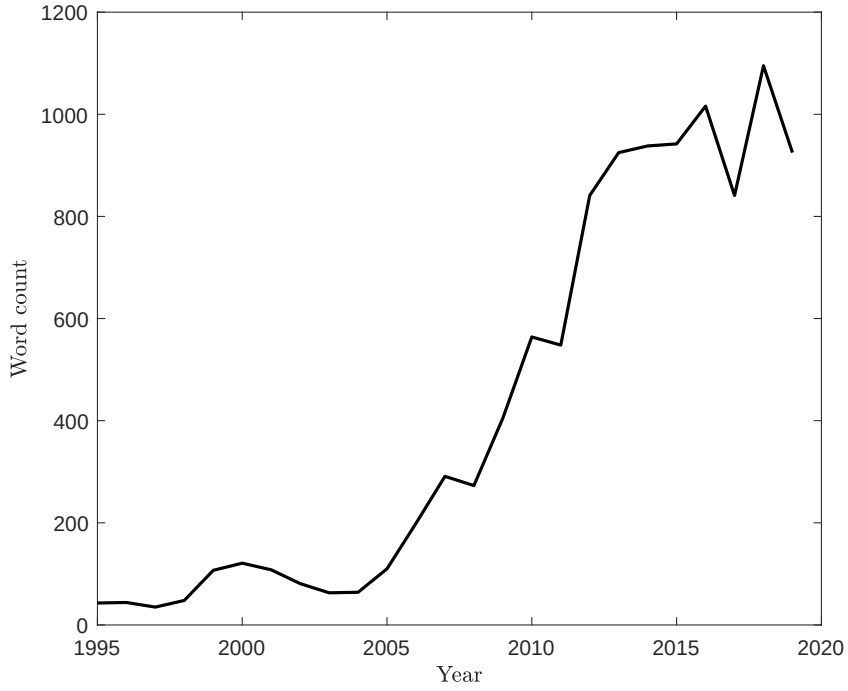

Figure SA.2: "Monetization" in the press. The figure shows the word count for "monetize/monetization" since 1995 in the following newspaper: USA Today, Chicago Tribune, Washington Post, Los Angeles Times, Boston Globe, San Francisco Chronicle, Dallas Morning News, New York Times, Financial Times, and Wall Street Journal.

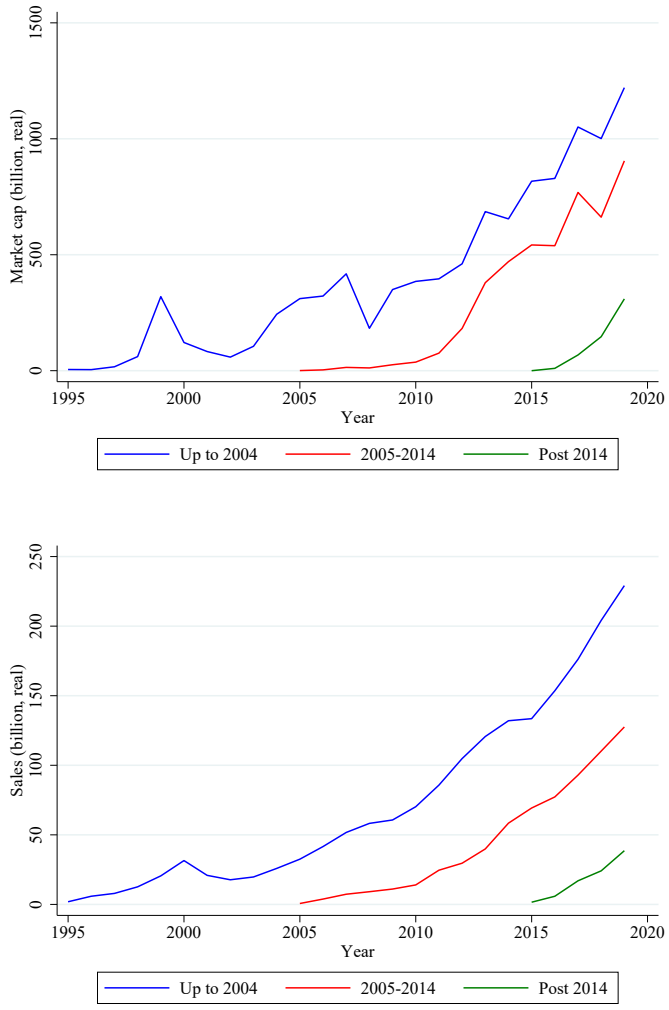

Figure SA.3: The rise of DS firms, by cohort. The figure shows the inflation-adjusted aggregate market capitalization (top panel) and aggregate sales (bottom panel) of DS firms for cohorts of firms that enters before 2005, between 2005 and 2014, and after 2014. Definitions and details are provided in Appendix A.