Private Equity Funds and Firm Products*

Wenhao Yang
Darla Moore School of Business
University of South Carolina
1014 Greene Street, Columbia, SC 29028
wenhao.yang@moore.sc.edu
Tel: 803-777-3171

Feng Zhang
David Eccles School of Business
University of Utah
1655 E. Campus Center Drive
Salt Lake City, UT 84112
feng.zhang@eccles.utah.edu
Tel: 801-587-9476

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Abstract

We examine whether and how private equity funds affect the target firm's product development after a leveraged buyout. Employing a novel and comprehensive dataset of announcements of new products, we find that the target firm significantly reduces the number of new product announcements after the buyout compared to its product market competitors. Additional tests suggest that some private equity funds cut the target firm's investment on product innovation to boost its short-term earnings at the cost of its long-term performance, and other private equity funds cut the investment on new products to reduce agency costs. In contrast, the results are inconsistent with that private equity funds select target firms that they anticipate to announce fewer new products in the future regardless of whether the leveraged buyout occurs. The results are consistent with that private equity funds decelerate the target firm's product development after the leveraged buyout to boost its short-term earnings or to reduce its agency costs.

Keywords: private equity funds, new products, leveraged buyouts
JEL classification: G34; G23; L11

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1. Introduction

Finance researchers know by now that the target firm's operating performance improves after private equity (PE) funds take the firm private through a leveraged buyout (LBO), and that the improvement becomes smaller after the 1980s and reverses soon after private equity funds exit (we review related studies in Section 2). Notwithstanding the findings on the target firm's overall operating performance after the LBO, finance researchers still do not know whether and how PE funds impact the target firm's products. Until we know their impacts on firm products, we cannot know whether and how PE funds influence consumer welfare by changing the products available to consumers. The sheer size of the assets under the management of PE funds, which reaches $2.5 trillion at the end of June 2016,[1] renders it important to understand PE funds' impacts on the target firm's products. In addition, understanding their impacts on products will shed new light on a long-studied research question, namely how PE funds improve the target firm's operating performance: by reducing agency costs (Jensen, 1986) or by boosting short-term earnings at the cost of long-term investment on product innovation (Stein, 1989)?

Firm products are a useful arena to examine PE funds' impacts on the target firm: revenue comes from sales of products; the firm succeeds if and only if consumers like its products. Given the central role of products in firm operations, the PE fund's operational changes are likely to be reflected in the target firm's products. For example, if the PE fund optimizes the target firm's operations to reduce production costs, then product price will likely decrease and the quantity of products sold will likely increase; if the fund increases (cuts) investment on product innovation, the target firm will announce more (fewer) new products. In this study, we do not examine cost-saving operational changes because we do not observe

[1] See the 2017 Preqin Global Private Equity & Venture Capital Report.

production cost, product price or the quantity of products sold. Instead, we focus on product innovation and in particular examine whether the target firm announces more or fewer new products after the LBO.

It is difficult to identify PE funds' impacts on firm products because researchers lack a comprehensive database of firm products until recently. In this study, we circumvent the difficulty by employing a novel and comprehensive database of announcements of new products recently constructed by Standard & Poor's (S&P). In a sample of 276 LBOs of United States public target firms in the 2002-2013 period, we estimate a difference-in-difference (diff-in-diff hereafter) model and find that the target firm significantly reduces the number of product announcements after the LBO compared to its competitors with similar products. Our diff-in-diff model not only satisfies the parallel trends assumption, but also produces unbiased estimates and rejects the null hypothesis at approximately the theoretical rejection rate in Monte Carlo simulations; that is, it is well specified and produces reliable estimates of PE funds' impacts on product innovation of the target firm. The estimation results show that the LBO firm announces fewer new products after the LBO, implying that consumers have fewer products to choose from after the LBO than they would have had if the private equity fund had not taken the target firm private.

Why does the target firm announce fewer new products after the LBO? There are at least three explanations. One explanation is that target firm managers overinvest on product development before the LBO because they have incentives to build an empire with more products; PE funds cut the overinvestment after the LBO in order to raise the value of the target firm (Jensen, 1986; the reduced-agency-cost hypothesis hereafter). In contrast, Stein (1989) suggests that PE funds, who typically exit the target firm within several years after the LBO,

have incentives to boost the target firm's short-term earnings at the cost of long-term investment on product development (the myopic-management hypothesis hereafter). The third explanation is that PE funds select target firms that they anticipate to announce fewer new products in the future (the self-selection hypothesis hereafter). In contrast to the first two explanations, the third explanation assumes that PE funds play a passive role in the LBO target firm rather than actively change the products of the target firm.

In a battery of tests, we find that the results are most consistent with the myopic-management hypothesis, are mixed regarding the reduced-agency-cost hypothesis, and are inconsistent with the self-selection hypothesis. The myopic-management hypothesis predicts that the target firm will perform better (worse) in the long run if it increases (decreases) its investment on product development, which is the opposite of the prediction of the reduced-agency-cost hypothesis. Consistent with the prediction of the myopic-management hypothesis but inconsistent with that of the reduced-agency-cost hypothesis, we find that the target firm is significantly more likely to go public again if it increases the number of product announcements after the LBO than before the LBO. The reduced-agency-cost hypothesis also predicts that target firms with more free cash flow will reduce the number of product announcements by more after the LBO; consistent with the prediction, we find greater decreases in the number of product announcements among target firms with more free cash flow.

The self-selection hypothesis says that PE funds target a firm because they anticipate it to announce fewer new products in the future regardless of whether they take it private. It implies that the target firm is different from its competitors before the LBO; but we find that before the LBO the target firm is not different from its product market competitors in terms of the number of product announcements, research and development expenses or capital expenditures.

Furthermore, the relationship between the target firm's and the control firm's number of product announcements weakens after the LBO, suggesting an active rather than a passive role of the PE fund in the target firm's product decisions. Taken together, the results cast doubt on the self-selection hypothesis.

This study contributes to the literature with its new findings of PE funds' impacts on the products of public LBO target firms, and by shedding new light on the long-studied research question regarding how PE funds improve the target firm's operating performance. Bernstein and Sheen (2016) and Fracassi, Previtero, and Sheen (2017) examine a similar research question but center on small private target firms including restaurants and grocery goods producers. Our findings complement theirs with a different focus on large public LBO target firms. We further differentiate our study from theirs in the next section.

2. Related studies

Our study closely relates to Bernstein and Sheen (2016) and Fracassi, Previtero, and Sheen (2017). Employing 145 buyouts of grocery goods producers, Fracassi et al. find that the producers marginally increase product prices by 0.6% relative to their competitors after the buyout; they sell more units of products, introduce more products to the market, and raise the geographic availability of their products. In a sample of 118 buyouts of Florida restaurant chains, Bernstein and Sheen find that the restaurants are less likely to violate health regulations after the buyout. The two studies focus on restaurants and small grocery producers, while we focus on large public firms: among the 145 buyout targets studied by Fracassi et al., only 17 are public firms; none is a public firm in the sample of Bernstein and Sheen. More important, Fracassi et al. find no evidence of significant changes in product prices, sales, product

innovation, or the geographic availability of products after the 17 buyouts of public grocery goods producers. Since grocery goods producers represent only a portion of all public firms, it remains unknown whether and how private equity funds affect the products of a typical public LBO target firm.

Restaurants and small grocery goods producers differ greatly from large public firms in terms of the characteristics of their products and the complexity of their operations. For example, consider Old Orchard Brands, LLC—a family-owned private juice producer that is acquired by Allied Capital Corporation, a business development company, on 2 May 2007—and Dell Inc., a computer producer that is taken private in October 2013 by its founder Michael Dell and Silver Lake Partners, a private equity firm. Apple juice does not involve cutting-edge technologies but computers do because information technology changes faster; Old Orchard Brands does not need to coordinate among numerous suppliers but Dell does because a computer requires much more suppliers than a bottle of apple juice. Because of these differences and many others, Allied Capital Corporation and Silver Lake Partners will likely implement different changes to the products of their buyout targets (apple juice versus computers). Therefore, the findings of Bernstein and Sheen (2016) and Fracassi, Previtero, and Sheen (2017) may not apply to large public LBO target firms. It is unsurprising that our findings are indeed different from theirs.

Sheen (2014) examines changes to the products of the acquirer and the target firm after 88 strategic mergers and acquisitions, which do not involve private equity funds. Employing a novel dataset of consumer products, he finds that the acquirer's and the target's products converge in quality, product price declines, and overall product value for customers increases. Our study is different with a focus on financial buyouts involving private equity funds rather

than on strategic mergers and acquisitions. Private equity funds usually exit after several years of the LBO while strategic acquirers are more likely to keep the target firm for a longer period; in addition, strategic acquirers own operating assets but private equity funds do not. Because of these differences, private equity funds and strategic acquirers are expected to implement different changes to the target firm's products after the acquisition.

This study also relates to a stream of studies on the target firm's operating performance after private equity buyouts. The studies find consistent evidence of improved post-buyout operating performance in the target firm in the 1980s, and attribute the improvement to strengthened managerial incentives (Kaplan, 1989), better working capital management (Smith, 1990), cost reduction (Muscarella and Vetsuypens, 1990), or enhanced productivity in plants (Lichtenberg and Siegel, 1990). Compared with private equity buyouts in the 1980s, recent private equity buyouts experience weaker improvement in the target firm's operating performance (Leslie and Oyer, 2009; Guo, Hotchkiss, and Song, 2011). Whereas the buyout target firms outperform their industry peers in operating performance, the outperformance disappears within a few years after the target firm goes public (Holthausen and Larcker, 1996; Harris, Siegel, and Wright, 2005; Leslie and Oyer, 2009; Acharya, Gottschalg, Hahn, and Kehoe, 2013). On balance, these results are consistent with that private equity funds improve the operating performance of the buyout target firm, and that the improvement ceases after the fund exits.

3. Data

3.1. Data sources

We construct our sample of LBOs and the LBO target firms' product announcements using four databases: the SDC Platinum mergers and acquisitions database, Compustat, CRSP, and Capital IQ. We first retrieve from SDC Platinum the completed LBOs of United States public firms over the 2002-2013 period, and merge with the other three databases to obtain the LBO target firm's permanent stock number in CRSP and the GVKEY number in Compustat and Capital IQ. Our sample starts in 2002 because the product announcements in Capital IQ start in 2002; it ends in 2013 to allow for a window of three years for private equity funds to make changes to the target firm's products. Our sample has 276 LBOs with available data on accounting performance, stock prices, and announcements of new products. The number of LBOs varies greatly from year to year, ranging between seven in 2002 and 51 in 2007 (see Table 1).

3.2. Choose control firms

We use a diff-in-diff method to identify the impacts of private equity funds on the target firm's product development. The first difference is before versus after the LBO, while the second difference is between the LBO target firm and its product market competitors (the control firms) that are not taken over by private equity funds and thus are not affected by private equity funds. That is, we identify the treatment effect of the private equity fund by comparing the changes of the target firm's products after the LBO with the changes of the products of the control firms over the same period.

Since we focus on firm products, we choose control firms whose products are most similar to the LBO target firm's products based on the Text-Based Network Industry Classifications (TICs) constructed by Hoberg and Phillips (2010, 2016). The Hoberg-Phillips industry classification assigns a pairwise similarity score between a firm and its competitors

based on the descriptions of their products in 10-K filings. For each LBO target, we choose five control firms with closest product similarity scores in the year before the LBO.

Table 2 compares the characteristics of the LBO target firms to their control firms at the end of the year before the LBO. The average target firm has been listed in the Compustat database for 18.2 years at the time of the LBO, while the average control firm has been in the database for 18.9 years. Although the target firms have the same average return on assets (2% for both) and similar average leverage ratio (0.24 vs. 0.21) as their control firms, they are smaller (with average total assets of $2.1 billion vs. $4.0 billion) and have lower Tobin's Q (1.51 vs. 1.87). They announce fewer new products than the control firms do (1.07 vs. 2.11) because they are smaller; the number of new products they announce is not significantly different from that of the control firms once we take into account firm size and other firm characteristics (see the first column of Table 7). The comparison indicates that the control firms have largely comparable characteristics to the LBO target firms, and thus are an appropriate control group for our diff-in-diff analysis.

3.3. Clean the data of new product announcements

S&P collects material news and firm announcements related to firm products from all sorts of sources including news wires, firm announcements and firm filings, and incorporates them into the Capital IQ database. According to S&P, the database contains all important and publicly available product announcements of both public and private firms, making it a useful data source for our study, which examines public LBO target firms that become private after the LBO. Some product announcements in the database, however, are unrelated to a launch of new product or an improvement on existing products, and thus are not useful for our purpose. We also find a few duplicate entries of the same product announcement in the database, probably

because S&P obtains the news from multiple sources. In order to construct a clean sample of material new product announcements, we manually review each product announcement for the LBO target firms and the control firms.

The LBO target firms and the control firms have 22,319 product announcements over the 72 months (six years) around the completion of the LBO. Each product announcement has a brief description (the "headline") and a more detailed summary (the "situation"), based on which we decide whether the announcement relates to the launch of a new product, important progress towards a new product or an improvement of an existing product. Appendix A provides an example of product announcement. On October 24, 2013, Hittite Microwave Corporation announces the launch of a new amplifier. This announcement in the Capital IQ database has a headline "*Hittite Microwave Corporation Announces New Gallium Nitride MMIC Power Amplifier Product*", and a "situation" field that describes the new amplifier in more detail. After reading the headline and the situation, we determine that this is a new product announcement.

Before manually reviewing each of the 22,390 product announcements, we conduct a pilot study of the announcements of a sample of randomly chosen firms. In particular, we randomly choose a firm (an LBO target or a control firm) from each of the 2-digit SIC industries in our sample, and read all their product announcements over the six years around the LBO (160 announcements in total). The pilot study helps us understand the typical content and structure of a product announcement for each industry, and thus enables us to classify the product announcements consistently in the second-stage manual review of all announcements. The pilot study suggests that the product announcements fall into four categories: (1) launch of new products; (2) important progress towards new products; (3) improvements and updates of existing products; and (4) others. The product announcements in the first three categories are

relevant to our study, but those of the last category are not and thus are excluded from our analysis. Below we explain each of the four categories of product announcements.

Launch of new products. This category includes the launch of a new physical product, a new service, a new major version of a software (e.g. from version 5 to version 6), and a scheduled launch of a new product on a specific date when there is no follow-up announcements of the new product. The majority (51.58%) of the 22,390 product announcements are in this category.

Progress towards new products. These are announcements of material progress toward a new product. They include regulatory approval of a new product, important research progress toward a new product, showcase of a product in development, announcement of the beta version of a new product, completion of important tests of a product in development, and presentation of research findings or data from clinical trials in a conference. We classify 6.73% of the 22,390 product announcements into this category.

Improvements and updates of existing products. This category is similar to the second one except that the announcements in this category relate to developmental progress on existing products rather than on new products. The announcements in this category include an existing product entering a major new market; the introduction of a new model of an existing product with major changes; an update of a software (e.g., update from version 5.1 to 5.2 or periodic updates from V1999 to V2000); new features added to an existing product; the launch of a new periphery product; and new brands added to department stores. Since one could regard an improved existing product as a "new" product, it is difficult to draw a distinction between some announcements in this category and those in the second category. We classify 30.69% of the 22,390 announcements into this category.

Others. We put all other announcements into this category and exclude them from our empirical analysis because they are unrelated to new products. They include duplicate records of the same product announcement, rare cases of product recalls, discontinuation of a product, deferred launch of a new product, rumors about a new product, research progress unrelated to specific firm products, commercials about products, demos after the launch of a new product, and other cases that are unrelated to new products or improvements on existing products. About 11% of the 22,390 announcements fall into this category. While the announcements in this category show that the Capital IQ database of firm products is imperfect, 11% is low enough to convince us that the database is reasonably accurate. Nevertheless, our manual review suggests that later studies using this database should carefully clean the product announcements.

We use the product announcements in the first three categories in our main analysis. Whereas the classification of the product announcement is clear-cut in most cases, they are admittedly arbitrary in some cases: for example, in some cases it is hard for researchers to tell whether a software is a new product or an improvement upon its current version. To alleviate potential impacts of the arbitrariness, we conduct robustness checks using only announcements in the first category (the launch of a new product). As discussed later in the paper, the results remain qualitatively unchanged in this more restrictive sample, suggesting that the occasional arbitrariness in the classification of product announcements does not materially affect our results.

4. Effects of private equity funds on LBO target firm's products

In this section, we investigate whether and how private equity funds affect the target firm's products using a diff-in-diff approach. Specifically, we estimate the following two

regressions using the panel data comprised of firm-year observations of the target and control firms over the six years around the LBO (three years before and three years after it):

$$Ln(1 + \#Prod.Ann.)_{it} = a + b \times LBO_i + c \times Post_t + d \times LBO_i \times Post_t + u_{it}, \quad (1)$$

$$Ln(1 + \#Prod.Ann.)_{it} = a + d \times LBO_i \times Post_t + F_i + T_t + u_{it}. \quad (2)$$

The dependent variable in both models is the natural logarithm of one plus the number of firm *i*'s product announcements in year *t*; *LBO* is an indicator equal to one if firm *i* is an LBO target firm and zero if it is a control firm; *Post* is an indicator equal to one if year *t* is one of the first three years after the LBO and zero if it is one of the three years before the LBO; F_i and T_t are firm and year fixed effects. The two models are the same except that the second model includes the firm and year fixed effects but the first model does not. The coefficient on the interaction variable ($LBO \times Post$) estimates the effects of private equity funds on the number of product announcements of the LBO target firm. Following the suggestion of Petersen (2009), we cluster the standard error by firm in all models because there are a large number of unique firms in our sample but only a small number of temporal periods.

Before estimating the models in the data, we assess whether they are appropriately specified by checking the parallel trends assumption and examining the specification of the models using Monte Carlo simulations. The assessments suggest that the parallel trends assumption is satisfied and the models are well specified, which in turn suggest that the diff-in-diff methods reliably estimate the effects of private equity funds on the products of the target firm. The estimation results show that private equity funds significantly reduce the number of product announcements of the target firm after the LBO relative to its product market competitors.

4.1. The parallel trends assumption

The diff-in-diff method assumes that before the treatment (the LBO in our case) the trends of the outcome variable (the number of product announcements in our case) are similar or parallel to each other between the treated firm and the control firm. Where the parallel trends assumption does not hold, the diff-in-diff estimate may reflect the diverging trends of the treated and control firms rather than the treatment effect. Plotted in Figure 1 are the trends of the number of product announcements of the LBO target firms and the control firms. The target firm and the control firm all increase the number of product announcements during the three years before the LBO. For the target firm, the number of product announcements increases from approximately 1.4 in the third year before the LBO to 1.6 in the year immediately before the LBO; for the control firm, from 2.5 to about 2.6. Whereas the two trend lines are not perfectly parallel to each other, they are similar and more important are different from the downward trends after the LBO. In short, the parallel trends assumption holds in our data.

4.2. Assess model specification using Monte Carlo simulations

We use Monte Carlo simulations to assess the specification of the diff-in-diff models in equations (1)-(2). In each year from 2002-2013, we randomly choose a number of firm-month observations from the CRSP-Compustat merged sample; the number of randomly chosen observations is set to the number of observed LBOs in the year (see Table 1) so that the simulated sample is comparable to the observed sample. For example, 7 random firm-month observations are chosen in 2002 and 29 observations are chosen in 2010. Each chosen firm-month is a pseudo-LBO: the firm is the pseudo-target firm and the month is the pseudo-time of deal completion. For each pseudo-LBO target firm we identify five control firms following the same procedure in Section 3.2: the control firms' products are most similar to those of the pseudo-target firm based on the product similarity score of Hoberg-Phillips (2010). After

retrieving the product announcements of the pseudo-target firms and their control firms over the six years around the pseudo-LBO from Capital IQ, we estimate the diff-in-diff models specified in equations (1)-(2) using the pseudo-LBOs.

We repeat the simulation 1,000 times and present the simulation results in Table 3. The first two rows report the mean and median coefficients on the interaction variable ($LBO \times Post$), which measure the percentage change in the pseudo-target firm's number of product announcements around the LBO less that of its control firms. Since the pseudo-LBOs are random firm-month observations, the estimated coefficient shall be close to zero if the two diff-in-diff models are properly specified. The mean coefficient estimate is -0.02 for both models, while the median estimate is -0.01 for both models. The numbers are economically small, indicating that the coefficient estimates are unbiased.

The last three rows of Table 3 present the fraction of the 1,000 simulations in which the null hypothesis of zero coefficient on $LBO \times Post$ is rejected at three theoretical significance levels: 1%, 5%, or 10%. The rejection rate of the null hypothesis shall be close to the corresponding theoretical rejection rate if the models are properly specified. We observe that the rejection rate for both models is close to the theoretical rejection rate. For example, at the 10% significance level, the null hypothesis is rejected in 7.2% of the 1,000 simulations for model (1) and 6.6% for model (2); at the 5% level, the rejection rate is 3.6% and 2.4%; at the 1% level, 0.8% and 0.2%.

In summary, Figure 1 indicates that the parallel trends assumption holds in our data: the target firms and the control firms have similar upward trends in the number of product announcements before the LBO but diverging downward trends after the LBO. Therefore, the estimation results of our diff-in-diff models are unlikely to be the continuation of the pre-LBO

trend in the number of product announcements. The simulation results in Table 3 show that our diff-in-diff models not only produce unbiased coefficient estimates but also reject the null hypothesis of zero coefficient with rejection rates close to the theoretical rejection rates. Taken together, the results suggest that our diff-in-diff models are properly specified, and thus will reliably estimate the effects of private equity funds on the target firm's product innovation. We now proceed to the estimation results of the diff-in-diff models.

4.3. Effects of private equity funds on LBO target firm's product innovation

In columns (1)-(2) of Table 4, we present the OLS regression results of the diff-in-diff models in equations (1)-(2). The coefficient on the LBO indicator is -0.11, while that on the post-LBO indicator is -0.03; both coefficients are statistically significant at the five percent level, consistent with the patterns shown in Figure 1: LBO targets announce fewer new products than the control firms do and the number of product announcements declines after the LBO. The coefficient on the interaction variable $LBO \times Post$ is -0.10 in column (1) with an associated *t*-statistic of -3.23 and -0.11 in column (2) with a *t*-statistic of -3.54, indicating that the LBO target firm reduces its product announcements by about 10 percentage points more than its control firms do.

The dependent variable in columns (1)-(2) of Table 4 counts all product announcements including launch of a new product, progress toward a new product, and improvement on an existing product. As a robustness check, in columns (3)-(4) we replace the dependent variable with the number of announcements of only new product launch. The estimated coefficients remain qualitatively unchanged compared to those in columns (1)-(2). In particular, the coefficient on the interaction variable is about -0.06 and statistically significant in both columns, suggesting that the LBO target firm reduces the number of new products launched by about 6

percentage points more than the control firms do. Taken together, the results in Table 4 indicate that the LBO target firm significantly reduces the number of new product announcements after the LBO. We investigate explanations for the central results in the next section.

5. Explanations for the results

Why does the target firm reduce the number of product announcements after the buyout? Jensen (1986) provides an explanation based on conflicts of interest between managers and shareholders. He proposes that managers have incentives to overinvest so that the firm grows beyond the optimal size, because managerial compensation tends to increase with firm size. In addition, managers are motivated to finance investments with internal free cash flows rather than with external financing in order to avoid the monitoring of financial markets. Jensen suggests LBOs as a solution to the problems of overinvestment and free cash flow: an LBO helps restore the monitoring of financial markets because firm leverage ratio significantly increases after the LBO; an LBO also helps re-align the interests of managers and shareholders as managerial ownership increases after the LBO. These post-LBO changes will help reduce overinvestments, including overinvestment in product innovation. In short, the reduced-agency-cost hypothesis predicts that the target firm overinvests in product innovation before the LBO and the private equity fund reduces or eliminates the overinvestment after the LBO.

Stein (1989) offers an alternative explanation based on managerial myopia: private equity funds have incentives to boost the target firm's short-term earnings at the cost of long-term performance because they typically exit within several years after the LBO. In his model, Stein shows that while investors correctly anticipate and discount the boosted short-term earnings when valuing the target firm, firm value still increases with short-term earnings in equilibrium.

Therefore, private equity funds are motivated to cut investment on product innovation after the LBO in order to boost the target firm's short-term earnings and its value when they exit.

Whereas both explanations predict that the target firm will reduce its investment in product innovation after the LBO, they have different predictions about the extent of the reduction across target firms and about the long-run performance of the target firm. The reduced-agency-cost hypothesis predicts a greater reduction for target firms with greater pre-LBO overinvestment or greater free cash flow; the myopic-management hypothesis predicts that the target firm will perform better (worse) in the long term if it reduces investment on production innovation by less (more), but the reduced-agency-cost hypothesis predicts the opposite.

In contrast to the first two explanations, the third explanation assumes that private equity funds do not actively change the target firm's products after the LBO; instead, they select target firms that will announce fewer new products in the future. The self-selection implies that the target firm is different from the control firm before the LBO. In this section, we test the predictions of the three explanations.

5.1. The reduced-agency-cost hypothesis

5.1.1. Free cash flow and the number of product announcements

The reduced-agency-cost hypothesis predicts that target firms with more free cash flow overinvest more in product innovation before the LBO than those with less free cash flow do, and thus are likely to reduce the overinvestment on product innovation by more after the LBO. To test this prediction, we divide the target firms into two groups based on whether the target firm's free cash flow as a fraction of total assets is above the sample median at the fiscal yearend before the LBO, and estimate the diff-in-diff model specified in equation (1) separately for the high- versus low-free-cash-flow target firms. To conserve space, we do not report the estimation

results of the diff-in-diff model specified in equation (2) for the high- and low-free-cash-flow target firms; the estimation results are qualitatively the same as those of model (1).

The first column of Table 5 presents the estimation results of the diff-in-diff model for the LBO target firms with high free cash flow; the second column for the target firms with low free cash flow. For the target firms of high free cash flow, the coefficient on the interaction variable $LBO \times Post$ is -0.16 and statistically significant at the one-percent level; for those of low free cash flow, however, it is statistically insignificant and economically smaller (-0.05). The difference in the coefficient between the two groups of target firms is statistically significant as shown in column (3) of Table 5, indicating that the high-free-cash-flow target firms reduce the number of product announcements after the LBO by more than the low-free-cash-flow targets do. The results are consistent with the prediction of the reduced-agency-cost hypothesis.

5.1.2. Single-segment target firms versus multi-segment ones

A firm could overinvest by acquiring unrelated businesses and form a multi-segment conglomerate (Jensen and Murphy, 1990; Betton, Eckbo, and Thorburn, 2008). In addition, a multi-segment conglomerate could further overinvest in value-decreasing projects because it usually has more discretionary resources under control than a single-segment firm does (Lang and Stulz, 1994; Berger and Ofek, 1995). These imply that a multi-segment target firm may be more likely to overinvest in product innovation before the LBO than a single-segment target firm; and if so, the reduced-agency-cost hypothesis predicts that the multi-segment target firm will likely divest itself of its peripheral businesses and refocus on its core business after the LBO, leading to a greater reduction in product innovation. To test this prediction of the reduced-agency-cost hypothesis, we divide our sample LBO target firms into two groups depending on whether the target firm has multiple business segments at the end of the year before the LBO,

and estimate the diff-in-diff model in equation (1) separately for the single-segment target firms versus the multi-segment target firms.

Columns (4)-(5) of Table 5 present the estimation results of the diff-in-diff model for the single-segment target firms and the multi-segment ones. The coefficient on the interaction variable $LBO \times Post$ is not only greater in absolute value but also statistically more significant for the single-segment target firms than for the multi-segment ones: it is -0.11 with an associated *t*-statistic of -2.74 for the single-segment targets versus -0.09 with a *t*-statistic of -1.83 for the multi-segment ones. The difference in the coefficient, however, is economically small and statistically insignificant as shown in column (6) of Table 5. The results suggest that single- and multi-segment target firms reduce the number of new product announcements by similar percentages after the LBO.

The results in columns (4)-(6) of Table 5 do not necessarily reject the reduced-agency-cost hypothesis for two reasons. First, the multi-segment target firms significantly reduce their product announcements after the LBO, suggesting that the LBO still reduces agency costs if there is any in these conglomerates. Second, a multi-segment conglomerate target may not overinvest in product innovation by more than a single-segment target does. For example, acquirer shareholders do not lose money around the announcement of mergers and acquisitions in which the target firm is from a different industry, suggesting that on average the diversifying mergers and acquisitions are not detrimental to shareholder wealth and thus are not overinvestment of the acquirer (Matsusaka, 1993; Betton, Eckbo, and Thorburn, 2008).

The results in Table 5 suggest that target firms of high pre-LBO free cash flow reduce the number of product announcements after the LBO by more than low-cash-flow target firms do, while multi- and single-segment target firms reduce the number of product announcements by

similar magnitudes. Taken together, they provide certain support for the reduced-agency-cost hypothesis.

5.2. The myopic-management hypothesis

The myopic-management hypothesis proposes that private equity funds have incentives to boost the target firm's short-term earnings after the LBO by cutting its investment on product innovation; it predicts that the target firm will perform better in the long term if the private equity fund does not cut the target firm's investment on product innovation after the LBO. It is difficult to test the prediction because we do not observe the target firm's accounting performance after it goes private. We circumvent the difficulty with a proxy for the target firm's long-term operating performance: whether the target firm goes public again through an initial public offering (IPO) after the LBO. This is a reasonable proxy because prior studies find that better performing LBO target firms are more likely to relist their stocks in a public offering (Degeorge and Zeckhauser, 1993; Holthausen and Larcker, 1996).

We track whether the target firm conducts an IPO after the LBO in two steps. First, we implement a fuzzy name matching procedure to match the LBO target firms' names with the names of the IPO firms retrieved from the equity offerings database of SDC Platinum. To ensure the accuracy of the matching, we manually examine each pair of matched firm names and search for relevant news about the IPO using Google and the Lexis-Nexis database.

In Table 6, Panel A, we divide the target firms into two groups depending on whether the target firm announces more or fewer new products after the LBO than before, and summarize the fraction of the target firms in each group that go public again, either within five years or at any time after the LBO. We observe that the target firm is more likely to go public after the LBO if it announces a greater number of new products than before the LBO. For example, among the 46

target firms that announce more products after the LBO than before, 5 (or 10.87%) go public again within five years after the LBO, compared with 2 (or merely 1.83%) of the 109 target firms that announce fewer new products after the LBO than before. Almost 20% of the target firms with an increased number of product announcements go public at any time after the LBO, while only 6.42% of those with a decreased number of product announcements do so.

We next examine the relationship between the change in the number of product announcements after the LBO and the likelihood of going public after the LBO using linear probability models and probit models. Since market condition affects a firm's going-public decision (Loughran and Ritter, 2000; and Pastor and Veronesi, 2005), we control for dummy variables indicating the year of the LBO in the linear probability model, but do not do so in the probit model because the dummy variables could lead to biased and inconsistent coefficient estimates in probit models (Greene, 2002).

In Panel B of Table 6, we present the estimation results of the linear probability model. Consistent with the results in Panel A, Panel B shows that the target firms that announce a greater number of new products after the LBO are more likely to go public again, either within the first five years or at any time after the LBO. The coefficient estimates on the key explanatory variables—the dummy variable indicating an increased number of product announcements after the LBO or the growth rate of the number of product announcements—are positive and statistically significant in all four models. In terms of the economic magnitude, the target firms with an increased number of product announcements are 8.8% more likely to go public within five years after the LBO than those with a decreased number of product announcements, and 9.6% more likely at any time after the LBO. In addition, the results show

that larger target firms and target firms with higher Tobin's Q are more likely to relist their stocks after the LBO.

The probit model estimation results, reported in Panel C of Table 6, are similar to those in Panel B based on the linear probability model. The coefficients on the two key explanatory variables are positive and statistically significant in all models, indicating that the target firm is more likely to go public again if it announces a greater number of new products after the LBO. The economic magnitude is also similar to that in the linear probability model: the target firms that announce a greater number of new products after the LBO are 5.7% more likely to go public within five years after the LBO than other target firms, and 9.6% more likely to do so at any time after the LBO.

In summary, Table 6 shows that the LBO target firm is more likely to relist its stocks if it announces a greater number of new products after the LBO. The results are consistent with the prediction of the myopic-management hypothesis but are inconsistent with the reduced-agency-cost hypothesis, which predicts that the more a target firm reduces its investment on product innovation, the more profitable it will be (and thus more likely to go public again).

5.3. The self-selection hypothesis

The reduced-agency-cost hypothesis and the myopic-management hypothesis propose that private equity funds actively change the target firm's investment on product innovation. The self-selection hypothesis, in contrast, proposes that private equity funds select into target firms that they anticipate to undergo certain changes in product innovation. It has at least two predictions. First, the LBO target firms are different from non-target firms in terms of product innovation before the LBO (and thus are chosen as a target). Second, the relationship between the target firm's and the control firm's number of product announcements remain similar after

the LBO versus before, because the self-selection hypothesis assumes that private equity funds do not actively change the target firm's products. Below we test the two predictions.

5.3.1. Are target firms different from non-target firms before the LBO?

No. As shown in Table 7, in which we regress three proxies for the investment on product innovation (the number of product announcements, research and development expense, and capital expenditure) on a dummy variable indicating the LBO target firm and on a set of firm characteristics, the coefficient on the dummy variable is insignificant in all three models. That is, the target firm is not significantly different from the control firm in product innovation before the LBO. In addition, Figure 1 shows that the target firm and the control firm have parallel pre-LBO trends of the number of product announcements, suggesting that they are not different from each other in terms of product innovation before the LBO. Taken together, the results indicate that the target firm has similar product innovation as the control firm before the LBO.

5.3.2. Does the relationship between the target firm's and the control firm's number of product announcements change after the LBO?

Yes. To test this prediction, we regress the number of the target firm's product announcements on the average number of its five control firms' product announcements, both expressed in natural logarithm, over the three years before the LBO and over the three years after the LBO. The regression results, reported in the first two columns of Table 8, show that the coefficient on the average number of control firms' product announcements decreases from 0.53 before the LBO to 0.33 after the LBO. The difference is not only economically large but also statistically significant with an associated *t*-statistic of -6.16 (column 3 of Table 8).

In summary, the relationship between the target firm's and the control firm's number of product announcements becomes weaker after the LBO (Table 8); the target firm is not

significantly different from the control firm in terms of product innovation and capital investment before the LBO (Table 7 and Figure 1). The results cast doubt on the self-selection hypothesis but are consistent with the reduced-agency-cost hypothesis and the myopic-manager hypothesis. The evidence on the reduced-agency-cost hypothesis is mixed. On one hand, the private equity fund's effects on the target firm's product innovation are stronger where the target firm has more free cash flow before the LBO (Table 5), consistent with the reduced-agency-cost hypothesis. On the other hand, the target firm is more likely to go public again if it announces a greater number of new products after the LBO than before (Table 6), inconsistent with the reduced-agency-cost hypothesis but supportive of the myopic-management hypothesis. On balance, the results are most consistent with the myopic-management hypothesis, consistent with the reduced-agency-cost hypothesis to a lesser degree, and inconsistent with the self-selection hypothesis.

6. Conclusions

Before this study, finance researchers do not know whether and how private equity funds affect the target firm's products after a leveraged buyout. We investigate the question, and find that the target firm announces fewer new products after the LBO than before, compared with its product market competitors. The results are most consistent with Stein's (1989) hypothesis that private equity funds are motivated to boost short-term earnings at the cost of long-term investment on product innovation. They are, to a lesser degree, consistent with Jensen's (1986) hypothesis that private equity funds cut (over)investment on product development to reduce agency costs. In contrast, we find no evidence that private equity funds select target firms that will reduce the number of product announcements in the future. On balance, we conclude that

private equity funds decelerate the target firm's product development after the LBO; some private equity funds do so to boost the target firm's short-term earnings while others do so as a means of reducing agency costs in the target firm.

Our findings lead to new research questions, which we cannot answer in this study because we do not have relevant data. For example, do private equity funds improve the quality of the target firm's products after the LBO? Do they raise or reduce product prices? How do competitors respond to the target firm's changes in product development, product quality and price? We leave the questions for future studies.

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Appendix A. An Example of Product Announcement in the Capital IQ Database

GVKEY: 163927
Announcement Date: 10/24/2013

Headline: Hittite Microwave Corporation Announces New Gallium Nitride MMIC Power Amplifier Product

Situation:
Hittite Microwave Corporation announced a new Gallium Nitride (GaN) MMIC power amplifier product which offers significant performance, size and durability advantages for communications, test instrumentation and radar systems operating in the 6 to 18 GHz frequency range. The HMC7149 is a 10W GaN MMIC Power Amplifier which operates between 6 and 18 GHz. The amplifier typically provides 20 dB of small signal gain and +40 dBm of saturated output power. The amplifier draws 680 mA quiescent current from a +28V DC supply and features RF I/Os that are matched to 50 Ohms for ease of use. The HMC7149 GaN MMIC amplifier also offers high output power capability, a compact die size and simplified biasing, which make it ideal for integration into high power density Multi-Chip-Module (MCM) and subsystem applications.

Appendix B. Variable Definitions

Variable	Definition
Firm Age	The number of years since the firm first appears in the Compustat database.
Total Assets	Total assets (Compustat item *at*).
Tobin's Q	[Total book assets (*at*) + market value of equity (*csho*prcc_f*) - book value of equity (*ceq*)] / total book assets (*at*).
ROA	The ratio of earnings to total book assets at the beginning of the year (*at*), where earnings equals income before extraordinary items (*ib*) - preferred dividends (*dvp*) - deferred income tax (*txdi*).
Leverage	The ratio of total liabilities (current liabilities (*dlc*) plus long-term debt (*dltt*)) to total book assets (*at*).
LBO	A dummy variable that takes the value of one if it is an LBO target firm, and zero if it is a control firm.
Post	A dummy variable that takes the value of one if it is after the LBO completion date, and zero otherwise.
Asset Growth	The ratio of total book assets (*at*) at the fiscal yearend to total book assets at the beginning of the year minus one.
R&D / Sales	The ratio of research and development expenses (*xrd*) to sales (*sale*). Missing R&D expenses are set as zero.
CapX / Sales	The ratio of capital expenditure (*capx*) to sales (*sale*).
Increased Product Announcement	A dummy variable that takes the value of one if the number of product announcements of the target firm over the three years after the LBO is greater than that over the three years before the LBO, and zero otherwise. If the number of news is zero both before and after the LBO, we drop these observations from our tests.
Growth of Product Announcement	The ratio of the number of product announcements of the target firm over the three years after the LBO to that over the three years before the LBO, minus one. If the number of news is zero both before and after the LBO, we drop these observations from our tests.

Table 1: Number of Leveraged Buyouts

This table presents the number of leveraged buyouts in our sample, by year.

Year	Number of Leveraged Buyouts
2002	7
2003	14
2004	20
2005	25
2006	35
2007	51
2008	13
2009	12
2010	29
2011	28
2012	20
2013	22
Total	276

Table 2: Summary Statistics

This table reports summary statistics of the characteristics of the LBO target firms and their comparable control firms. All accounting variables are calculated at the end of the fiscal year before the completion of the LBO, while the number of new products is measured in the 12-month period before the LBO. The control firms are those with the closest product similarity scores constructed by Hoberg and Phillips (2010). Detailed definitions of the variables can be found in Appendix B.

	N	Mean	StdDev	P10	P25	Median	P75	P90
LBO Target Firms								
Firm Age	276	18.16	12.02	8.00	10.00	15.00	21.00	35.00
Total Assets ($B)	273	2.15	5.39	0.06	0.14	0.48	1.51	4.23
Tobin's Q	270	1.51	0.79	0.90	1.01	1.31	1.76	2.30
ROA	272	0.02	0.12	-0.11	-0.01	0.03	0.07	0.11
Leverage	273	0.24	0.24	0.00	0.02	0.20	0.38	0.57
# Product announcements	276	1.07	3.68	0.00	0.00	0.00	1.00	3.00
Control Firms								
Firm Age	1317	18.92	13.96	6.00	9.00	14.00	23.00	42.00
Total Assets ($B)	1316	4.06	14.32	0.04	0.16	0.61	2.15	8.65
Tobin's Q	1314	1.87	1.17	0.97	1.14	1.50	2.12	3.16
ROA	1314	0.02	0.15	-0.15	-0.01	0.04	0.09	0.15
Leverage	1316	0.21	0.23	0.00	0.00	0.15	0.34	0.53
# Product announcements	1317	2.11	7.61	0.00	0.00	0.00	1.00	5.00

Table 3: Simulation Results to Assess the Model Specification

This table presents simulation results to assess whether the two difference-in-difference models in equations (1)-(2) are properly specified. Among all the firm-months in the CRSP-Compustat merged sample from 2002 to 2011, we randomly choose *K* firm-months in each year as pseudo-LBOs, where *K* is the number of LBOs occured in that year. Then we conduct the same difference-in-difference analysis as in the first two columns of Table 3 for these pseudo-LBOs. We repeat the simulation 1,000 times, and report in this table the number of times (in percentage) that the null hypothesis of the coefficient on the interaction variable ($LBO \times Post$) being zero is rejected at three theoretical significance levels: 1%, 5%, and 10%. Model 1 refers to the model in equation (1), while Model 2 refers to the model in equation (2).

	Model 1	Model 2
Average Coefficient on $LBO \times Post$	-0.02	-0.01
Median of Coefficient on $LBO \times Post$	-0.02	-0.01
Rejection Rate at 1%	0.8%	0.2%
Rejection Rate at 5%	3.6%	2.4%
Rejection Rate at 10%	7.2%	6.6%

Table 4: Effects of LBO on the Target Firm's Product Announcements

This table presents the difference-in-difference regression results, where the dependent variable is the natural logarithm of one plus the number of product announcements in each of the six years around the LBO. In the first two columns the announcements include the launch of a new product, progress towards a new product, or improvement on an existing product; in the last two columns the announcements are restricted to the launch of new products. LBO is a dummy variable that equals one if it is an LBO target firm and zero for a control firm. Post is a dummy variable that equals one if the year is after the LBO completion and zero otherwise. Standard errors are clustered by firm. The associated *t*-statistics are reported in the parentheses below each coefficient. Superscripts ***, **, and * correspond to statistical significance at the one, five, and ten percent levels.

	(1)	(2)	(3)	(4)
Dependent var.	Ln(1 + # Product Announcements)			
	All Product Announcements		Announcements of Launch of New Products	
LBO × Post	-0.101***	-0.109***	-0.056**	-0.063***
	(-3.231)	(-3.537)	(-2.261)	(-2.597)
LBO	-0.113**		-0.078**	
	(-2.281)		(-2.013)	
Post	-0.030**		-0.029**	
	(-2.169)		(-2.392)	
Constant	0.576***		0.400***	
	(20.326)		(18.334)	
Obs.	9,558	9,558	9,558	9,558
Adj. Rsq.	0.006	0.762	0.004	0.707
Firm & year FEs	N	Y	N	Y

Table 5: Effects of LBO on the Target Firm's Product Announcements: Subsample Analysis

This table presents the difference-in-difference regression results for two sets of subsamples, where the dependent variable is the natural logarithm of one plus the number of product announcements in each of the six years around the LBO. On the left half of the table, we divide the sample based on whether the target firm has high (above median) or low (below median) operating cash flow in the year before the LBO; on the right half of the table, we divide the sample into two based on the number of business segments of the target firm before the LBO. LBO is a dummy variable that equals one if it is an LBO target firm and zero for a control firm. Post is a dummy variable that equals one if the year is after the LBO and zero otherwise. Standard errors are clustered by firm. The associated *t*-statistics are reported in the parentheses below each coefficient, while the *p*-values are report in the brackets. Superscripts ***, **, and * correspond to statistical significance at the one, five, and ten percent levels.

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent var.	Ln(1 + # Product Announcements)					
	High Cash Flow	Low Cash Flow	(1)-(2)	Single Segment	Multiple Segments	(4)-(5)
LBO × Post	-0.156***	-0.048	-0.108*	-0.111***	-0.089*	-0.022
	(-3.030)	(-1.324)	[0.089]	(-2.738)	(-1.827)	[0.12]
LBO	-0.038	-0.186***	0.148	-0.113*	-0.114	0.001
	(-0.510)	(-2.830)	[0.131]	(-1.793)	(-1.471)	[0.99]
Post	-0.016	-0.043**	0.027	-0.018	-0.045**	0.027
	(-0.879)	(-2.207)	[0.301]	(-1.007)	(-2.201)	[0.32]
Constant	0.530***	0.620***		0.555***	0.603***	
	(15.066)	(16.157)		(16.011)	(15.176)	
Obs.	4,644	4,914		5,274	4,284	
Adj. Rsq.	0.004	0.009		0.007	0.005	

Table 6. Product Announcement and the Likelihood of Going Public after LBO

Panel A reports the fraction of the LBO target firms that go public again within the first five years or at any time after the LBO, grouped by whether the LBO target has more or fewer product announcements over the three years after the LBO compared to the three years before the LBO. Panel B presents the estimation results of the linear probability model (OLS), in which we regress the going public indicator on the dummy variable indicating increased product announcements after the LBO or the percentage growth of product announcements after the LBO, a set of firm characteristics, and the LBO year fixed effects. Panel C presents the marginal effects of the independent variables on the likelihood of going public in probit models without controlling for the LBO year fixed effects. Increased Product Announcement is a dummy variable that equals one if the number of product announcements of the target firm over the three years after the LBO is greater than that over the three years before the LBO, and zero otherwise; Growth of Product Announcement is the growth rate of product announcements expressed in percentage from the three years before the LBO to the three years after the LBO. See Appendix B for variable definitions. Standard errors are clustered by firm. The associated *t*-statistics are reported in the parentheses below each coefficient. Superscripts ***, **, and * correspond to statistical significance at the one, five, and ten percent levels.

Panel A. Summary Statistics of the Fraction of LBO Target Firms That Go Public Again

	LBO Target Announces More Products after LBO	LBO Target Announces Fewer Products after LBO
# LBOs	46	109
# IPOs within 5 years	5	2
% IPOs within 5 years	10.87%	1.83%
# IPOs any time after LBO	9	7
% IPOs any time after LBO	19.57%	6.42%

Panel B. Linear Probability Model

	(1)	(2)	(3)	(4)
	Going Public Within 5 Years of LBO		Going Public Any Time after LBO	
Dependent variable	Going Public Dummy			
Increased Product Announcement	0.088**		0.096*	
After the LBO	(2.195)		(1.653)	
Growth of Product Announcement		0.069***		0.094***
After the LBO		(3.178)		(3.005)
Log(Firm Age)	-0.019	-0.015	-0.065	-0.057
	(-0.577)	(-0.462)	(-1.341)	(-1.201)
Log(Total Assets)	0.019	0.019	0.048**	0.049**
	(1.363)	(1.418)	(2.402)	(2.492)
Tobin Q	0.068**	0.072***	0.077*	0.083**
	(2.526)	(2.716)	(1.966)	(2.171)
ROA	0.060	0.012	-0.003	-0.085
	(0.366)	(0.074)	(-0.015)	(-0.365)
Leverage	-0.056	-0.053	-0.170	-0.163
	(-0.620)	(-0.599)	(-1.295)	(-1.273)
Constant	-0.143	-0.126	-0.136	-0.130
	(-1.199)	(-1.102)	(-0.784)	(-0.784)
Observations	147	147	147	147
R-squared	0.191	0.221	0.202	0.238

Panel C. Probit Model

	(1)	(2)	(3)	(4)
	Going Public Within 5 Years of LBO		Going Public Any Time after LBO	
Dependent variable	Going Public Dummy			
Increased Product Announcement	0.057**		0.096**	
After the LBO	(2.236)		(1.994)	
Growth of Product Announcement		0.018***		0.066***
After the LBO		(2.867)		(3.520)
Log(Firm Age)	-0.019	-0.017**	-0.072	-0.070*
	(-1.286)	(-2.106)	(-1.586)	(-1.706)
Log(Total Assets)	0.009**	0.007**	0.046***	0.042***
	(2.121)	(2.322)	(2.962)	(3.004)
Tobin Q	0.024***	0.019***	0.054**	0.055**
	(3.339)	(3.969)	(2.093)	(2.383)
ROA	0.021	-0.011	-0.140	-0.194
	(0.257)	(-0.300)	(-0.725)	(-1.264)
Leverage	-0.007	-0.005	-0.145	-0.121
	(-0.150)	(-0.153)	(-1.270)	(-1.155)
Constant	-3.517**	-3.219**	-2.761***	-2.677***
	(-2.450)	(-2.137)	(-2.845)	(-2.652)
Observations	147	147	147	147
Pseudo R-Squared	0.229	0.301	0.163	0.231

Table 7. Pre-LBO Product Announcement and Investment of LBO Targets vs. Control Firms

This table presents the OLS regression results where the dependent variable is the natural log of one plus the number of product announcement in each of the three years (every 12 months is regarded as a year) before the LBO, the ratio of research and development expenses to sales in each of the three fiscal years before LBO, or the ratio of capital expenditures to sales in each of the three fiscal years before LBO. The independent variables include a dummy variable equal to one if it is an LBO firm and zero if it is a control firm, firm characteristics in each of the three fiscal years before LBO, and year fixed effects. See Appendix B for definitions of the firm characteristics. Standard errors are clustered by deal. The associated *t*-statistics are reported in the parentheses below each coefficient. Superscripts ***, **, and * correspond to statistical significance at the one, five, and ten percent levels.

	(1)	(2)	(3)
Dependent variable	Ln(1 + # Product Ann.)	R&D/Sales	CapX/Sales
LBO	0.001	-0.016	0.066
	(0.033)	(-1.020)	(0.931)
Ln(Firm Age)	0.022	0.037	0.194
	(0.719)	(0.757)	(1.027)
Ln(Total Assets)	0.118***	-0.020	-0.113
	(6.534)	(-0.883)	(-1.008)
Ln(TobinQ)	0.362***	0.291*	0.015
	(8.119)	(1.859)	(0.447)
ROA	-1.248***	-1.769**	1.654
	(-9.655)	(-2.393)	(0.935)
Leverage	-0.907***	0.076	0.275
	(-7.900)	(0.254)	(1.604)
Observations	4,613	4,607	4,584
Adj. Rsq.	0.133	0.052	0.003

Table 8. Relationship between LBO Target Firms' Product Announcement and Control Firms' Product Announcement before vs. after the LBO

This table presents the OLS regression results where the dependent variable is the natural log of one plus the number of LBO target's product announcement in a year. The independent variables include a dummy variable equal to one if it is after the LBO, the natural log of one plus the average number of product announcements of the control firms in the year, and the interaction variable of the two variables. Standard errors are clustered by deal. The associated *t*-statistics are reported in the parentheses below each coefficient. Superscripts ***, **, and * correspond to statistical significance at the one, five, and ten percent levels.

	(1)	(2)	(3)
	Before LBO	After LBO	All
Dependent variable	Ln(1 + # Product Announcements of LBO Target)		
Ln(1 + Average # Ann. of Control Firms)	0.534***	0.331***	0.534***
	(12.170)	(6.947)	(12.166)
Post			0.023
			(0.767)
Post × Ln(1 + Average # Ann. of Control Firms)			-0.204***
			(-4.307)
Constant	0.059**	0.083***	0.059**
	(2.081)	(2.779)	(2.080)
Observations	828	828	1,656
R-squared	0.388	0.195	0.316

Figure 1: Number of Product Announcements for LBO Targets and Control Firms

This figure plots the average number of product announcements over the six years around the LBO for the LBO targets and their control firms.