Financing Innovation through Minority Acquisitions

by

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Abstract: This study unveils the financing role of minority equity purchases on innovation activities of US target firms. We provide evidence of increased innovation following minority acquisitions accompanied by cash flows to financially constrained target firms, and to firms with relatively small patent portfolios prior to acquisition. To address endogeneity concerns we create matched control groups of firms that were targets of minority acquisitions without cash transfers, and show that the positive effects of minority equity purchases on target firms' innovation are nonexistent if minority acquisitions are not accompanied by cash flow transfer to target firms. We also create a sample of similar firms which were targets of failed minority acquisitions, and find that those targets experience no change in their innovation activity.

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1. Introduction

This paper investigates the financing role of minority equity purchases on innovation activities of US target firms.[3] This is an important topic for at least two reasons: first, innovation plays a crucial role in the survival, competitiveness, and growth of firms, and second, minority acquisitions are widespread,[4] yet their impacts on the subsequent performance of firms are little understood. Additionally, financing innovation might be difficult even in competitive markets. The difficulty is closely related to the need of making financial decisions by relying on the opaque informational structure associated with high tech investments. Still, financial synergies are often motivations among the participants of the market for corporate control. An unexplored side of acquisitions is the degree to which acquisitions affect the innovation activities of target firms when minority stake is purchased, and to what extent financing plays a role.[5]

Despite the increasing body of research unveiling acquirer firms and their innovative performances (Sevilir and Tian, 2012, Bena and Li, 2014), target firms and their post-acquisition performances are relatively left unexplored. One explanation is that the information about the activities of target firms is not available independently following mergers and majority acquisitions. One of the advantages of our paper is that focusing on minority acquisitions enables us to examine the innovation performance of US targets as independent units even after the acquisition. To the best of our knowledge this is the first study to investigate the post-acquisition innovation performance of target firms, using detailed patent data.

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[3] Minority acquisitions refer to acquisitions of equity stakes where acquirers acquire less than 50 percent of targets' shares.

[4] Minority acquisitions represent a substantial share of the overall M&As activity in the US. During 1983-2002, SDC reports that about 36% of the M&As of US public firms are coded as partial or minority acquisitions.

[5] Bayer's purchase of minority interest in Millennium Pharmaceuticals provides an illustrative case. The acquisition announcement "Bayer A.G., the German drug and chemical company, said yesterday that it would pay $96.6 million to buy a 14 percent equity stake in Millennium Pharmaceuticals Inc,… Bayer will also pay $33.4 million in licensing fees, and up to $335 million in research and development financing in the next five years" and analysts' comments on the deal " A validation of Millennium's science and strategy" , "For Millennium, it is a critical deal, both in terms of alleviating their short-term cash flow problems, and allowing them to increase productivity across the board for their in-house research and development[5]," highlights the financing role of minority acquisitions along with the other implications.

Several considerations might lead firms to acquire minority positions in other firms: mitigating incomplete contracts and facilitating cooperation between two independent firms, aligning the incentives of the acquirer with those of the target, preserving or enhancing target's managerial incentives, providing financing directly to the target, etc. (see Allen and Phillips (2000), Fee, Hadlock, and Thomas (2006), and Ouimet (2012)). A strong determinant of minority acquisitions is also relieving target firm's financial constraints; Liao (2014) finds that firms that are financially constrained are more likely to be targets in minority equity acquisitions. Cash flow from the sale of minority stakes can relieve financial constraints of the target and thus provide cash to fund innovation or investment activities of the target. Overcoming the financial constrains while staying as an independent entity may provide the advantage of keeping target's incentives to innovate alive (Ouimet, 2012). This would precisely be the case of young, relatively small, innovative firms, which are often the case of minority acquisitions. Even if there is no cash flow, as in the exchange of equities between target and acquirer, the acquirer may certify the innovation potential of the target through investing in it. If holding large blocks of target[6], the acquirer may mitigate free-rider problems, monitor and obtain more accurate information about the investment opportunities and may have the power on the investment decisions of the target (Shleifer and Vishny, 1986)). A prior alliance of two tech-firms in the same industry may become more strengthened through acquisitions of minority stakes or an alliance can be formed at the same time with the purchase of minority stake. Minority acquisitions may therefore impact the performance of the target firms.[7]

This study sheds lights on these issues. Combining several databases and collecting data on cash flows transfers for every minority acquisition deal in the study allow us to address several important questions: Do minority acquisitions affect the post-acquisition innovation performance of the target firms? How is the post-acquisition innovation performance affected by the pre-acquisition innovation capability of the target? Does it matter whether the acquisition was

[6] In some cases, the acquirer firm assigns a board member to the target firm following the minority share purchase.
[7] It is common in high tech industries that firms form joint product development alliances and fund them through equity purchases.

accompanied by cash transfer to the target firm? Do pre-acquisition financially constrained target firms innovate more following the minority stakes acquisition?

One of the main econometric issues when investigating issues like these is the possible endogeneity in estimation. It may be the case that acquirer firms selectively purchase minority stakes from targets with better innovation potential, in other words they cherry pick targets with best innovation activities or potential before acquisition. We overcome this problem in several ways: first, we control for the unobserved heterogeneity of firms *before* entering the sample by dividing firms into two subsample based on their innovation performance prior-to-acquisition. Blundell et al (1999) argues that pre-sample technology shocks to firms are exogenous to shocks to innovation in the post-acquisition period. Therefore, the division of firms before entering the sample enables us to control for some permanent innovative capabilities of target firms. Second, we identify acquisitions where targets issue shares directly to the acquirer and disclose the amount investment by acquirer. We classify these as minority acquisitions *with* cash transfers to target. This information provides us a convenient experimental design to test whether it is the inflow of cash from minority acquisitions which causes the subsequent increase in the innovation performance of the target firms. We also collect data on minority acquisitions where there is no simultaneous cash transfer to target, such as equity exchanges or open market purchases long after the new share issues. We present results indicating that when there is no financing from minority share purchase there is no discernible impact on post-acquisition innovation performance of the target firms. Third, for each firm targeted in minority acquisitions accompanied by cash flow transfer we find a match, a similar-sized firm in the same industry and year, having similar before acquisition age and innovation capability, which was acquired but with no cash flow transferred. We then examine whether the innovation performance of these matched firms also increase. The results from this analysis show that target firms in minority acquisitions which received cash inflows increase their innovation post acquisition, while matched acquired firms which didn't receive cash transfers experience no increase in innovation performance. Last but not least, we follow Seru (2015) and Savor and Lu (2009), and use information on previously announced but failed minority acquisitions. We compare the innovation output of those targets where the acquisition failed to go through (the control group) with the innovation output of matched target firms that were successfully acquired (the treatment group). We find that targets that were

successfully acquired innovate more, particularly those with small patent portfolios prior to the acquisitions, and which receive cash transfers from the transaction. If indeed there is no systematic relation between the innovativeness of a firm and the probability that the firm's announced acquisition fell through, this approach allows us to establish a causal relation between minority acquisition and the subsequent innovation performance of the target.

We provide evidence that US publicly held firms having small patent portfolios prior to acquisitions accompanied by cash inflows significantly increase innovation quality and quantity after the sale of minority stakes. We investigate both the quality and the quantity of innovation by using detailed patent data. The interesting finding of our paper is that the positive impact on target firms' innovation is present only if there are cash transfers from the acquirer to the target, indicating that cash transferred through minority stake purchase is an important source of financing for target firms to fund their innovation activities. The positive impact of the minority acquisitions on innovation performance is nonexistent when there is no cash flow transfer to the target firm. The results using various measures of liquidity constraints confirm our results - we find that liquidity constrained target firms innovate more following minority acquisitions accompanied by cash transfers to targets. The results are robust to accounting for endogeneity in estimation and to using an alternate econometric model. Several robustness checks confirm the validity of our results.

This paper contributes to the M&As literature by investigating a highly important outcome of the previously overlooked minority acquisitions, namely increased target firms' innovation performance post acquisition. In addition, it contributes to the literature on financing of young, innovative firms with intangible assets in high tech industries. We focus on minority acquisitions and highlight the crucial importance of cash transfers for target firms' post acquisition innovation performance.

The reminder of the paper is organized as follows. The next section briefly reviews the related literature. Section 3 explains the data sources and the empirical methodology used. Section 4 presents the empirical findings. Section 5 discusses endogeneity in estimation. Section 6 discusses additional robustness checks and presents the results from an alternative econometric model. Section 7 concludes.

2. Related Literature

There are three lines of research on which our paper builds and to which it contributes: the first investigates how M&As effect firms' innovation performance. The second line of related literature sheds light on the financing of innovative firms. Lastly, studies on the relation between financial constraints and M&As are reviewed.

2.1. M&As and Innovation

While the M&As literature is relatively large, studies focusing on the impact of M&As on innovation have been scarce until very recently. Two recent studies in the finance literature examines the innovation outcome of M&As from the perspective of the acquirer firms. Bena and Li (2014) investigate what characteristics of corporate innovation activities are related to whether a firm becomes an acquirer or a target firm. They show that firms with large patent portfolios and low R&D expense are acquirers, while companies with high R&D expenses and slow growth in patent output are more likely to be targets. They also find that acquirers with prior technological linkage to their target firms innovate more after acquisitions. The paper concludes that synergies obtained from combining innovation capabilities are important drivers of acquisitions. Similarly, Sevilir and Tian (2012) provide evidence that acquirer firms innovate more following acquisitions. They find that the effect is more pronounced when the acquirer's innovation output is lower than that of the target firm, which suggests that firms with a lower ability to innovate acquire more innovative firms to enhance their innovation output. The paper uses detailed patent data to provide evidence that firms in a wide variety of industries rely on M&A to increase their innovation output. Our study differentiates from these studies in that we are able to investigate target firms' innovation performance following minority acquisitions and highlight the financing role of the M&As activity.

In a similar vein and consistent with the above studies, Phillips and Zhdanov (2013) find that an active market for corporate control leads to more R&D activities undertaken by smaller firms, with larger firms engaging more in acquisitions of smaller innovative firms. They argue that

it is more advantageous for larger firms to purchase smaller innovative firms instead of competing against them.

Our study contributes to this literature by examining the innovation output when the acquirers invest in targets while staying as independent organizations. Furthermore, none of the studies relating M&As transactions to innovation examines what happens to targets' innovation performance post-acquisition.

2.2 Financing of Innovation

This paper contributes to a large literature documenting the effects of financial frictions on innovation and R&D expenditure. Brown, Fazzari, and Petersen (2009) is one of the most influential papers to investigate the financing of innovative firms. They show that only seven high tech industries are responsible for almost all the variation in R&D spending and show that most of the R&D in those industries is conducted by young firms, which finance innovation mostly with cash flows and new share issues. "The financial cycles for young high-tech firms alone can explain about 75% of the aggregate R&D boom and subsequent decline". Similarly Atanassov, Nanda, and Seru (2007) compare high-tech and non-high-tech firms in terms of their financing decisions and highlight public equity as an important source of funding and as an efficient mechanism for the evaluation of intangible assets. They stress not only the type of financing itself, but its continuity as well for the success of innovation. Ayyagari et al. (2007) study the determinants of broadly defined innovation and find a positive relationship between the use of external finance and the extent of innovation. A more recent paper by Gorodnichenko and Schnitzer (2013) provide theoretical rationale why access to external finance matters for firms' innovation, even though most firms report to rely on internal finance for their innovation activities. They also find empirical evidence that difficult and costly access to external finance hampers firms' innovation and exporting activities, and preclude firms from benefiting from potential complementarities between exporting and innovation. They also find that financial frictions affect primarily small and young firms, especially in services sectors.

The above studies generally stress how crucial equity financing is for innovative firms. They also show that equity financing is preferable to debt financing due to lack of assets which can be used as collateral, particularly in the case of lending to innovative, high tech firms. The

study here contributes to this literature by unfolding another way of funding innovation, namely, minority stake purchases which come with cash inflows.

2.3. M&As and Financial Constraints

Financial synergies between target and acquirer as a motivation is one of the numerous topics studied in the M&As literature. Ouimet (2013), Liao (2014), and Erel, Jang and Weisbach (2015) are some of the studies which provide evidence that financially constrained firms tend to be acquisitions targets. Ouimet (2013) examines the choice between minority and majority acquisitions and indicates that minority equity acquisition is more likely when target experiences negative cash flows and when it is important to keep the incentives of the target management alive. Similarly, Liao (2014) provides an international comparison of targets of minority acquisitions versus other existent firms, and show that non-dividend payer firms are more likely to be targets of minority acquisition deals. Non-dividend payments are used as a measure of liquidity constraints.

The recent study by Erel, Jang and Weisbach (2015) is unique due to its ability to examine European target firms' financial constraints before and after full acquisitions. They focus on full acquisitions and document significant declines in targets firms' financial constraints post acquisitions. They also report increases in targets' investment in the post-merger period.

Following these highlighted findings in the literature, a natural question to ask is whether innovative, patenting firms, which are more likely to be in need of financing due to their higher share of intangible assets benefit from funding through the partial equity stake sales. Further, if there are improvements in the financial situation of target firms it is important to know whether or not these improvements are reflected in the innovation performance in the post-acquisition period.

3. Data, Sample Construction and Empirical Methodology

3.1. Data

Several databases are combined for this study. Our starting point is the data on minority acquisition deals. First, from Thomson Reuters Securities Data Commission (SDC), a database

covering M&As, we extract data on partial equity acquisitions of United States publicly held companies between 1983 and 2002, for all industries except the financial sector. We restrict the sample to deals in which the acquirer firm acquires less than 50 percent of the target's shares. These deals are coded as "Acquisition of Partial Interest" in the database. This database contains identifier codes for targets and acquirers, deal characteristics such as payment methods, deal status, the value of the partial acquisition, the percentage of the shares acquired, the announcement date for the acquisition, etc.

Second, balance sheet information for target firms is obtained from WRDS Compustat Database for the same period. Even though we exclude targets in financial industries while downloading SDC data, after a second check with merged Compustat file we still observe some financial firms among targets. Using Compustat SIC codes we dropped the deals in which the target operates in the financial industries with the codes between 60 and 69. Deals where financial companies such as banks, investment and insurance companies are the acquirers are also excluded from the sample due to their more complicated motivations. Dropping deals for which we do not have at least 3 years post-acquisition and 1 year prior financial information and deals which are not completed gives us a sample of 508 partial acquisitions during the 1983-1999 period.

Patenting is not a common activity among firms in most of the industries and even in patent intensive industries there are many firms which do not patent. Therefore, to examine the relevant targets of minority acquisitions in terms of patenting we follow Chava et al (2013) and Lerner et al (2011) and keep only those firms which patented at least once over the sample period. After this final adjustment, the deal number drops to 297.

Patent Data is obtained from the National Bureau of Economic Research (NBER) Patent Database. We make use of the 2006 version of NBER data which includes all patents (over 3.2 million) granted by the Unites States Patent and Trademark Office (USPTO) between 1976 and 2006 and documents over 20 million citations received by these granted patents. Detailed explanation about the database is given by Hall, Jaffe, and Trajtenberg (2001). Instead of grant year of a patent we make use of patent application year; Comanor and Scherer (1969) find that the timing of a new product introduction is better reflected in the patent applications since grant year of a patent may depend on external factors rather than firm related ones. Patent data suffers from truncation problem since it only includes a patent if it is granted by the USPTO. Therefore, toward the end of the sample period the number of the patents granted per applied patent number increases

dramatically since the data only includes granted patents. Similarly, since patents keep receiving citations after the sample period, the number of citations per patent applied in the later periods are downward biased. Following Hall, Jaffe, and Trajtenberg (2001) we address these problems by using truncation correction weights calculated from application-grant lag distribution for both citation numbers and patent counts.[8]

Finally, for all 297 minority stake acquisition deals data on the existence of a cash flow transfer from acquirer to target through the transaction is collected. Cash flows are identified through online resources, such as Factiva. In most cases, the amount of shares issued to the acquirer is announced, together with the cost of the shares. However, not all minority acquisitions are conducted between target and acquirer directly. In many cases, acquirer firm purchases minority stakes in the stock market, long after the shares were issued by the target. We code those acquisitions as open market purchases with no simultaneous cash flows to target and examine them separately. Further, when we code these deals as open market minority acquisitions we also use the SDC Global New Issues database to verify that there are no new shares issued by the target firms during the year of minority stake purchases. We subsequently make use of the open market deals in placebo regressions as control groups.

3.2. Summary Statistics

The definitions of all variables used in this study are explained in Table 1 below. We focus on firms' innovation measured using patent data. Firm Age, Size, R&D expenses, Cash/total assets, Earnings before interest, taxes, depreciation and amortization (EBITA) divided by Total assets are used as control variables.

[Insert Table 1 here]

Table 2 below presents the summary statistics for all variables used in regressions, together with the results from mean difference tests for various classes of target firms before and after acquisition. We classify target firms into two categories, based on their cumulative patent

[8] As an additional precaution we do not use the patent data later than 2002 since the variation in the ratio of number of patents applied divided by the number of patents granted is very high for those years.

portfolios before acquisitions. We use this classification in order to account for some ex-ante firm characteristics which may impact post-acquisition innovation.[9] The variable of interest in dividing the sample of target firms is the cumulative number of patents applied by the target firm until the year of acquisition announcement.[10] If a target firm possesses more than the median cumulative patent count among all firms, the firm is coded as *Large Pre-Acquisition Patent Portfolio Firm*; a firm with less than the median cumulative patent count prior to the minority acquisitions is coded as *Small Pre-Acquisition Patent Portfolio Firm.*

[Insert Table 2 about here]

Table 2 is divided into four panels. In all panels except panel D cash is transferred to target firms. Panel A includes all firms targeted in minority acquisitions *with* cash flows to targets. Panels B and C are subsamples of Panel A based on the median cumulative patent portfolios of the target firms before acquisitions. To be able to conduct mean difference tests we restrict the observations to one, respectively two years before and after acquisitions (panels B and C). In the last three columns summary statistics for the unbalanced sample used in regressions are presented.[11] The definitions of all variables are provided in Table I.

Firms in Panel B *(Small Pre-acquisition Patent Portfolio* target firms, acquisitions *with* cash transfers*)* have some distinct properties. Targets in this subsample have lower than the median cumulative patent count before acquisition, and received cash inflow through minority acquisition. These firms are younger and smaller in size, but average R&D expenses are high and comparable with targets in samples C and D. Unlike all other subsamples they experienced a statistically significant increase in the mean patent quantity and quality following the minority acquisitions. Noticeably, targets in this subsample significantly increase their cash holdings after acquisitions,

[9] As Blundell et al (1999) argues, pre-sample technology stocks to firms are exogenous to shocks to innovation in the post-acquisition period.

[10] The cumulative patent count considers patent applications since 1976, the beginning of 1976-2006 version of the NBER patent data.

[11] To conduct the mean difference tests the sample is restricted to firms for which we have observations at least two years before and after the deal (panels B and C). The significance tests are conducted using deal level clustered standard errors. The whole sample statistics (panel A) include all firms used in regressions, i.e. firms with information for at least 1 year before and 5 years after the minority acquisition.

unlike targets in all other subsamples. These summary statistics seem to suggest that it is precisely the *Small Pre-acquisition Patent Portfolio targets* that are most affected by minority acquisitions accompanies by cash inflows.

Panel C shows *Large Pre-acquisition Patent Portfolio* targets of minority acquisitions *with* cash transfer. They too had large R&D expenditure levels, but contrary to the small patent portfolio firms, they had much higher levels of cash flow before being acquired. Interestingly, post-acquisition there is no statistically significant change either in the levels of cash or in the quantity or the quality of innovation.

Subsample D (targets of *no* cash transfers minority acquisitions) also provides interesting observations. Deals in this subsample, where no cash is transferred to the target firm, are used to conduct regressions for placebo minority acquisitions. These targets are also the oldest among all firms, and have high R&D expenses, and high levels of innovation. These target firms are also the largest in the sample, and the ratio of cash over total assets is the smallest relative to the other samples. Very small cash holdings relative to their size implies that they are not financially constrained as much as the other targets. There is no statistically significant difference between the levels of innovation, cash to total assets or R&D, before and after the minority acquisition.

Comparisons of the mean age among the various subsamples show that there seems to be a nonlinear relation between the mean ages of the target firms and the ratio of cash holdings to total assets. The oldest and largest firms in the sample are the targets of no cash transfer minority acquisitions and have the lowest cash holdings rates among the subsamples. Interestingly, among the cash transfer acquisitions, pre-acquisition Small Patent Portfolio firms are the youngest and have lower cash holdings relative to their total assets, especially relative to large-patent portfolio firms.

3.3. Empirical Methodology

We start to investigate the impact of minority acquisitions on the post-acquisition innovation performance of target firms by using the ordinary least squares method. We set up the following baseline panel regression model:

$$lnY_{it} = \alpha_i + \beta After\_Acquisition_{it} + \lambda(After\_Acquisition_{it} * Small\ Patent\ Portfolio\ Firm_i) + \gamma X_{it-1} + \delta_t + \tau_i + \varepsilon_{ict} \quad (1)$$

Where the dependent variable lnY_{it} is the measure of innovation, calculated in two ways: first, as the log of one plus the total number of patents applied in year *t*; and second, as the log of one plus firm *i*'s total number of non-self citations received per patent applied in the year *t*. The independent variable *After-Acquisition*$_{it}$ is a dummy variable equals one for five years following the acquisition of minority interest in the target firm.[12] X_{it-1} is a vector of time variant target firms control variables lagged one year. It includes log of Total Assets as a measure of firm's Size, Earnings before Interest, Taxes, Depreciation and Amortization (EBITA) divided by Total Assets, log of R&D expenses, Cash amount held divided by Total Assets. The firm's Age and Age squared are also introduced in the regression. $\boldsymbol{\tau_i, \delta_t}$, control for target firm and year fixed effects, respectively. Standard errors are clustered at deal level in all regressions.

The independent variable of interest is the interaction term *After-Acquisition*$_{it}$**Small Patent Portfolio Firm*$_i$. Firms with less than median cumulative patent count before acquisition form the subsample of *Small Patent Portfolio Firms* (the dummy takes the value 1 for target firms which had lower than median cumulative patent count before announcement, and zero otherwise). Through this division we aim to account for the size of the patent portfolio of firm *i* before the acquisition, and thus to some extent capture some permanent differences among firms. If indeed minority stakes purchases accompanied by cash transfers are most beneficial to small, innovative target firms which are most in need, the coefficient of the interaction variable *After-Acquisition*$_{it}$**Small Patent Portfolio Firm*$_i$ will be positive and statistically significant.

4. Empirical Results

4.1. Baseline Regressions

We start by presenting the results from minority acquisitions accompanied by cash transfers to the target firm. The results are presented in Table 3.

[12] Redefining the *After-Acquisition*$_{it}$ dummy equal to one for three years after the minority acquisition does not change the results.

[Insert Table 3 about Here]

The first two columns of Table 3 provide estimates for the quantity of innovation measured as the patent count, while the last two columns capture the quality of innovation, measured as the number of non-self citations received per patent applied. Interestingly, the *After-Acquisition*$_{it}$ dummy, which equals one for five years after the minority stake purchase is statistically insignificant and indicates no impact of minority acquisitions on the post-acquisition innovation performance of target firms. However, this is not the case for all targets. *Small Patent Portfolio Firms*, which also experienced the largest increase in the levels of cash following the acquisition, innovate more following minority acquisitions accompanied by cash transfers. The interaction term *After-Acquisition*$_{it}$**Small Patent Portfolio Firm*$_i$ is positive, and highly statistically significant, suggesting that it is precisely the cash constrained small, innovative firms which benefited from cash inflows following minority acquisitions by increasing their innovation activity. The other variables have the expected signs. R&D expenditure is an important determinant of innovation, and has positive and statistically significant impact on targets' post acquisition innovation performance. The results also show that the size of the firm is positively and significantly related to the innovation quantity. The age of the firm is important, estimated coefficients confirming a non-linear relation between firm's age and its innovation performance, younger firms innovate more, while the innovation of older firms tappers down.

The last two columns of Table 3 confirm our previous findings. In the last two columns we capture the quality of innovation, measured as the log of one plus the simple count of the non-self citations received per patent applied in the year. As before the coefficient of the interaction term *After-Acquisition*$_{it}$**Small Patent Portfolio Firms*$_i$ is positive and statistically significant. Minority acquisitions accompanied by cash transfer positively affect targets' innovation but only in the case of young, high R&D expense, pre-acquisition Small Patent Portfolio Firms. The impact is economically significant, controlling for age in the last column we find that the number of non-self citations received per patent applied by a Small Patent Portfolio firm increases by 23% following the sale of minority equity stake.

4.2 Financial Constraints

As previously mentioned, financial synergies between targets and acquirers are often stressed in the literature as one of the main determinants of acquisitions. Particularly, alleviating target firms' liquidity constraints, which allows firms to increase investment following the acquisition has been stressed as an important outcome of majority acquisitions (Erel, Yang, Weisbach (2015)). Our previous results corroborate these findings in the context of minority acquisitions – we find a statistically significant impact on targets' post acquisition performance but only for acquisitions accompanied by cash flows to the target firms which seem most in need. To strengthen our results from the financial constraints perspective, we provide further analysis in this section. We divide the sample of target firms into *more* and *less* financially constrained and investigate whether minority acquisitions accompanied by cash transfers to targets improve their post-acquisition innovation performance distinctly for these types of firms.

There is no unanimously accepted measure of liquidity constraints, therefore we follow existing literature and use various measures of financial constraints in an attempt to verify that the results are robust to using different measures.[13] First, we follow the classification suggested by Fazzari, Hubbard, and Petersen (1988). The authors highlight the difference in the costs of internal versus external financing, and argue that firms facing financial constraints will retain more of their funds to finance their investments. Therefore, they differentiate firms based on the retention rates, and label those who pay low percentage of their incomes in dividend as financially constrained. We conduct a similar analysis. Based on target firms' pre-acquisition dividend policies we divide them into two samples: firms which pay dividends and firms which do not. We then re-estimate the regression model for these two subsamples of firms. The results for both subsamples are presented in Table 5.

[Insert Table 5 about Here]

The first two columns of Table 5 provide estimates for financially constrained firms, i.e. non-dividend payer firms prior to the minority acquisition. The results show that these firms increase

[13] See also Erel, Jang, Weisbach (2015)

the number of non-self citations received following the sale of minority stakes accompanied by cash transfers. The coefficient of the interaction term *After-Acquisition*Small Patent Portfolio* is positive and statistically significant. The economic impact of acquisitions is similar to the baseline regressions. Similar results are also obtained when the number of patents applied is used, financially constrained firms increase the number of the patent applications after the sale of minority stakes. Consistent with the observations of Fazzari, Hubbard, and Petersen (1988), excluding non-dividend payer firms, thus financially constrained firms, our positive significant interaction term becomes statistically insignificant in the last two columns of table 5.

As another measure of liquidity constraints we use the Kaplan-Zingales index (KZ-Index)[14]. The higher KZ-Index for a firm indicates that the firm faces higher financial constraints to finance ongoing operations. Using the pre-acquisition observations for target firms, we create KZ-Index for each firm. We then repeat our baseline regressions for firms which had a KZ-Index which is lower than the median among other firms, i.e. not financially constrained. The results are presented in Table 6.

[Insert Table 6 about Here]

The first column in Table 6 presents the results for firms with low KZ-Index, thus less financially constrained. The results are in line with the previous findings; when target firm is not financially constrained, minority acquisitions do not result in increases in the innovation. The last three columns provide the results for financially constrained firms, which had KZ-Index larger than the median (Column II), the third quartile (Column III), the highest decile (Column IV). All the results in these regressions indicate that there are economically and statistically significant increases in the innovation performance of financially constrained target firms following minority acquisitions accompanied by cash transfers.

We also use yet another definition for financially constrained firms. We divide firms based on their Earnings before Interest, Taxes, Depreciation, and Amortization prior to the sale of

[14] For more detail about the index, see Kaplan and Zingales (1997) and Livdan, Sapriza and Zhang (2009).

minority shares. Excluding firms which had negative earnings (i.e. financially constrained firms) produces estimates which are no longer statistically significant. For financially constrained targets the results are positive and statistically significant. That is, the post minority acquisition innovation performance of target firms increases, but only in the case of a priori liquidity constrained targets which received cash inflows. Results are available upon request.

Together with the results from the baseline model, these findings suggest that it is particularly the relief of financial constraints through the sale of minority equities which drives our results. Small, innovative, liquidity constrained firms increase both the quantity and the quality of innovation following minority acquisitions accompanied by cash transfers.

5. Endogeneity in estimation

5.1. No-Cash Transfer Placebo Minority Acquisitions

One of the possible concerns related to the results in the previous section is that they might be biased due to endogeneity. If acquirer firms purchase minority stakes because they anticipate that some targets with specific characteristics will increase their innovation in the near future then our causality is flawed. We hypothesize that the channel through which the increase in the innovation performance is experienced is cash flow transfer to liquidity constrained target firms. Therefore, if there is no cash flow transferred from acquirer to target we should not see any positive impact of minority acquisition on the post-acquisition innovation performance of the target.

The collected data identifying open market purchases with no cash transfer to the target enable us to set up a natural experimental design to address the concerns. We focus on minority acquisitions where the acquirer purchase already issued and traded shares in the open market. In these acquisitions shares change hands but no cash funds are transferred to the target firm. However, if indeed it is the case that acquirer firms cherry pick targets with potential of increased innovation performance regardless of their cash constraints, we should obtain the same positive impact after acquisition.

We therefore focus next on a sample of open market minority acquisitions, where there was *no* simultaneous cash transfer to target firms. The econometric model and the criteria for

sample classifications are the same are in the baseline specification. The results are presented in Table 7.

[Insert Table 7 about here]

We again present two estimates for the quantity and two for the quality of innovation. The estimates across all models show that minority acquisitions do not impact the post-acquisition innovation capability of the target when there is no cash transfer to the target firm. Interestingly, the formerly positive and statistically significant effect of minority stake purchase on the innovation of target firms with Small Patent Portfolios prior to acquisition turns insignificant. The results confirm our hypothesis that in the case of minority acquisitions that are not followed by cash transfers there is no impact on the post-acquisition performance of any target firms. We thus find no support for the argument that firms anticipate the increase in the innovation performance and invest in a priori potentially highly innovation targets. The results support our hypothesis that it is precisely the cash transfer to target firms which helps liquidity constrained innovative targets to innovate more after the acquisitions.

5.2. Matched Samples

While the previous results indicate that firms increase their innovation performance after being financed through minority acquisitions, in this section we address the following question - does a similar sized firm, which is not target of a minority acquisition, having similar previous technological stock in the same industry as a matched targeted firm increase its innovation performance?

For the sample of target firms examined in the baseline regressions (acquired with cash inflows), we found patenting firms which are *not* targeted in minority acquisition which have similar characteristics the year prior to the minority acquisition. In the same year and in the same two digit industry we found firms with the closest size and having similar the technological stock (cumulative patent stock). One year before the minority acquisition firms in the base sample have a mean total assets of $1.12B while firms in the matched sample has the mean total assets of

$1.08B. In addition, the average cumulative number of patents applied until the year of minority acquisition is 110 for base sample, and 119 for the matched sample.

[Insert Table 8A about here]

The main analysis investigating the impact of minority acquisition on innovation in Table 3 is repeated for the matched sample. The results for the matched sample are presented in the Table 8A. The results indicate that there is no statistically significant increase in innovation for the matched firms (which were never acquired), unlike the targeted firms. If anything, similar size matched firms having smaller patent stocks show a slightly deteriorating innovation performance. This finding confirms our previous results that firms financed through minority acquisitions increase their innovation performance in the subsequent years, unlike matched firms not subject to acquisitions.

As a second matching we focus this time on the universe of acquired firms, and match *acquired firms* which *received* cash inflows through minority acquisitions with *acquired firms* in the same industry, having the same size, age and patent portfolio prior to the acquisition, which did *not* receive cash inflows. The sample of deals declines to 38. We then examine whether the innovation performance of these matched firms also increase.

[Insert Table 8B about here]

The results for both the base and the matched samples are presented in Table 8B. The results indicate that there is no statistically significant increase in either the quantity or the quality of innovation of matched firms (acquired but with no cash transferred) unlike base sample firms (target firms financed through minority acquisitions)) which significantly increase their post-acquisition innovation.

Again, the results support our hypothesis that it is precisely the cash transfer to target firms which helps liquidity constrained innovative targets to innovate more after the acquisitions.

5.3 Announced but Failed Acquisitions

Another way of potentially addressing the endogeneity concern is to investigate incomplete deals. We follow Seru (2015) and Savor and Lu (2009) and compare the innovation activities of firms which were targets of failed acquisitions with those successfully acquired and which received cash inflows. Unsuccessfully acquired targets can be considered proxies for how the successfully acquired might have performed in the absence of M&As.

Thomson Reuters SDC database report deals where a minority acquisition is announced but the acquirer and the target do not complete the transaction. In those deals there is an attempt by the acquirer firms to purchase shares in target firms, but the transaction is not finalized and no money is transferred from acquirers to targets. Again, if acquirers indeed select target firms with potential for increased innovation performance we would expect that firms targeted in acquisitions improve their performance even after the failed acquisition attempt. If, on the other side, minority acquisitions improve target's performance by alleviating target firms' liquidity constrained, announced but failed acquisitions should show no impact the performance of targets.

[Insert Table 9 about here]

Table 9 presents the results using the baseline regressions on a sample of announced but failed minority acquisitions. The estimates are insignificant when we use the number of patents applied as our dependent variable, supporting our hypothesis. However, the number of non-self citations received increases following the incomplete deals. This increase might be because target firms may get more publicity when the acquisitions are announced, more exposure and thus get more citations.

6. Robustness Checks

6.1 Alternative Econometric Model

We next consider an alternative econometric model to verify the validity of our results. Following Hausman, Hall, and Grilliches (1984) we employ a fixed effects panel Poisson regression model for two the dependent variables in count data form: the number of patents applied

by target firm and the number of non-self citations received per patent applied after the minority acquisition. The dependent variables are thus used without any transformation in their count data form. We set up the following model;

$$E[Y_{it}|Minority\ Acquisition_{it}] = exp[\alpha + \beta After + \gamma X_{it-1} + \tau_i + \delta_t] \qquad (2)$$

To address the concerns related to the use of interaction terms in non-linear models (see Ai and Norton (2003)) we estimate the Poisson regressions without interaction terms, separately for the two subsamples: the pre-acquisition smaller patent portfolio firms and the pre-acquisition Large Patent Portfolio firms.

[Insert Table 10 about here]

The results of the panel Poisson model are presented in a dynamic setting in Table 10 for the two count dependent variables. The first two columns present the results for firms with large pre-acquisition patent portfolios; in the last two columns firms with small pre-acquisition patent portfolios are considered. The dependent variables are the simple non-self citation count per patent (columns 1 and 3) and patent count (2nd and 4thcolumns). The results are consistent with our previous findings - there is a strong positive correlation between the minority equity sale and our measures for the quantity and the quality of innovation, but only in the case of small pre-acquisition patent portfolio firms. The results hold when both measures of innovation are used.

6.2. Other robustness checks

Since our analysis is the deal level, there are some deals where the acquirers are the same firms. Therefore, a concern is that our results might be driven by a few acquirers. While the percentage of the deals where one acquirer buys minority shares in different targets is very low, we take into consideration this possibility and re-estimate the regressions including acquirer fixed effects. This exercise also account for acquirer specific characteristics which may impact the post-acquisition performance of the target. The results confirm our previous findings - small patent

portfolio firms subject to minority acquisitions followed by cash transfers increase the quantity as well as the quality of innovation post acquisition.

Also, sometimes firms are targeted in minority share acquisitions more than once over the sample. While these deals do not comprise a large percentage of our sample, we repeat the analysis by only including first time minority acquisition deals. The results do not change.

Finally, including further control variables commonly used in the finance literature such as HHI (Herfindahl-Hirschman Index), Leverage, Capital Expenditures do not change the results significantly. All the above estimations provide results similar to the ones reported above, which is credit constrained, Small Patent Portfolio firms which receive cash transfers as a result of minority acquisitions innovate more post acquisition. The results are available upon request.

7. Conclusion

The study investigates the impact of minority acquisitions on the innovation performance of publicly held US target firms. The results highlights that cash transferred through minority stake sales is an important source of financing the innovation activities of target firms, particularly for previously liquidity constrained targets. The study indicates that the acquisition of minority interest in target firms having relatively small patent portfolios prior to acquisition increases targets' total number of non-self citations per patent received by 23% following the acquisition. Additionally, the total number of simple patent count increases by 10%. We find also that if minority shares are acquired from a priori large patent portfolio firms, or firms which are not financially constrained, minority acquisitions do not result in any change in targets' post-acquisition innovation. Similarly, the results suggest that minority acquisitions not accompanied by direct cash transfer to target firms have no impact on these firms' subsequent innovation activity.

To address the endogeneity concerns, we use various matching techniques, and investigate announced but failed acquisitions. In the year of minority acquisition, we find similar-sized firms in the same industry, having similar age and technological stock and show that these matched acquired firms do not increase innovation performance if they do not receive cash transfers. We also investigate announced but failed acquisitions, and find that there is no impact on the ex-post innovation of targets following incomplete deals. An alternative econometric model using count data provides similar results with the baseline regressions.

In sum, our study provides evidence for a previously unexplored benefit of minority stake purchases. Funds obtained by financially constrained and relatively small patent portfolio target firms through minority stakes sales result in increased innovation activity. Both the quantity and the quality of innovation increase for these target firms following minority acquisitions accompanied by cash transfers.

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Table 1: Variable Definitions and Data Sources

Table I provides the definitions of the variables used in the study and sources of the variables.

Dependent Variables

Ln(Non-Self Citations per Patent Applied)	Logarithm of one plus The total number of non-self citations received per patent applied by firm i in year t. (NBER Patent Data Project)
Ln(Total Patent number Applied)	Logarithm of one plus The total number of patents applied by firm i in year t. (NBER Patent Data Project)
Patent Count	The total number of patents applied by firm i in year t (NBER Patent Data Project)
Non-Self Citation Count	The total number of non-self citations received for the patents applied by firm i in year t (NBER Patent Data Project)
Total Citation Count	The total number of citations received for the patents applied by firm i in year t (NBER Patent Data Project)

Independent Variables

Ln(Sales)	Logarithm of Sales (Compustat)
Ln(Total Assets)	Logarithm of Total Assets(Compustat)
Ebitda/Total Assets	Earnings Before Interests, Taxes, Depreciation and Amortization divided by Total Assets (Compustat)
Cash/Total Assets	Cash Amount held by firm i in year t normalized by total assets. (Compustat)
Ln(R&D Exp)	Research and Development Expenses by firm i in year t. (Compustat)
Age	The total number of years since the time firm first appears on compustat (Compustat)
After-Acquisition	A dummy which equals one for the observations five years after the announcement of the minority acquisition.
Small Patent Portfolio Firm	A dummy variable which equals one if the target firm has lower than the median cumulative patent count one year prior to the announcement of the minority stake purchase

Table 2: Summary Statistics and Non-Parametric Before-After Acquisition Mean Tests

Table 2 shows the descriptive statistics for targets of minority acquisitions. In all panels except panel D cash is transferred to target firms. Panels B and C are subsamples of Panel A based on the median cumulative patent portfolios of the target firms before acquisitions. To be able to conduct mean difference tests we restrict the observations to one, respectively two years before and after acquisitions. In the last three columns summary statistics for the unbalanced sample used in regressions are presented. The definitions of all variables are provided in Table I.

Deal level clustered standard errors are used to conduct mean difference tests. ∗, ∗∗, and ∗∗∗ denote significance at 10%, 5%, and 1% level, respectively.

	Before-After Acquisition Mean Comparison Test		**Overall Sample Statistics**		
Variable Name	**Before Mean**	**After Mean**	**Sample Mean**	**St. Dev.**	**Observation Number**
Panel A: Minority Acquisitions *with* Cash Transferred to Targets					
Ln(Total Assets)	4.77	4.93	5.04	2.19	2075
Ebitda/Total Assets	-0.09	-0.07	-0.06	0.30	2075
Ln(R&D Exp)	2.98	3.09	3.24	2.04	2075
Cash/Total Assets	0.17	0. 20	0.17	0.21	2075
Ln(Total Patent number Applied)	1.18	1.50	1.38	1.45	2075
Ln(No of non-self citations received)	1.63	2.06***	1.91	1.32	2075
Age			23.29	26.29	2075
Percentage of Shares Acquired			10.75	7.98	2075
Panel B: *Subsample* of Panel A - Pre-Acquisition *Small* Patent Portfolio Firms					
Ln(Total Assets)	4.66	4.59	4.79	2.15	1019
Ebitda/Total Assets	-0.08	-0.07	-0.06	0.30	1019
Ln(R&D Exp)	3.04	3.01	3.30	2.31	1019
Cash/Total Assets	0.13	0.18	0.16	0.19	1019
Ln(Total Patent number Applied)	0.30	0.90***	0.77	1.03	1019
Ln(No of non-self citations received)	0.96	1.68***	1.55	1.37	1019
Age			16.30	19.64	1019
Percentage of Shares Acquired			11.21	8.94	1019
Panel C: *Subsample* of Panel A - Pre-Acquisition *Large* Patent Portfolio Firms					
Ln(Total Assets)	4.88	5.23	5.29	2.19	1056
Ebitda/Total Assets	-0.11	-0.08	-0.06	0.30	1056
Ln(R&D Exp)	2.93	3.17	3.18	1.74	1056

Cash/Total Assets	0.20	0.21	0.19	0.22	1056
Ln(Total Patent number Applied)	2.21	2.40	1.97	1.55	1056
Ln(No of non-self citations received)	1.97	2.02	2.26	1.17	1056
Age			30.04	29.89	1056
Percentage of Shares Acquired			10.24	6.79	1056

Panel D: Minority Acquisitions, *No-Cash Transfers* (Open Market Minority Acquisitions)

Ln(Total Assets)	5.31	5.54	5.56	2.12	1399
Ebitda/Total Assets	0.09	0.08	0.09	0.15	1399
Ln(R&D Exp)	3.50	3.81	3.65	2.56	1399
Cash/Total Assets	0.08	0.08	0.08	0.14	1399
Ln(Total Patent number Applied)	0.99	0.98	1.03	1.32	1399
Ln(No of non-self citations received)	1.18	1.41	1.45	1.18	1399
Age			47.11	38.25	1399
Percentage of Shares Acquired			7.55	6.59	1399

Table 3-Baseline Regressions, Patent Number Applied and Non-Self Citations Received per Patent Applied after Minority Acquisitions

The table presents estimates from panel OLS regressions. **Only minority stake purchases *with* cash transfers to target are included**. Any deal in which acquirer or target is a financial firm excluded from the sample. The dependent variables are: log total number of patent applied by target firm in the year (first two columns), and log total number of non-self citations received per patent applied by firm (last two columns). *After-Acquisition* dummy equals one for five years after the minority acquisition announcement year. *After-Acquisition*Small Patent Portfolio Firm* is a dummy which equals one for five years after the acquisition announcement of the target firms which had lower than median cumulative patent count before announcement. Standard errors are robust and clustered at deal level. The definitions of all variables are provided in Table 1. ∗, ∗∗, and ∗∗∗ measure significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable			
	Ln(Patent Count)		Ln(Non-Self Citations per Patent)	
	(I)	(II)	(III)	(IV)
After-Acquisition	-0.088	-0.088	-0.330***	-0.324***
	(0.060)	(0.056)	(0.088)	(0.090)
After-Acquisition*Small	0.186**	0.186**	0.558***	0.554***
Patent Portfolio Firms	(0.090)	(0.088)	(0.147)	(0.148)
Ln(Total Assets)	0.198***	0.197***	0.242**	0.246**
	(0.062)	(0.061)	(0.112)	(0.113)
Ebitda/Total Assets	-0.063	-0.064	0.081	0.089
	(0.144)	(0.146)	(0.335)	(0.336)
Cash/Total Assets	0.063	0.063	0.160	0.159
	(0.138)	(0.138)	(0.287)	(0.287)
Ln(R&D Exp.)	0.474***	0.473***	0.009	0.017
	(0.099)	(0.099)	(0.123)	(0.124)
Age		-0.025		-0.116***
		(0.017)		(0.025)
Age(Squared)		-0.000		0.000
		(0.000)		(0.000)
Constant	-0.760**	0.023	-1.014**	2.428***
	(0.339)	(0.404)	(0.451)	(0.543)
Firm Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
Deal Number	165	165	165	165
N	1587	1587	1587	1587
R-Squared	0.3232	0.3232	0.1892	0.1894

*Standard errors in parentheses, * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 5- Financially Constrained vs Not-Constrained Firm: The case of Dividend/No-Dividend Payer Firms

The table presents results separately for pre-acquisition dividend paying, and not paying firms. The dependent variable is the log of the total number of non-self citations received per patent applied by firm in the year in the columns I and III, the log of the total number of patent applied by firm in the year in the columns II and IV. After-Acquisition dummy equals one for five years after the announcement year of the minority acquisition. *After-Acquisition*Small Patent Portfolio Firm* is a dummy which equals one for five years after the announcement year for the target firms which had lower than median cumulative patent count one year before the announcement. Standard errors are robust and clustered at deal level. The definitions of the variables are provided in Table 1. ∗, ∗∗, and ∗∗∗ measure significance at the 10%, 5%, and 1% level, respectively.

	No-Dividend Payer (liquidity constrained)		**Dividend Payer (not-liquidity constrained)**	
	Ln(Non-self Citation Count)	Ln(Patent Count)	Ln(Non-self Citation Count)	Ln(Patent Count)
	(I)	(II)	(III)	(IV)
After-Acquisition*Small Patent Portfolio Firm	0.501***	0.334***	0.114	0.153
	(0.120)	(0.096)	(0.180)	(0.157)
After-Acquisition	-0.238**	-0.122*	0.041	0.050
	(0.094)	(0.069)	(0.101)	(0.130)
Ln(Total Assets)	-0.020	-0.020	0.062	0.054
	(0.039)	(0.038)	(0.102)	(0.087)
Ebitda/Total Assets	0.119	-0.073	-0.534**	-0.582**
	(0.157)	(0.118)	(0.262)	(0.252)
Cash/Total Assets	0.547**	0.218	-0.180	-0.838***
	(0.249)	(0.160)	(0.406)	(0.302)
Ln(R&D Exp.)	-0.022	0.077	-0.015	0.169*
	(0.040)	(0.048)	(0.080)	(0.097)
Age	0.159***	0.119***	0.092***	0.015
	(0.020)	(0.024)	(0.031)	(0.028)
Age(Squared)	-0.000*	-0.001***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.086	-0.123	-2.579***	-0.086
	(0.326)	(0.479)	(0.891)	(0.795)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Deal Number	131	131	52	52
N	1318	1318	574	574
R-Squared	0.2748	0.2420	0.2050	0.1275

*Standard errors in parentheses, * $p < .10$, ** $p < .05$, *** $p < .01$

Table 6 -Financially Constrained vs Not-Constrained Firms: Kaplan-Zingales (KZ) Index

The table presents results separately for pre-acquisition financially constrained/not-constrained firms. KZ is Kaplan-Zingales Index of Financial Constraints. *Higher KZ index for a firm indicates higher financial constraints.* Only the minority stake purchases with cash flow to target are included. Any deal in which acquirer or target is a financial firm excluded from the sample. The dependent variables are the log of the total number of non-self citations received per patent applied by firm in the year for all models. The *After-Acquisition* dummy equals one for five years after the announcement year of the minority acquisition. *After-Acquisition*Small Patent Portfolio Firm* is a dummy which equals one for five years after the announcement year for the target firms which had lower than median cumulative patent count one year before the announcement. Standard errors are robust and clustered at deal level. The definitions of the variables are provided in Table 1. ∗, ∗∗, and ∗∗∗ measure significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable Ln(Non-Self Citations Per Patent Applied)			
	KZ<Q50	**KZ>Q50**	**KZ>Q75**	**KZ>Q90**
	(I)	(II)	(III)	(IV)
	OLS	OLS	OLS	OLS
After-Acquisition	0.215	0.661***	0.878***	1.493***
*Small Patent Portfolio	(0.278)	(0.172)	(0.235)	(0.412)
Firm				
After-Acquisition	0.058	-0.469***	-0.737***	-0.945***
	(0.156)	(0.102)	(0.137)	(0.250)
Ln(Total Assets)	0.010	0.326**	0.374**	0.219
	(0.191)	(0.128)	(0.179)	(0.302)
Ebitda/Total Assets	0.373	0.012	-0.164	-0.453
	(0.594)	(0.397)	(0.543)	(1.157)
Cash/Total Assets	0.112	0.136	0.446	0.734
	(0.468)	(0.338)	(0.616)	(0.944)
Ln(R&D Exp.)	0.035	0.044	0.003	-0.188
	(0.155)	(0.161)	(0.211)	(0.349)
Age	-0.160***	-0.112***	-0.087	0.040
	(0.045)	(0.030)	(0.053)	(0.099)
Age(Squared)	-0.000*	-0.001***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	5.534***	1.307**	1.114	-1.647
	(0.712)	(0.621)	(1.262)	(1.351)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Deal Number	54	111	64	27
N	446	1141	648	285
R-Squared	0.2554	0.2022	0.1822	0.2257

*Standard errors in parentheses, * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 7- Regressions for No-Cash Transfer Placebo Minority Acquisitions

The table presents estimates from panel ordinary least square regressions below. Only the minority stake purchases *without* cash flow to target are included. Any deal in which acquirer or target is a financial firm excluded from the sample. The dependent variable is the log of the total number of patent applied for first two columns, (I)-(II), the log of the number of non-self citations received per patent applied by firm in the year is for the last two models, (III),(IV).After-Acquisition dummy equals one for five years after the announcement year of the minority acquisition. *After-Acquisition*Small Patent Portfolio Firm* is a dummy which equals one for five years after the announcement year for the target firms which had lower than median cumulative patent count one year before the announcement. In all regressions year fixed effects are included and standard errors are robust and clustered at deal level. The definitions of the variables are provided in Table 1. ∗, ∗∗, and ∗∗∗ measure significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable			
	Ln(Patent Count)		Ln(Non-Self Citations per Patent)	
	(I)	(II)	(III)	(IV)
After-Acquisition *Small Patent Portfolio Firm	-0.067	-0.106	0.101	0.100
	(0.148)	(0.148)	(0.203)	(0.201)
After-Acquisition	-0.052	-0.018	-0.189*	-0.187*
	(0.087)	(0.085)	(0.108)	(0.109)
Ln(Total Assets)	-0.177	-0.188	0.419**	0.420**
	(0.192)	(0.189)	(0.188)	(0.188)
Ebitda/Total Assets	1.281***	1.403***	0.176	0.179
	(0.426)	(0.438)	(0.515)	(0.514)
Cash/Total Assets	0.208	0.256	0.750*	0.752*
	(0.289)	(0.279)	(0.449)	(0.451)
Ln(R&D Exp.)	0.867***	0.939***	-0.185	-0.183
	(0.218)	(0.221)	(0.185)	(0.187)
Age		-0.031		-0.084***
		(0.029)		(0.030)
Age(Squared)		0.000**		0.000
		(0.000)		(0.000)
Constant	0.838	1.033	-1.530*	2.834***
	(0.974)	(1.060)	(0.870)	(0.806)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Deal Number	85	85	87	87
N	590	590	891	891
R-Squared	0.3514	0.3637	0.0963	0.0963

*Standard errors in parentheses, * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 8A - Matched Sample Results - Matched Never Acquired firms

The table presents results from panel ordinary least square regressions. Firms in this sample have the same two digit SIC code, have the similar size and similar patent stock with the firms in the base sample (acquired, with cash inflow) one year before the minority stake purchases occur. The firms in this sample were *never acquired*. The dependent variable is the log of the total number of patent applied for first two columns, (I)-(II), the log of the number of non-self citations received per patent applied by firm in the year is for the last two models, (III),(IV). After-Acquisition dummy equals one for the matched firm for five years after the announcement year of the minority acquisition for the base sample firms. Standard errors are robust and clustered at deal level. The definitions of the variables are provided in Table 1. ∗, ∗∗, and ∗∗∗ measure significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable			
	Ln(Patent Count)		Ln(Non-Self Citations per Patent)	
	(I)	(II)	(III)	(IV)
After-Acquisition	-0.225**	-0.178*	-0.127	-0.086
*Small Patent Portfolio Firm	(0.102)	(0.095)	(0.194)	(0.193)
After-Acquisition	0.054	0.019	0.070	0.042
	(0.072)	(0.065)	(0.127)	(0.126)
Ln(Total Assets)	0.055	0.026	0.159*	0.143
	(0.081)	(0.084)	(0.086)	(0.089)
Ebitda/Total Assets	-0.335**	-0.301*	-0.567**	-0.609**
	(0.158)	(0.156)	(0.269)	(0.270)
Cash/Total Assets	0.193	0.112	0.240	0.224
	(0.200)	(0.202)	(0.306)	(0.317)
Ln(R&D Exp.)	0.300***	0.277***	0.020	0.011
	(0.105)	(0.095)	(0.095)	(0.096)
Age		-0.069***		-0.080***
		(0.023)		(0.019)
Age(Squared)		-0.000		-0.000
		(0.000)		(0.000)
Constant	-1.667***	1.234***	-1.217**	1.570***
	(0.605)	(0.405)	(0.528)	(0.368)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Number	107	106	112	111
N	1043	1032	1845	1830
R-Squared	0.2261	0.2474	0.2069	0.2025

*Standard errors in parentheses, * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 8B. Matched Sample Results 2 - Acquired Firms *with* Cash Flow versus Matched Acquired Firms *no* Cash Flow to target

The table presents estimates from panel ordinary least square regressions. *Base* sample includes minority acquired firms *with* cash transfers. *Matched* sample includes similar minority acquired firms (firms of similar size, age, in the same industry with similar patent portfolio before minority acquisition) where *no* cash was transferred. The dependent variable is the log of the total number of patent applied for first two columns, (I)-(II), the log of the number of non-self citations received per patent applied by firm in the year is for the last two models, (III),(IV).*After-Acquisition* dummy equals one for five years after the announcement year of the minority acquisition. *After-Acquisition*Small Patent Portfolio Firm* is a dummy which equals one for five years after the announcement year for the target firms which had lower than median cumulative patent count one year before the announcement. In all regressions year fixed effects are included and standard errors are robust and clustered at deal level. The definitions of the variables are provided in Table 1. ∗, ∗∗, and ∗∗∗ measure significance at the 10%, 5%, and 1% level, respectively.

	Base Sample		*Matched* Sample	
	Nonself Citations per Patent	Patent Number	Nonself Citations per Patent	Patent Number
	(I)	(II)	(III)	(IV)
After-Acquisition*	0.488***	0.033	0.352	0.057
Small Patent Portfolio Firm	(0.170)	(0.133)	(0.257)	(0.157)
After-Acquisition	-0.324**	0.054	-0.209	-0.081
	(0.139)	(0.104)	(0.221)	(0.133)
Ln(Total Assets)	0.272	0.279**	0.381	0.297*
	(0.200)	(0.106)	(0.257)	(0.164)
Ebitda/Total Assets	0.756**	0.393**	0.422	0.487**
	(0.281)	(0.194)	(0.576)	(0.227)
Cash/Total Assets	-0.488	0.314	0.667	0.741**
	(0.568)	(0.279)	(0.489)	(0.340)
Ln(R&D Exp.)	-0.029	0.206	-0.023	0.309*
	(0.206)	(0.131)	(0.271)	(0.178)
Age	-0.165***	-0.073**	-0.101***	-0.032
	(0.048)	(0.030)	(0.037)	(0.021)
Age squared	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	4.511***	1.662***	1.428	-0.827
	(1.090)	(0.587)	(0.908)	(0.505)
Firm Fixed Effects	yes	yes	yes	yes
Year Fixed Effects	yes	yes	yes	yes
DealNumber	38	38	38	38
N	397	397	411	411
R-Sq	0.2194	0.2601	0.1480	0.3683

Table 9- Failed Minority Acquisitions

In this table only *incomplete* deals are included in the analysis. The table presents estimates from panel ordinary least square regressions. The dependent variables are the log of the total number of non-self citations received per patent applied by firm in the year for the first two models and the log of the total number of patent applied by firm in the year for the last two models. *After-Acquisition* dummy equals one for five years after the announcement year of the minority acquisition. *After-Acquisition*Small Patent Portfolio Firm* is a dummy which equals one for five years after the announcement year for the target firms which had lower than median cumulative patent count one year before the announcement. In all regressions year fixed effects are included and standard errors are robust and clustered at deal level. The definitions of the variables are provided in Table 1. ∗, ∗∗, and ∗∗∗ measure significance at the 10%, 5%, and 1% level, respectively.

	Dependent Variable Ln(Non-Self Citations Per Patent Applied)	Dependent Variable Ln(Patent Count)
	(I)	(II)
After-Acquisition	0.614***	0.008
*Small Patent Portfolio Firm	(0.208)	(0.132)
After-Acquisition	-0.149	0.162*
	(0.139)	(0.088)
Ln(Sales)	-0.047	0.012
	(0.121)	(0.084)
Ebitda/Total Assets	0.520	0.203
	(0.381)	(0.207)
Cash/Total Assets	0.127	0.093
	(0.470)	(0.204)
R&D/Total Assets	0.063	0.409***
	(0.160)	(0.096)
Constant	0.503	1.588**
	(0.561)	(0.748)
Firm Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Deal Number	78	76
N	790	571
R-Squared	0.1449	0.2907

*Standard errors in parentheses, * $p < .10$, ** $p < .05$, *** $p < .01$.

Table 10-Alternative Models: Poisson Regressions
Patent Count, Non-Self Citation Received Count After Minority Acquisitions

Table shows the results from fixed effects panel data poisson regressions. Any deal in which acquirer or target is a financial firm excluded from the sample. In the first two columns, only target firms having more than the median cumulative count before the announcement year are included and firms with less than the median cumulative count before the announcement year are included in the last two columns. In first and third columns, the dependent variable is the number of non-self citations received by firm in the year. For the second and fourth columns, the total number of patents applied by firm is the dependent variable. After-Acquisition(t+n) equals one for n^{th} year after the announcement of the minority acquisition. In all regressions firm and year fixed effects are included and standard errors are robust and clustered at deal level. The definitions of the variables are provided in Table 1. ∗, ∗∗, and ∗∗∗ measure significance at the 10%, 5%, and 1% level, respectively.

	Large Patent Portfolio		Small Patent Portfolio	
	Non-self Citation Count	Patent Count	Non-self Citation Count	Patent Count
	(I)	(II)	(III)	(IV)
After-Acquisition(t+1)	0.111	0.084	0.444**	0.290
	(0.103)	(0.141)	(0.201)	(0.207)
After-Acquisition(t+2)	0.012	-0.004	0.584**	0.479***
	(0.067)	(0.080)	(0.245)	(0.162)
After-Acquisition(t+3)	-0.095	0.003	0.598**	0.424**
	(0.074)	(0.077)	(0.251)	(0.188)
After-Acquisition(t+4)	-0.056	-0.004	0.339**	0.570***
	(0.118)	(0.103)	(0.142)	(0.167)
After-Acquisition(t+5)	0.072	0.081	-0.205	-0.350***
	(0.087)	(0.076)	(0.183)	(0.132)
Ln(Total Assets)	0.562***	0.457**	-0.023	0.687***
	(0.197)	(0.202)	(0.293)	(0.129)
Ebitda/Total Assets	-0.594*	-1.155***	0.100	-0.570**
	(0.317)	(0.312)	(0.530)	(0.285)
Cash/Total Assets	-0.636	-0.555	0.223	0.496
	(0.387)	(0.568)	(0.333)	(0.323)
Ln(R&D Exp.)	0.451***	0.403*	0.694***	0.472***
	(0.166)	(0.216)	(0.173)	(0.166)
Firm Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Deal Number	79	77	77	80
N	884	765	462	685

*Standard errors in parentheses, * $p < .10$, ** $p < .05$, *** $p < .01$.