# Valuation of private innovative targets*

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March 2018

**Abstract**

Despite the growing importance of acquisitions of private targets by incumbent technology firms and the need to value the intangible assets acquired in these business combinations, studies on the valuation of such assets are scarce. We use Cisco's acquisitions from 1993-2012 to explore how to value the intangible assets of private, innovative targets. We use Cisco's acquisitions because it is a large, dominant technology firm that grew primarily through acquisitions. Apart from unobserved demand and supply factors, we control for acquirer's and target's over- or under-valuation and deal synergies. We estimate that targets receive $81 million ($144 million) for every patent filed (granted) at the time of acquisition. Novel innovations are more valued: each citation to the target's patents increases value by $6.1 million. Targets receive $2.22 million per employee. However, estimates obtained using publicly listed innovative firms do not provide reliable proxies to value intangible assets of private targets.

Key Words: Acquisition, Innovation, Intangible Asset, Patent, Target, Value.

JEL Code: D82, G14, G32, G34, L33, O31

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*Chandra Sekhar Mangipudi is from the Goizueta Business School, Emory University, Krishnamurthy V. Subramanian is from the Indian School of Business and Rajkamal Vasu is from the Kellogg School of Business, Northwestern University. We would also like to thank Viral Acharya, Philippe Aghion, Ashish Arora, Ramin Baghai, Nick Bloom, N Chidambaram, Sanjiv Das, Alex Edmans, Jarrad Harford, David Hirshleifer, Ravi Jagannathan, Simi Kedia, Chris Malloy, David Matsa, Harold Mulherin, Randall Morck, Richard Nelson, David Offenberg, Dimitris Papanikolaou, Ed Paulson, Gordon Phillips, N Prabhala (Discussant at the ISB Summer Conference in Corporate Finance), Karthik Ramanna, Sampsa Patrikki Samila, Olav Sorenson, Per Strömberg, Rene Stulz, Raghu Sundaram, Xuan Tian, and Charlie Wang (discussant at the MIT Asia conference in Accounting), as well as participants at the Kellogg Finance Brownbag seminar 2015, London Business School's Summer Symposium 2014, the MIT Asia conference in Accounting 2014, and the ISB Summer Conference in Corporate Finance 2014 for their other comments. Krishnamurthy V. Subramanian would like to thank the Center for Leadership, Innovation and Change at the Indian School of Business for research support. All remaining errors are our responsibility.

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## Abstract

Despite the growing importance of acquisitions of private targets by incumbent technology firms and the need to value the intangible assets acquired in these business combinations, studies on the valuation of such assets are scarce. We use Cisco's acquisitions from 1993-2012 to explore how to value the intangible assets of private, innovative targets. We use Cisco's acquisitions because it is a large, dominant technology firm that grew primarily through acquisitions. Apart from unobserved demand and supply factors, we control for acquirer's and target's over- or under-valuation and deal synergies. We estimate that targets receive $81 million ($144 million) for every patent filed (granted) at the time of acquisition. Novel innovations are more valued: each additional citation to the target's patents increases the value by $6.1 million. Targets receive $2.22 million per employee. However, estimates obtained using publicly listed innovative firms do not provide reliable proxies to value intangible assets of private targets.



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# 1 INTRODUCTION

Acquisitions of private technology companies constitutes a central part of the new economy. Mergers and acquisitions (M&A) in the technology sector—of which acquisition of private technology companies comprise 85%—reached record levels in 2016. At an aggregate value of $467 billion in 2016, M&A deals in the technology sector constituted 36% of all M&A deals in the U.S. and outpaced deals in other industries, which fell 15% in value.[1] This phenomenon stems from the widespread use of acquisitions of private technology firms to stay at the cutting edge of the innovation frontier (Higgins and Rodriguez (2006), Aggarwal and Hsu (2013), Bena and Li (2014)). Incumbent technology firms prefer buying innovation rather than making it because startup firms are the primary drivers of mold-breaking innovation in the economy.[2] For instance, Apple's iTunes technology resulted from its acquisition of the startup SoundJam. The importance of private technology acquisitions to the new economy is underlined further by the fact that M&A constitutes the dominant mode for exit by innovative startups (Aggarwal and Hsu, 2013). In fact, data sourced from the tech-advisory firm CBInsights shows that in 2015 and 2016, 97% of all exits by innovative startups occurred through M&A.

The above phenomenon has significant implications for corporate finance as the Statement of Financial Accounting Standards (SFAS) 141 and the International Financial Reporting Standards (IFRS) 3 require acquirers to value their target's intangible assets and report the same in their financial statements. Given the complexities involved in estimating the value of intangible assets, especially those of private firms that do not have a long track record, the current state of the art in valuing the intangible assets of private technology firms presents significant scope for improvement. For instance, the Public Company Accounting Oversight Board (PCOAB) highlighted in its report in April 2016 that it found many deficiencies in the way auditors accounted for the value of intangible assets.[3] Yet, to our knowledge, prior academic work has not studied how to value the intangible assets of private targets. In this paper, we make a first attempt, albeit exploratory, to carefully estimate the value of intangible assets of private, innovative targets. We use hand-collected data to conduct a *longitudinal study* of all the acquisitions by Cisco Systems. We now explain why we focus on Cisco's acquisitions.

Obtaining detailed data on the intangible assets of private, innovative targets represents the *primary challenge* in studying the value paid for the intangible assets of private, innovative targets. Consider the

[1] Data sourced from E&Y Global technology M&A report, 2016 and CBInsights
[2] See Zucker et al. (1998), Kortum and Lerner (2000), Akcigit and Kerr (2010), and Chava et al. (2013).
[3] "Valuation experts will be held to a new standard," The Wall Street Journal, 24th November 2016.

data needed to ascertain the intangible assets of each target firm. For this purpose, think of the parallel represented by graduating PhD students, who are recruited as Assistant Professors based on the quality of their unpublished (job market) paper. Similarly, acquirers assess young, innovative firms based on the patents that they have applied for but have *not* yet been granted. Such patents as well as the citations to such patents are not available in standard sources such as the NBER patent database. This data, especially the data on citations, has to be hand-collected from the Google Patents database by manually sifting through the patents that cite each patent in each subsequent year. The number of times this effort-intensive exercise has to repeated equals number of targets * number of patents of each target.

Given the intensity of the data-collection exercise, we undertake a focused study using a small sample. Such a small sample study is best focused on the targets acquired by one serial acquirer because the values paid by an acquirer can be influenced by time-varying omitted variables specific to an acquirer. Focusing on one acquirer alleviates such econometric concerns. We choose Cisco because it contributes *close to half* of the acquisitions among the top five serial acquirers in the high-tech industry—Cisco, Microsoft, Intel, Yahoo and Google. Even after restricting our analysis to the targets acquired by Cisco, we hand-collect the details for each forward and backward citation for each of the 4150 patent-years.

Apart from the challenge relating to the data collection, the conceptual challenges involved in valuing intangible assets of private, innovative targets are non-trivial. First, private, innovative firms have minimal track records and scant information. For publicly listed, innovative firms, historical R&D numbers can be combined with stock market values to estimate the value of the portfolio (Hall, 1998, Kogan et al., 2016). However, neither metric is available for private, innovative firms. Second, the uncertainty surrounding innovative projects, especially those stemming from several "unknown unknowns", get compounded by the lack of track record/information. Third, the information asymmetry concerning a target's value is much more when the target is private than when it is public because privately held companies are more opaque than publicly traded ones (Officer et al., 2009). Such information asymmetry is particularly more pronounced with intangible assets than with tangible assets (Kimbrough, 2007). Finally, the price paid for a target is determined by supply and demand side factors.

Focusing on the targets acquired by Cisco enables us to overcome these challenges better than such a sample for any other serial acquirer. First, as Paulson (2001) describes, Cisco represents the "gold standard for M&A practices" as it employs acquisitions as the key strategy for growth. In contrast to other serial acquirers, Cisco follows well-tuned processes for the due diligence of the target. Therefore, when compared to sporadic acquirers or other serial acquirers, Cisco is likely to handle the complexities involved in valuing the intangible assets of private targets. We, in fact, provide evidence consistent with this key assumption

that we make for our empirical analysis. Second, because Cisco has acquired multiple targets each year, we can compare among the deals within a year. This empirical strategy is important to control for unobserved factors that are time-varying and are unlikely to change significantly within a year. For instance, the supply of potential targets undertaking innovation in a particular area or Cisco's demand for a particular technology – both of which can affect the price paid for a target – is unlikely to change significantly within a year. We also control for (i) whether the acquirer and target are over- or under-valued, (ii) potential synergies from combining the target's and acquirer's assets; and (iii) differences in value paid for intangible assets depending upon the industry and age of the private, innovative target. By controlling for these alternate determinants of the value paid, we estimate the intrinsic values more precisely. Furthermore, we contrast acquisitions that are paid fully with cash with other acquisitions to validate the estimates that we obtain. Existing studies examining acquisitions of private targets argue that acquisitions that are paid fully with cash represent zero net present value (NPV) investments. Thus, once we control for synergies, the value paid for this sample approximate the intrinsic value of the intangible assets of an innovative target. Therefore, comparing the estimates obtained for 100% cash acquisitions to the estimates obtained for other acquisitions enables us to infer whether our estimates are precise. By undertaking this comparison, we gain the confidence that our estimates are precise.

We explore the following questions. First, to guide practitioners in the difficult task of estimating the value of intangible assets of private targets, can we estimate a valuation multiple for each of the various dimensions of intangible assets of private targets? Specifically, what multiple can auditors apply to (i) the size of the target's patent portfolio as measured by the number of patents, (ii) the several dimensions of the quality of this portfolio as measured by various citation-based proxies, and (iii) the human capital of the target's employees? Second, to ease the difficulties in valuing private targets that have minimal track records and scant information, could the valuation multiples for publicly listed firms be employed as a reasonable proxy?

We report the following findings. First, we find that every additional patent filed before the acquisition (but granted eventually) increases the target's value by $81 million, whereas every additional patent granted before the acquisition fetches $144 million. This estimate is significantly larger than $5.4 million (in 2010 dollars to adjust for inflation) per patent estimated for 120 (manufacturing) firms over the time period 1968–1975 by Pakes (1985).

Second, the value of innovative private targets increases with the novelty of their innovations as captured using various citations-based proxies. We proxy novelty using citations to patents; we find that each additional citation to the target's patents before the acquisition increases the value by $6.1 million

while a standard deviation increase in the same increases the target's value by $505.3 million. To capture future growth opportunities stemming from the target's intangible assets, we estimate the lifetime citations that the target's patents are expected to receive. We find that a standard deviation increase in lifetime citations increases the target's value by $521.9 million.

Third, Cisco pays significantly for the human capital embedded in the target's employees. The value paid increases by $2.2 million with every additional employee. Because the number of employees correlates strongly with firm size, to disentangle these two effects, we use the number of patents that former employees of the target file as inventors at Cisco as another proxy for employee human capital. In regressions including both these variables, we find both variables to be positive and statistically significant. Thus, by controlling for the possible effect of firm size, we find that a private, innovative firm's value increases with employee human capital.

Practitioners—especially CEOs of high-technology firms—claim that acquisitions represent a key way for acquiring innovative employees. John Chambers, the CEO of Cisco states for example: "most people forget that in a high-tech acquisition, you really are acquiring only people. At what we pay, dollars $500,000 to $2 million per employee, we are not acquiring current market share. We are acquiring futures." Our estimate of about $2 million paid per target employee is consistent with such anecdotal claims of the value paid for the target employee's human capital.

Finally, we compare our estimates for the intangible assets of private, innovation targets with those of comparable public targets. Using a matched sample of similar-sized, similar-aged public targets in the same industry that are acquired around the same time, we find that the intangible assets of private, innovation targets are significantly more valuable on average than comparable public targets. This result is different from the findings in Officer (2007), who shows that private targets sell at a discount of 15% to 30% on average when compared to similar targets that are publicly listed. We rationalize these differences as stemming from young, private firms being significantly more innovative than their publicly listed counterparts (Akcigit and Kerr (2016), Lerner, Sorensen, and Strömberg (2011), Ferreira and Manso (2014), Chava et al. (2013) and Bernstein (2015)), on the one hand, and the market for the acquisition of young, private firms being an extremely competitive one for acquirers and a very attractive one for the targets (Aggarwal and Hsu (2013)). Thus, the valuation multiples obtained using publicly listed innovative firms cannot be employed as a reasonable proxy for the intangible assets of private targets.

The disadvantage of the "inductive research" approach that we employ is that we can only utilize a relatively small sample of targets acquired by one successful serial acquirer, Cisco systems. This approach potentially limits the strength of our conclusions as they may not generalize to other industries or even to

other acquirers. Nevertheless, our study contributes to the accounting literature by exploring a question that has not been studied carefully in an academic setting despite the current (and future) importance of the question. Our study provides practitioners a multiples-based method to value the intangible assets of private targets. We review the existing literature in section 2. In Section 3, we describe Cisco's acquisition strategy because it is crucial to our empirical design. Sections 4 and 5 describe respectively our data/proxies and the results. In Section 6, we discuss the implications of our research with pointers for further work in this area.

## 2 REVIEW OF LITERATURE

To our knowledge, our study represents the first attempt to estimate the values of intangible assets of private, innovative targets. An emerging literature in M&As examines acquisitions of private firms (Officer 2007; Fuller, Netter, and Stegemoller, 2002; Moeller, Schlingemann, and Stulz, 2004; Faccio, McConnell, and Stolin, 2006; Chang, 1998; Officer, Poulsen, and Stegemoller 2009). Several of these papers document positive returns to acquirers of private targets. We instead examine how intangible assets determine the value paid for acquisition. In this respect, our study resembles Officer (2007), who shows that premiums paid for private targets are significantly lower than those for similar public firms because the acquisition provides liquidity to the private target's owners. Unlike Officer (2007), we find that the intangible assets of private, innovation targets are significantly more valuable on average than comparable public targets. As we explain in detail in section 5.14, we rationalize these differences as stemming from young, private firms being significantly more innovative than their publicly listed counterparts, on the one hand, and the market for the acquisition of young, private firms being an extremely competitive one. Other studies investigate the post-acquisition performance of all serial acquirers (Mitchell and Lehn 1990; Fuller et al., 2002; Billett and Qian 2008; Aktas et al., 2011; Offenberg et al., 2012).

Within the literature studying acquisition of private firms, a growing number of studies examine mergers and acquisitions among innovative firms. Bena and Li (2014) find that acquisitions in innovation-intensive sectors are driven by synergies that can be generated from combining innovation capabilities. Sevilir and Tian (2012) examine the stock price reactions to acquisitions of innovative firms. Phillips and Zhdanov (2013) show that small, private firms innovate more when they are likely to be acquired by large firms. Bernstein (2015) shows that private ownership fosters innovation while public ownership discourages the same, which supports the theoretical arguments in Ferreira and Manso (2014).

Technology-related intangible assets represent one of the five categories of intangible assets recognized by FASB for valuation and reporting purposes. Thus, our study contributes to the corporate finance and accounting literature by estimating the determinants of the value of technology-related

intangible assets acquired in business combinations involving private targets. Our study therefore relates to the work of Sougiannis (1994), Lev and Sougiannis (1996), Aboody and Lev (1998) and Barth and Clinch (1998), Kallapur and Kwan (2004), Mohd (2005), Kimbrough (2007), Merkley (2013) and Curtis et al. (2017). Sougiannis (1994) estimates the investment value of R&D by examining whether reported accounting earnings reflect benefits from past R&D expenditures. Lev and Sougiannis (1996) demonstrate that the market implicitly capitalizes, at least partially, the future benefits associated with R&D investments. Aboody and Lev (1998) use software development costs to examine the value relevance of information on the capitalization of intangible assets. Barth and Clinch (1998) examine how the relevance, reliability, and timeliness of asset revaluations differ across tangible and intangible assets. Barth et al. (1998) and Kallapur and Kwan (2004) document the association between various forms of intangible assets and equity values. Mohd (2005) shows that information asymmetry associated with R&D assets lower when firms capitalize R&D. Kimbrough (2007) examines the mechanisms by which private information about firms' R&D activities affects equity value as assessed by investors. Merkley (2013) examines whether earnings performance relates to the quantity of narrative R&D disclosure that firms provide concurrently in their financial reports. Curtis et al. (2017) re-examine the continued practice of expensing R&D as required by U.S. GAAP given the changes in the nature of R&D in recent years.

# 3 BACKGROUND FOR USING TARGETS ACQUIRED BY CISCO AS OUR SAMPLE

The intensity of data collection necessitates that we select our sample carefully. We restrict this sample to the private, innovative targets acquired by Cisco. Here, we explain the rationale for this choice.

## 3.1 Acquisitions as a key element of corporate strategy at Cisco

Founded in 1984, Cisco Systems Inc. listed in the public equity markets in 1990 and now dominates the market for data networking. The way to this domination was paved by Cisco's acquisition strategy. In 1993, Cisco's management team realized that the market was changing rapidly, and this change put more demands on Cisco to provide a complex variety of networking solutions. Such rapid change could not be achieved purely by organic growth, as product life cycles usually stretch to less than 18 months and product development takes longer. Cisco has used the acquisitions of small private start-ups not only to enter into new product segments but also to expand its business in the existing segments. Cisco looks for start-ups if it decides it is too far behind competitors to take the time to build a product from scratch. For Cisco,

acquiring private, innovative targets has been as common a practice as hiring a person with requisite skills is for any other company:

"Cisco has constantly refined its acquisition process . . . the company has been so successful with its acquisitions that the industry created a new term for Cisco's type of research and development (R&D): Acquisition and Development (A&D). . . (Cisco is) the company that has become the gold standard of M&As practices, both strategically and operationally... Cisco has figured out a process for M&As that works... *the best practices (in M&As) are those of Cisco*. The acquisition process at Cisco is quite systemized with guidelines established for determining targets, opening of discussions at the companies, and performing due diligence. The established process has meant that acquisition has become more of a routine process for Cisco. Turning acquisition into a process enables a large number of Cisco personnel to acquire expertise in the acquisition methodology, which then makes it less personnel dependent and more repeatable. Cisco has taken out as much of the guesswork out of the acquisition process as possible, which increases its reliability and decreases its associated risks. Acquisition as an occasional or opportunistic process, which is the exception to the rule, does not apply to Cisco Systems. At Cisco, acquisition is simply one of the activities it pursues as intrinsic to its continued success. As such, it is fostered, cultivated, streamlined, and continually improved just as any critical business process would be for any top-notch company. In other words, at Cisco Systems, acquisition is simply another business decision and process." (Paulson 2001)

### 3.2 Value-added through acquisitions by Cisco

Consistent with acquisitions being a key element of corporate strategy at Cisco, it has generated value through its acquisitions. Figures 1 and 2 demonstrate this. In figure 1, we plot the return on assets, return on equity, operating profit margin as well as the rate of sales growth for Cisco and compare the same with the median for the industry in which Cisco operates. Clearly, we can observe that on each of these metrics Cisco dominates significantly when compared to other firms in its industry. We arrive at a similar inference even when we compare Cisco to its major competitors (see figuresA-2 and A-3 in the online appendix). In figure 2, in event time with 0 corresponding to the date of announcement of the acquisition, we plot the buy-and-hold return obtained by shareholders of Cisco and compare the same with CRSP value-weighted return as a benchmark. In figure A-4 in the online appendix, we show the buy-and-hold return obtained by shareholders of Cisco in calendar time and compare the same with two different benchmarks: NASDAQ as well as the technology and hardware index. From both these figures, we can infer very clearly

that when compared to the NASDAQ, the CRSP value-weighted index or the technology and hardware index, shareholders of Cisco reaped significantly higher returns. Thus, we can infer that Cisco has generated value for its investors through its strategy of acquisition and development.

One concern might be that Cisco's performance is a result of acquiring undervalued targets. If this were the case, our estimates would be biased downward because Cisco is paying less than the intrinsic value of the portfolio of intangible assets of the target. Since 90% of Cisco's targets are private firms, this concern is all the more relevant in light of the findings in the existing literature, which documents positive returns to acquirers of private targets. For example, Officer (2007) reports the average cumulative abnormal return over the event window (-1,1) for the acquirers of private firms in his sample to be 1.9%. However, the evidence of undervalued targets may not extend to our sample of private, innovative targets. Sevilir and Tian (2012) report a cumulative abnormal return of 0.01% over the event window (-1,1). Though the estimate is statistically significant in their large sample study, the economic magnitude is small. Crucially, from our perspective, they find an economically large positive announcement return of 1% for only those targets that have a patent granted at the time of the acquisition. For the sample of targets that do not possess a patent at the time of the acquisition, the announcement return is statistically insignificant even in their large sample. This evidence is quite relevant to our study because close to 75% of the targets in our sample do not have a patent granted at the time of the acquisition (though half the firms have at least filed a patent that is eventually granted).

The opposite concern that Cisco overpays for its innovative targets may be equally valid. For instance, when compared to sporadic acquirers, serial acquirers are more likely to destroy shareholder value (Moeller, Schlingemann, and Stulz 2004). In this case, our estimates would be biased upward because Cisco is paying more than the intrinsic value of the portfolio of intangible assets of the target.

To examine these concerns, we examine Cisco's average Cumulative Abnormal Returns in a window around the merger announcement date. Across all deals, we find that the CARs on the event day and in the (-1,1) and (-2,2) event windows are neither economically nor statistically significant. As argued above, because only 25% of the targets in our sample possess a patent that has been granted at the time of the acquisition (though half the firms have filed a patent by then), this evidence is consistent with that in Sevilir and Tian (2012). The economically insignificant announcement return, on the one hand, and the *combination* of significantly positive buy and hold returns in the long run, higher return on assets, return on equity and sales growth compared to its peers, on the other hand, may stem from the combination of (i) higher risk involved in acquiring targets that do not possess any patent that has been granted at the time of the acquisition; and (ii) stock market participants being unable to value innovation correctly (Cohen et al.,

2013). The economically insignificant announcement return, which suggests that Cisco's acquisitions may represent zero NPV investments, could also arise from the market for acquisitions of private, innovative targets being an extremely competitive one. As table 1 shows, all the large incumbent firms in the high-technology sectors have acquired private, innovative targets to stay at the cutting edge of the innovation frontier (Higgins and Rodriguez, 2006). Moreover, acquisitions have become the dominant mode for exit by innovative startups (Aggarwal and Hsu, 2013). Thus, our evidence suggests that on average, Cisco pays a fair price for the innovative assets it acquires. Therefore, our estimates for the intrinsic value of these assets are likely to be unbiased.

### 3.3 Advantages when compared to targets acquired by other serial acquirers

We now reason why the sample of acquisitions undertaken by Cisco enables us to reduce econometric concerns better than a sample of acquisitions undertaken by all acquirers. In general, the price paid for a target is determined by supply and demand side factors, which may be unobserved. For instance, the supply of potential targets, i.e. targets innovating in a particular industry segment, could be high during boom times and low during recessions. At the same time, the demand for particular technologies may also vary differently across the business cycle in different industries. So, sporadic acquirers may pay more during a boom and less during a recession. However, Cisco's acquisitions have spanned booms and busts. Moreover, *comparing among Cisco's deals within a year* ensures that unobserved supply-side factors are controlled for because the number of potential targets undertaking innovation in a particular area is unlikely to change within a year. Similarly, because Cisco's as well as Cisco's competitors' demand for a particular technology is unlikely to change significantly within a year, examining variation within a year enables us to control for unobserved demand-side factors.

Since unobserved factors affecting demand and supply of targets are likely to vary with time within an industry and possibly with time within an acquirer as well, we have to restrict our analysis to the sample of acquisitions by only one acquirer. Cisco is the natural choice for this empirical strategy. Unlike Cisco's acquisitions, the acquisitions made by other serial acquirers in the high-tech industry—Microsoft, Intel, Yahoo, and Google, for instance—are not as amenable to careful econometric analysis of the value of intangible assets. Microsoft and Intel have acquired about 70 targets each, which is less than half the number that Cisco has acquired. After we apply the filtering criteria in Table 2, neither Microsoft's nor Intel's sample of acquisitions would provide enough observations to power the statistical tests. Moreover, unlike Cisco's sample of acquisitions, neither Microsoft's nor Intel's sample exhibits rich within-year variation.

Yahoo's and Google's sample of acquisitions are even smaller than those of Microsoft or Intel. Moreover, none of the other firms' acquisitions provide the necessary variation to estimate a specification that includes year fixed effects.

# 4 DATA AND PROXIES

We combine data from several publicly available sources together with data that we hand-collect. Our acquisition data come from the Securities Data Company (SDC) M&A database. The data on patents and citations that we employ is hand-collected from the Google patents database. The data on employees of the private companies is collected from news reports through a search on Factiva. The stock return data are drawn from the Center for Research in Security Prices (CRSP).

## 4.1 Acquisition data from SDC Platinum

We start with the data from SDC by searching for all the acquisitions made by Cisco until 2012. We cross-checked the effective dates of the acquisition that we obtained from SDC with the information provided on Cisco's Website. Three acquisitions in which the acquisition status is "pending" in SDC are in fact listed as completed acquisitions in the Cisco website. In these cases, we change the status from "pending" as provided in SDC to "completed." For three deals, the SDC data does not provide the effective date of the acquisition; we supplement this information with that obtained from the Cisco Website and other internet sources. For three deals, we supplement information about the value paid from Cisco's balance sheets and news reports from Factiva because this value is missing in the SDC Platinum database. We then apply some filters, as listed in table 2, to obtain our sample. We augment the data on mode of payment, percentage paid by cash or stock, year founded with searches of news reports on Factiva. The final sample that we utilize for our analysis contains 122 acquisitions. The sample containing information on the number of employees is slightly smaller (116 acquisitions).

## 4.2 Hand-collected patent and citation data from Google patents

For each of the targets, we obtain data on patents and citations from the Google patents database. Hand-collecting this data represents an important and time-consuming part of this study. For each of the targets acquired by Cisco, we had to obtain information about their patents. Moreover, we measure the number of citations received by all target's patents−applied and granted−*at the time of its acquisition*. To calculate this measure, for each such patent of a given target, the citations received each year need to be

hand-collected. Therefore, in the second step, for each of the 415 patents obtained in the first step, and in turn for each of the 10 years in our sample (i.e. for each of the 4150 patent-years), we hand-collect the details for the forward and backward citations.

Previous studies on innovation (see studies cited in Section 2.2) have relied on the NBER patent database. Though Google's patent data has to be hand-collected, it offers several advantages compared to NBER's patent data. First, whereas the NBER patent database records only those patents that have been granted, Google's patent data provides information on the patent applications as well. To understand the importance of patents that have been applied for (but not yet granted), think of the parallel represented by graduating PhD students, who are recruited as Assistant Professors based on the quality of their unpublished(job market) paper. Similarly, potential acquirers assess many young, innovative firms based on the patents that they have applied for but have *not* yet been granted. Such patents and the citations to such patents are not available in the NBER patent database. This data has to be hand-collected.

Google provides the patent number and filing date for all patents. Using the advanced search option in Google patents, we search the number of patents for each of the targets. We manually search for the target's name in the "original assignee" field. When the target name contains more than one word, we use multiple combinations for the name to ensure that we do not omit information on any patent. In case we find a match for one such combination of a name containing multiple words, we compare the details of the target provided in SDC (such as headquarters, year of founding etc.) with those provided on the Google patents to ensure the sanctity of the data. We obtain the number of patents for each target, the year each patent was filed, the patent class, and the year it was granted. We obtain the details on the patents they cite as well as the firms that cite the target's patents. After obtaining this information, we aggregate the citations to the (target firm, year) level. We date the patents by the year in which they were applied for to avoid anomalies due to the lag between the date of application and the date of granting of the patent (Hall, Jaffe, and Trajtenberg 2001).Because we do not require the time series of citations for Cisco, we collect the patent data for Cisco from the USPTO database. For the analysis we undertake using a matched sample of publicly listed targets, we use the data from Kogan et al. (2016).

### 4.3 Number of employees

Of the 122 targets in our sample, we are able to obtain data on the number of employees for 116 targets by manually searching for news reports in Factiva. We use the target's name as the keyword to search for news reports containing information about the acquisition.

### 4.4 Dependent variable

The dependent variable equals the total consideration paid for the target by Cisco (excluding fees and expenses). The dollar value includes the amount paid for all common stock, common stock equivalents, preferred stock, debt, options, assets, warrants, and stakes that were purchased within six months of the announcement date of the transaction. If a portion of the consideration paid by Cisco is common stock, the stock is valued using the closing price on the last full trading day prior to the announcement of the terms of the stock swap. Our sample includes a few cases in which less than 100% of the target is acquired. In these cases, we scale the value paid to 100% to account for the value that would have been paid if 100% stake had been acquired. We undertake this transformation because our patent data corresponds to the patent portfolio of the target firm as a whole.

### 4.5 Explanatory variables

The various explanatory variables and their construction are described in Table A-1 in the Online Appendix. The citations based measures that we construct are based on Hall, Jaffe, and Trajtenberg (2001), who demonstrate that patent citations are a good measure of the value of an innovation. Intuitively, if another firm is willing to invest in a patentable project that is building upon a previous patent, the cited patent is economically important. Pakes and Shankerman (1984) and Jaffe, Trajtenberg and Henderson (1993) show that the distribution of importance of patents is extremely skewed, i.e., most of the value is concentrated in a small number of patents. Therefore, citations capture the importance of a patent (Pakes and Griliches, 1980).

### 4.6 Descriptive statistics

Table 1 shows the number of acquisitions undertaken by the top five serial acquirers in the high-tech industry. Cisco clearly dominates having undertaken 43% of these acquisitions. The descriptive statistics for the sample of Cisco's 122 acquisitions from 1993 to 2012 are provided in Table 2. First, we note that even the largest acquisition ($5.658 billion) is quite small when compared with Cisco’s current market capitalization of $139 billion and its highest market capitalization of $555.4 billion (in March 2000). Second, about half of the targets have not filed a patent before the acquisition.

# 5 VALUE OF INTANGIBLE ASSETS OF PRIVATE, INNOVATIVE TARGETS

## 5.1 Empirical strategy

As mentioned in the introduction, unobserved factors that influence the demand for Cisco's targets are unlikely to change within a year. Similarly, unobserved factors that influence the supply of targets innovating in the networking industry are unlikely to change within a year. Therefore, the year fixed effects enable us to control for secular time trends in demand and supply of private, innovative firms. FigureA-1 in the Online Appendix shows that our sample provides us the necessary variation to include year fixed effects in each of our specifications. In most years in our sample, Cisco acquired more than one target which enables us to compare the values paid for each target in the same year.

However, the use of year fixed effects may not be adequate. To understand this, note that the price paid for a target firm in an M&A deal depends on the intrinsic value of the target, whether the acquirer is overvalued/undervalued, whether the target is undervalued/overvalued, and the ability of the acquirer to create synergies from combining the target's assets with its own assets. Bena and Li (2014) conclude that many acquisitions are driven by synergies that can be generated from combining innovation capabilities. Hence, we would expect the value paid in an acquisition to be higher if there are more synergies in the acquisition. So, to tease out the "intrinsic value" of the target from the price paid, we control for: (i) whether the acquirer is overvalued/undervalued, (ii) whether the target is undervalued/overvalued, and (iii) the ability of the acquirer to create synergies from combining the target's assets with its own assets.

### *5.1.1 Controlling for acquirer's over- or under-valuation*

We control for the acquirer's over- or under-valuation as follows. As a first line of defense against overvaluation of the acquirer (in our case Cisco), our tests include year fixed effects. These fixed effects enable us to control for Cisco's overvaluation across the various years in our sample. However, that still leaves the effect of Cisco's overvaluation within the various targets bought by Cisco in a year. So, as our second line of defense, we use acquirer's stock run-up to control for the acquirer's overvaluation (Rosen 2006). Next, we reason that Cisco is likely to pay a greater percentage in stock if its stock is over-valued and, conversely, pay a greater percentage in cash if its stock is under-valued (Hansen, 1987). So, we include percentage of payment made in stock to indirectly control for by Cisco's over- or under-valuation.

### *5.1.2 Controlling for target's over- or under-valuation*

In our sample, 90% of the targets (110/122) are privately owned. Given the absence of a publicly available stock market value for the target, it is difficult to control for the target's over- or under-valuation. To control for systematic over- or under-valuation of the intangible assets of private, innovative targets, we include two sets of fixed effects. First, when compared to older innovative firms, younger firms may be financially constrained. Therefore, younger firms may decide to sell out to Cisco at a discount to tide over their financial difficulties. To account for such systematic differences and thereby over- or under-valuation, we include fixed effects for the target's age cohort. To avoid having few observations with a specific age, we group targets into age cohorts based on their age in years as follows: (0, 1], (1, 2], (2, 3], (3, 4], (4, 5], [6, 10], [11, 15], and greater than 15. Next, to account for systematic differences in the value paid across different industries to which the target belongs, and thereby over- or under-valuation, we include fixed effects for the (2-digit) SIC code of the target.

### *5.1.3 Controlling for synergies between the target and Cisco's intangible assets*

Following Bena and Li (2014), we control for the ability of the acquirer to create synergies from combining the target's assets with its own assets using the degree of overlap measured as the dot-product between the intangible assets of the target and the acquirer.

## 5.2 Use of pure cash acquisitions versus other acquisitions to validate our estimates

To examine if the above empirical strategies indeed enable us to estimate the intrinsic value of intangible assets of private, innovative firms, we exploit cross-sectional variation in the mode of payment. For acquisition of private targets, Chang (1998) shows that the acquirers experience no abnormal returns when they pay with cash. However, they experience positive abnormal returns when they acquire private targets by paying with stock. Thus, when Cisco acquires a target by paying with cash, it is quite likely that the acquisition itself will be a zero NPV project. As a result, in those acquisitions where Cisco acquires a target by paying with cash, the price paid must equal the intrinsic value of the target plus the value of the synergies. Once we control for synergies, we obtain the target's intrinsic value.

To formalize this notion for clarity, let's say that $p'_A$ and $p'_T$ be the intrinsic values of the shares of the acquirer and the target and $p_A$ and $p_T$ be their market values. "Market" value for the privately listed target is based on the market for acquisitions. Let S equal synergies from the deal. Also say that $N_A$ equal the number of equity shares of the acquirer. The post-announcement stock price for the acquirer equals:

$$p_{AT} = \frac{N_A p'_A + N_T p'_T + S - Price}{N_A} \quad (4)$$

Using $p_{AT}=p_A$ after cash offers for private targets,

$$Price = \underbrace{N_A(p'_A - p_A)}_{Cisco's\ over-or\ under-valuation} + \overbrace{N_T p'_T}^{Target's\ intrinsic\ value} + \underbrace{S}_{Synergies} \quad (5)$$

Therefore, once we control for the acquirer's over- or under-valuation and synergies, the price paid in an all cash deal provides a correct estimate of the intrinsic value of the target. Thus, we can estimate precisely the intrinsic value of the target using those acquisitions by Cisco where full cash payment was made. By contrasting the estimates that we obtain in deals where full cash payment was made vis-à-vis those where full stock payment or a combination of cash and stock payment was made, we can examine if we are obtaining estimates that are close to the intrinsic value.

### 5.3 Empirical specification

The literature on estimating the value of intangible assets (Griliches (1981), Hall et al. (2000)) has focused on manufacturing firms. We modify their approach for innovative firms, where intangible assets comprise the bulk of the assets of the firm. The existing literature assumes that the value of a manufacturing firm is given by the additively separable linear specification: $V_{it} = b_t(A_{it} + \gamma K_{it})$, where $V_{it}$, $A_{it}$, and $K_{it}$ represent the value, the stock of physical assets, and the stock of intangible assets of firm *i* at time *t*. For manufacturing firms, $\frac{K}{A} < 1$ because physical assets account for a significant proportion of its assets. Therefore, the above specification is estimated as $\ln\left(\frac{V_{it}}{A_{it}}\right) \approx lnb_t + \gamma\frac{K_{it}}{A_{it}}$.

However, for private, innovative firms, intangible assets account for a significant proportion of the assets. Because the ratio $\frac{K}{A} \gg 1$, we cannot approximate$\ln(1+\gamma\frac{K_{it}}{A_{it}}) \approx \gamma\frac{K_{it}}{A_{it}}$. So, we first employ an additively separable linear specification:

$$V_{it} = \alpha_t + \beta K_{it}, \quad (1)$$

where $\alpha_t$ denote year fixed effects and β captures the value paid for the portfolio of intangible assets of a private, innovative firm. Second, we use a multiplicative specification:

$$V_{it} = \alpha_t {K_{it}}^{\tau}. \quad (2)$$

The specification leads to the following regression equation:

$$lnV_{it} = ln\alpha_t + \tau\ln(K_{it}), \quad (3)$$

where $\beta_t \equiv \ln\alpha_t$ denotes year fixed effects. The coefficient $\tau$ represents the shadow price for the value of intangible assets. While we estimate both Equations (1) and (3) to ensure that our results are robust to different functional form specifications, in the main body of the paper, we report the results using Equation (1). In the Online Appendix (Tables A-4and A-5), we show the main results obtained using Equation (3). We prefer reporting the results using Equation (1). Because many of the measures for the intangible assets of the target have zero values in some cases, $\ln(K_{it})$ has to be replaced by $\ln(1 + K_{it})$ to account for these zero values. As a result of this transformation, the coefficient $\tau$ in Equation (3) cannot be interpreted as a measure of elasticity. In contrast, the coefficient β in Equation (1) captures directly the value paid for the intangible assets of the firm ($K_{it}$) and is therefore easier to interpret.

### 5.4 Value of patents

We start by examining the value of patents using the following specification:

$$Value\ of\ transaction_{i\to t} = \beta_0 + \beta_t + \beta_1 * patents_{i\to t} + \beta X + \varepsilon_{i\to t}, \quad (6)$$

where $Value\ of\ transaction_{i\to t}$ is the value paid for 100% of target *i* acquired in year *t*, $patents_{i\to t}$ equals the patents of target *i* in the year of the acquisition *t*. $\beta_t$ denotes fixed effects for the year of acquisition.

We control for the following effects. As argued in Section 5.2, to control for the acquirer's over-valuation, we include the following control variables. The variables "Trailing 12-month BHAR on Cisco's stock" and "Trailing 12-month returns on CRSP V-W Index" enable us to control for the acquirer's stock run-up and general run-up in the stock market (Rosen, 2006). In tables A-8 to A-12, A-13 to A-17 and A-18 to A-22 respectively, we replicate all our results using 1-month, 3-month and 6-month returns instead of 12-month returns. Cisco is likely to pay a greater percentage in stock if its stock is over-valued and, conversely, pay a greater percentage in cash if its stock is under-valued (Hansen, 1987). So, we also include percentage of payment made by Cisco in stock to indirectly control for over- or under-valuation of the acquirer. Following Bena and Li (2014), the variable "Technological overlap with Cisco" controls for the ability of the acquirer to create synergies from combining the target's assets with its own assets using the degree of overlap between them. We include this in the regression specifications to disentangle the portion of the payment that goes towards the value of the assets and the portion that goes towards the synergies. Of the control variables, only two, Cisco's stock run-up (in all specifications) and the overlap metric (in some specifications) associate significantly with the value paid. As predicted, both of these associate positively with the amount paid in the acquisition.

Columns 1 and 2 of Table 4 report the results of estimating equation (6). In Column 1, we use the "number of patents granted" and find the effect to be statistically significant at the 5% level. Every additional patent granted to the target before the acquisition associates with an increase in the value paid by $144.5million. In Column 2, using the number of patents filed before but granted after the acquisition, we find the effect to be statistically significant at the 5% level. Economically, every additional patent filed before but granted after the acquisition associates with an increase in the value paid by $81.28 million. In columns 3 and 4, we re-estimate equation (6) after adding fixed effects separately for the age cohort and the (2-digit) SIC code of the target. The specification we use is:

$$Value\ of\ transaction_{i\to t} = \beta_0 + \beta_t + \beta_{age} + \beta_{SIC2} + \beta_1 * patents_{i\to t} + \beta X + \varepsilon_{i\to t}, \quad (5)$$

As argued in Section 5.2, these fixed effects enable us to control for possible under- or over-valuation of the target. We see that both the variables used in columns 1 and 2 are statistically significant at the 1% level. Economically, every additional patent granted to the target before the acquisition and every additional patent filed before but granted after the acquisition associates with an increase in the value paid by $166.47 million and respectively $94.9 million. Thus, adding the age cohort and industry fixed effects for the target increases the coefficient by approximately 15%.

### 5.5 Cash acquisitions vs. other acquisitions to validate the estimates of value of patents

Following the arguments outlined in section 5.3, in columns 5 and 6, we use pure cash acquisitions versus other acquisitions to validate the above estimates. We add an interaction of the proxy for innovation with a dummy for the deal being paid fully using cash to the specification in equation (6). We also include the dummy for the deal being paid fully using cash. We find both in columns 5 and 6 that the coefficient of the interaction term is statistically indistinguishable from zero. Thus, the estimate using an all-cash deal is no different from that using the other deals. Since we argued in section 5.3 that the sample using the all cash deals certainly provides a true estimate of the intrinsic value of the intangible assets, these tests provide the comfort that our estimates in columns 3-4 are correct. This is not surprising given the evidence in Section 3.2 that on average Cisco's acquisitions have been zero NPV investments.

### 5.6 Value of novelty of innovations

Next, we examine the value paid for the novelty of the target's innovations:

$$Value\ of\ transaction_{i\to t} = \beta_0 + \beta_t + \beta_{age} + \beta_{SIC2} + \beta_1 * Novelty_{i\to t} + \beta X_{i\to t} + \varepsilon_{i\to t}, \quad (5)$$

where $\text{Novelty}_{i \to t}$ denotes a measure for the novelty of innovations of target *i* acquired in time *t*. Table 5 presents the results of these tests. Column 1 shows that the effect of citations received before acquisition is statistically significant at 1% level. Table A-6 in the online appendix shows the results of tests including only year fixed effects. Economically, a one-standard-deviation increase in the number of citations received before acquisition associates with a $505.25 million increase in the value paid.

### 5.7 Separating different dimensions of novelty of target's innovations

We now take a closer look at different dimensions of the novelty of the target's innovations. Hall, Jaffe, and Trajtenberg (2005) find that market-value premium for firms in their sample correlates with future citations rather than the citations that have been received in the past. They also find that the market-value premium is correlated the most with the portion of total lifetime citations that cannot be predicted based on the citation history. In a similar vein, we look at the effect of future and past citations on the value paid to test whether the unpredictable citations matter more than the expected ones. Columns 2-5 of Table 5 show the results of these regressions. In Column 2, we use the total number of citations expected over the target's patent lifetimes and find the effect to be statistically significant at the 1% level. Economically, a one-standard-deviation increase in the total number of citations expected over the patent lifetimes associates with an increase in value by 521.9 million. We next split the expected citations over the target's patents lifetimes into those received before the acquisition and those expected after the acquisition. When both these variables are simultaneously included (Column 3), we find that the coefficients of both these variables are statistically significant at the 5% level or lower. A one-standard-deviation increase in the citations expected after the acquisition associates with an increase in value by $324.63 million, whereas a one-standard-deviation increase in the citations received before the acquisition associates with an increase in value by 301.65 million. Thus, Cisco pays for both the current value of the target's innovations (as measured by the citations received before the acquisition) as well as the expected future value of the target's innovations (as measured by the citations expected after the acquisition). However, Cisco pays about 10% less for the current value of the target's innovations when compared to the expected future value from such innovations.

### 5.8 Does Cisco estimate the value of the target's innovations correctly?

Next, in Column 4we split the future citations (those received after the acquisition) into a part that can be predicted given the past citation history and the residual unpredictable part. We find that the portion

of future citations that can be predicted using historical citations is the only part that impacts the value of private, innovative targets. If Cisco correctly estimates the future value of the target's innovations, then the amount paid should correlate with the citations expected in the future and should not correlate with surprises in the future citations. This is because value, when correctly estimated, should equal the discounted value of the cash flows expected from the target' innovations. Therefore, in contrast to stock market participants, who do not seem to value innovation correctly (Cohen et al. 2013), this result shows that Cisco possesses expertise in valuing the complex, intangible assets of private, innovative targets. Thus, the evidence that we obtain in column 4 of table 5 validates our empirical strategy of focusing on the acquisitions undertaken by Cisco. In Column 5, we use the same specification as in column 4 but excluding the citations received before the acquisition. Our results stay the same, both in terms of statistical and economic significance.

### 5.9 Cash acquisitions vs. other acquisitions to validate the estimates of value of citations

As in section 5.5, we use pure cash acquisitions versus other acquisitions to validate the above estimates. We focus on the main proxies – citations received before acquisition and total number of citations over patent lifetime – because the sample does not provide adequate variation to include multiple interactions with the dummy for the deal being paid fully using cash. Columns 6 and 7 show the results of these tests, where we find that the coefficient of the interaction term is statistically indistinguishable from zero in both columns. Thus, the estimate using an all-cash deal is no different from that using the other deals. Again, these tests provide the comfort that our estimates in columns 1-2 are correct.

### 5.10 Value of employees' human capital

Practitioners—especially CEOs of high-technology firms—claim that acquisitions represent a key way for acquiring innovative employees. The CEO of Facebook, Mark Zuckerberg, for instance mentions: "Facebook has not once bought a company for the company itself. We buy companies to get excellent people."[4]John Chambers, the CEO of Cisco states for example: "most people forget that in a high-tech acquisition, you really are acquiring only people. At what we pay, dollars $500,000 to $2 million per employee, we are not acquiring current market share. We are acquiring futures."[5] A key question therefore that arises is: what is the value paid for the human capital embedded in the target's employees?

[4]http://www.huffingtonpost.in/entry/mark-zuckerberg-we-buy-co_n_767338
[5]http://www.strategy-business.com/article/15617?gko=3ec0c

We now examine this question. Table 6 reports the results of the tests, where we include year, industry and age cohort fixed effects. Table A-7 in the online appendix shows the results of tests including only year fixed effects. In column 1 of Table 6, we test for the effect of the number of employees and find its effect to be positive and statistically significant at the 1% level. Economically, each additional employee adds to the target's value by $2.22 million. This estimate is just marginally above the estimate of the value paid per employee by John Chambers, the CEO of Cisco. Bena and Li (2014) show that following an acquisition, acquirers produce more patents if they had prior technological linkage to their target. Furthermore, the number of employees may capture firm size primarily because intangible assets dominate among the firms that we are analyzing. Therefore, to capture the effect of target employees' human capital above and beyond the pure effect of firm size, on the one hand, and to proxy the effect documented in Bena and Li (2014), we use two other proxies: (1) the number of future patents of Cisco that are attributed to the target's employees and (2) the fraction of target employees that are recorded as inventors with Cisco.

To construct these measures, we exploit the fact that the patent data provides information not only on the assignee to which the patent is assigned but also the inventor(s) of the patent. In most cases, the assignee corresponds to a firm and the inventor(s) correspond to the employees of the firm. To identify the employees that were inventors when they were employed with the target, we use the name of the inventors recorded in any of the patents that are assigned to the target before the acquisition. We then match these inventor names to the inventor names recorded as inventors in any of the patents that are assigned to Cisco after the date of the acquisition (using the application date for the patents).Using this match, we construct the number of future patents of Cisco that are attributed to the target's employees and the fraction of target employees that are recorded as inventors with Cisco. We use data over the full sample period to calculate these measures. Thus, for finding employees that were inventors at the target firm, we use all the inventors named in the target's patents provided these patterns were filed before the date of acquisition. Similarly, the use all the patents filed by Cisco after the date of the acquisition (till the end of the sample period) to match the inventors in these patents to those inventors listed in the target's patents. As seen in table 2, the number of future patents of Cisco that are attributed to the target's employees vary from 0 to 189 with the mean of 7. The fraction of target employees recorded as inventors with Cisco has a mean of 0.16.

Using the first proxy in column 2, we find that the number of future Cisco patents generated by the target's employees correlates positively with the value. Economically, a standard deviation increase in this variable associates with an increase in the value paid by $78.38million. As the effect of size is possibly controlled by including the number of employees, the significant correlation of value to number of patents

filed at Cisco by former employees of the target suggests that a private, innovative firm's value increases with employee human capital.

Using the second proxy in column 3, we find that the fraction of target employees that are recorded as investors in Cisco does not correlate significantly with the value paid. In column 4, we add the number of employees as well as the other two proxies for employees' human capital simultaneously and find that the number of employees continues to be positive and statistically significant.

### 5.11 Cash acquisitions vs. other acquisitions to validate estimates of value of employees'

As in section 5.5 and 5.9, we use pure cash acquisitions versus other acquisitions to validate the above estimates. We focus on the value of number of employees in the year of acquisition and number of future Cisco patents generated by the target's employees because the coefficient estimates for the other proxy fraction of target employees that are recorded as investors in Cisco is insignificant in the first place. Column5shows the results of including the interaction of the number of employees with the dummy for the deal being paid fully using cash. In column 6, we show the results of including the interaction of the number of employees as well as the fraction of target employees that are recorded as inventors in Cisco with the dummy for the deal being fully paid using cash.

Interestingly, we find in column 5 and 6 that the coefficient of the interaction of the number of employees with the dummy for the deal being paid fully using cash is negative and statistically significant at the 1% level. Because the estimate obtained using the sample of all cash deals provide a true estimate of the intrinsic value of employees, this evidence suggests that Cisco may be over-paying for employees in deals that involve some stock payment. Employees in innovative firms typically receive stock-based compensation. Moreover, use of stock-based compensation to retain the target's employees is more likely when the target is acquired using (complete or partial) stock payment. Thus, these results are consistent with overpayment for the target's employees occurring possibly through the use of stock-based compensation. However, the interaction of the fraction of target employees that are recorded as inventors in Cisco with the dummy for the deal being fully paid using cash is statistically indistinguishable from zero. Thus, the estimate of value of employees' human capital captured using future inventions is correct.

### 5.12 Value paid for specialization of target's assets to those of Cisco

Bena and Li (2014) conclude that many acquisitions are driven by synergies that can be generated from combining innovation capabilities. Hence, we would expect the value paid in an acquisition to be

higher if there are more synergies in the acquisition. In the regression so far, we have controlled for the overlap between the innovation portfolios of Cisco and the target and found a positive association between the value paid and the overlap. Next, in table 7, we examine how the value paid depends on the target's specialization to Cisco even controlling for the overlap.

In column 1, we use the citations made by Cisco to the target's patents. Citations by Cisco suggest that it finds value in the intangible assets of the target and would potentially benefit by specializing to these assets. We find that the citations from Cisco are statistically significant at 1% level. Economically, we find that a one standard deviation increase in the number of citations made by Cisco to the targets patents (=13.0) associates with an increase in the value paid by $544.115 million, which is about 10% greater than the value of a one standard deviation increase in the total number of citations received before the acquisition. Thus, Cisco pays 10% more for targets whose intangible assets it can specialize to when compared to the average target. In column 2, we examine the effect of citations from Cisco after the acquisition and find that a one standard deviation increase in this variable associates with an increase in value by a $386.17million. Using the summary statistics displayed in table 2, we find that the mean number of citations made by Cisco after the acquisition is more than eight times that of the citations made by Cisco before the acquisition (=30.7/3.7). Thus Cisco values the target's patents and utilizes them post the acquisition to generate new innovations. In column 3, we examine if the value paid for the target is affected by the target's ability to generate follow-up innovations from its existing patents. If Cisco were to acquire the target to scuttle potential competition, then it is unlikely that Cisco would care about the target's ability to generate follow-up innovations. In contrast, if Cisco acquires the target to build on its intangible assets, then Cisco would care about the target's ability to generate follow-up innovations based not only on its own expertise but also on Cisco's expertise. To examine the value of the target's ability to generate follow-up innovations based on its own portfolio, we follow Jaffe, Trajtenberg, and Henderson (1993) to calculate the self-citations, i.e. the citations by the target to its own patents. We find that a one-standard-deviation increase in the self-citations before acquisition associates with an increase in value by $449.48 million. Along similar lines, in column 4, we also test if Cisco values the target's ability to generate follow-up innovations using Cisco's patents. For this purpose, we calculate the number of citations made by the target's patents to Cisco's patents before the acquisition. We find that a one standard deviation increase in this measure associates with an increase in value by $173.39 million. Thus, Cisco values the target's ability to exploit its existing innovations and those of Cisco.

Note that in all these specifications, we control for the measure of overlap of the target's assets with Cisco's computed using the number of patents. We find that this overlap measure is positively correlated

with the value paid in all specifications, with the coefficients being statistically significant at the 95% level in two of the four specifications. These results collectively suggest that the target's value increases with the specialization of its intangible assets to those of Cisco.

### 5.13 Value paid for the target's attractiveness to Cisco's competitors

We also examine the value that Cisco pays for the target's attractiveness to Cisco's competitors. If a particular target is quite attractive to Cisco's competitors, then the target's outside options would be greater. Theories of bargaining (Nash (1953), Rubinstein (1982)) postulate that the share of surplus obtained by an agent increases with his or her outside options. Greater overlap of the target's intangible assets with those of Cisco's competitors would potentially make the target more attractive to Cisco's competitors. Such overlap would increase the target's outside options and thereby increase the value paid.

The results from these tests are presented in Table 8. In column 1, we examine the effect of citations from Cisco's competitors before the acquisition. We find that a standard deviation increase in this variable increases the value by $679.15million. Thus, Cisco finds citations to the target's patents by Cisco's competitors 25% more valuable than its own citations to the target's patents, which as we saw in column 1 of table 7 equals $544.11million. In columns 2 and 3, we find that overlap with Cisco's competitors is not positively correlated with the value paid. In column 4, we include citations from Cisco, self-citations, and citations from firms other than Cisco and itself and find none of these variables to be significant. In column 5, we investigate the effect of the number of Cisco's competitors (defined as firms in the same industry as Cisco as per the SIC 2-digit codes) that cite the target's patents before merger. We find that an additional competitor citing the target's patents is associated with an increase of $87.8 in the transaction value. These results suggest that the value depends on the actual citing behavior of Cisco's competitors rather than just the overlap between the innovation portfolios of the target and the competitors. In other words, Cisco does not pay higher for targets which have similar patents as a competitor if the competitor does not cite the target's patents. Overall, we can therefore infer that Cisco pays more for those targets that are attractive to its competitors when compared to an average target.

### 5.14 Comparison with acquisitions of innovative, public targets

Is the value paid for the intangible assets of Cisco's targets high or low compared to other acquisitions involving intangible assets? To answer this question, we follow the methodology used in Officer (2007) to benchmark the value paid for intangible assets of Cisco's targets vis-à-vis the value paid

for comparable publicly listed innovative targets. We use the data on innovation portfolios of these publicly listed targets from Kogan et al. (2016). Although this sample extends to 2010, it only includes patents that are granted by the end of 2010 which leads to a downward bias in the patents and citation counts towards the end of the sample. Therefore, following the suggestion in Hall, Jaffe, Trajtenberg (2001), we truncate the last four years of the data and restrict our study to 1993-2006. For each of the 106 acquisitions made by Cisco before 2006, we match controlling stake acquisitions (>50% acquired) of public targets in the same 2-digit SIC code of the target, announced within a window of 3 calendar years around the year of announcement, same age cohort, and having employees within 25% range of the employees of the private target (to proxy for firm size). We allow the publicly listed targets to appear in the matched portfolio of multiple private targets.

Table 9 shows the comparison between Cisco's targets and the (publicly listed) matched firms. We find the value paid for Cisco's targets is about 2.5 (3.7) times the value paid for the publicly-listed matched firms using the mean (median). We then estimate the value paid per unit of the metric for intangible assets. Because we have already matched based on the year of acquisition, industry, age and size, we do a simple comparison of the value paid per unit of the metric between Cisco's targets and the publicly listed matched firms. We find that the value paid per unit of the metric is about 40%-400% higher for the private targets acquired by Cisco when compared to the publicly listed matched firms. This is uniformly true using the median values of the ratios and except for future expected citations and unexpected citations, this is true using the mean values of the ratios as well. These results are different from those in Officer (2007) who shows that private targets sell at a discount of 15% to 30% on average when compared to similar targets that are publicly listed. Officer (2007) argues that the discount for private targets stems from privately listed firms being more constrained for liquidity than publicly listed firms. The difference that we find for private, innovative firms, as against private firms across all industries in Officer (2007), is consistent with three key phenomena. Officer (2007) argues that the discount for private targets stems from privately listed firms being more constrained for liquidity than publicly listed firms. In contrast, the significant premium paid by Cisco for private, innovative targets (when compared to publicly listed innovative targets) is consistent with three key phenomena. First, young private firms are the primary drivers of mold-breaking innovation in an economy (as highlighted by Akcigit and Kerr (2016) and Chava et al. (2013)). Second, private firms are significantly more innovative than publicly listed firms because private ownership fosters innovation while public ownership discourages innovation (Ferreira and Manso (2014), Lerner, Sorensen, and Strömberg (2011), Bernstein (2015)). Given the importance of innovation in an economy, the high values paid for path-breaking innovators, i.e. the private, innovative firms, is not surprising. Third, the market for

acquisitions of private, innovative targets is an extremely competitive one as (i) all the large incumbent firms in the high-technology sectors have acquired private, innovative targets to stay at the cutting edge of the innovation frontier (Higgins and Rodriguez, 2006); (ii) acquisitions have become the dominant mode for exit by innovative startups (Aggarwal and Hsu, 2013); and (iii) small, private firms innovate more when they are likely to be acquired by large firms (Phillips and Zhdanov, 2013). When compared to the innovative industries, acquisition of private firms is more sporadic in the brick-and-mortar sectors. The greater competition for private targets in the innovative industries also serves to increase their price paid. Taken together, it is not surprising that the intangible assets of private, innovative firms are valued significantly more than those of publicly listed innovative firms. In contrast, the lower liquidity of private firms leads to a discount (when compared to publicly listed firms) in brick-and-mortar industries.

### 5.15 Tests examining external validity

Given our focus on Cisco's acquisitions, a natural concern that arises is the following: can our results be generalized to other settings? Therefore, we check for external validity of the results by considering a sample of acquisitions undertaken by Google and Yahoo in a period similar to the one we have considered for Cisco, that is, 1993 to 2012. As before, we only consider acquisitions in which a majority stake was acquired. For this sample, we collect data on the total number of number of patents granted/filed before the acquisition as well as the total number of citations received. For each of these key variables, we use the respective coefficients from the specification with only year fixed effects (Tables 4 and A-6). Using these coefficient estimates, we compute the difference between the actual value of these acquisitions and the value predicted using the coefficients from our regressions. Because all our specifications include year fixed effects, to compute the error using a predictor variable, we use the following specification for acquisition *i* in year *t*

$$Error_{it}=Value_{i\rightarrow t}-\overline{Value_t}=\text{Coefficient on predictor n}*\left(Predictor_{n\rightarrow t}-\overline{Predictor_t}\right) \quad (8)$$

where $\overline{Value_t}$, $\overline{Predictor_t}$ are the average values of 100% equity and the predictor variableacross all acquisition transactions announced in year t. Because the absolute value of the error varies with the size of the transaction, we normalize the $Error_{it}$ using the standard deviation of the error. We report the results in Table A-2 in the online Appendix. We observe that the median prediction error is about -0.5% to -4.8%, depending on the predictor variable used in the specification. The average value of the prediction error, however, is zero across all the predictors. Because Yahoo and Google are Internet Search Engines, whereas

Cisco represents a firm in the telecommunications sector, the values we estimate using proxies for the intangible assets of young innovative firms are reasonably valid out-of-sample.

# 6 SUMMARY AND IMPLICATIONS FOR FUTURE RESEARCH

In this paper, we explore how to value the intangible assets of private, innovative targets through a longitudinal study of the acquisitions made by the serial acquirer Cisco Systems. Given the challenges we described in valuing intangible assets of private targets and the absence of prior studies in this area, we contribute by undertaking an explorative study. However, since studies examining the value of intangible assets are scant, we discuss implications for future research.

## 6.1 Valuation of intangible assets

Because intangible assets are non-rivalrous and non-excludable, the externalities generated from an intangible asset can be significantly more important than that from physical assets. Thus, estimating the value of intangible assets to private agents vis-à-vis the social value of intangible assets can be very useful in guiding national level innovation policies. Hall et al. (2005) use Tobin's Q to estimate the value of intangible assets of manufacturing firms. Apart from the fact that the intangible assets of high-technology firms is more important, Cohen et al. (2013) show that the stock market seems to mis-value innovation even in the case of publicly listed firms, which have better track records than those of private firms. Given the several "unknown unknowns" that characterize an innovative venture, the challenges involved in valuing the assets of innovative private firms are only multiplied manifold. In contrast to an average participant in the stock market, serial acquirers such as Cisco Systems have strong incentives to develop the expertise in valuing intangible assets of private, innovative targets because of the larger stakes being acquired and because of the control acquired over the business. We have introduced the approach of comparing the values paid by the same acquirer for multiple targets acquired in the same year. This approach can be extended to value intangible assets of innovative firms in general, which can be useful to academics, policymakers, investors, and corporates.

## 6.2 Testing the resource-based theories versus property rights theories

The value of innovative firms can stem from their "resources" as suggested by the resource-based theories (Penrose (1959), Wernerfelt (1984), Rajan and Zingales (1998)) or from their "property rights" as suggested by the property rights theory (Hart (1995)) or possibly from a combination of both the resources

as well as the property rights. Patents represent the intellectual property rights possessed by innovative firms while employees represent the resources possessed by innovative firms. Similarly, the novelty of the target's innovations, as captured using various citations-based measures, represents a resource possessed by an innovative firm. If innovative firms derive their value primarily from their resources, property rights provided by patents may be less welfare enhancing than if innovative firms derived (private) value from their patents. Understanding these sources of value of innovative firms is not only of academic interest, but also of interest to policymakers in framing policies relating to (i) patent trolls and (ii) anti-trust measures for innovative firms.

Because data on patents applied for but not granted are important to examine the above questions, a more comprehensive data collection exercise that builds on this study can enable research on these questions. Given the limitations imposed by the intensive data collection process, we have restricted our sample to the targets acquired by Cisco. We hope our study fosters more comprehensive efforts in collecting such data to further research on these questions.

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**Figure 1: Profitability metrics for Cisco vis-à-vis industry median**

This figure depicts profitability variation of Cisco over time for the period 1990-2012. The plots also include profitability variation of a median firm in the industry for comparison. Industry considered is 'Computer and Electronic Product Manufacturing' (NAICS code 334). Median values are computed across all firms in the industry for each year.

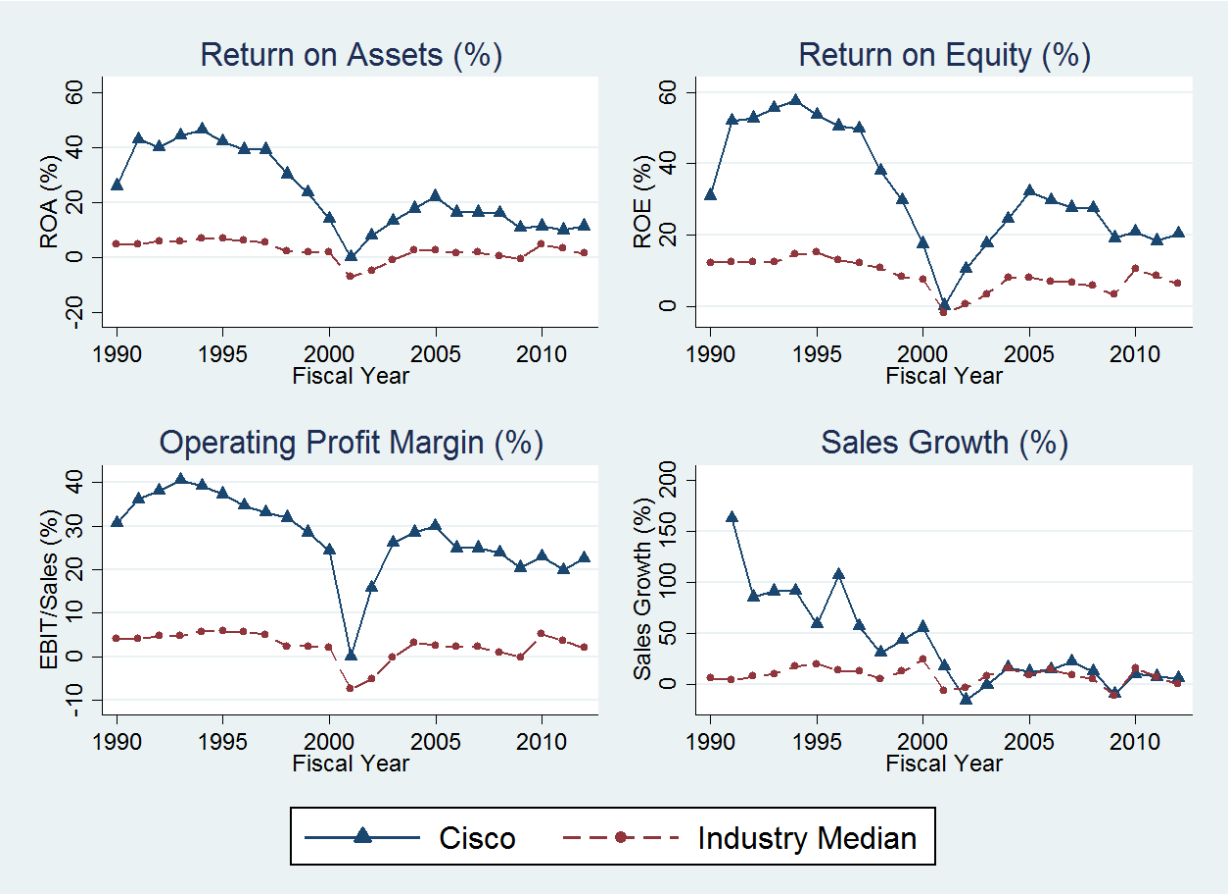


**Figure 2: Post-acquisition buy and hold returns in event-time for Cisco and the market**

This figure shows the average buy and hold returns for an investor who invests in Cisco, CRSP value-weighted index on the day of a merger announcement by Cisco. Buy-and-hold returns are computed from the date of announcement of each merger up to number of days represented on the x-axis. These are then averaged across all the 125 acquisition announcements made by Cisco over the period 1993-2012 which also had a transaction value announced.

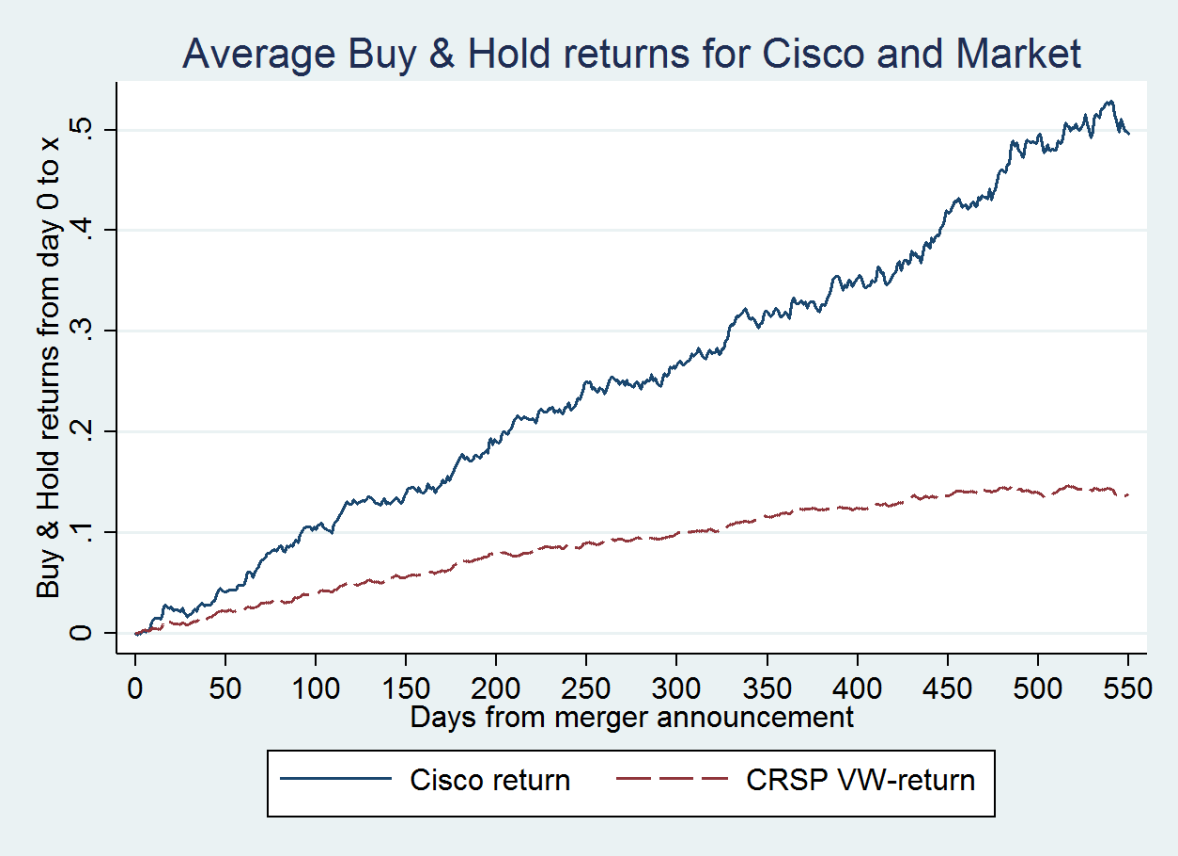


**Table 1: Acquisitions by top serial acquirers in the technology sector from 1993- 2012**

| **Panel A: Number of acquisitions by top serial acquirers (1993- 2012)** | |
|---|---|
| Acquirer Name | Number of targets acquired from 1993-2012 |
| Cisco Systems Inc | 163 |
| Intel Corp | 78 |
| Microsoft Corp | 70 |
| Yahoo! Inc | 49 |
| Google Inc | 20 |
| **% contributed by Cisco** | **43%** |

| **Panel B: Summary statistics for sample of acquisitions by Google and Yahoo (1993- 2012)** | | | | |
|---|---|---|---|---|
| Variable | Obns | Min. | Median | Std. Devn. |
| Value paid (US$ mn) | 56 | 0.09 | 120 | 1878.8 |
| Number of patents filed before but granted after acquisition | 56 | 0 | 0 | 111.0 |
| Patents granted before acquisition | 56 | 0 | 0 | 31.6 |
| Total number of citations expected over patent lifetime | 56 | 0 | 0 | 673.6 |

## Table 2: Filter criteria to construct the sample

This table shows the sequential procedure used in obtaining the final sample beginning with raw SDC Platinum data.

| Sl. No. | Initial obns. | Filter applied | Rationale for filter | Obns. dropped | Final obns. |
|---|---|---|---|---|---|
| 1 | 257 | Is Cisco the acquirer in the transaction? | We are only interested in those transactions where Cisco is the acquirer. In some cases, where a division of Cisco is sold, Cisco is listed as the target and not the acquirer. | 59 | 198 |
| 2 | 198 | Is the status of the acquisition "Comp leted"? | We are only interested in transactions that have been completed, not those where the status is "rumored "or "pending" or "unknown". | 9 | 189 |
| 3 | 189 | Does the synopsis contain "minority stake" or is the percentage of shares acquired less than 50%? | We only investigate those acquisitions where Cisco acquired a majority stake because only in these instances the target's intangible assets can be integrated with Cisco's. | 26 | 163 |
| 4 | 163 | Is the acquisition specific division of a company? | We cannot get the patent data for divisions of a company. | 6 | 157 |
| 5 | 157 | Is the percentage of shares acquired unknown? | If the percentage of shares acquired is unknown, we cannot analyze these deals. | 2 | 155 |
| 6 | 155 | Is the value of the transaction unknown? | If the value of the transaction is not known, we cannot analyze these deals. | 30 | 125 |
| 7 | 125 | Is the target an outlier? | We drop two companies with 150 and 500 patents respectively (Tandberg ASA and Scientific Atlanta), which are clear outliers (see summary statistics in table 3). As well, Cerent corp has zero patents, but Cisco paid a very high value for it. This is clearly not a company whose innovation is captured by our proxy for innovation. Hence, we remove it. | 3 | 122 |
| 8 | 122 | Is the data on number of employees available? | Data on number of employees is found only for 116 targets | N/A | 116 |

## Table 3: Descriptive statistics for the sample of Cisco's acquisitions (1993-2012)

The table shows the summary statistics for the variables used in our study.

| Variable | Obns. | Mean | Median | Std. Devn. |
|---|---|---|---|---|
| Value of 100% of equity of the target (US$ mn) | 122 | 330.9 | 130.7 | 771.0 |
| Number of patents granted before acquisition | 122 | 1.1 | 0 | 3.2 |
| Number of patents filed before acquisition but granted after acquisition | 122 | 2.3 | 0 | 5.1 |
| Citations received before acquisition | 122 | 29.6 | 0 | 83.1 |
| Citations from Cisco before the acquisition | 122 | 3.7 | 0 | 13.0 |
| Citations from Cisco after the acquisition | 122 | 30.7 | 0 | 188.1 |
| Self-citations before acquisition | 122 | 0.70 | 0 | 3.0 |
| Citations from firms other than Cisco and itself before acquisition | 122 | 25.2 | 0 | 71.5 |
| Citations from Cisco's competitors before merger | 122 | 8.9 | 0 | 24.0 |
| Number of Cisco's competitors citing the target before merger | 122 | 2.7 | 0 | 5.7 |
| Total number of citations expected over patent lifetime | 122 | 143.6 | 0 | 431.3 |
| Citations after acquisition adjusted for truncation | 122 | 114.0 | 0 | 368.9 |
| Future expected citations | 122 | 60.9 | 0 | 135.1 |
| Unexpected citations | 122 | 53.1 | 0 | 293.5 |
| Citations made to Cisco's patents by the target's patents | 122 | 2.2 | 0 | 12.5 |
| Technological overlap with Cisco using patents (%) | 122 | 15.3 | 0 | 30.9 |
| Technological overlap with Cisco using citations (%) | 122 | 15.4 | 0 | 31.6 |
| Technological overlap with competitors using patents (%) | 122 | 14.2 | 0 | 32.0 |
| Technological overlap with competitors using citations (%) | 122 | 14.6 | 0 | 32.9 |
| Number of future Cisco patents generated by targets' employees | 122 | 7.0 | 0 | 24.5 |
| Fraction of target employees as inventors in Cisco | 122 | 0.16 | 0 | 0.32 |
| Number of Employees in the year of acquisition | 116 | 117.4 | 56.5 | 242.1 |
| Age of target (years) | 122 | 5.3 | 4 | 5.2 |
| Trailing 12-month BHAR on Cisco's stock (%) | 122 | 39.0 | 23.2 | 57.0 |
| Trailing 1-month BHAR on Cisco's stock (%) | 122 | 1.2 | 0.43 | 7.4 |
| Trailing 3-month BHAR on Cisco's stock (%) | 122 | 6.0 | 5.3 | 15.9 |
| Trailing 6-month BHAR on Cisco's stock (%) | 122 | 14.8 | 10.6 | 31.2 |
| Trailing 12-month returns on CRSP V-W Index (%) | 122 | 13.0 | 15.4 | 15.5 |
| Trailing 1-month returns on CRSP V-W Index (%) | 122 | 0.5 | 1.2 | 4.1 |
| Trailing 3-month returns on CRSP V-W Index (%) | 122 | 2.1 | 2.2 | 7.2 |
| Trailing 6-month returns on CRSP V-W Index (%) | 122 | 5.6 | 4.8 | 11.0 |
| Percentage paid by stock and options | 122 | 56.0 | 100 | 48.7 |
| Dummy for cash only deal | 122 | 0.31 | 0 | 0.47 |

## Table 4: Estimates of value paid for the targets' patents

This table shows results from OLS regressions estimating the value paid for the target's patents. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement are included in all specifications. Fixed effects for target's 2 digit SIC code and age cohort are included in columns (3)-(6). Columns (5), (6) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of patents with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of patents granted | 144.51** | | 166.47*** | | 198.40*** | |
| before acquisition | (61.40) | | (61.99) | | (64.90) | |
| Number of patents filed before but | | 81.28** | | 94.90*** | | 90.29* |
| granted after acquisition | | (38.98) | | (34.94) | | (48.06) |
| Dummy for cash only deal * | | | | | -64.18 | 8.09 |
| Innovation proxy | | | | | (84.01) | (42.04) |
| Dummy for cash only deal | | | | | -294.38 | -173.25 |
| | | | | | (230.36) | (267.23) |
| Percentage paid by stock and options | 3.07* | 2.13 | 2.38 | 1.42 | 0.35 | 0.80 |
| | (1.80) | (1.96) | (1.60) | (1.72) | (1.59) | (1.85) |
| Technological overlap with Cisco | 1.37 | 1.33 | 2.48 | 1.53 | 2.84 | 1.61 |
| using patents | (4.73) | (5.37) | (4.97) | (5.46) | (4.62) | (5.36) |
| Trailing 12-month BHAR on | 7.93* | 7.78* | 9.38** | 9.48** | 9.21* | 9.67** |
| Cisco's stock | (4.61) | (4.50) | (4.55) | (4.54) | (4.71) | (4.62) |
| Trailing 12-month returns on | -2.11 | -3.45 | -1.81 | -2.53 | -0.55 | -2.14 |
| CRSP V-W Index | (5.96) | (4.93) | (6.84) | (6.41) | (6.67) | (6.70) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry, Age FE | No | No | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.30 | 0.28 | 0.35 | 0.35 | 0.36 | 0.34 |

## Table 5: Estimates of value paid for the novelty of the targets' innovations

This table shows results from OLS regressions estimating the value paid for the novelty of the target's innovations. "Total number of citations expected over patent lifetime" is constructed by adjusting citations received till 2012 for truncation bias using the citation-lag distribution of citations from Hall et al. (2001). "Future expected citations" is estimated at the time of acquisition using the distribution of citations and "Unexpected citations" equals the difference between the actual citations received till 2012 and the expected future citations. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Columns (6), (7) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of citations with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Citations received before acquisition | 6.08*** | | 3.63** | 1.08 | | 8.58** | |
| | (1.69) | | (1.69) | (2.11) | | (3.46) | |
| Total number of citations | | 1.21*** | | | | | 1.29*** |
| over patent lifetime | | (0.18) | | | | | (0.11) |
| Citations after acquisition | | | 0.88*** | | | | |
| adjusted for truncation | | | (0.30) | | | | |
| Future expected citations | | | | 3.61** | 4.00** | | |
| | | | | (1.81) | (1.58) | | |
| Unexpected citations | | | | 0.56 | 0.61 | | |
| | | | | (0.44) | (0.43) | | |
| Dummy for cash only deal * | | | | | | -3.54 | -0.53 |
| Innovation proxy | | | | | | (3.43) | (0.56) |
| Dummy for cash only deal | | | | | | -410.37* | -213.33 |
| | | | | | | (216.87) | (199.36) |
| Percentage paid by stock and options | 2.79 | 2.69 | 2.55 | 1.33 | 1.25 | -0.30 | 0.80 |
| | (1.84) | (1.94) | (1.88) | (1.71) | (1.65) | (1.69) | (1.46) |
| Technological overlap with Cisco | 2.00 | 3.06 | 1.05 | -2.66 | -2.28 | 0.81 | 3.96 |
| using patents | (3.31) | (3.54) | (3.23) | (3.71) | (3.77) | (3.21) | (3.45) |
| Trailing 12-month BHAR on | 8.39* | 5.21 | 6.07 | 4.64 | 4.26 | 8.43* | 5.07 |
| Cisco's stock | (4.49) | (3.93) | (4.13) | (3.19) | (3.35) | (4.76) | (4.02) |
| Trailing 12-month returns on | -3.51 | -1.97 | -2.46 | -0.89 | -0.58 | -1.91 | -2.21 |
| CRSP V-W Index | (7.27) | (6.92) | (6.99) | (5.22) | (5.04) | (6.60) | (6.18) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.41 | 0.47 | 0.49 | 0.57 | 0.57 | 0.45 | 0.48 |

## Table 6: Estimates of the value paid for target employees' human capital

This table shows results from OLS regressions for the effect of target employees' human capital on the value paid for the target. The variable "Number of future Cisco patents generated by targets' employees" equals the sum total of Cisco patents generated by erstwhile target's employees after being acquired by Cisco. Fraction of target employees as inventors in Cisco equals the percent of total inventors in the target who file patents as Cisco employees after the acquisition. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012 for which data on number of employees is available; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Columns (5), (6) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of employees with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of Employees | 2.218*** | 2.220*** | 2.218*** | 2.219*** | 4.893*** | 4.966*** |
| in the year of acquisition | (0.512) | (0.501) | (0.516) | (0.510) | (0.624) | (0.662) |
| Number of future Cisco patents | | 3.199** | | 2.131 | | -1.056 |
| generated by targets' employees | | (1.304) | | (1.746) | | (1.371) |
| Fraction of target employees as | | | 248.138 | 164.196 | | |
| inventors in Cisco | | | (221.395) | (267.748) | | |
| Dummy for cash only deal * | | | | | - | - |
| | | | | | 3.220*** | 3.305*** |
| Number of employees | | | | | (0.649) | (0.691) |
| Dummy for cash only deal * Proxy | | | | | | 0.470 |
| for employee human capital | | | | | | (3.645) |
| Dummy for cash only deal | | | | | 113.732 | 108.674 |
| | | | | | (154.852) | (161.622) |
| Percentage paid by stock and options | 0.969 | 0.908 | 0.831 | 0.837 | -1.394 | -1.461 |
| | (1.370) | (1.389) | (1.427) | (1.446) | (1.925) | (1.981) |
| Technological overlap with Cisco | 5.180* | 4.524 | 4.198 | 4.093 | 3.942 | 4.076 |
| using patents | (3.044) | (2.994) | (2.565) | (2.610) | (2.616) | (2.781) |
| Trailing 12-month BHAR on | 9.021** | 8.678** | 8.743** | 8.608** | 6.516* | 6.568* |
| Cisco's stock | (4.006) | (3.939) | (3.815) | (3.865) | (3.439) | (3.492) |
| Trailing 12-month returns on | -8.899 | -6.454 | -8.481 | -6.994 | -7.697 | -8.423 |
| CRSP V-W Index | (5.826) | (6.098) | (5.590) | (6.524) | (4.869) | (5.083) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 116 | 116 | 116 | 116 | 116 | 116 |
| Adjusted R-squared | 0.554 | 0.557 | 0.557 | 0.554 | 0.686 | 0.679 |

## Table 7: Estimates of the value paid for the target's specialization to Cisco

This table shows results from OLS regressions for the effect of specialization of the targets' intangible assets to Cisco on the value paid by Cisco. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable | Value of 100% equity ($ million) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Citations from Cisco before acquisition | 41.855*** | | | |
| | (11.156) | | | |
| Citations from Cisco after acquisition | | 2.053*** | | |
| | | (0.377) | | |
| Self-citations before acquisition | | | 149.828*** | |
| | | | (27.434) | |
| Citations made to Cisco's patents by the target's patents | | | | 13.871*** |
| | | | | (5.093) |
| Percentage paid by stock and options | 3.726 | 3.130* | 2.358* | 3.660* |
| | (2.263) | (1.845) | (1.418) | (1.992) |
| Technological overlap with Cisco | 2.631 | 8.726** | 6.933 | 10.544** |
| using patents | (2.979) | (4.224) | (4.286) | (4.081) |
| Trailing 12-month BHAR on | 5.916* | 5.667 | 6.649 | 7.985* |
| Cisco's stock | (3.408) | (4.245) | (4.210) | (4.715) |
| Trailing 12-month returns on | -0.470 | -3.916 | 0.368 | -3.053 |
| CRSP V-W Index | (6.687) | (7.031) | (7.358) | (6.997) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.478 | 0.380 | 0.428 | 0.232 |

## Table 8: Estimates of the value paid for the target's attractiveness to Cisco's competitors

This table shows results from OLS regressions for the effect of overlap of the targets' intangible assets with those of Cisco on the value paid by Cisco. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable | Value of 100% equity ($ million) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Citations from Cisco's competitors before merger | 28.298*** | | | | |
| | (5.957) | | | | |
| Technological overlap with competitors | | -3.980 | | | |
| using patents | | (8.488) | | | |
| Technological overlap with competitors | | | -4.857 | | |
| using citations | | | (8.490) | | |
| Citations from Cisco before acquisition | | | | 28.574 | |
| | | | | (20.594) | |
| Self-citations before acquisition | | | | 38.670 | |
| | | | | (70.880) | |
| Citations from firms other than Cisco | | | | 2.527 | |
| and itself before acquisition | | | | (1.584) | |
| Number of Cisco's competitors | | | | | 87.797** |
| citing the target before merger | | | | | (38.564) |
| Percentage paid by stock and options | 2.557 | 3.739* | 3.747* | 3.017* | 2.555 |
| | (2.007) | (2.069) | (2.075) | (1.695) | (1.962) |
| Technological overlap with Cisco | -2.959 | 15.034 | 15.929 | 0.919 | -1.324 |
| using patents | (2.677) | (9.809) | (10.101) | (2.326) | (4.829) |
| Trailing 12-month BHAR on | 6.773* | 8.041* | 7.945* | 6.413* | 8.742* |
| Cisco's stock | (3.601) | (4.494) | (4.411) | (3.676) | (4.773) |
| Trailing 12-month returns on | -1.726 | -3.015 | -2.929 | -0.801 | -1.791 |
| CRSP V-W Index | (6.211) | (7.461) | (7.414) | (7.180) | (6.817) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.538 | 0.184 | 0.187 | 0.510 | 0.326 |

## Table 9: Estimates of the value paid for Cisco's targets vis-à-vis other public targets

This table shows the difference in valuation of innovation portfolios of Cisco's target relative to innovation portfolios of other public targets in the same industry as Cisco's target. For each target of Cisco a matched portfolio is constructed from public targets in the same 2 digit SIC, announced within 3 calendar years centered on the year of announcement, and with employees within ±25% of employees of the private target; all the variables are averaged across the firms in the portfolio. We only include acquisitions with more than 50% acquired in the portfolio. Public firms are allowed to appear in the matched portfolio of multiple private targets. Patent data for these public firms is taken from Kogan et al. (2016) which restricts the sample period to 1993-2006. The final sample has 63 targets of Cisco each with a corresponding matched portfolio record. Control variables used in the regressions are 'Percentage paid by stock and options', 'Trailing 12-month BHAR on acquirer's stock', and 'Trailing 12-month returns on CRSP V-W Index'. Fixed effects for the year of announcement and 2-digit SIC code of target are included in all the specifications. Standard errors reported in parentheses are robust to heteroskedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| | Cisco's acquisitions | | | Matched portfolio of public targets | | |
|---|---|---|---|---|---|---|
| | Mean | Median | Std. Dev. | Mean | Median | Std. Dev. |
| Value of 100% equity ($ million) | 501.2 | 254.3 | 787.5 | 203.9 | 69.2 | 461.3 |
| **Value paid ($ million) / metric of intangible assets:** | | | | | | |
| Value paid per patent filed before acquisition | 350.6 | 116.3 | 990.8 | 67.7 | 19.8 | 174.6 |
| Value paid per patent granted before acquisition | 582.7 | 232.6 | 1363.0 | 114.3 | 26.2 | 362.9 |
| Value paid per employees in the year of acquisition | 3.3 | 2.3 | 2.8 | 1.8 | 0.4 | 3.7 |
| Value paid per citation over patent lifetime | 1.7 | 1.2 | 1.9 | 1.1 | 0.4 | 1.7 |
| Value paid per citation received before acquisition | 23.6 | 11.4 | 21.4 | 9.6 | 1.3 | 14.1 |
| Value paid per citations after acquisition adjusted for truncation | 2.0 | 1.2 | 2.3 | 1.4 | 0.6 | 2.1 |
| Value paid per future expected citations | 3.5 | 3.8 | 2.7 | 4.6 | 0.9 | 9.4 |
| Value paid per unexpected citations | 1.5 | 2.7 | 25.6 | 2.7 | 0.6 | 7.4 |

# Online Appendix (Not for Publication)

**Figure A-1: Variation within a year in the number of acquisitions undertaken by Cisco**

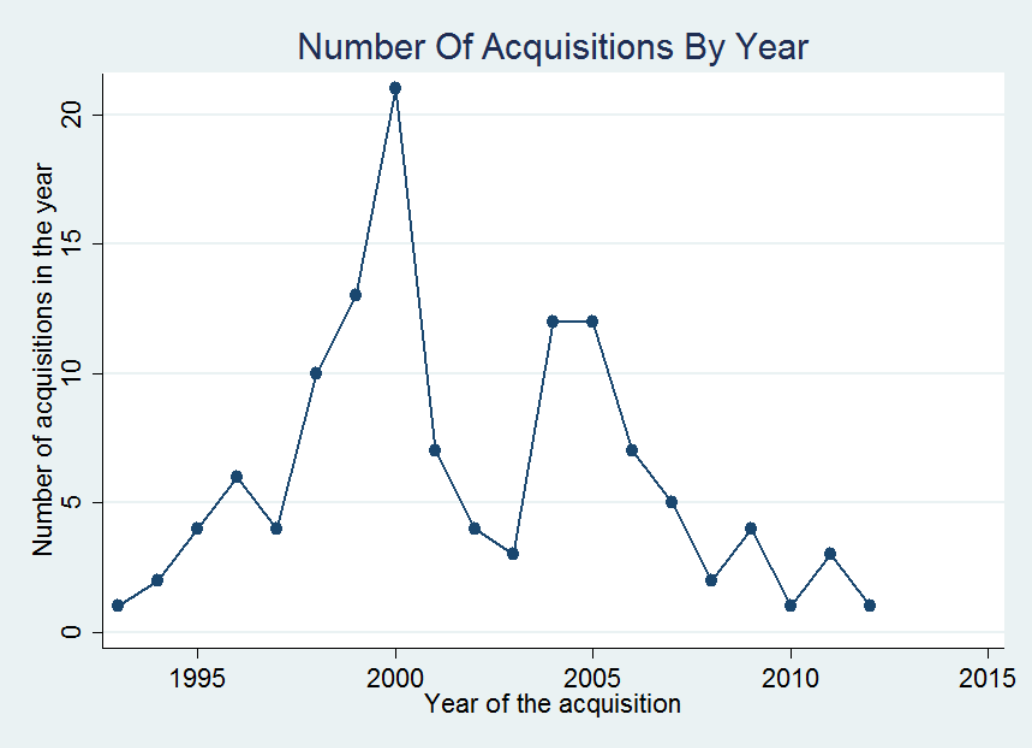


**Figure A-2: Post acquisition profitability in event-time for Cisco and industry**

This figure shows profitability variation for Cisco and a median firm in the industry in the years after acquisition. Industry considered is 'Computer and Electronic Product Manufacturing' with NAICS code 334. Median values are computed across all firms in the industry for each year. Profitability metrics are computed for each year after a merger announcement is made in the period 1993-2009 and are then averaged across all acquisitions.

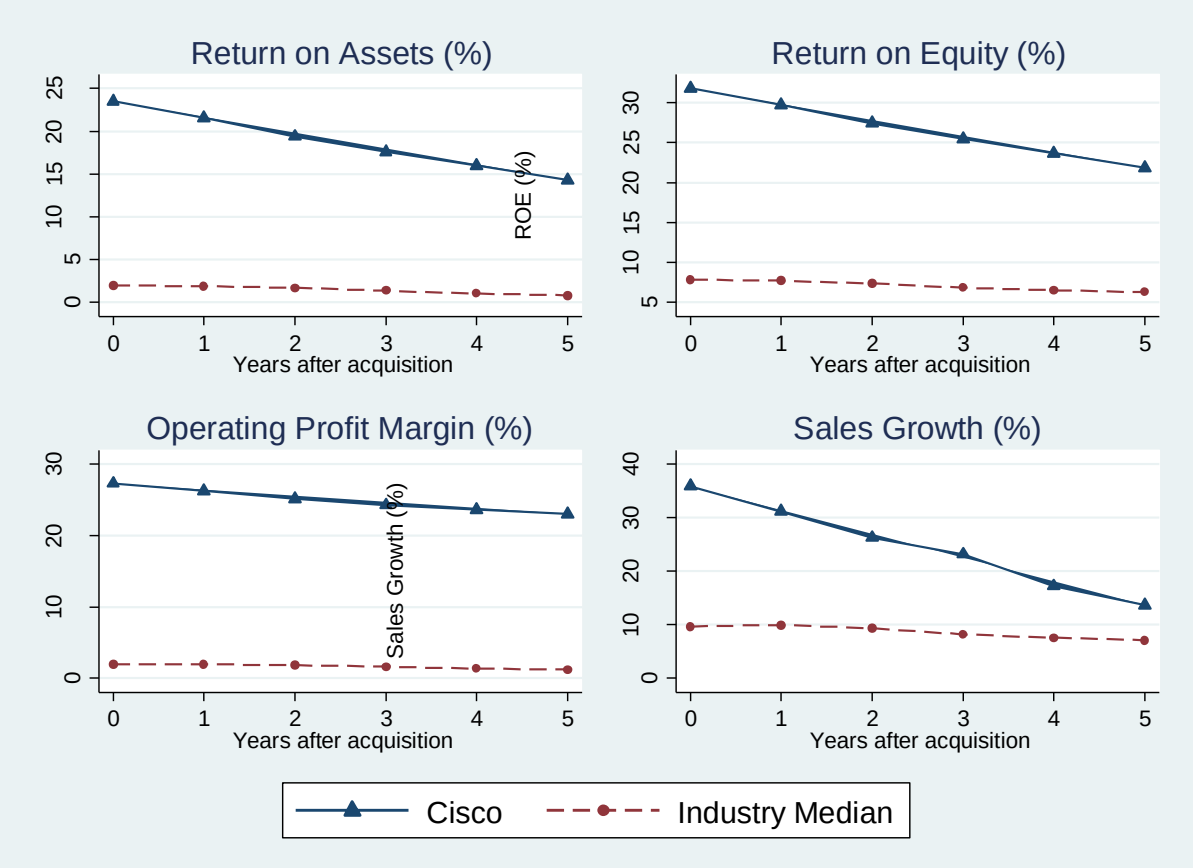
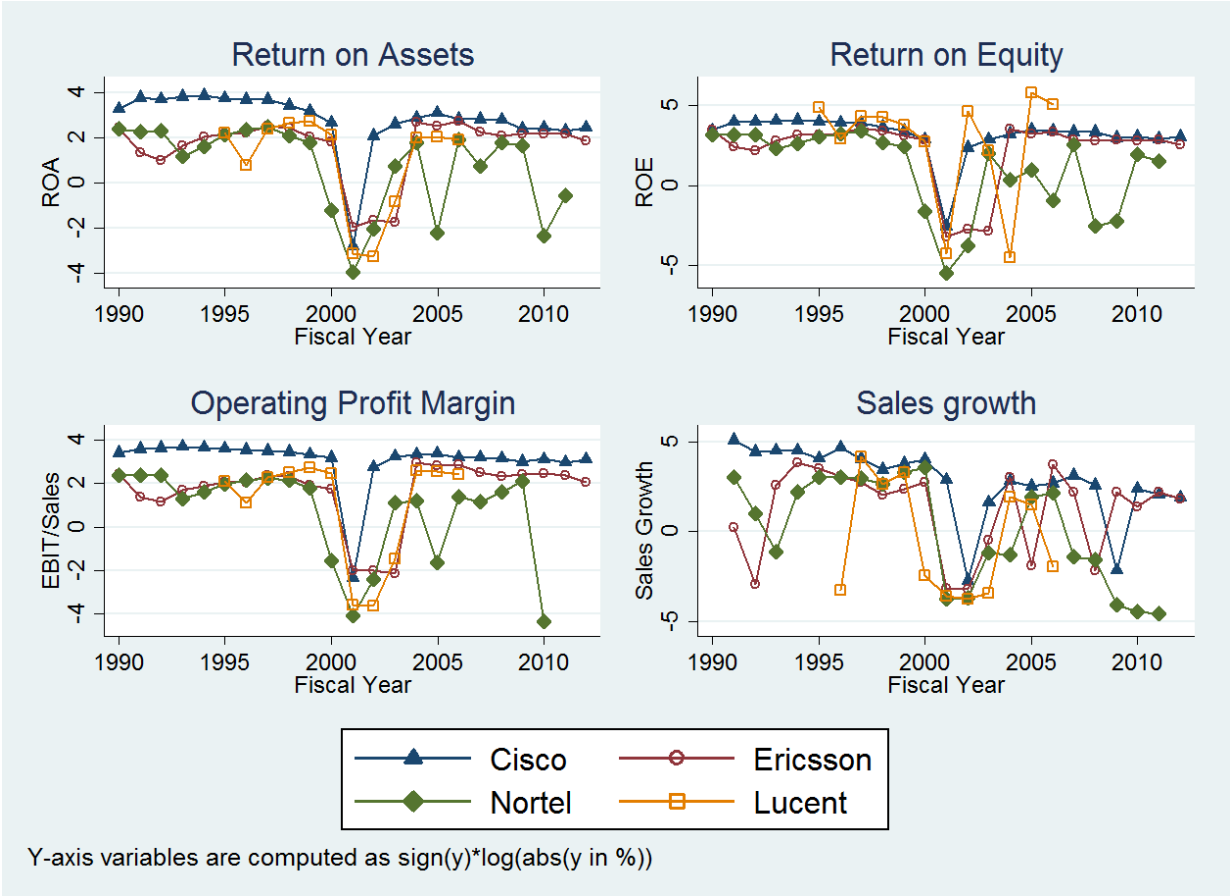


**Figure A-3: Profitability metrics for Cisco vis-à-vis competitors**

This figure compares profitability metrics for Cisco with its main competitors in the networking industry over the period 1990-2012. Y-axis in the plots below is represented in logarithmic scale to reduce the effect of outliers. When the y-variable is negative, logarithm of the absolute value is computed and is then multiplied by -1. All the firms do not exist for the full length of the sample period and hence the plots are of different length.



## Figure A-4: Cumulative Stock Returns for Cisco & Market

This figure shows a comparison of cumulative return for an investor who invests in the Cisco stock, NASDAQ index, and the S&P North American Technology Hardware Index on 1/1/1996. Returns include both capital gains and cash flows. The plot for Cisco also shows some major acquisitions in this period. Source: 'Serial Acquirer Case Study: Cisco System' by Fortuna Advisors.

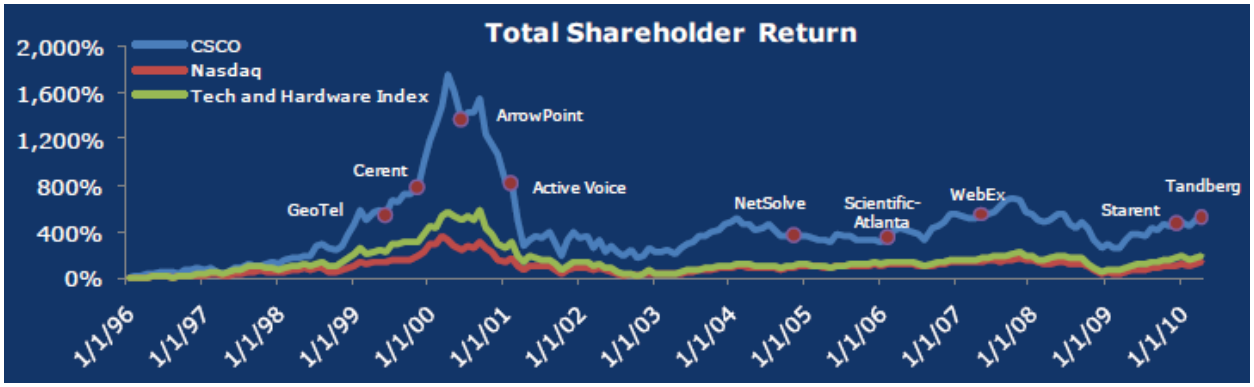


**Table A-1: Variable Description**

This table describes in detail all the variables used in our study.

| | |
|---|---|
| *Number of target patents filed before the acquisition* (*but granted after the acquisition*) | This variable equals the number of patents filed by the target before the date of announcement of the acquisition. We exclude those patents that were filed before acquisition and that were not eventually granted because a granted patent signals that the innovation is above a threshold level of quality, which cannot be ascertained if the filed patent has not been granted. |
| *Number of target patents granted before the acquisition* | This variable equals the number of patents granted to the target before the date of announcement of the acquisition. |
| *Indicator for at least one patent filed* | This is an indicator variable that takes the value of one if at least one patent has been filed by the target before the date of announcement of the acquisition and zero otherwise. The patents filed before the acquisition only include those that are granted by the last year in the sample. |
| *Indicator for at least one patent granted* | This is an indicator variable that takes the value of one if at least one patent has been granted to the target before the date of announcement of the acquisition and zero otherwise. |
| *Number of citations received before the acquisition* | This variable equals the total number of citations to the target's patents received before the date of announcement of the acquisition. |
| *Number of self-citations before the acquisition* | This variable equals the total number of self-citations, i.e., citations to target's own patents. Self-citations reflect follow-up innovation/knowledge flowing from the knowledge underlying a firm's predecessor patents (Jaffe, Trajtenberg, and Henderson 1993). Therefore, self-citations capture the target's ability to exploit its existing innovations. |
| *Total number of citations expected over the patent lifetimes* | This variable equals the total citations received until 2012 after adjusting for the truncation bias in citations. Because patents filed in recent years have had less time to accumulate citations when compared with the older patents, raw citation counts will suffer from a truncation bias. We adjust for this truncation bias by using the citation-lag distribution estimated by Hall, Jaffe, and Trajtenberg (2001). Formally, *Total number of citations expected over the lifetime of a patent=*$E_{2012}$*[citations expected over lifetime of a patent]*, where $E_{2012}$ denotes the expectation calculated based on the citations received until 2012. |
| *Citations received after acquisition* | This variable captures the actual citations received after the acquisition after adjusting for the fact that citations received until 2012 do not capture fully the total citations expected over the lifetime of the patents. |

| | |
|---|---|
| | This variable is calculated as: $E_{2012}$*[citations expected over the lifetime of a patent]- citations received until the year of acquisition.* |
| *Future citations expected at the time of acquisition* | This variable equals the number of future citations to the target's patents expected at the time of the acquisition, using the citation-lag distribution mentioned above. This variable is calculated as: $E_{acquisition}$*[citations expected over the lifetime of a patent]- citations received until the year of acquisition,* where $E_{acquisition}$ denotes the expectation calculated based on the citations received until the year of the acquisition. |
| *Unexpected future citations:* | This variable captures the "surprise" in the citations received by the target post the acquisition. This variable is calculated as: $E_{2012}$*[citations expected over the lifetime of a patent]-*$E_{acquisition}$*[citations expected over the lifetime of a patent]= {*$E_{2012}$*[citations expected over the lifetime of a patent]- citations received until the year of acquisition} – {*$E_{acquisition}$*[citations expected over the lifetime of a patent]- citations received until the year of acquisition}*<br>The first-term captures the actual estimate of lifetime citations *after* the acquisition (based on the citations received until 2012), whereas the second term captures the estimate of lifetime citations after the acquisition based on the citations received until the time of the acquisition. Therefore, the difference captures the surprise part of future citations. |
| *Number of citations to target's patents made by Cisco after the acquisition* | This variable equals the total number of citations made by Cisco to the target's patents after the acquisition. |
| *Number of target employees in the year of acquisition* | This variable equals the number of employees of the target in the year of acquisition. This variable proxies the size of the target's intangible assets because data for sales or assets are not easily available for private targets. |
| *Number of future Cisco patents generated by target's employees* | This variable equals the number of Cisco's patents that lists a former employee of the target as the inventor. Because the patent data have information about the assignee to the patent, which is usually the firm, as well as the inventor of the patent, which is usually the employee of the firm, we track all the inventors of the target firm that are recorded as inventors in Cisco's patents after the acquisition. |
| *Fraction of target employees that are inventors in Cisco* | This variable equals the fraction of former employees of the target that have continued as employees of Cisco and have a Cisco patent recorded in their name as the inventor. |
| *Number of citations made by Cisco before the* | This variable equals the total number of citations made by Cisco before acquisition to the patents filed by or granted to the target. |

| | |
|---|---|
| *acquisition to the target's patents* | |
| *Number of citations made by the target before the acquisition to Cisco's patents* | This variable equals the total number of citations made by the target before acquisition to Cisco's patents. This variable also captures the overlap between the target's and Cisco's assets. |
| *Number of citations to target's patents made by Cisco after the acquisition* | This variable equals the total number of citations made by Cisco to the target's patents after the acquisition. |
| *Technological overlap with Cisco's assets (using the number of patents granted before acquisition):* | To construct this variable, we generate a vector that represents the portfolio of patents of a firm by calculating the number of patents of the firm that belongs to a particular patent class. Since patent class represents the most granular form of categorization available, we are able to generate a finely tuned overlap measure. The overlap measures equals the dot product of the patent portfolio vectors of Cisco and the target: $\frac{\sum_{across\ all\ patent\ classes} Patents\ of\ Cisco\ in\ that\ class * Patents\ of\ target\ in}{\sqrt{\sum_{across\ all\ patent\ classes} Patents\ of\ Cisco\ in\ that\ class^2} * \sqrt{\sum_{across\ all\ patent\ classes} Patents}}$ By construction, this variable lies between 0 and 1. The higher is the value of the variable, the greater the overlap between the patent portfolios of Cisco and that of the target. |
| *Technological overlap with Cisco's assets (using the number of citations)* | We compute this variable in a similar manner to the overlap measure generated using the number of patents granted. The only difference is that instead of using the number of patents granted in a class to calculate the overlap, we use the total number of citations expected over the patent lifetime to patents granted in that class. |
| *Number of Cisco's competitors citing the target before merger* | For each target of Cisco, this variable equals the number of competitors citing its patents before merger. In this context, competitors are defined as firms that are in the same 2 digit SIC codes as Cisco (SIC 35, 36). Since we do not have SIC codes of the firms in the patents data we collect from Google patents, we map these firms to CRSP msenames data using their names. We employ the name standardization routines from the NBER Patents database[6] to clean the names from CRSP database and our patents data. We use the Levenshtein distance to identify potential matches with a similarity of at least 90%. |
| *Citations from Cisco's competitors before merger* | For each target of Cisco, this variable equals the total number of citations made by Cisco's competitors before the acquisition and across all of its patents. In this context, competitors are defined as firms that are |

[6] https://sites.google.com/site/patentdataproject/Home/posts/namestandardizationroutinesuploaded

| | |
|---|---|
| | in the same 2 digit SIC codes as Cisco (SIC 35, 36). Since we do not have SIC codes of the firms in the patents data we collect from Google patents, we map these firms to CRSP msenames data using their names. We employ the name standardization routines from the NBER Patents database6 to clean the names from CRSP database and our patents data. We use the Levenshtein distance to identify potential matches with a similarity of at least 90%. |
| *Technological overlap with competitors' assets (using the number of patents granted before acquisition)* | We compute this variable for Cisco's competitors in an identical manner to the way it is calculated for Cisco. In constructing this variable, we consider only the main competitors of Cisco which include Alcatel-Lucent, Aruba Networks, Avaya Inc., Brocade, Juniper Networks and Polycom Inc. |
| *Technological overlap with competitors' assets (using the number of citations)* | We compute this variable for Cisco's competitors identically to the way it is calculated for Cisco. In constructing this variable, we consider only the main competitors of Cisco which include Alcatel-Lucent, Aruba Networks, Avaya Inc., Brocade, Juniper Networks and Polycom Inc. |
| *Percentage paid by stock and options* | This variable equals the percentage of transaction value paid in stock, options or other non-cash methods. We use this to control for the effect of acquirer's over- or under-valuation on the transaction value. It is taken from SDC Platinum database. |
| *Trailing 12-month BHAR on Cisco's stock* | This variable is computed as the buy and hold return on Cisco's stock in the 12 months ending three days before an announcement minus buy and hold return on CRSP value-weighted index in the same period. |
| *Trailing 12-month returns on CRSP V-W Index* | This variable is computed as the buy and hold return on CRSP value-weighted index in the 12 months ending three days before an announcement. |

## Table A-2: Tests of external validity using acquisitions by Google and Yahoo

We check for external validity of the results by considering a sample of acquisitions undertaken by Google and Yahoo in a similar period to the one we have considered for Cisco, i.e. 1993 to 2013 and predicting the value using predictor variables from the Cisco regressions. We only consider acquisitions where a majority stake was acquired. We compute the error as the difference between the actual value of these acquisitions and the value calculated using the coefficients of the predictor variables from the Cisco regressions. The table summarizes the normalized percentage error from these tests.

To compute the error using predictor variable n, we use the following specification for acquisition i in year t:

$$Value_{i\to t}-\overline{Value_t}=\text{Coefficient on predictor n}*\left(Predictor_{n\to t}-\overline{Predictor_t}\right)+\epsilon_{i\to t}$$

where $\overline{Value_t}$, $\overline{Predictor_t}$ are the average values of 100% equity and the predictor variableacross all acquisition transactions announced in that year. For example, if the predictor variable were the number of patents granted before acquisition, we would have:

$$Value_{i\to t}-\overline{Value_t}=\text{Coefficient on patents granted}*\left(\text{patents granted}_{n\to t}-\overline{\text{patents granted}_t}\right)+\epsilon_{i\to t}$$

The normalized percentage error forthe $i^{th}$ transaction in year tis given by:

$$[(Value_{i\to t}-\overline{Value_t})-\text{Coefficient on predictor n}*\left(Predictor_{n\to t}-\overline{Predictor_t}\right)]*100/StDev(Value_{i\to t}-\overline{Value_t})$$

| Variable | N | Median(%) | Mean(%) | Std. Devn.(%) |
|---|---|---|---|---|
| % Error based on number of patents granted before merger | 56 | -0.5 | 0 | 163.1 |
| % Error based on number of patents filed before merger | 56 | 0 | 0 | 397.6 |
| % Error based on citations received before merger | 56 | -4.8 | 0 | 75.12 |
| % Error based on total citations received over lifetime | 56 | -4.1 | 0 | 70.84 |

**Table A-3: Correlations between the explanatory variables used in the study**

| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | Number of patents granted before acquisition | 1 | | | | | | | | | | | | | |
| (2) | Number of patents filed before but granted after acquisition | 0.80 | 1 | | | | | | | | | | | | |
| (3) | Citations received before acquisition | 0.78 | 0.69 | 1 | | | | | | | | | | | |
| (4) | Citations from Cisco before the acquisition | 0.67 | 0.60 | 0.76 | 1 | | | | | | | | | | |
| (5) | Self-citations before acquisition | 0.71 | 0.66 | 0.79 | 0.79 | 1 | | | | | | | | | |
| (6) | Citations from Cisco's competitors before merger | 0.78 | 0.69 | 0.89 | 0.93 | 0.76 | 1 | | | | | | | | |
| (7) | Number of Cisco's competitors citing the target before merger | 0.72 | 0.74 | 0.85 | 0.76 | 0.61 | 0.91 | 1 | | | | | | | |
| (8) | Total number of citations expected over patent lifetime | 0.68 | 0.62 | 0.79 | 0.93 | 0.80 | 0.92 | 0.82 | 1 | | | | | | |
| (9) | Future expected citations | 0.58 | 0.72 | 0.80 | 0.66 | 0.59 | 0.80 | 0.84 | 0.74 | 1 | | | | | |
| (10) | Unexpected citations | 0.51 | 0.38 | 0.51 | 0.85 | 0.68 | 0.74 | 0.58 | 0.91 | 0.40 | 1 | | | | |
| (11) | Technological overlap with Cisco using patents (%) | 0.65 | 0.65 | 0.57 | 0.47 | 0.38 | 0.62 | 0.74 | 0.48 | 0.57 | 0.27 | 1 | | | |
| (12) | Technological overlap with competitors using patents (%) | 0.66 | 0.62 | 0.52 | 0.47 | 0.36 | 0.59 | 0.71 | 0.49 | 0.49 | 0.35 | 0.90 | 1 | | |
| (13) | Technological overlap with competitors using citations (%) | 0.65 | 0.61 | 0.52 | 0.46 | 0.34 | 0.59 | 0.72 | 0.49 | 0.49 | 0.34 | 0.90 | 1 | 1 | |
| (14) | Number of Employees in the year of acquisition | 0.64 | 0.67 | 0.82 | 0.56 | 0.73 | 0.65 | 0.58 | 0.57 | 0.66 | 0.30 | 0.37 | 0.32 | 0.31 | 1 |

**Table A-4: Effect of targets' patents, novelty of the targets innovations on the value paid using log-log specification**

This table shows results from OLS regressions estimating the value paid for target's patents and novelty of the target's patents. "Total number of citations expected over patent lifetime" is constructed by adjusting citations received till 2012 for truncation bias using the citation-lag distribution of citations from Hall et al. (2001). The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Log of Value of 100% equity ($ millions) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| log(1+Patents granted before merger) | 0.082 | | | | |
| | (0.364) | | | | |
| log(1+Patents filed before merger) | | 0.742*** | | | |
| | | (0.198) | | | |
| log(1+Citations received before merger) | | | 0.193* | | |
| | | | (0.112) | | |
| log(1+Total number of citations | | | | 0.166** | |
| over patent lifetime) | | | | (0.068) | |
| log(1+Citations from Cisco before merger) | | | | | 0.432** |
| | | | | | (0.176) |
| Percentage paid by stock and options | 0.013*** | 0.011*** | 0.012*** | 0.012*** | 0.012*** |
| | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| Technological overlap with Cisco | 0.016** | 0.000 | 0.007 | 0.006 | 0.006 |
| using number of patents granted | (0.007) | (0.006) | (0.007) | (0.006) | (0.007) |
| Trailing 6-month BHAR on Cisco's | 0.004 | 0.004 | 0.002 | 0.001 | 0.002 |
| Stock | (0.004) | (0.004) | (0.004) | (0.004) | (0.004) |
| Trailing 6-month returns on CRSP | -0.005 | -0.003 | -0.004 | -0.005 | -0.003 |
| V-W Index | (0.012) | (0.011) | (0.011) | (0.011) | (0.011) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 |
| Adj R-squared | 0.442 | 0.442 | 0.442 | 0.442 | 0.442 |

## Table A-5: Effect of target employees' human capital on the value paid using log-log specification

This table shows results from OLS regressions for the effect of target employees' human capital on the value paid for the target. In columns (2) and (4) we use the number of future Cisco patents by targets' employees, i.e. for every target we compute the sum total of patents by its employees after being acquired by Cisco. Fraction of target employees in columns (3) and (5) indicate the percent of total inventors in the target who file patents (inventors) as Cisco employees after merger. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012 for which data on number of employees is available; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Log of Value of 100% equity ($ millions) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| log(Employees) | 0.944*** | | | 0.928*** | 0.943*** |
| | (0.070) | | | (0.070) | (0.070) |
| log(1+No. of future Cisco patents by targets' employees) | | 0.247** | | 0.061 | |
| | | (0.107) | | (0.057) | |
| log(1+Fraction of target employees as inventors in Cisco) | | | 0.381 | | 0.170 |
| | | | (0.593) | | (0.296) |
| Percentage paid by stock and options | 0.005* | 0.012*** | 0.013*** | 0.005* | 0.005* |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Technological overlap with Cisco using number of patents granted | 0.005** | 0.011** | 0.016*** | 0.004 | 0.005* |
| | (0.003) | (0.005) | (0.005) | (0.003) | (0.003) |
| Trailing 6-month BHAR on Cisco's Stock | 0.005 | 0.004 | 0.004 | 0.005 | 0.005 |
| | (0.003) | (0.004) | (0.004) | (0.003) | (0.003) |
| Trailing 6-month returns on CRSP V-W Index | -0.018*** | -0.001 | -0.005 | -0.016*** | -0.018*** |
| | (0.005) | (0.012) | (0.011) | (0.006) | (0.005) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 116 | 122 | 122 | 116 | 116 |
| Adjusted R-squared | 0.797 | 0.430 | 0.390 | 0.797 | 0.795 |

**Table A-6: Estimates of value paid for the novelty of the targets' innovations with only year FE**

This table shows results from OLS regressions estimating the value paid for the novelty of the target's innovations. "Total number of citations expected over patent lifetime" is constructed by adjusting citations received till 2012 for truncation bias using the empirical distribution of citations from Hall et al. (2001). "Future expected citations" is estimated at the time of acquisition using the distribution of citations and "Unexpected citations" equals the difference between the actual citations received till 2012 and the expected future citations. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the actual year of acquisition are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Citations received before acquisition | 5.40*** | | 2.77* | 0.43 | |
| | (1.57) | | (1.53) | (2.39) | |
| Total number of citations over patent lifetime | | 1.16*** | | | |
| | | (0.18) | | | |
| Citations after acquisition adjusted for truncation | | | 0.91*** | | |
| | | | (0.26) | | |
| Future expected citations | | | | 3.79* | 3.94** |
| | | | | (2.24) | (1.86) |
| Unexpected citations | | | | 0.55 | 0.58 |
| | | | | (0.45) | (0.47) |
| Percentage paid by stock and options | 3.68* | 3.66* | 3.68* | 2.15 | 2.08 |
| | (1.88) | (1.94) | (1.96) | (1.55) | (1.49) |
| Technological overlap with Cisco | 1.12 | 1.25 | 0.09 | -3.44 | -3.27 |
| using number of patents granted | (2.64) | (2.90) | (2.75) | (3.78) | (3.90) |
| Trailing 6-month BHAR on Cisco's | 7.19 | 4.89 | 5.42 | 4.08 | 3.94 |
| Stock | (4.59) | (4.19) | (4.32) | (3.07) | (3.44) |
| Trailing 6-month returns on CRSP | -3.12 | -1.10 | -1.49 | -1.20 | -1.13 |
| V-W Index | (5.95) | (5.84) | (5.91) | (4.27) | (4.22) |
| Year FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.37 | 0.44 | 0.44 | 0.53 | 0.54 |

**Table A-7: Estimates of the value paid for target employees' human capital with only year FE**

This table shows results from OLS regressions for the effect of target employees' human capital on the value paid for the target. The variable "Number of future Cisco patents generated by targets' employees" equals the sum total of Cisco patents generated by erstwhile target's employees after being acquired by Cisco. Fraction of target employees as inventors in Cisco equals the percent of total inventors in the target who file patents as Cisco employees after the acquisition. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012 for which data on number of employees is available; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Number of Employees in the year of acquisition | 2.218*** | 2.220*** | 2.218*** | 2.219*** |
| | (0.512) | (0.501) | (0.516) | (0.510) |
| Number of future Cisco patents generated by | | 3.199** | | 2.131 |
| targets' employees | | (1.304) | | (1.746) |
| Fraction of target employees as inventors in Cisco | | | 248.138 | 164.196 |
| | | | (221.395) | (267.748) |
| Percentage paid by stock and options | 0.969 | 0.908 | 0.831 | 0.837 |
| | (1.370) | (1.389) | (1.427) | (1.446) |
| Technological overlap with Cisco | 5.180* | 4.524 | 4.198 | 4.093 |
| using number of patents granted | (3.044) | (2.994) | (2.565) | (2.610) |
| Trailing 6-month BHAR on Cisco's | 9.021** | 8.678** | 8.743** | 8.608** |
| Stock | (4.006) | (3.939) | (3.815) | (3.865) |
| Trailing 6-month returns on CRSP | -8.899 | -6.454 | -8.481 | -6.994 |
| V-W Index | (5.826) | (6.098) | (5.590) | (6.524) |
| Year Fixed Effects | Yes | Yes | Yes | Yes |
| Observations | 116 | 116 | 116 | 116 |
| Adjusted R-squared | 0.554 | 0.557 | 0.557 | 0.554 |

**Table A-8: Estimates of value paid for the targets' patents using 1-month returns of Cisco and market in place of 12-month returns**

This table is a replication of table 4 from the paper using 1-month returns of Cisco and market in place of 12-month returns. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement are included in all specifications. Fixed effects for target's 2 digit SIC code and age cohort are included in columns (3)-(6). Columns (5), (6) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of patents with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of patents granted before acquisition | 129.57* | | 148.37* | | 191.52** | |
| | (74.91) | | (75.28) | | (84.33) | |
| Number of patents filed before acquisition but | | 73.94* | | 86.03** | | 87.21 |
| granted after acquisition | | (44.29) | | (39.73) | | (53.73) |
| Dummy for cash only deal * Innovation proxy | | | | | -92.36 | -5.26 |
| | | | | | (94.91) | (46.62) |
| Dummy for cash only deal | | | | | -175.60 | -76.98 |
| | | | | | (219.25) | (275.14) |
| Percentage paid by stock and options | 3.09* | 2.31 | 1.97 | 1.12 | 0.19 | 0.65 |
| | (1.85) | (2.07) | (1.52) | (1.66) | (1.41) | (1.81) |
| Technological overlap with Cisco | 3.51 | 3.32 | 4.93 | 3.85 | 5.57 | 4.08 |
| using number of patents granted | (5.98) | (6.85) | (6.20) | (6.89) | (5.92) | (6.99) |
| Trailing 6-month BHAR on Cisco's | 6.42 | 9.33 | 9.63 | 13.70 | 8.38 | 13.85 |
| Stock | (5.13) | (6.06) | (7.53) | (8.56) | (7.28) | (8.73) |
| Trailing 6-month returns on CRSP | -9.97 | -8.15 | -17.38 | -14.88 | -20.49 | -15.71 |
| V-W Index | (19.21) | (18.42) | (22.91) | (22.20) | (23.16) | (22.93) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry, Age FE | No | No | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.23 | 0.22 | 0.27 | 0.27 | 0.29 | 0.26 |

**Table A-9: Estimates of value paid for the novelty of the targets' innovations using 1-month returns of Cisco and market in place of 12-month returns**

This table is a replication of table 5 from the paper using 1-month returns of Cisco and market in place of 12-month returns. "Total number of citations expected over patent lifetime" is constructed by adjusting citations received till 2012 for truncation bias using the citation-lag distribution of citations from Hall et al. (2001). "Future expected citations" is estimated at the time of acquisition using the distribution of citations and "Unexpected citations" equals the difference between the actual citations received till 2012 and the expected future citations. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Columns (6), (7) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of citations with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Citations received before acquisition | 5.86*** | | 3.03 | 0.39 | | 8.68** | |
| | (1.93) | | (1.86) | (2.47) | | (4.18) | |
| Total number of citations over patent lifetime | | 1.26*** | | | | | 1.36*** |
| | | (0.20) | | | | | (0.14) |
| Citations after acquisition adjusted for truncation | | | 1.03*** | | | | |
| | | | (0.33) | | | | |
| Future expected citations | | | | 3.93** | 4.06** | | |
| | | | | (1.92) | (1.61) | | |
| Unexpected citations | | | | 0.64 | 0.66 | | |
| | | | | (0.47) | (0.45) | | |
| Dummy for cash only deal * | | | | | | -4.18 | -0.81 |
| Innovation proxy | | | | | | (4.04) | (0.58) |
| Dummy for cash only deal | | | | | | -319.08 | -131.75 |
| | | | | | | (200.94) | (183.09) |
| Percentage paid by stock and options | 2.45 | 2.41 | 2.29 | 0.96 | 0.94 | -0.50 | 0.55 |
| | (1.81) | (1.88) | (1.84) | (1.73) | (1.67) | (1.51) | (1.43) |
| Technological overlap with Cisco using number of patents granted | 3.58 | 3.71 | 2.18 | -1.85 | -1.69 | 2.50 | 5.25 |
| | (3.87) | (3.87) | (3.80) | (3.81) | (3.78) | (3.86) | (3.94) |
| Trailing 6-month BHAR on Cisco's Stock | 7.60 | 2.47 | 2.50 | 3.81 | 3.90 | 6.71 | 3.33 |
| | (7.05) | (5.22) | (5.36) | (5.48) | (5.32) | (6.50) | (5.32) |
| Trailing 6-month returns on CRSP V-W Index | -15.89 | -21.20 | -18.17 | -18.07 | -18.60 | -20.81 | -30.06* |
| | (19.63) | (17.92) | (18.26) | (14.41) | (12.91) | (19.44) | (17.05) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.35 | 0.45 | 0.46 | 0.55 | 0.56 | 0.39 | 0.48 |

## Table A-10: Estimates of the value paid for target employees' human capital using 1-month returns of Cisco and market in place of 12-month returns

This table is a replication of table 6 from the paper using 1-month returns of Cisco and market in place of 12-month returns. The variable "Number of future Cisco patents generated by targets' employees" equals the sum total of Cisco patents generated by erstwhile target's employees after being acquired by Cisco. Fraction of target employees as inventors in Cisco equals the percent of total inventors in the target who file patents as Cisco employees after the acquisition. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012 for which data on number of employees is available; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Columns (5), (6) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of employees with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of Employees in the year of acquisition | 2.244*** (0.576) | 2.249*** (0.565) | 2.241*** (0.576) | 2.245*** (0.570) | 5.250*** (0.752) | 5.212*** (0.745) |
| Number of future Cisco patents generated by targets' employees | | 4.293** (1.657) | | 2.932* (1.570) | | 0.178 (1.322) |
| Fraction of target employees as inventors in Cisco | | | 341.642 (272.119) | 222.096 (296.506) | | |
| Dummy for cash only deal * Number of employees | | | | | -3.631*** (0.788) | -3.602*** (0.786) |
| Dummy for cash only deal * Proxy for employee human capital | | | | | | -2.986 (4.314) |
| Dummy for cash only deal | | | | | 117.895 (137.680) | 133.017 (141.474) |
| Percentage paid by stock and options | 1.268 (1.104) | 0.872 (1.227) | 1.058 (1.201) | 0.861 (1.270) | -1.353 (1.513) | -1.328 (1.531) |
| Technological overlap with Cisco using number of patents granted | 6.357* (3.758) | 5.581 (3.536) | 4.991 (3.028) | 4.938 (3.031) | 4.819 (2.984) | 5.134 (3.221) |
| Trailing 6-month BHAR on Cisco's Stock | 11.243 (7.630) | 10.827 (7.275) | 12.018 (7.506) | 11.463 (7.363) | 5.405 (5.460) | 5.500 (5.579) |
| Trailing 6-month returns on CRSP V-W Index | -20.175 (21.127) | -21.334 (20.094) | -21.355 (20.663) | -21.734 (20.237) | -28.889 (19.493) | -29.696 (20.211) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 116 | 116 | 116 | 116 | 116 | 116 |
| Adjusted R-squared | 0.490 | 0.501 | 0.500 | 0.500 | 0.663 | 0.655 |

**Table A-11: Estimates of the value paid for the target's specialization to Cisco using 1-month returns of Cisco and market in place of 12-month returns**

This table is a replication of table 7 from the paper using 1-month returns of Cisco and market in place of 12-month returns. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable | Value of 100% equity ($ million) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Citations from Cisco before acquisition | 43.236*** | | | |
| | (11.704) | | | |
| Citations from Cisco after acquisition | | 2.141*** | | |
| | | (0.376) | | |
| Self-citations before acquisition | | | 151.428*** | |
| | | | (32.279) | |
| Citations made to Cisco's patents by the target's patents | | | | 16.362*** |
| | | | | (3.804) |
| Percentage paid by stock and options | 3.322 | 2.979* | 1.816 | 3.276* |
| | (2.071) | (1.695) | (1.441) | (1.792) |
| Technological overlap with Cisco | 3.137 | 9.545** | 7.995 | 11.957** |
| using number of patents granted | (3.391) | (4.742) | (5.017) | (4.699) |
| Trailing 6-month BHAR on Cisco's | 6.049 | 5.083 | 9.615 | 12.071 |
| Stock | (6.083) | (6.395) | (7.046) | (9.031) |
| Trailing 6-month returns on CRSP | -2.587 | -20.986 | -11.292 | -36.553* |
| V-W Index | (14.855) | (20.839) | (21.670) | (19.762) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.444 | 0.362 | 0.390 | 0.213 |

## Table A-12: Estimates of the value paid for the target's attractiveness to Cisco's competitors using 1-month returns of Cisco and market in place of 12-month returns

This table is a replication of table 8 from the paper using 1-month returns of Cisco and market in place of 12-month returns. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable | Value of 100% equity ($ million) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Citations from Cisco's competitors before merger | 28.714*** | | | | |
| | (6.661) | | | | |
| Technological overlap with competitors | | -6.674 | | | |
| using number of patents granted | | (9.100) | | | |
| Technological overlap with competitors | | | -7.468 | | |
| using number of citations | | | (9.132) | | |
| Citations from Cisco before acquisition | | | | 30.332 | |
| | | | | (21.860) | |
| Self-citations before acquisition | | | | 43.148 | |
| | | | | (74.991) | |
| Citations from firms other than Cisco | | | | 2.113 | |
| and itself before acquisition | | | | (1.815) | |
| Number of Cisco's competitors citing the | | | | | 81.565* |
| target before merger | | | | | (43.763) |
| Percentage paid by stock and options | 2.166 | 3.402* | 3.404* | 2.613 | 2.118 |
| | (1.865) | (1.828) | (1.830) | (1.583) | (1.827) |
| Technological overlap with Cisco | -2.238 | 18.824* | 19.698* | 1.798 | 1.078 |
| using number of patents granted | (3.058) | (10.777) | (11.077) | (2.652) | (5.615) |
| Trailing 6-month BHAR on Cisco's | 3.598 | 13.065 | 13.497 | 5.514 | 9.761 |
| Stock | (5.862) | (9.795) | (9.741) | (6.037) | (7.385) |
| Trailing 6-month returns on CRSP | -6.280 | -28.868 | -28.548 | -2.293 | -22.288 |
| V-W Index | (14.972) | (21.860) | (21.630) | (15.384) | (20.138) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.492 | 0.154 | 0.159 | 0.469 | 0.265 |

**Table A-13: Estimates of value paid for the targets' patents using 3-month returns of Cisco and market in place of 12-month returns**

This table is a replication of table 4 from the paper using 3-month returns of Cisco and market in place of 12-month returns. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement are included in all specifications. Fixed effects for target's 2 digit SIC code and age cohort are included in columns (3)-(6). Columns (5), (6) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of patents with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of patents granted before | 136.08* | | 159.81** | | 201.13** | |
| acquisition | (72.25) | | (75.36) | | (82.08) | |
| Number of patents filed before acquisition | | 76.56* | | 89.26** | | 89.53 |
| but granted after acquisition | | (42.69) | | (39.60) | | (55.86) |
| Dummy for cash only deal * | | | | | -88.58 | -1.96 |
| Innovation proxy | | | | | (97.03) | (48.65) |
| Dummy for cash only deal | | | | | -168.27 | -58.22 |
| | | | | | (215.08) | (267.81) |
| Percentage paid by stock and options | 3.03* | 2.24 | 1.93 | 1.07 | 0.21 | 0.75 |
| | (1.77) | (2.00) | (1.41) | (1.57) | (1.43) | (1.78) |
| Technological overlap with Cisco | 2.79 | 2.72 | 3.82 | 3.18 | 4.42 | 3.29 |
| using number of patents granted | (5.70) | (6.44) | (6.06) | (6.58) | (5.74) | (6.57) |
| Trailing 6-month BHAR on Cisco's | 2.05 | 2.06 | 2.24 | 1.38 | 1.83 | 1.44 |
| Stock | (3.19) | (2.73) | (3.93) | (3.54) | (4.24) | (3.56) |
| Trailing 6-month returns on CRSP | 4.76 | 2.01 | 2.91 | -0.50 | 1.96 | -0.38 |
| V-W Index | (8.08) | (6.42) | (13.18) | (11.79) | (13.11) | (12.18) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry, Age FE | No | No | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.23 | 0.21 | 0.26 | 0.26 | 0.28 | 0.24 |

## Table A-14: Estimates of value paid for the novelty of the targets' innovations using 3-month returns of Cisco and market in place of 12-month returns

This table is a replication of table 5 from the paper using 3-month returns of Cisco and market in place of 12-month returns. "Total number of citations expected over patent lifetime" is constructed by adjusting citations received till 2012 for truncation bias using the citation-lag distribution of citations from Hall et al. (2001). "Future expected citations" is estimated at the time of acquisition using the distribution of citations and "Unexpected citations" equals the difference between the actual citations received till 2012 and the expected future citations. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Columns (6), (7) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of citations with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Citations received before acquisition | 6.22*** | | 3.29* | 0.57 | | 8.89** | |
| | (1.99) | | (1.85) | (2.39) | | (4.14) | |
| Total number of citations over patent lifetime | | 1.29*** (0.19) | | | | | 1.38*** (0.13) |
| Citations after acquisition adjusted for truncation | | | 1.03*** (0.31) | | | | |
| Future expected citations | | | | 3.97** | 4.16** | | |
| | | | | (1.94) | (1.64) | | |
| Unexpected citations | | | | 0.66 | 0.69 | | |
| | | | | (0.45) | (0.44) | | |
| Dummy for cash only deal * Innovation proxy | | | | | | -3.88 | -0.65 |
| | | | | | | (4.14) | (0.57) |
| Dummy for cash only deal | | | | | | -335.28 | -136.84 |
| | | | | | | (207.56) | (164.71) |
| Percentage paid by stock and options | 2.47 | 2.39 | 2.28 | 0.93 | 0.89 | -0.47 | 0.73 |
| | (1.76) | (1.76) | (1.75) | (1.65) | (1.58) | (1.57) | (1.36) |
| Technological overlap with Cisco using number of patents granted | 2.49 | 3.08 | 1.35 | -2.64 | -2.41 | 1.34 | 4.26 |
| | (3.71) | (3.78) | (3.54) | (3.65) | (3.67) | (3.55) | (3.85) |
| Trailing 6-month BHAR on Cisco's Stock | 2.67 | -1.80 | -0.50 | -1.80 | -2.13 | 2.89 | -2.18 |
| | (4.04) | (3.11) | (2.88) | (3.15) | (3.63) | (4.55) | (3.22) |
| Trailing 6-month returns on CRSP V-W Index | 4.10 | 4.23 | 5.34 | 5.90 | 5.65 | 3.21 | 0.47 |
| | (11.97) | (11.58) | (11.32) | (8.64) | (8.49) | (11.54) | (10.62) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.34 | 0.44 | 0.45 | 0.55 | 0.55 | 0.38 | 0.46 |

**Table A-15: Estimates of the value paid for target employees' human capital using 3-month returns of Cisco and market in place of 12-month returns**

This table is a replication of table 6 from the paper using 3-month returns of Cisco and market in place of 12-month returns. The variable "Number of future Cisco patents generated by targets' employees" equals the sum total of Cisco patents generated by erstwhile target's employees after being acquired by Cisco. Fraction of target employees as inventors in Cisco equals the percent of total inventors in the target who file patents as Cisco employees after the acquisition. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012 for which data on number of employees is available; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Columns (5), (6) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of employees with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of Employees in the year of acquisition | 2.296*** | 2.296*** | 2.295*** | 2.295*** | 5.215*** | 5.259*** |
| | (0.588) | (0.563) | (0.583) | (0.570) | (0.759) | (0.809) |
| Number of future Cisco patents generated by targets' employees | | 4.387*** | | 3.096 | | -0.782 |
| | | (1.499) | | (2.049) | | (1.593) |
| Fraction of target employees as inventors in Cisco | | | 315.720 | 204.054 | | |
| | | | (254.984) | (302.623) | | |
| Dummy for cash only deal * Number of employees | | | | | -3.546*** | -3.603*** |
| | | | | | (0.788) | (0.856) |
| Dummy for cash only deal * Proxy for employee human capital | | | | | | -0.617 |
| | | | | | | (4.480) |
| Dummy for cash only deal | | | | | 137.076 | 135.493 |
| | | | | | (143.567) | (151.526) |
| Percentage paid by stock and options | 1.061 | 0.762 | 0.899 | 0.745 | -1.379 | -1.398 |
| | (1.147) | (1.223) | (1.220) | (1.254) | (1.707) | (1.745) |
| Technological overlap with Cisco using number of patents granted | 5.697 | 4.872 | 4.385 | 4.267 | 4.143 | 4.337 |
| | (3.698) | (3.638) | (3.079) | (3.107) | (3.028) | (3.337) |
| Trailing 6-month BHAR on Cisco's Stock | 4.397 | 3.441 | 4.345 | 3.689 | 2.870 | 3.027 |
| | (3.470) | (3.218) | (3.438) | (3.301) | (3.265) | (3.271) |
| Trailing 6-month returns on CRSP V-W Index | -3.316 | 3.155 | -0.800 | 2.877 | -3.538 | -4.815 |
| | (9.424) | (9.785) | (8.031) | (9.971) | (7.914) | (9.309) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 116 | 116 | 116 | 116 | 116 | 116 |
| Adjusted R-squared | 0.479 | 0.488 | 0.487 | 0.486 | 0.646 | 0.638 |

**Table A-16: Estimates of the value paid for the target's specialization to Cisco using 3-month returns of Cisco and market in place of 12-month returns**

This table is a replication of table 7 from the paper using 3-month returns of Cisco and market in place of 12-month returns. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable | Value of 100% equity ($ million) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Citations from Cisco before acquisition | 44.471*** | | | |
| | (11.631) | | | |
| Citations from Cisco after acquisition | | 2.224*** | | |
| | | (0.369) | | |
| Self-citations before acquisition | | | 157.463*** | |
| | | | (30.102) | |
| Citations made to Cisco's patents by the target's patents | | | | 15.008*** |
| | | | | (4.364) |
| Percentage paid by stock and options | 3.360* | 2.940* | 1.802 | 3.282* |
| | (2.018) | (1.645) | (1.317) | (1.684) |
| Technological overlap with Cisco | 2.723 | 9.189** | 7.478 | 11.460** |
| using number of patents granted | (3.207) | (4.616) | (4.770) | (4.797) |
| Trailing 6-month BHAR on Cisco's | -0.107 | -1.898 | 0.963 | -1.215 |
| Stock | (3.062) | (3.439) | (3.184) | (4.024) |
| Trailing 6-month returns on CRSP | 6.658 | -3.347 | 4.321 | -0.684 |
| V-W Index | (11.245) | (12.884) | (12.384) | (12.340) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.444 | 0.350 | 0.381 | 0.167 |

## Table A-17: Estimates of the value paid for the target's attractiveness to Cisco's competitors using 3-month returns of Cisco and market in place of 12-month returns

This table is a replication of table 8 from the paper using 3-month returns of Cisco and market in place of 12-month returns. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable | Value of 100% equity ($ million) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Citations from Cisco's competitors before merger | 29.735*** | | | | |
| | (6.492) | | | | |
| Technological overlap with competitors using | | -6.719 | | | |
| number of patents granted | | (9.339) | | | |
| Technological overlap with competitors using | | | -7.416 | | |
| number of citations | | | (9.395) | | |
| Citations from Cisco before acquisition | | | | 31.405 | |
| | | | | (21.933) | |
| Self-citations before acquisition | | | | 42.214 | |
| | | | | (73.341) | |
| Citations from firms other than Cisco and itself | | | | 2.271 | |
| before acquisition | | | | (1.776) | |
| Number of Cisco's competitors citing the target | | | | | 87.190* |
| before merger | | | | | (44.918) |
| Percentage paid by stock and options | 2.184 | 3.415* | 3.418* | 2.659* | 2.092 |
| | (1.798) | (1.755) | (1.756) | (1.544) | (1.691) |
| Technological overlap with Cisco | -3.084 | 18.365* | 19.155* | 1.150 | -0.309 |
| using number of patents granted | (2.885) | (11.027) | (11.335) | (2.431) | (5.616) |
| Trailing 6-month BHAR on Cisco's | 0.933 | 0.201 | 0.211 | 1.090 | 1.680 |
| Stock | (3.487) | (4.361) | (4.361) | (2.953) | (4.118) |
| Trailing 6-month returns on CRSP | 8.280 | -2.563 | -2.189 | 7.775 | 3.187 |
| V-W Index | (10.038) | (12.522) | (12.272) | (11.097) | (12.530) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.495 | 0.119 | 0.124 | 0.471 | 0.247 |

**Table A-18: Estimates of value paid for the targets' patents using 6-month returns of Cisco and market in place of 12-month returns**

This table is a replication of table 4 from the paper using 6-month returns of Cisco and market in place of 12-month returns. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement are included in all specifications. Fixed effects for target's 2 digit SIC code and age cohort are included in columns (3)-(6). Columns (5), (6) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of patents with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of patents granted before acquisition | 148.02** | | 172.15** | | 212.37*** | |
| | (66.39) | | (69.55) | | (74.26) | |
| Number of patents filed before acquisition but granted after acquisition | | 81.47** | | 94.53** | | 95.70* |
| | | (40.26) | | (37.28) | | (54.54) |
| Dummy for cash only deal * Innovation proxy | | | | | -83.95 | -4.79 |
| | | | | | (90.27) | (49.89) |
| Dummy for cash only deal | | | | | -223.47 | -80.51 |
| | | | | | (215.93) | (264.64) |
| Percentage paid by stock and options | 3.48* | 2.54 | 2.51 | 1.54 | 0.59 | 1.08 |
| | (1.78) | (2.00) | (1.52) | (1.69) | (1.64) | (1.92) |
| Technological overlap with Cisco using number of patents granted | 1.59 | 1.78 | 2.49 | 2.00 | 2.95 | 2.17 |
| | (5.16) | (5.92) | (5.28) | (5.87) | (4.90) | (5.82) |
| Trailing 6-month BHAR on Cisco's stock | 5.06 | 4.75 | 6.05 | 5.64 | 5.73 | 5.60 |
| | (4.97) | (4.79) | (4.81) | (4.66) | (5.04) | (4.78) |
| Trailing 6-month returns on CRSP V-W Index | 6.59 | 4.68 | 6.79 | 5.06 | 7.86 | 5.49 |
| | (7.70) | (6.25) | (7.67) | (6.38) | (8.06) | (7.65) |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry, Age FE | No | No | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.27 | 0.24 | 0.31 | 0.29 | 0.32 | 0.28 |

## Table A-19: Estimates of value paid for the novelty of the targets' innovations using 6-month returns of Cisco and market in place of 12-month returns

This table is a replication of table 5 from the paper using 6-month returns of Cisco and market in place of 12-month returns. "Total number of citations expected over patent lifetime" is constructed by adjusting citations received till 2012 for truncation bias using the citation-lag distribution of citations from Hall et al. (2001). "Future expected citations" is estimated at the time of acquisition using the distribution of citations and "Unexpected citations" equals the difference between the actual citations received till 2012 and the expected future citations. The dependent variable equals the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains 122 acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Columns (6), (7) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of citations with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | | |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| Citations received before acquisition | 6.30*** | | 3.49* | 0.88 | | 8.92** | |
| | (1.93) | | (1.82) | (2.25) | | (4.01) | |
| Total number of citations over | | 1.29*** | | | | | 1.36*** |
| patent lifetime | | (0.19) | | | | | (0.13) |
| Citations after acquisition adjusted | | | 1.00*** | | | | |
| for truncation | | | (0.30) | | | | |
| Future expected citations | | | | 3.77** | 4.08** | | |
| | | | | (1.86) | (1.60) | | |
| Unexpected citations | | | | 0.65 | 0.69 | | |
| | | | | (0.44) | (0.42) | | |
| Dummy for cash only deal * | | | | | | -3.75 | -0.51 |
| Innovation proxy | | | | | | (3.93) | (0.56) |
| Dummy for cash only deal | | | | | | -370.60* | -218.92 |
| | | | | | | (207.23) | (191.37) |
| Percentage paid by stock and options | 2.99 | 2.94 | 2.81 | 1.47 | 1.40 | -0.05 | 1.06 |
| | (1.84) | (1.83) | (1.83) | (1.66) | (1.58) | (1.71) | (1.49) |
| Technological overlap with Cisco | 1.92 | 2.45 | 0.61 | -3.08 | -2.76 | 0.72 | 3.33 |
| using number of patents granted | (3.23) | (3.42) | (3.12) | (3.55) | (3.60) | (3.16) | (3.32) |
| Trailing 6-month BHAR on Cisco's | 5.44 | 3.89 | 4.53 | 2.53 | 2.17 | 5.29 | 3.67 |
| Stock | (4.63) | (4.37) | (4.45) | (3.08) | (3.39) | (4.78) | (4.44) |
| Trailing 6-month returns on CRSP | 4.71 | 5.79 | 5.47 | 6.38 | 6.54 | 5.65 | 5.60 |
| V-W Index | (7.14) | (7.30) | (7.23) | (5.31) | (5.22) | (7.41) | (7.22) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.37 | 0.46 | 0.48 | 0.56 | 0.56 | 0.41 | 0.48 |

## Table A-20: Estimates of the value paid for target employees' human capital using 6-month returns of Cisco and market in place of 12-month returns

This table is a replication of table 6 from the paper using 6-month returns of Cisco and market in place of 12-month returns. The variable "Number of future Cisco patents generated by targets' employees" equals the sum total of Cisco patents generated by erstwhile target's employees after being acquired by Cisco. Fraction of target employees as inventors in Cisco equals the percent of total inventors in the target who file patents as Cisco employees after the acquisition. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012 for which data on number of employees is available; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Columns (5), (6) show results comparing the estimates of value paid for cash deals vs. others. They include interaction of employees with a dummy which equals one for 'cash only' deals and zero otherwise. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable: | Value of 100% equity ($ million) | | | | | |
|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Number of Employees | 2.343*** | 2.316*** | 2.325*** | 2.312*** | 5.259*** | 5.413*** |
| in the year of acquisition | (0.599) | (0.578) | (0.591) | (0.582) | (0.750) | (0.820) |
| Number of future Cisco patents | | 3.806** | | 2.613 | | -1.885 |
| generated by targets' employees | | (1.468) | | (1.876) | | (1.700) |
| Fraction of target employees as | | | 289.889 | 200.099 | | |
| inventors in Cisco | | | (235.448) | (276.255) | | |
| Dummy for cash only deal * | | | | | -3.525*** | -3.689*** |
| Number of employees | | | | | (0.730) | (0.806) |
| Dummy for cash only deal * Proxy | | | | | | 1.325 |
| for employee human capital | | | | | | (4.496) |
| Dummy for cash only deal | | | | | 165.964 | 155.105 |
| | | | | | (161.163) | (169.882) |
| Percentage paid by stock and options | 0.898 | 0.802 | 0.847 | 0.797 | -1.463 | -1.581 |
| | (1.375) | (1.408) | (1.393) | (1.427) | (1.961) | (2.015) |
| Technological overlap with Cisco | 5.602* | 4.799 | 4.375 | 4.204 | 3.989 | 4.173 |
| using number of patents granted | (3.196) | (3.168) | (2.661) | (2.708) | (2.619) | (2.833) |
| Trailing 6-month BHAR on Cisco's | 7.672 | 6.810 | 7.284 | 6.813 | 6.955 | 7.348* |
| Stock | (4.706) | (4.674) | (4.440) | (4.641) | (4.182) | (4.348) |
| Trailing 6-month returns on CRSP | -5.558 | -1.424 | -3.405 | -1.234 | -6.576 | -8.553 |
| V-W Index | (5.773) | (6.117) | (4.920) | (5.967) | (5.368) | (6.222) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 116 | 116 | 116 | 116 | 116 | 116 |
| Adjusted R-squared | 0.511 | 0.517 | 0.517 | 0.515 | 0.676 | 0.670 |

## Table A-21: Estimates of the value paid for the target's specialization to Cisco using 6-month returns of Cisco and market in place of 12-month returns

This table is a replication of table 7 from the paper using 6-month returns of Cisco and market in place of 12-month returns. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable | Value of 100% equity ($ million) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Citations from Cisco before acquisition | 44.757*** | | | |
| | (11.668) | | | |
| Citations from Cisco after acquisition | | 2.217*** | | |
| | | (0.345) | | |
| Self-citations before acquisition | | | 161.503*** | |
| | | | (27.588) | |
| Citations made to Cisco's patents by the target's patents | | | | 14.080*** |
| | | | | (4.216) |
| Percentage paid by stock and options | 3.957* | 3.442** | 2.419* | 3.707** |
| | (2.149) | (1.723) | (1.372) | (1.787) |
| Technological overlap with Cisco | 2.018 | 8.496* | 6.651 | 10.955** |
| using number of patents granted | (2.844) | (4.299) | (4.295) | (4.585) |
| Trailing 6-month BHAR on Cisco's | 4.659 | 4.400 | 4.787 | 2.985 |
| Stock | (3.960) | (4.706) | (4.711) | (4.837) |
| Trailing 6-month returns on CRSP | 6.629 | 3.530 | 7.720 | 4.338 |
| V-W Index | (6.649) | (7.625) | (8.160) | (7.114) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.474 | 0.370 | 0.417 | 0.180 |

## Table A-22: Estimates of the value paid for the target's attractiveness to Cisco's competitors using 6-month returns of Cisco and market in place of 12-month returns

This table is a replication of table 8 from the paper using 6-month returns of Cisco and market in place of 12-month returns. The dependent variable corresponds to the value paid by Cisco for 100% of the target's equity, which is calculated by dividing the actual value paid by Cisco by the percentage of equity acquired. The sample contains acquisitions by Cisco over the period 1993-2012; see table 2 for the steps involved in constructing this sample. Fixed effects for the year of announcement, target's 2 digit SIC code, and age cohort are included in all specifications. Standard errors reported in parentheses are robust to heteroscedasticity. ***, **, and * denote statistical significance at 1%, 5%, and 10% respectively.

| Dependent Variable | Value of 100% equity ($ million) | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Citations from Cisco's competitors before merger | 29.846*** | | | | |
| | (6.419) | | | | |
| Technological overlap with competitors | | -5.236 | | | |
| using number of patents granted | | (8.718) | | | |
| Technological overlap with competitors | | | -6.227 | | |
| using number of citations | | | (8.831) | | |
| Citations from Cisco before acquisition | | | | 30.779 | |
| | | | | (21.166) | |
| Self-citations before acquisition | | | | 46.926 | |
| | | | | (69.599) | |
| Citations from firms other than Cisco and itself | | | | 2.274 | |
| before acquisition | | | | (1.617) | |
| Number of Cisco's competitors citing the target | | | | | 91.009** |
| before merger | | | | | (43.360) |
| Percentage paid by stock and options | 2.787 | 3.846** | 3.853** | 3.227* | 2.685 |
| | (1.910) | (1.837) | (1.838) | (1.673) | (1.796) |
| Technological overlap with Cisco | -3.733 | 16.491 | 17.507 | 0.548 | -1.540 |
| using number of patents granted | (2.640) | (10.331) | (10.724) | (2.206) | (5.212) |
| Trailing 6-month BHAR on Cisco's | 4.789 | 2.645 | 2.455 | 5.229 | 4.551 |
| Stock | (3.940) | (3.983) | (3.916) | (4.187) | (4.772) |
| Trailing 6-month returns on CRSP | 7.106 | 5.667 | 5.906 | 6.641 | 7.932 |
| V-W Index | (6.316) | (7.811) | (7.817) | (7.295) | (7.185) |
| Year, Industry, Age FE | Yes | Yes | Yes | Yes | Yes |
| Observations | 122 | 122 | 122 | 122 | 122 |
| Adjusted R-squared | 0.526 | 0.133 | 0.137 | 0.506 | 0.281 |