Essays in Intangible Capital Reallocation, Mergers and Acquisitions and Financial Frictions

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I constantly remind myself of a verse my father once quoted from the great poet Allama Iqbal. These beautiful words have carried me through graduate school. It seems apt to end with them:

Tundi-e baad-e-mukhalif say na ghabra aey Uqaab,
(O Falcon! Worry not of the winds that hinder your flight,)
Yeh tou chalti hai tujhay ooncha urranay kay liye
(These winds are present to help you fly higher)
\- *Allama Iqbal*

Dedication

Abbu aur Ammi kay liay
(To my parents)

Abstract

This dissertation consists of three essays.

In the first essay, I document novel empirical facts at the aggregate and the firm level on the reallocation of tangible and intangible capital. First, at the aggregate level, I interpret firm physical capital sales data as tangible capital reallocation and data on mergers and acquisitions (M&As) data on intangible capital reallocation. I document the cyclicality patterns of the reallocation of both forms of capital. I show that in recessions, the correlation of intangible capital reallocation with GDP is greater than the correlation of tangible capital reallocation with GDP but in booms, the correlation of both types of capital reallocation with GDP are the same. I interpret this result as suggestive evidence that tangible capital serves a collateral motive which intangible capital does not since in recessions, firms choose to reallocate intangible capital over tangible. I also show that in the last decade the correlation of tangible capital reallocation with GDP has decreased to a quarter of its 1980s level. However, the correlation of intangible capital reallocation with GDP has remained the same in the last decade as in the 1980s. This result indicates that tangible capital collateralizability has become more important over time. Both these results show the distinctive cyclicality of the reallocation of both forms of capital. Second, at the firm level, I use data on M&As to document the effects of capital reallocation on firm productivity and the importance of including intangible capital when evaluating the effects of capital reallocation. I document that after an M&A, acquirer's structurally estimated productivity increases on average 4% annually, and this productivity is 45% higher when intangible capital is excluded from the estimation. This serves as evidence that capital reallocation is beneficial for the acquirers and intangible capital reallocation can account for measured productivity gains.

In the second essay, I contribute to the recent macroeconomics literature on financial frictions at a theoretical and a quantitative level. This literature attempts to quantify the magnitude of output fluctuations attributable to financial market disturbances through frictions on the reallocation of capital among firms. At the theoretical level, I build a model in which heterogeneous firms use two forms of capital, tangible and intangible capital, to

produce output. These firms are subject to idiosyncratic productivity shocks. I assume that only tangible capital is collateralizable and that both forms of capital are reallocatable across firms post-shock. I show that a financial market disturbance in the form of a tighter collateral constraint leads to a decline in output in the model with both forms of capital that is 2.8 times greater than the decline in output in the model with only tangible capital, in the sense, allowing for intangible capital magnifies the effects of financial market disturbances on output. A tighter collateral constraint causes tangible capital reallocation to decline sharply because firms are more constrained and leads to a fall in intangible capital reallocation because both types of capital are complementary in production.

In the third essay, I present novel empirical observations about mergers and acquisitions. I show that acquirer productivity increases after an merger or an acquisition and that these the ex-post productivity gains are an inverse function of the productivity difference between the acquirer and target at the time of the merger or an acquisition. I also note that the higher the ex-post productivity gains for an acquirer, the bigger the decline in acquirer announcement returns and smaller the increase in target announcement returns. Lastly, I show that the executive compensation increase does not account for most of the ex-post productivity gains. These findings show that gains after a merger or an acquisition are not accruing towards shareholders or executives. Thus, I find suggestive evidence that labor obtains the most benefit associated with a merger or an acquisition in the form of increased wages and benefits.

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Chapter 1

Micro and Macro Implications of Growth and Reallocation of Intangible Capital

1.1 Introduction

At the empirical level, this paper documents novel facts, at the firm-level and at the aggregate level, that serve as motivation for the model. At the firm-level, this paper notes facts on the effects of mergers and acquisitions (M&As). I interpret M&As as the primary source for intangible capital reallocation in the economy. I construct intangible capital stocks at the firm-level as the sum of research and development capital, and sales, marketing and administrative capital following Hulten and Hao (2008). First, I show that the structurally estimated productivity of acquirers increases by 4% annually, for three years after an M&A and, second, this productivity would be 23% higher if intangible capital and its reallocation are excluded from the previous analysis. The first result indicates that M&As are beneficial for acquirers. I interpret this result as evidence that capital reallocation yields an increase in output through a more productive use of capital. I show these results are robust to comparing the documented changes to two benchmarks: productivity changes of non-M&A firms and productivity changes of acquirers involved in exogenously failed M&As. The second firm-level fact indicates that firm-level measurements of intangible capital stocks account for a significant portion of the estimated productivity increase. This shows that intangible capital reallocation can partially account for the productivity gains experienced after M&As.

Figure 1.1 shows the time series growth rates of tangible capital, intangible capital and sales at the firm level. The stocks of tangible capital, intangible capital and sales are normalized to 100 at 1980. The figure shows that tangible capital and sales have grown at very similar growth rates over 1980-2010 but intangible capital has grown much faster. This suggests that over the time series, firms are choosing to accumulate intangible capital faster than tangible capital. This empirical evidence suggests that incorporating intangible capital into firm based aggregate models is key to study the aggregate phenomenon.

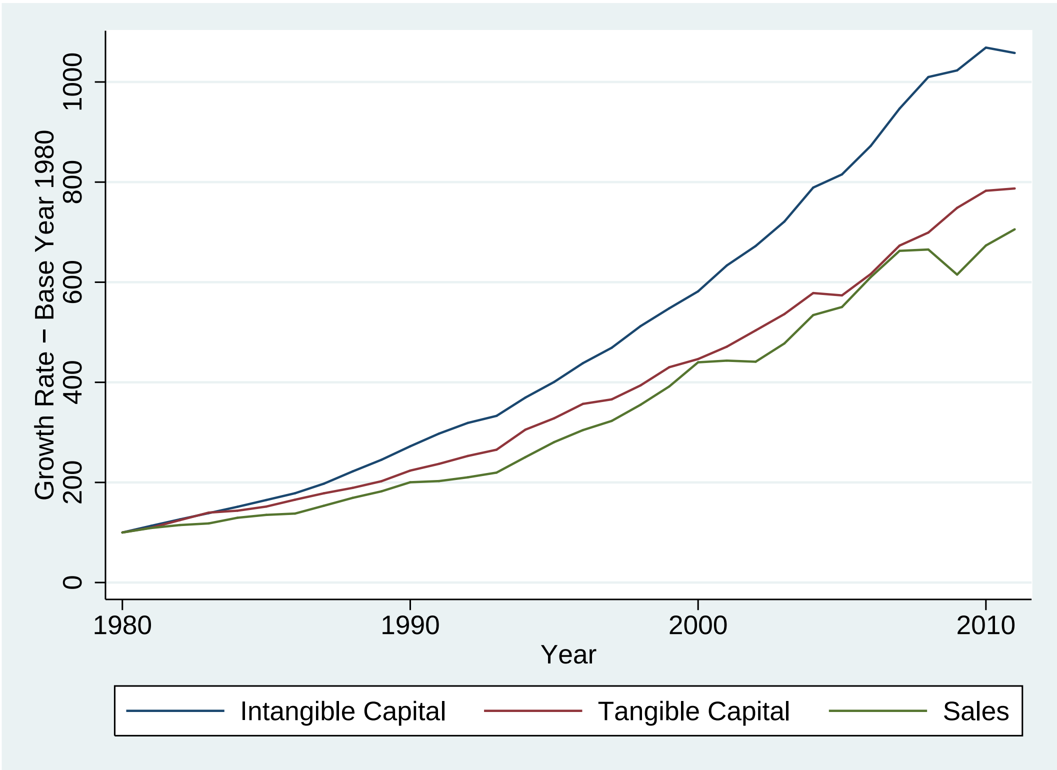

Figure 1.1: Time-series of the growth of sales, tangible and intangible capital.

At the aggregate level, this paper documents the cyclical properties on the reallocation of both forms of capital. In the data, I interpret tangible capital reallocation as the sum of physical capital sales on firms' balance sheet while I view intangible capital reallocation as the sum of the value of M&As in the economy. First, I show that in booms, the correlation of intangible capital reallocation with Gross Domestic Product (GDP) and the correlation of tangible capital reallocation with GDP are the same. In recessions, the correlations of both types of capital reallocation with GDP are higher than in booms. But the correlation of intangible capital reallocation with GDP is greater than the correlation of tangible capital reallocation with GDP. I interpret this result as suggestive evidence that, in recessions, firms choose to reallocate intangible capital over tangible capital as the latter serves a collateral motive. Second, I show that, in the last decade, the correlation of tangible capital reallocation with GDP has decreased to a quarter of its 1980s level. However, the correlation of intangible capital reallocation with GDP was the same in the last decade as in the 1980s. This result indicates that tangible capital reallocation has decreased in cyclicality over time while the cyclicality of intangible capital reallocation has remained unchanged. Both these results provide evidence of the distinct nature of the cyclicality patterns of the reallocation of both forms of capital.

The rest of the paper in arranged in the following format. In the next subsection, I discuss the related literature. Section 2 discusses the novel empirical facts. Section 3 presents two models, the benchmark model, with only tangible capital and its reallocation, and the second model with both forms of capital and their reallocation. Section 4 presents the quantitative results associated with both the models to show the amplifications effects from the addition of the second form of capital and its reallocation. Finally, section 5 concludes the paper.

1.1.1 Related Literature

My paper relates to multiple sets of papers. Another recent strand of macroeconomic literature my paper is related to can broadly be classified through Corrado, Hulten, and Sichel (2005), Atkeson and Kehoe (2005), Atkeson and Kehoe (2007) and McGrattan and Prescott (2010). These papers explore the effects of intangible capital on the aggregate economy. McGrattan and Prescott (2010) show that a good percentage of previously 'unexplained' economics growth can be accounted for using macroeconomic data on R&D investment. The main difference between my work and McGrattan and Prescott (2010) is that they work with a representative firm model and hence, in their model, there is no need for reallocation since capital is always allocated optimally. My model added dimensions of TFP heterogeneity and financial constraints allow for misallocation and hence the need for reallocation through a reallocation market. Another contribution of my paper to the literature is the firm-level structural estimation of the input shares of both tangible and intangible capital.

Intangible capital measurement at the firm level is also an active area of research as evidenced by Lev (2001), Hulten and Hao (2008) and Hulten (2010). My paper reports structurally estimated input shares of tangible and intangible capital using a modified versions of the methods of Hulten and Hao (2008) and Olley and Pakes (1996).

A paper closely related to mine is Eisfeldt and Rampini (2006) who posit the idea of reallocation being instantaneous while investment resulting in lagged benefit. I adopt the same difference between investment and reallocation. While Eisfeldt and Rampini (2006) use convex adjustment costs as the friction that hinders reallocation in their model, I use financial constraint which have been shown to have significant effects on the ability of acquirers to engage in M&As. I also add to their empirical results regarding the cyclical properties of reallocation by noting the increased cyclicality of M&As in the last decade and a decrease in the cyclicality of capital sales. I establish that the cyclicality of the two firms of reallocation moves in very different ways in terms of financial recession versus non-recession years: While capital sales exhibit the same cyclicality across financial recession versus non-recession years, M&As exhibit different correlation with GDP.

Another set of papers that started with Lichtenberg and Siegel (1990) examine estimated productivity changes at the plant-level, using data from the Longitudinal Research Database (LRD), after the change of ownership of the plant. Schoar (2002) finds that the effects on productivity of the newly acquired plants are positive, yet small at 1%. Maksimovic and Phillips (2001) also find that the sale of assets and plants result in mean productivity increases of 2%. Harris, Siegel, and Wright (2005) find productivity changes for UK plant sales to be quantitatively much higher than those reported for US LRD data. This paper finds large mean TFP changes at the firm-level at about 9.1-13.6% over a three year period. Why the difference? The larger point of this paper, using the differentiation of tangible capital and intangible capital is to suggest that the studies cited above look at productivity changes accruing from tangible capital sales but not from intangible capital sales. My data includes sale of both forms of capital and I show that the main gains associated with capital reallocation are a product of the intangible capital reallocation that occurs from less productive units to more productive units. A recent paper by Levine (2010) does a similar production function estimation to show productivity changes at the firm-level. A difference between this paper and Levine (2010) is that the latter focuses on the costs in firm accounts while the former uses the costs to construct intangible capital stock. Since Levine (2010) focuses on costs, the production technology only has tangible capital while, in this paper, the technology for production takes inputs of tangible and intangible capital.

My paper also has implications for the M&A literature. Within the set of ex-post M&A performance evaluation literature, there are two major strands[1]. The first is a literature in finance while the other is in industrial organization. Both use different sets of tools to understand the effects of M&As. Given both these literatures are large and the points made in this paper are not mainly associated with this literature, I will refer the interested reader to the cited survey articles.

1.2 Stylized Facts

In this section, I establish novel stylized facts on the effects of tangible and intangible capital reallocation at the aggregate and the firm level.

At the aggregate level, I establish facts on the cyclicality of capital reallocation using data on capital sales and mergers and acquisitions. The stylized aggregate facts are:

1. Reallocation of both forms of capital is procyclical with different magnitudes of cyclical movements during recessions

2. Recent years have seen divergent changes in the magnitudes of these cyclical movements.

[1]For an excellent recent survey, look at Andrade, Mitchell, and Stafford (2001). Older surveys include Jensen and Ruback (1983) and Jarrell, Brickley, and Netter (1988). For an older survey contrasting the IO and Finance approaches and results, see Caves (1989).

The aggregate level results provide evidence that the reallocation of each form of capital is unique. Hence, this data compels models that feature capital reallocation to consider both forms of capital and their reallocation rather than modelling one capital as a stand-in for both forms of capital.

At the firm level, I establish facts about the importance of intangible capital and its reallocation and show that precise measurements of intangible capital can help in accounting for puzzling TFP changes at the firm level after a merger or an acquisition. The firm level stylized facts established in this paper are:

1. Acquirer Total Factor Productivity (TFP) increases after the acquisition of capital

2. Ignoring intangible capital results in, at most, 23% higher measured TFP for the acquirer

The firm level results show that the acquisition of capital by a firm has positive effects for the acquiring firm. This is significant because this shows that reallocation, on average, is beneficial for the acquiring firm. This is in contrast to work on mergers and acquisitions that uses abnormal announcement returns to measure the effects of a merger or an acquisition. This work finds that acquiring firms' shareholders receive negative returns from a merger or an acquisition and use this to suggest that the returns for the acquiring firm are also negative. Given a merger or an acquisition can result in either tangible capital or intangible capital to be acquired, or both, using measurements of intangible capital as suggested by Hulten and Hao (2008), I measure how important firm level intangible capital stocks are in accounting for the productivity increase experienced by acquirers. I find that firm-level productivity would be, at most, 23% higher if intangible capital was ignored in these calculation. This suggests that intangible capital and its reallocation are important drivers of productivity changes at the firm-level.

In the next two subsections, I go into details related to both sets of novel facts and discuss in detail data construction and calculation and significance of the empirical results.

1.3 Capital Reallocation at the Aggregate Level

In this section, I use data on capital sales and mergers and acquisitions to verify[2] and extend the facts related to capital reallocation at the aggregate level. Eisfeldt and Rampini (2006) established that capitals sales and M&As are both procyclical and that M&As are more procyclical than M&As. I view capitals sales as the dominant form of tangible capital reallocation while I consider M&As as the chief way to reallocate intangible capital. Hence, I consider the evidence presented by Eisfeldt and Rampini (2006) as showing that both tangible and intangible capital reallocation is procyclical and that intangible capital reallocation is more procyclical than tangible capital reallocation.

I show that the cyclicality has become quantitatively less pronounced, in the last 10-15 years, for tangible capital reallocation while it has remained the same for intangible capital reallocation. This suggests that intangible capital is becoming more pervasive in the economy over time. I also find that the pattern of cyclicality for both forms of capital differs in recessionary years while is quantitatively similar in non-recessionary years. This suggests that firms prefer to reallocate intangible capital in recessionary years over tangible capital while opting to reallocate both forms of capital in a similar fashion in non-recessionary years.

1.3.1 Data Construction and Calculation

In this section, I go through the details of the data construction and the calculations[3] that lead to the results mentioned above.

I use data on capital sales in the US as reported on the balance sheets of firms in CompuStat from 1985-2010. The capital sales data tracks the reported sales of capital from one firm to another. Data on M&As is obtained for US firms as reported by SDC Platinum for 1985-2010. The SDC Platinum data is transaction-level data that reports dollar values of M&A transactions involving US firms. The GDP figures are obtained from the Bureau of Economic Analysis (BEA) for the same time period.

[2]The need for verification arises because the dataset of mergers and acquisitions that I use is different than Eisfeldt and Rampini (2006). My dataset is more expansive than the one they use. As I show later, the results of Eisfeldt and Rampini (2006) hold almost exactly in my dataset aswell.

[3]Both the construction and the calculations are the same as Eisfeldt and Rampini (2006), except the dataset on M&As is different in this paper.

The capital sales data tracks only capital sales, and not capital acquisitions, hence there is no issues related to double counting that need correction. After summing the firm capital sales by years, I take logs and use the Hodrick-Prescott (HP) filter (using a smoothing parameter of 100, which is standard for annual data) to separate out trend and cyclicality components from the data. Then, I use the CPI deflator to remove effects of inflation on the time-series data. The same exercise is conducted on the M&A transaction-level data to obtain a similar cyclicality dataset of M&As. Finally, GDP statistics are also separated into trend and cyclical components and deflated. This results in three time series that show the cyclical components of GDP, tangible capital reallocation and intangible capital reallocation.

I normalize each of the time series using the variance to allow for standard deviations from the mean to be reported. This exercise allows for comparison of the series.

The standard errors are corrected for heteroskedasticity and autocorrelation of the residuals ala Newey and West (1987) and computed using the Generalized Method of Moments (GMM) approach of Hansen, Heaton and Ogaki.

Figure 1.2 shows the results for the exercise. First, as reported by Eisfeldt and Rampini (2006), both series are procyclical. Second, tangible capital reallocation is more cyclical than intangible capital reallocation. The correlation of the cyclicality of physical capital sales, or tangible capital reallocation, with GDP variations is 0.4500 while the correlation of M&A cyclicality, or intangible capital reallocation, with GDP variations is 0.6120. These results are almost identical to the ones reported by Eisfeldt and Rampini (2006), hence showing that the use of a different dataset of M&As produces results that are consistent with established facts.

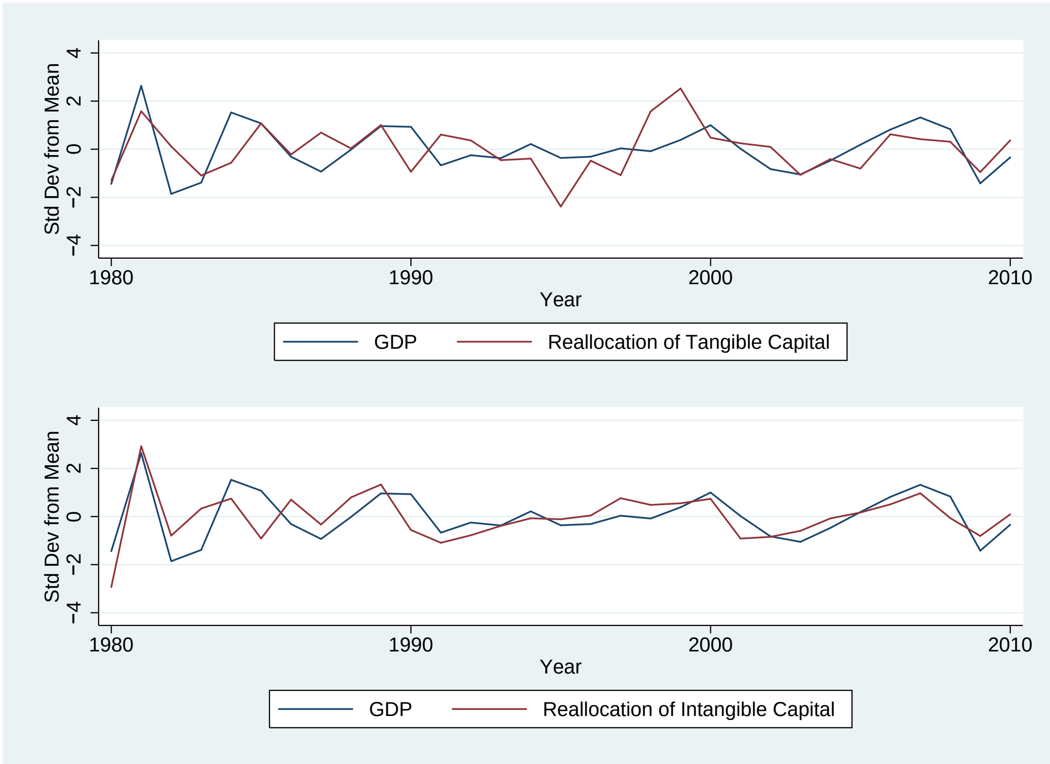

Figure 1.2: Time-series of the cyclicality of reallocation of tangible and intangible capital.

1.3.2 Results

In this section, I discuss the novel results established in this paper. The first result states that tangible capital reallocation is becoming less procyclical, over time, while intangible capital reallocation's procyclicality has remained unchanged. Table 1.1 presents the evidence associated with the first fact. As we can see, tangible capital reallocation exhibits a correlation with GDP of 0.45 in the last 31 years but in the last 15 years, this correlation has decreased to around 0.26. In the same period, the correlation of intangible capital reallocation with GDP has remained the same. If we look at the same statistics over the first and last 10 years, the numbers diverge even more. For this time period, the correlation of tangible capital reallocation with GDP does from 0.81 to 0.21, almost a quarter of what it used to be while intangible capital reallocation's correlation with GDP has remained essentially the same.

Time Period	**Capital Sales**	**M&As**	Years
Whole Sample	0.4500	0.6120	1980-2010
	(0.1017)	(0.1368)	
First 15 years	0.6140	0.6347	1980-1994
	(0.1446)	(0.1704)	
Last 15 years	0.2622	0.5955	1996-2010
	(0.1618)	(0.1444)	
First 10 years	0.8071	0.6764	1980-1989
	(0.1218)	(0.1912)	
Last 10 years	0.2108	0.7061	2001-2010
	(0.2398)	(0.1741)	

Table 1.1: Correlations with GDP of Tangible and Intangible Capital Reallocation over Different Time-Periods.

Hence, I find that over the time series, intangible capital reallocation is becoming more correlated with the business cycle while tangible capital reallocation is becoming less correlated with the business cycle. This suggests that, when trying to understand the effects of reallocation over the business cycle, there is a need to consider intangible capital reallocation as a separate phenomenon than tangible capital reallocation.

Time Period	**Capital Sales**	**M&As**	Years
Whole Sample	0.4500	0.6120	1980-2010
	(0.1017)	(0.1368)	
Financial Recessions	0.7625	0.8387	
	(0.1667)	(0.0718)	
Non-Recessions	0.4678	0.4236	
	(0.1001)	(0.2050)	

Table 1.2: Correlations with GDP of tangible and intangible capital reallocation for financial recessions years and non-recession years.

The second novel result established in this paper is that the magnitude of the correlation of tangible capital and intangible capital reallocation with GDP in non-recessionary years is the same yet different in years of financial recession. The evidence for this is presented in table 1.2. In specific, we can see that reallocation of both forms of capital exhibit procyclical magnitude of around 0.45 in non-recessions. But in times of financial recessions, these increase and are of different magnitudes. Value of M&As falls more than value of capital sales showing firms reallocate more intangible capital in financial recessions than they do tangible capital.

Hence, I find evidence that firms choose to identically reallocate both forms of capital in non-recessionary years but prefer to reallocate intangible capital over tangible capital in years of financial recessions. This suggests that tangible capital might be serving a special purpose in recession that intangible capital does not, a purpose that is severe in recessions and not in non-recessions. In my model, I use this evidence to justify collateralization of only tangible capital when borrowing for the purpose of reallocation. The data supports the assumption of intangible capital being uncollateralizable. Other studies have noted the uncollateralizability or the weaker collateralizability of intangible capital relative to tangible capital like Giglio and Severo (2012), Aghion, Askenazy, Berman, Cette, and Eymard (2012) and Carpenter and Petersen (2002), among others. Hence, an explanation consistent with the data in table 1.2 is that firms are unwilling to part with tangible capital since, during recessions, it serves a collateral motive, a motive that intangible capital does not serve, and this is the reason why tangible capital reallocation changes more dramatically when compared to intangible capital reallocation.

1.4 Capital Reallocation at the Firm Level

In this section, I establish novel empirical results on the effects of capital reallocation at the firm level with specific emphasis on the importance effects of intangible capital reallocation. The first fact is firms that acquire capital see an increase in TFP after the capital acquisition. I also show that the aforementioned increase in TFP would be 23% higher if intangible capital and its reallocation was ignored.

1.4.1 Data Construction

I use data on M&As from SDC Platinum from 1980-2008 and obtain firm financial data from CompuStat for 1977-2011. I merge the transaction-level data to the firm financial data to obtain financial data from income statements and balance sheets for the acquirer. Note, that since the CompuStat data is on public firms only, my panel will exclusively consist of M&A transactions undertaken by public firms but the targets are not necessarily public. I exclude transactions where the acquisition is of less than 50% ownership of the target as this potentially does not give the acquirers control over the target. I consider only transactions that are confirmed to be completed in my dataset.

An important element in the paper is how intangible capital is constructed since no measurements of intangible capital exist in firm's traditional 10-K financial accounts. Multiple studies suggest different methods of intangible capital based on differing definitions. This paper uses the definition of intangible capital as proposed by Hulten and Hao (2008). There are two main reasons why their method is adopted: First, they consider Sales, Marketing and General Administrative (SMA) Capital in addition to Research and Development (R&D) Capital as part of their definition of intangible capital. Since firm studies have suggested that the former is becoming a big part of the capital of a firm, it is appealing to include this under the definition of intangible capital. Second, the authors show that their accounting for intangible capital allows for accounting valuations that are closer to market values than any traditional accounting practices. Hence, this is suggestive evidence that their intangible capital calculations are an important element of a firm's capital.

Hulten Hao 'New' Accounting

CompuStat uses 10-K reports as the major source of firm financial data and 10-K reports do not account for intangible capital of firms. In order to fix this issue,as mentioned above, I utilize the methodology of Hulten and Hao (2008) to construct intangible capital stocks. The basic idea of their methodology is that some types of expenses of the firm are completely expensed in a firm's traditional accounts (and hence not capitalized), because of accounting rules, when they are, in fact, investments. Given that such expenses are for investment, Hulten and Hao (2008) argue that these should be capitalized and firm accounts should be adjusted to show the correct levels of capital as well as the correct levels of profits. They focus on two main expenses, Research and Development (R&D) expenses and Sales, Marketing and General Administrative (SMA) expenses. They claim that most of a firm's intangible capital lies in the form of these two capital stock and hence accounting for these should allow us to construct reasonable figures for the stocks of intangible capital. They suggest that all of R&D Expenses should be capitalized while 30% of SMA Expenses should be capitalized.

Their 'new' accounting affects two main sections of 10-K accounts. They are:

1. Income Statement
2. Balance Sheet

Under the 'new' accounting, in the income statement, the expenses are adjusted to reflect the idea that R&D and SMA expenses are investments. In doing the adjustment, these expenses are added back to reflect the 'correct' expenses for the period. That results in decreased expenditures for the period. Since no adjustments have been made to sales or other forms of income, this mechanically results in operating income (Op Inc) to increase. Hence, we have:

$$\text{`New' Op Inc}_{it} = (\text{10-K Op Inc}_{it}) + \text{R\&D Expenses}_{it} + 0.3^{*}(\text{SMA Expenses}_{it})$$

On the balance sheet side, a new item called 'Intangible Capital' is created that tracks the capitalized values of the combination of the R&D Expenses and SMA Expenses. I will refer to the capitalized value of the R&D Expenses as R&D Capital and the capitalized value of the SMA Expenses are SMA Capital.

To construct R&D Capital stock for firm i, Hulten and Hao (2008) use a perpetual inventory method resulting in each year's expenses in R&D to be added to the R&D Capital stock of the preceding year, after the stock has been adjusted for depreciation. The capital is discounted over a 10-year write-off period using quasi-hyperbolic or $\beta - \delta$ discounting. I use $\beta = 0.75$ and $\delta = 0.85$ when depreciating the capitals. Thus, the R&D Capital is defined as:

$$\text{R\&D Capital}_{it} = \sum_{s=t}^{s-10} \beta.\delta^{s}(Expenses_{is}^{R\&D})$$

Similar to the R&D Capital stock for firm i, Hulten and Hao (2008) construct the SMA Capital using a perpetual inventory method with depreciation over a 5-year write-off period. This depreciation is again using a quasi-hyperbolic pattern with $\beta = 0.75$ and $\delta = 0.85$. One difference in accounting for SMA capital is that Hulten and Hao (2008) impute that 30% of SMA expenses should be capitalized. Thus, SMA Capital is defined as:

$$\text{SMA Capital}_{it} = \sum_{s=t}^{s-5} \beta.\delta^s (0.3 * Expenses_{is}^{SMA})$$

After constructing these two capital statistics, Hulten and Hao (2008) define Intangible Capital as the sum of the two capital statistics constructed above. Thus, intangible capital is defined as:

$$\text{Intangible Capital}_{it} = \text{SMA Capital}_{it} + \text{R\&D Capital}_{it}$$

Other Adjustments

To estimate firm level TFP, which is the eventual purpose of this data exercise, one needs either values for input costs along with sales or data on value added. But as is common knowledge, CompuStat does not have data of material input costs nor wage bills as firms rarely declare these in their 10-K reports. Hence, tasked with such a problem, I use the strategy of Imrohoroglu and Tuzel (2011a) to construct wage bills at the firm level and add these to the 'new' operating income to obtain data on value added. The wage bill construction involves using number of employees and multiplying this with the average wage in the economy for the year[4]. The average wage data is obtained from the Bureau of Labor Statistics (BLS). Imrohoroglu and Tuzel (2011a) report that this estimate ends up being very accurate when compared to non-zero wage bills in 10-K reports. Therefore, the value added used in the firm level TFP estimation is:

$$\text{Value Added}_{it} = \text{`New' Op Inc}_{it} + (\text{Constructed Wages}_{it})$$

Hence, a firm's value-added is the sum of 'new' operating income, before deprecation,

[4]I have redone this exercise using average wages by industry at the 2-digit SIC code as reported by BLS and find that my results are not affected by this. Because the industry level data is only available from 1990 onwards, I revert of economy average wages to be able to look at productivity in the 1980s as well.

and the estimated total labor payments made by that firm.

An important adjustment that needs to be made for capital acquirers is, given intangible capital is constructed and does not appear in firm accounts, it needs to be adjusted for the acquirer, after acquisition of both forms of capital, to reflect the added intangible capital from the M&A. We do not need to do that for tangible capital or labor because these variables are adjusted in firm accounts and, hence, such adjustments show up in 10-K reports.

To do this, I follow a simple strategy by looking at the subset of my data where intangible capital stocks for the targets are available after the M&A and calculate the relative size of this stock to that of the target's eventual acquirer. Interestingly, I find that, even though the equity ratio of the target/acquirer is 1:20, the intangible capital ratio is 1:5 suggesting that most targets hold a more intensive ratio of their worth in intangible capital compared to their acquirer. This fact lends more credence to the idea that these acquirers are buying the targets for their intangible capital rather than for the tangible capital.

Given I find the 1:5 ratio in the subset of my data, I mechanically perform a 20% lump-sum and permanent increase in intangible capital of the acquirer right after the M&A. This adjustment allows me to reflect a more reasonable stock of intangible capital of the acquirer after the M&A.

Summary Statistics and Figures

The summary statistics of the acquirers in my data set is shown below. These are summary statistics are from the firm annual accounts before the M&A.

	Count	Mean	Std. Dev.	1st Qu.	Median	3rd. Qu
Sales	36857	4195.99	13883.42	87.23	426.64	1957.20
Tangible Capital	36892	2205.06	9289.93	25.01	142.10	832.46
Intangible Capital	36892	1260.64	4732.38	15.39	72.62	390.44
R&D Capital	24786	871.25	3101.21	1.00	23.18	195.68
Sales,Mkting,Admin Capital	36094	690.22	2424.16	12.32	54.59	281.30
Shareholder Equity	36880	1964.27	6881.15	44.81	196.93	869.42
Employees	36892	17.10	52.52	0.56	2.50	11.05
Capital / Sales	36335	14.75	381.95	2.24	4.26	8.09
Cost Goods Sold / Sales	36719	97.31	1656.55	46.84	63.42	74.85
Employees / Sales	36719	1.11	9.99	0.36	0.60	0.95
Gross Profit / Sales	36719	2.69	1656.55	25.15	36.58	53.16
Operating Income / Sales	36671	-39.63	1828.80	7.27	13.22	20.28
Shareholder Equity / Sales	36716	112.40	4282.11	28.53	47.05	83.50
Sales / Shareholder Equity	36854	392.50	18838.42	110.74	201.20	328.38
R&D Expenditure / Sales	22583	34.50	1077.67	0.54	3.15	10.95
Sales,Mkting,Admin Exp / Sales	35353	75.83	5794.57	13.63	22.52	36.69

Statistics before M&A

Table 1.3: Summary Statistics for Capital Acquirers.

The statistics in table 1.3 show the summary for the whole sample. These statistics comprise of mean, standard deviations and the quartiles. As we can see, the mean statistics are quite different from the median statistics. This is a well-known idiosyncrasy of CompuStat accounting data. This is because outliers on the right tail of the distribution (that is, very large firms) skew the statistics. This is evident from the fact that most mean statistics for the economic variables are higher than the values for the third quartile.

Table 1.3 shows that the firms in my dataset are mostly large firms since the median sales are $427 million and median employees are 2500. This is not surprising given that the firm financial data is on public firms. Since public firms are the main acquirers in M&As, it should be understood that issues related to small firms' capital acquisitions might be missed in this dataset. The larger point of this paper is about macroeconomic variables and since public firms account for most of the sales and account for most of the capital held by firms in the aggregate economy, concerns about how the biased dataset might paint an incorrect picture are mitigated to a large extent.

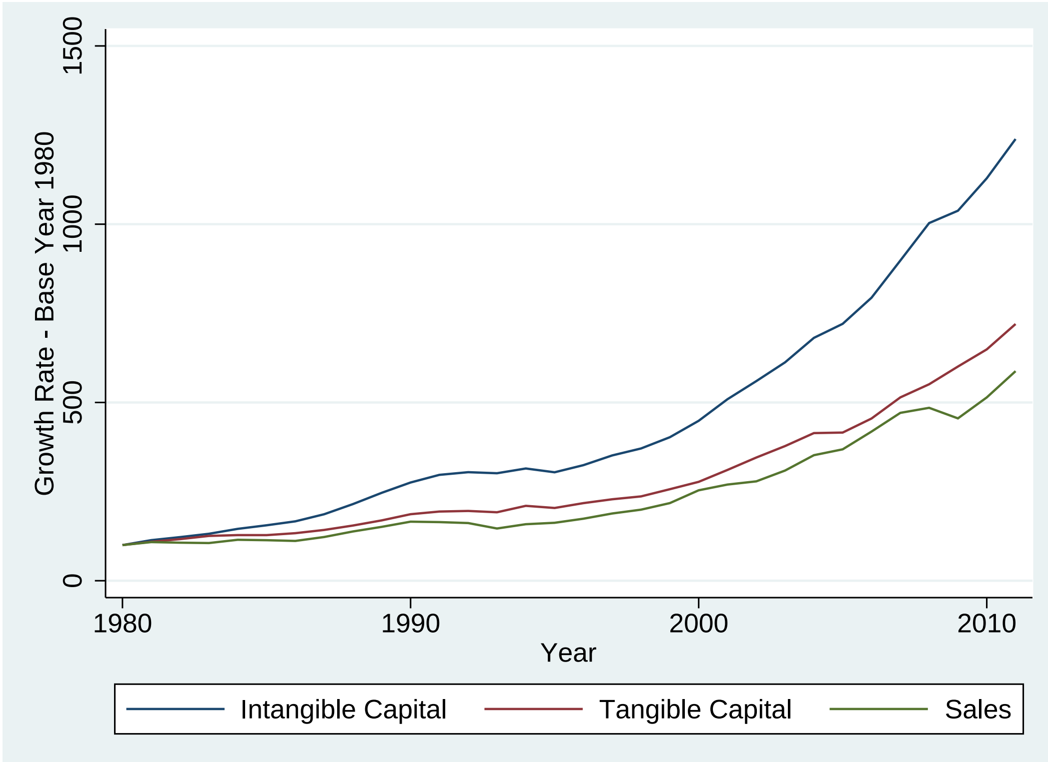

Figure 1.3: Time-series of the mean growth of firm-level sales, tangible and intangible capital.

Figure 1.3 shows the time series of the mean growth rates of sales, tangible capital stock and intangible capital stock. The 1980 levels of each of the three variables are normalized to 100. As we can see, the growth of intangible capital is much faster than that of tangible capital and sales, the latter two of which grow at the same rate for the time period. Figure 1.4 shows the growth rates of the two forms of capital relative to the sales growth rates. This drives the point of higher growth of intangible capital, relative to tangible capital, in a more drastic visual way.

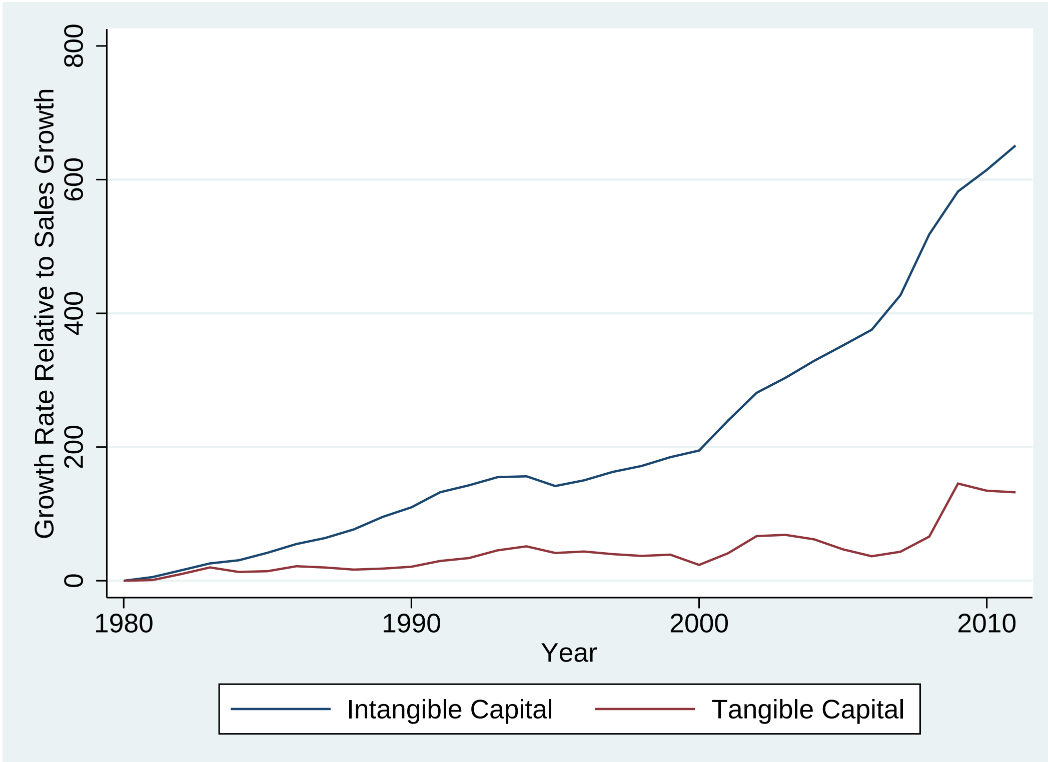

Figure 1.4: Time-series of the mean growth of tangible and intangible capital relative to sales.

1.4.2 Firm-Level TFP Estimation

This section details the exercise performed to calculate productivity of the firms. The purpose of the exercise is to obtain firm-level TFP, measured as the Solow residual, for the all firms in my panel, including capital acquirers. For the purpose of this exercise, I posit a production function that takes inputs as firm-level measurements of tangible capital, intangible capital and labor and structurally estimates the firm TFP.

The productivity calculation uses Olley and Pakes (1996)'s method, which is standard in estimating firm-level TFP. The reason this method is preferred over ordinary least squares (OLS) or fixed effects (FE) estimation procedures is because Olley and Pakes (1996) takes into account selectivity and simultaneity bias when backing out TFP. Olley and Pakes (1996) model is written for one capital model in which they use the investments in tangible capital as the proxy for estimating TFP. Given my model has two capitals, I use both investment of tangible and intangible capital as proxies for TFP and find that the model produces very similar results. Hence, in the paper, I only present the estimations that result from using tangible capital investments as a proxy for TFP.

Another important restriction that I place in my estimation is imposing constant returns to scale in the estimation[5]. To do this, I use the suggested method of Hall and Mairesse (1995) and recast my data in terms of 'per unit of tangible capital' and then impute the factor input for tangible capital. Because of this imputation, as will be seen, the tangible capital input share will not have a standard error associated with it.

I now provide the technical specification and details of the TFP estimation.

Assume each firm i has a Cobb-Douglas production function of the specification:

$$Y_{ijt} = A_{ijt} K_{ijt}^{\alpha} M_{ijt}^{\gamma} L_{ijt}^{\omega} e^{\lambda_1 t} e^{\lambda_2 j}$$

In the data, y_{it} is firm value added, A_{it} is firm's TFP, K_{it} is the tangible capital, M_{it} is the intangible capital, L_{it} is labor in number of employees, λ_1 the dummy variable for time and λ_2 is the dummy variable for industry. In my estimation, each period length is one year and the industry is specified by one-digit SIC codes[6]. As is standard in estimating TFP under a Cobb-Douglas production function, I take logarithms of the production function to obtain the following linear equation (where the lower cases letters denote logarithms of the variables):

$$y_{it} = a + \alpha k_{it} + \gamma m_{it} + \omega l_{it} + \lambda_1 (Year) + \lambda_2 (Industry)$$

Under constant returns to scale with respect to three inputs, the sum of the factor shares will be unity, i.e. $\alpha + \gamma + \omega = 1$.

When the tangible capital stock is dropped in an estimation, its factor share can be imputed by subtracting, from unity, the estimated factor share of the other inputs. This is

[5]The need for imposing this restriction resulted from the estimation from Olley and Pakes (1996) resulting in factor inputs that imply increasing returns to scale. Given the model has a production technology that is constant returns to scale, I impose this as a requirement in my estimation. The results without the CRS imposition are also presented.

[6]More detailed SIC industry definition results in problems in bootstrapping when the method of Olley and Pakes (1996) is used. The most detailed specification that works is one-digit SIC codes.

exactly the procedure that allows me to impose constant returns to scale in the estimation. One obvious drawback of this procedure is that it does not allow for standard errors to be computed during the estimation of the production function. As mentioned above, when estimating using the methods of Olley and Pakes (1996), I use the logarithm of the investment in tangible capital as the proxy for the TFP.

Estimation Results[7]

The detailed results of the estimation is presented in table 1.4. In this exercise, the factor elasticities are restricted to sum up to unity. Because of this restriction, I estimate my variables in terms of the Log of 'per-unit of tangible capital' and then impute the factor elasticity of tangible capital. In column (1), I show the results associated with standard ordinary least squares (OLS) regression, in column (2), I show the results for a fixed effects (FE) model while in the last column, I present the factor shares obtained using the method of Olley and Pakes (1996) (OP) to estimate firm-level TFP.

[7]I would like to thank Mahmud Yassar for his advice in using the methods of Olley-Pakes (1996).

	OLS	FE	OP
VARIABLES	Log of Value Added		
Log(Intangible Capital)	0.225***	0.139***	0.147***
	(0.000474)	(0.000854)	(0.00745)
Log(Labor)	0.534***	0.668***	0.535***
	(0.000571)	(0.000993)	(0.00199)
Imputed Log(Tangible Capital)	0.241	0.193	0.318
Observations	1,014,826	1,014,826	1,014,826
R-squared	0.777	0.522	
No. of Acq		61,473	

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 1.4: Estimated factor input shares.

The main result to note is the high factor share of intangible capital. As the table shows, the intangible capital factor share in production ranges from 0.139-0.241. As discussed, since the OLS and FE models are unable to give consistent estimates, we will utilize the factor share from Olley and Pakes (1996)'s method which is 0.147. The result is significant because this is the first attempt of estimating factor shares of intangible capital that is beyond just R&D. Factor shares for R&D have been reported in previous studies, for example Hall and Mairesse (1995), but no estimates currently exist of intangible capital under a broader definition like Hulten and Hao (2008)'s. Macroeconomic studies that have considered explicit intangible capital like McGrattan and Prescott (2010) have imputed this share from aggregate data as 0.074 which is almost half of my lowest estimate and almost a third of my highest estimate. This suggests that the importance of intangible capital in aggregate models might have been understated and that intangible capital might be quantitatively more important at the aggregate level than the exploration of previous studies.

1.4.3 Results

In this section, I establish and discuss the two main results associated with my micro-level data. First, I find that the firm-level TFP of acquirers increases after acquisition of both forms of capital (which is an M&A in the dataset) and, second, this increase in TFP would be much higher if intangible capital and its reallocation was ignored. The first observation points towards the importance of capital reallocation at the firm-level. It suggests that the movement of capital in the data is resulting in acquiring firms experiencing gains in their TFP. The second empirical observation points towards the importance of intangible capital and its reallocation by suggesting that if intangible capital was missing from the production function, the 'measured' TFP (which is the resultant TFP if intangible capital is unaccounted for) would be higher than what is estimated using intangible capital as an input in production.

The first result will be shown with an exercise and then two robustness checks will be conducted. In the main exercise, I show that the productivity of the acquirers increases 9.1-13.6% after an M&A in a three year period. Hence, this amounts to almost an annual productivity increase of 4%. In the first robustness exercise, I establish this firm-level TFP increase of the acquirers is 6.4-7% higher than the TFP change in non-M&A firms. Hence, I establish that acquirers' TFP increase is higher than the cross-section of all firms. To do this, I split my estimated TFP panel into sets of M&A conducting firms and non-M&A conducting firms. Then I construct a six year window (three prior to and three after) for M&As in each year and compare the changes in TFP for each acquirer against the average cross-sectional change in TFP of the non-M&A firms in the years before and after the M&A year. This allows to evaluate the veracity of the results by comparing them with a benchmark, in this case firm cohorts that do not engage in capital acquisition. In the second exercise, I conduct the natural experiment to evaluate the changes in the firm-level TFP of the acquirers by comparing them to the benchmark of firms that tried to engage in a capital acquisition but failed to do so because of an exogenous reason. Hence, I conduct a difference-in-difference exercise with the control group for my experiment as the set of 'exogenously' failed M&As. Given the well-known endogeneity issues present in failed M&As and the difficulty of parsing out an acceptable set of 'exogenously' failed

M&As, I use the dataset of Savor and Lu (2009) of exogenously failed M&As[8].

The second result, which shows the importance of intangible capital and its reallocation in accounting for firm TFP changes after capital acquisition, is established by comparing the change in logarithm TFP (when intangible capital and its reallocation is included) with the change in logarithm of TFP (when intangible capital and its reallocation is ignored). For convenience, I will refer to the latter as measured TFP as opposed to TFP. The idea is to then look at the TFP increase from the two exercises and account the difference across the two exercises as the contribution of intangible capital and its reallocation in the TFP increase.

An important technical note for working with my panel is that I have a dynamic panel which was established using the Fisher-type Augmented Dickey Fuller test. Given I have a dynamic panel, the relevant regressions that I consider are the Arellano and Bond (1991) one-step and two-step regressions. To obtain consistent standard errors for these, I use robust standard errors for the two-step regressions while the standard errors for the one-step regressions are GMM computed.

Result 1: Acquirers' TFP Increases from a Capital Acquisition

In this section, I establish that the acquirers involved in capital acquisition (or, equivalently, M&As) experience a significant and positive TFP increase after the acquisition. I establish this by documenting changes in estimated TFP at the firm level in a three year window after an M&A. Then, I show that these results are robust by conducting two exercises that I discuss in the next sections. In the first one, I show the increase in the TFP exists when controlling for TFP changes in the cross-section of firms that do not engage in capital acquisition in my panel. In the second one, I show that comparing completed capital acquisitions with exogenously failed capital acquisitions still results in evidence of positive TFP increases for the capital acquirers.

The first finding that acquirer TFP increases at the firm level is established by showing changes at the firm-level of the estimated TFP from the previous section. This is the most obvious way to see the results from the M&A. To achieve this, the following general OLS

[8] I would like to thank Pavel Savor for sharing his dataset that indentifies exogenously failed M&As.

specification equation is used:

$$\begin{aligned} \ln TFP_{it} &= a_i + b(Lagged\ \ln(TFP)) + c(AFTER) \\ &\quad + d(SIZE_{it}) + e(PAYMENT\ METHOD) + \epsilon_{it} \end{aligned} \tag{1.1}$$

I now discuss each of the terms of (1.1). First, given the knowledge that the structurally estimated panel of TFP is dynamic, I have the previous period's TFP as a term on the right hand side (RHS). This is referred to as '$Lagged\ \ln(TFP)$'. I construct a dummy variable '$AFTER$' that is 0 for years before the M&A and 1 for years after the M&A. I also control for firm size effects and the payment method of the M&A using '$SIZE$' and '$PAYMENT\ METHOD$' variables in the regression respectively. Here size is measured as the equity value of the firms twenty days before the M&A and the variable '$SIZE$' splits the sample into 5 quintiles. The reason these are important is because we know from previous studies that firm-level TFPs are highly correlated with firm size, and hence, controlling for effects related to size is important. Lastly, payment method is considered since it has been shown in the M&A literature to result in significant effects on the economic effects of the M&A. Thus, I use dummy variable '$PAYMENT\ METHOD$' that controls for different payment methods.

	OLS 1	OLS 2	OLS 3	FE 1	FE 2	AB 1	AB 2
VARIABLES				ln TFP			
Lag ln(TFP)	0.959***	0.902***	0.903***	0.654***	0.592***	0.387***	0.468***
	(0.000313)	(0.000617)	(0.000631)	(0.00149)	(0.00198)	(0.00147)	(0.00502)
AFTER	-0.0145***	0.00633***	0.00573***	0.115***	0.106***	0.136***	0.0911***
	(0.00139)	(0.00154)	(0.00154)	(0.00138)	(0.00158)	(0.00127)	(0.00183)
SIZE							
SIZE 2		0.149***	0.149***		0.161***		
		(0.00253)	(0.00253)		(0.00334)		
SIZE 3		0.217***	0.216***		0.302***		
		(0.00273)	(0.00273)		(0.00425)		
SIZE 4		0.269***	0.268***		0.420***		
		(0.00307)	(0.00308)		(0.00517)		
SIZE 5		0.408***	0.404***		0.536***		
		(0.00380)	(0.00382)		(0.00659)		
PAYMENT							
COMBINED			0.0193***				
			(0.00331)				
OTHER			0.0245***				
			(0.00195)				
STOCK			0.0509***				
			(0.00326)				
UNKNOWN			0.0223***				
			(0.00247)				
Constant	0.261***	0.185***	0.164***	0.835***	0.769***	1.383***	1.157***
	(0.00119)	(0.00186)	(0.00234)	(0.00287)	(0.00493)	(0.00287)	(0.00999)
Observations	201,599	130,120	130,120	201,599	130,120	189,542	189,542
R-squared	0.979	0.981	0.981	0.675	0.663		
No. of Acq				38,547	35,782	37,846	37,846

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.5: Post-acquisition change in TFP for acquirers.

The results of the exercise are shown in table 1.5. Columns (1), (2) and (3) present the results for different versions of the OLS regressions, columns (4) and (5) present the results using the fixed-effects model while columns (6) and (7) presents the results using the Arellano and Bond (1991) 1-step and 2-step regressions respectively. The standard errors for the one-step regression are obtained using GMM while the two-step regression has robust standard errors.

I will focus on the results from the Arellano and Bond (1991) regressions in columns (6) and (7) since for dynamic panels these are the ones that present the consistent standard errors. As we can see, the AFTER dummy shows that firms that engage in M&As see 9.1-13.6% higher TFP over a three year period. That is a significant advantage for the firms that engage in an M&A.

Given this exercise might be sensitive to measurement methods, I conduct two additional exercises with different benchmarks to show that the performance of M&A acquirers is better than other benchmarks. This is to argue that the reason M&A acquirers perform better is, seemingly, because of the capital acquisition and not because of an exogenous reason.

Controlling for TFP Growth of Firms that Do Not Acquire Capital

This section presents evidence that shows that the TFP increase of capital acquirers (firms that engage in M&As) is positive and significant even after controlling for changes in the TFP of firms that do not acquire capital (firms that do not engage in M&As) in my panel. Hence, the control group of non-M&A cohorts is used as a benchmark. This benchmark is constructed for a 6 year window around each year in which M&As occur using the average TFP change for the firms that never engaged in M&As.

An obvious issue that exists with this exercise is selection. Firms that engage in M&As self-select themselves into a special group of firms, a group that might be biased in different ways compared to firms that do not engage in any M&As. As much as this issue is important, this exercise provides a very useful benchmark if capital acquirers do see positive gains from the acquisition. Hence, the purpose here is to make sure that any cross-sectional changes in TFP can be controlled for. Another justification for this exercise is that recognizing this bias, I can build the same bias in my theoretical model which will allow for more appropriate comparison. The general OLS specification equation which is estimated is:

$$\begin{aligned} \ln TFP_{it} &= a_i + b(Lagged\ \ln(TFP)) + c(Non - M\&A\ TFP) + d(AFTER) \\ &\quad + e(SIZE_{it}) + f(PAYMENT\ METHOD) + \epsilon_{it} \end{aligned} \tag{1.2}$$

I now discuss each of the terms of (1.2). First, given the knowledge that the structurally estimated panel of TFP is dynamic, I have the previous period's TFP as a term on the RHS. This is referred to as '$Lagged\ \ln(TFP)$'. Given the benchmark in this exercise is the TFP of non-M&A firms in the cohort that existed in a 6 year window at the time of the M&A, I use variable '$Non-M\&A\ TFP$' which is the average change in the firm-level TFP annualized. I construct a dummy variable '$AFTER$' that is 0 for years before the M&A and 1 for years after the M&A. I also control for firm size effects and the payment method of the M&A using '$SIZE$' and '$PAYMENT\ METHOD$' variables in the regression respectively. Here size is measured as the equity value of the firms twenty days before the M&A and the variable '$SIZE$' splits the sample into 5 quintiles. The reason these are important is because we know from previous studies that firm-level TFPs are highly correlated with firm size, and hence, controlling for effects related to size is important. Lastly, payment method is considered since it has been shown in the M&A literature to result in significant effects on the economic effects of the M&A. Thus, I use dummy variable '$PAYMENT\ METHOD$' that controls for different payment methods.

	OLS 1	OLS 2	OLS 3	FE 1	FE 2	AB 1	AB 2
VARIABLES				ln TFP			
Lag ln(TFP)	0.959***	0.902***	0.902***	0.615***	0.545***	0.347***	0.375***
	(0.000321)	(0.000621)	(0.000634)	(0.00150)	(0.00197)	(0.00149)	(0.00495)
Non-M&A	0.0144***	-0.0218***	-0.0214***	0.614***	0.637***	0.792***	0.830***
	(0.00184)	(0.00211)	(0.00212)	(0.00631)	(0.00754)	(0.00635)	(0.00738)
AFTER	-0.0142***	0.0122***	0.0116***	0.0582***	0.0616***	0.0704***	0.0644***
	(0.00142)	(0.00157)	(0.00157)	(0.00152)	(0.00167)	(0.00141)	(0.00148)
SIZE							
SIZE 2		0.153***	0.153***		0.152***		
		(0.00253)	(0.00253)		(0.00321)		
SIZE 3		0.223***	0.223***		0.287***		
		(0.00275)	(0.00276)		(0.00409)		
SIZE 4		0.278***	0.277***		0.402***		
		(0.00311)	(0.00312)		(0.00498)		
SIZE 5		0.419***	0.415***		0.512***		
		(0.00387)	(0.00390)		(0.00636)		
PAYMENT							
COMBINED			0.0199***				
			(0.00332)				
OTHER			0.0257***				
			(0.00196)				
STOCK			0.0464***				
			(0.00326)				
UNKNOWN			0.0219***				
			(0.00248)				
Constant	0.263***	0.184***	0.163***	0.883***	0.837***	1.425***	1.390***
	(0.00120)	(0.00187)	(0.00235)	(0.00281)	(0.00475)	(0.00284)	(0.0118)
Observations	196,983	127,481	127,481	196,983	127,481	185,071	185,071
R-squared	0.979	0.981	0.981	0.701	0.695		
Firm FE	No	No	No	Yes	Yes	Yes	Yes
No. of Acq				37,594	34,895	36,896	36,896

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 1.6: Controlling for TFP change with TFP changes of firms that do not acquirer capital.

The results of the exercise are shown in table 1.6. Columns (1), (2) and (3) present the results for different versions of the OLS regressions, columns (4) and (5) present the results using the fixed-effects model while columns (6) and (7) presents the results using the Arellano and Bond (1991) 1-step and 2-step regressions respectively. The standard errors for the one-step regression are obtained using GMM while the two-step regression has robust standard errors.

I will focus on the results from the Arellano and Bond (1991) regressions in columns (6) and (7) since for dynamic panels these are the ones that present the consistent standard errors. As we can see, the AFTER dummy shows that firms that engage in M&As see 6.4-7% higher TFP than firms that do not engage in M&As in the panel. That is a significant advantage for the firms that engage in an M&A.

Economic reasons as to why the capital acquirers see an increased TFP can be a few. One plausible explanation is that the capital acquirers are able to transfer capital into their firm which they utilize more efficiently than the previous owners. This can occur because the acquirers understand that, because of one reason or another, they have the resources to most effectively utilize the capital in production.

Another explanation for this result can be one of complementarities, an idea has gotten attention in the M&A literature as well. Here the argument would be that the capital acquirers buy capital that works well in complementing their existing stock of capital and hence they experience some form of complementarities, or increasing returns, from the joining of the old and the new capital.

Selection might also be a reason for these results. If we take as a given that M&A acquirers are more productive firms to begin with, the addition of capital will make their returns be better than the ones of their non-acquiring cohorts since they were more productive to start with. Given this problem, I conduct the next exercise to try to allay this concern.

Difference-in-Difference with Acquirers of Exogenously Unsuccessful Capital Acquisitions

This section presents evidence that capital acquirers that are able to complete a capital acquisition perform better than their counterparts that are unable to complete a capital acquisition. This is the natural experiment when evaluating M&A performance and is commonly explored in the M&A literature. The benchmark to which capital acquirers'

TFP will be compared is the performance of the potential acquirers who were unable to complete their capital acquisition. Hence, the control group for this experiment are failed M&As. The method of analysis will be the standard difference-in-difference approach and I will argue that the counterfactual for M&A acquirers would have been lower TFP.

The choice of the failed M&As as a benchmark is natural since it alleviates concerns related to selection, a weakness of the analysis presented in the previous section. Hence, having firms that self-selected themselves into attempting to undertake an M&As allows the selection bias concerns to be alleviated.

There is a well-known endogeneity issue that has to be addressed when doing the natural experience in M&As. That issue is that failed M&As might have failed because of endogenous reasons i.e. an M&A might have not been completed because an acquirer found out, for example, in the process of due-diligence, that the target is not an attractive proposition resulting in the M&A to be abandoned by the acquirer. This would result in the M&A being termed 'failed' M&A in my dataset yet it would have failed for endogenous reasons that would bias the TFP measurements that are obtained from the sample. I attempt to address this issue by using the dataset of Savor and Lu (2009) who meticulously construct a set of exogenously failed M&As. I utilize their dataset and estimate the productivity of the potential acquirers that were involved in the 'exogenously' failed M&As. This is my control group for this exercise. One change I make to the dataset of Savor and Lu (2009) is that they classify M&As that were denied by regulators (SEC, Justice Department, etc) as exogenously failed M&As. In my dataset, given I use value added, if an M&A would increase the acquirer's monopoly power, this would result is higher TFP in my estimation results. Thus, for my analysis, these M&As should be excluded from the set of exogenously failed M&As.

A drawback of using the dataset of Savor and Lu (2009) is the small sample of exogenously failed M&As that span from 1966-2003. Since my data is from 1980 onwards, I consider only the successful M&As that were undertaken in 1980-2003 when doing the difference-in-difference exercise. Hence, because of the small sample in the control group, as will be shown below, my results suffer from the lack of statistical significance.

To undertake the difference-in-difference exercise, after constructing the control group as described above, I generate dummy variables '$M\&A$' and '$AFTER$', where the former is 1 when an M&A is successful and 0 otherwise and the latter is 1 for periods after the M&A and 0 otherwise. The term '$M\&A$x$AFTER$' is the interaction term of the '$M\&A$' and '$AFTER$' terms or the term that measures the first difference with respect to the control group and second difference compares the performance before and after the M&A. As mentioned earlier, given that I find that my panel is dynamic, I also include '*Lagged* $\ln(TFP)$' on the RHS. I also control for firm size using the quintile variable '$SIZE$', which splits into 5 groups, the equity of the acquirer twenty days prior to the date of announcement of the M&A. Lastly, I also control for the payment method using the dummy variable '$PAYMENT\ METHOD$'. Hence, the general OLS specification that use is:

$$\begin{aligned} \ln TFP_{it} &= a_i + b(\ln TFP_{it-1}) + c(M\&A) + d(AFTER) \\ &+ e(M\&A * AFTER) + f(SIZE_{it}) + g(PAYMENT\ METHOD) + \epsilon_{it} \end{aligned}$$

	OLS 1	OLS 2	OLS 3	FE 1	FE 2	AB 1	AB 2
VARIABLES				ln TFP			
Lag ln(TFP)	0.955***	0.891***	0.892***	0.635***	0.574***	0.396***	0.477***
	(0.000395)	(0.000743)	(0.000760)	(0.00171)	(0.00222)	(0.00169)	(0.00544)
M&A x AFTER	0.0814	0.118	0.114	0.0833	0.0463	0.0552	0.0229
	(0.0947)	(0.105)	(0.105)	(0.0793)	(0.0916)	(0.0916)	(0.0333)
M&A	-0.0952	-0.160*	-0.161*				
	(0.0698)	(0.0824)	(0.0824)				
AFTER	-0.0808	-0.0904	-0.0871	0.0733	0.102	0.114	0.0927**
	(0.0947)	(0.105)	(0.105)	(0.0793)	(0.0915)	(0.105)	(0.0333)
SIZE							
SIZE 2		0.172***	0.172***		0.162***		
		(0.00306)	(0.00306)		(0.00390)		
SIZE 3		0.257***	0.256***		0.312***		
		(0.00327)	(0.00328)		(0.00495)		
SIZE 4		0.322***	0.320***		0.431***		
		(0.00365)	(0.00367)		(0.00595)		
SIZE 5		0.464***	0.460***		0.570***		
		(0.00448)	(0.00452)		(0.00756)		
PAYMENT							
COMBINED			0.0224***				
			(0.00409)				
OTHER			0.0217***				
			(0.00246)				
STOCK			0.0293***				
			(0.00368)				
UNKNOWN			0.0155***				
			(0.00306)				
Constant	0.373***	0.327***	0.311***	0.787***	0.691***	1.220***	1.035***
	(0.0698)	(0.0824)	(0.0824)	(0.00284)	(0.00518)	(0.00286)	(0.00983)
Observations	142,870	92,548	92,548	142,870	92,548	133,010	133,010
R-squared	0.976	0.979	0.979	0.704	0.696		
Firm FE	No	No	No	Yes	Yes	Yes	Yes
No. of Acq				27,709	25,790	27,145	27,145

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.7: Difference-in-Difference with control group as exogenously failed M&As.

The results of the exercise are presented in 1.7. Columns (1), (2) and (3) present the results for different versions of the OLS regressions, columns (4) and (5) present the results using the fixed-effects model while columns (6) and (7) presents the results using the Arellano and Bond (1991) 1-step and 2-step regressions respectively. Again, the standard errors for the 1-step Arellano and Bond (1991) regression are computed using GMM while the 2-step regression have robust standard errors for consistency.

As previously done, I will focus on the results from the Arellano and Bond (1991) regressions. The difference-in-difference exercise shows that the firms that were able to follow through with the M&A experienced in the range of 2.3-5.5% higher TFP than acquirers that were unable to follow through with the M&A. Unfortunately, as eluded to previously, the results are not statistically significant because of small sample issues. Hence, even though this exercise results in us failing to reject the null, it allows us to see how the returns across successful and failed M&As differ.

Discussion

The results from the two exercises above provide evidence to suggest that the productivity increases estimated for the capital acquirers would be potentially less (or even negative) if the acquisition had not occurred. This result is significant because it suggests that M&As, in fact, help the acquiring firms improve their performance.

One of the most accepted conclusions from the M&A literature is that capital acquirers experience negative returns after the acquisition of capital, a conclusion that is in conflict with my results and hence this warrants a discussion. Given the well-known problems associated with long-run studies using abnormal stock returns[9], I will consider only short-run abnormal studies which conclude that the acquirers' value decreases (-3 to -5% abnormal returns) in a short window around the announcement of the M&A.

These studies base this conclusion on measuring the abnormal returns in the stock price after the public announcement of the M&A. My results show that the capital acquirer is experiencing positive gains but is silent as to where these gains might be accruing making comparison somewhat tricky. Since this issue is outside the scope of this paper, I will quickly discuss this. In Barlas (2012), I discover that these gains might be accruing towards management and labor. Hence, what this means is that even though the M&A literature

[9]For an excellent paper on the issues associated with long-run abnormal returns exercises, look at Mitchell and Stafford (2000). Other papers discussing the issue are Barber and Lyon (1997), Kothari and Warner (1997), Lyon, Barber, and Tsai (1999) and Brav (2000).

is correct in calculating the negative returns for the shareholders of the firm, this does not mean that the firm itself is experiencing negative returns. In fact, what I find is that the negative returns of the shareholders might be a result of management and workers obtaining the gains associated with the capital acquisition. For effects of M&A for acquirer management, there is work that finds that managers see increased compensation, through payments like golden parachutes, as discussed by Martos-Vila (2008) and references therein. This presents a very interesting light to M&As in general but since it is inherently outside the scope of this paper, I will leave this issue for now and refer the reader to Barlas (2012).

A separate issue, brought to light recently in Ahern and Sosyura (Forthcoming), is the veracity of conclusions based on announcement returns. Ahern and Sosyura (Forthcoming) find that the short-run studies suffer from problems since it is difficult to parse the effects of an M&A. They claim that announcements such an those of M&As are made hand in hand with other corporate announcements. Hence, it is difficult to say if the price reaction was purely attributed to the M&A announcement or to some other announcement. Hence, the comparison of my results with those of stock market reaction studies seems not very clear cut given the differing nature of my approach and the traditional announcement returns approach in evaluating M&As.

Result 2: TFP Increase Attributable to Measured Intangible Capital

In this section, I establish the second main result associated with the micro-level data: A significant portion of the productivity increase mentioned in the section above can be accounted towards firm-level measurements of intangible capital. Here, intangible capital defined using the definition of Hulten and Hao (2008). This results highlights the importance of intangible capital and its reallocation in accounting for increases in firm-level TFP for capital acquirers.

For the purpose of elucidating this point, I will borrow language from McGrattan and Prescott (2010) and compare TFP and 'measured' TFP at the firm level. To do so, define TFP, denoted TFP, as the structurally estimated TFP using Olley and Pakes (1996) as shown previously. Define 'measured' TFP $\widehat{TFP}$ as:

$$\widehat{TFP} = TFP + \beta_{IC} * Log(\text{Intangible Capital})$$

where β_{IC} is the estimated coefficient of the logarithm of intangible capital.

The idea for this comparison is simple: If intangible capital and its reallocation are not significant for firm-level TFP changes established above, we will find that the difference between the estimates using the two would be very similar. Hence, the difference of the results obtained using the two measures of TFP can shed light on the magnitude of importance of intangible capital and its reallocation.

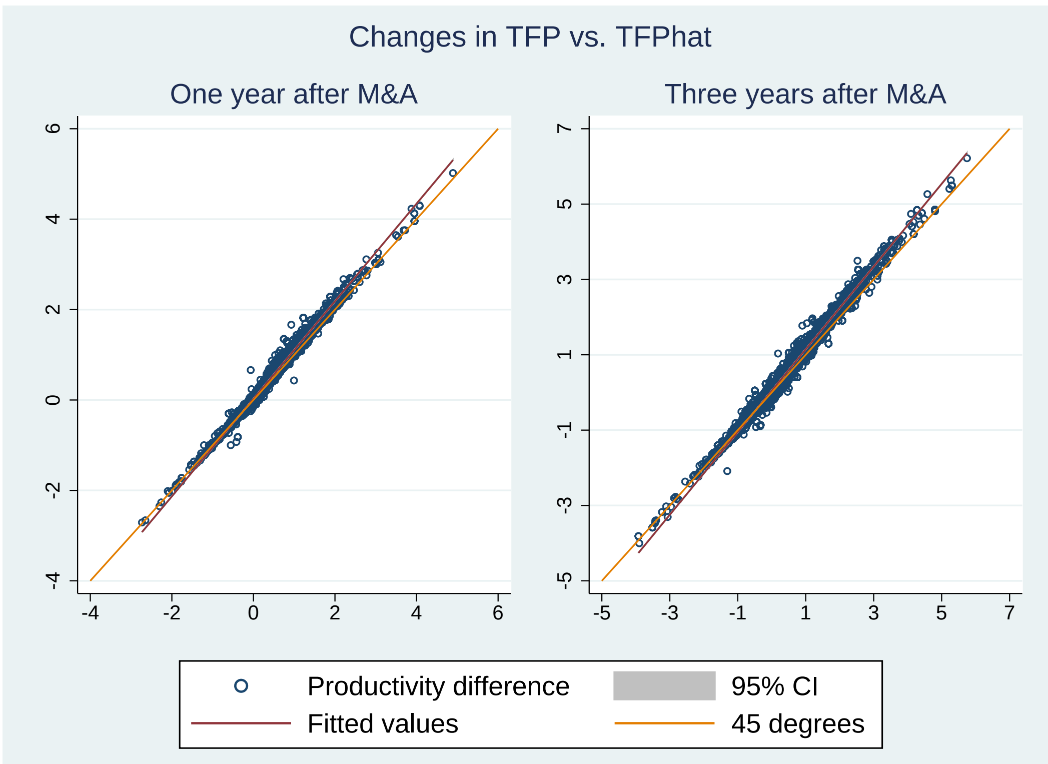

Figure 1.5: Scatter plot showing the difference between TFP and $\widehat{TFP}$ one year and three years after the capital acquisition.

The scatter plots found in figure 1.5 give a crude picture of the result. On the x-axis is the change in the structurally estimated firm-by-firm TFP after the M&A and on the y-axis is the change in $\widehat{TFP}$. Hence, when an observation is above the 45° line, that means that $\widehat{TFP} > TFP$ suggesting that not accounting for intangible capital or its reallocation results in higher TFP measures. The column plots show snap shots of the comparison of

TFP and $\widehat{TFP}$ at different time periods after the M&A, namely one-year and three-years after. Both scatter plots tell the same story: Estimated TFP would have been higher if intangible capital and its reallocation are unaccounted for. In specific, the best fit line, shown in red, suggests that, conditional on most data accumulating above the 45° line, the differences between TFP and measured TFP are significant. Hence, this scatter plot shows in a crude way that intangible capital and its reallocation are critical in accounting for changes in the acquirer TFP that are observed after capital acquisition.

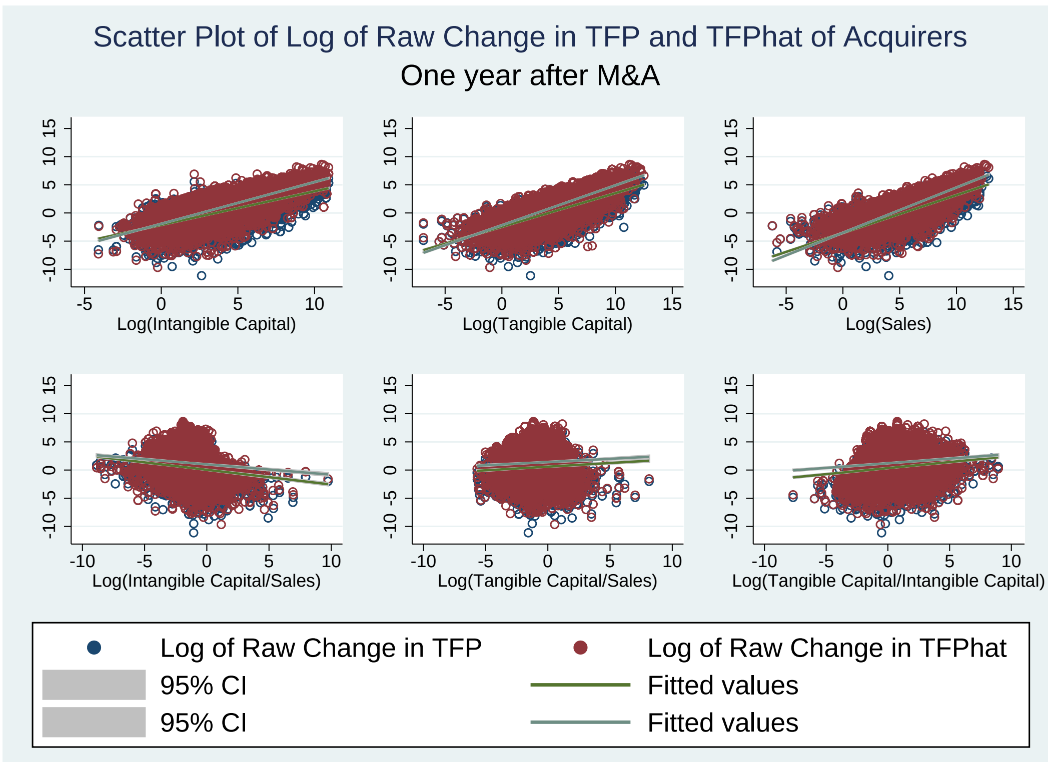

Figure 1.6: Scatter plot of Log Change in TFP and $\widehat{TFP}$ for capital acquirers

The next two scatter plots, found in figures 1.6 and 1.7 show each firm observation for TFP (in blue) and measured TFP (in red) after the M&A, separated on a host of financial statistics. On the y-axis, we have the logarithm of the change in TFP of a firm after one year and three years of the M&A respectively. The first row of plots have firm observations scaled by the logarithm of tangible capital, intangible capital and sales respectively. As the best-fit linear trends indicate, measured TFP is higher than TFP, indicating that the intangible capital measurements account for the change in TFP after the M&A. The second row measures the same statistics but this time, for robustness, I look at the logarithm of the ratios of tangible capital, intangible capital and sales. As can be seen, the results indicate the same as the conclusions reached before.

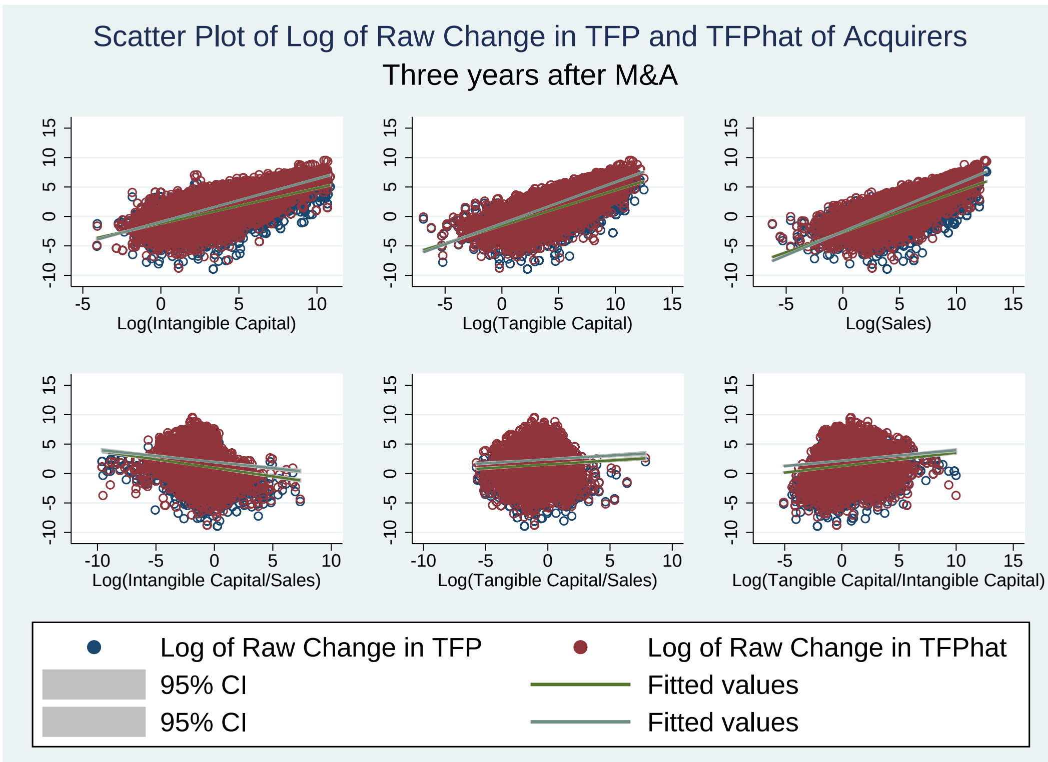

Figure 1.7: Scatter plot of Log Change in TFP and $\widehat{TFP}$ for capital acquirers

Hence, all the scatter plots show that the TFP increase experienced after an M&A would have been higher if intangible capital reallocation would have been excluded from the structural estimation. These scatter plots are meant to give qualitative evidence for my result.

To obtain formal quantitative results to argue that measured TFP accounts for the TFP increase, I use regression analysis on both TFP and $\widehat{TFP}$ separately and argue that the difference in the quantitative measure of the relevant dummy variable measures the contribution of intangible capital and its reallocation in the change in the TFP. Again, as mentioned previously, since my panel data is dynamic, I will have lagged variables, denoted *Lagged* $\ln(TFP)$ and *Lagged* $\ln(\widehat{TFP})$, that measures the persistence of TFP. I construct a dummy variable '$AFTER$' that is 0 for years before the M&A and 1 for years after the M&A. This will be my relevant variable to measure the contribution of intangible capital. I also control for firm size using the quintile variable of '$SIZE$' which is the equity of the acquirer 20 days prior to the date of the announcement of the M&A. Hence, the general OLS specification for the two regressions will be:

$$\begin{aligned}\ln TFP_{it} &= a_i + b(\ln TFP_{it-1}) + c(AFTER) \\ &+d(SIZE_{it}) + e(PAYMENT\ METHOD) + \epsilon_{it}\end{aligned}$$

Similarly, I have:

$$\begin{aligned}\ln \widehat{TFP}_{it} &= a_i + b(\ln \widehat{TFP}_{it-1}) + c(AFTER) \\ &+d(SIZE_{it}) + e(PAYMENT\ METHOD) + \epsilon_{it}\end{aligned}$$

The results of the exercise are presented in table 1.8.The two pair of columns present the results for different versions of the OLS regressions for both TFP and $\widehat{TFP}$, the next two pairs present the results using the fixed-effects model while the last two pairs present the results using the Arellano and Bond (1991) 1-step and 2-step regressions respectively. Again, the standard errors for the 1-step Arellano and Bond (1991) regression are computed using GMM while the 2-step regression have robust standard errors for consistency.

	FE 1		AB 1		AB 2	
VARIABLES	$\ln(\widehat{TFP})$	$\ln(TFP)$	$\ln(\widehat{TFP})$	$\ln(TFP)$	$\ln(\widehat{TFP})$	$\ln(TFP)$
Lag $\ln(\widehat{TFP})$	0.667***		0.436***		0.530***	
	(0.00139)		(0.00136)		(0.00451)	
Lag $\ln(TFP)$		0.654***		0.387***		0.468***
		(0.00149)		(0.00147)		(0.00502)
AFTER	0.128***	0.115***	0.167***	0.136***	0.104***	0.0911***
	(0.00145)	(0.00138)	(0.00131)	(0.00127)	(0.00202)	(0.00183)
Constant	1.054***	0.835***	1.674***	1.383***	1.324***	1.157***
	(0.00354)	(0.00287)	(0.00349)	(0.00287)	(0.0110)	(0.00999)
Observations	201,350	201,599	189,222	189,542	189,222	189,542
R-squared	0.720	0.675				
No. of Acq	38,547	38,547	37,837	37,846	37,837	37,846

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 1.8: Contribution of Intangible capital and its reallocation in TFP increase after capital acquisition.

As we can see from the results in the Arellano and Bond (1991) regressions, if intangible capital and its reallocation is ignored, TFP measures would be, at most, 23% higher, measured by the change in the dummy variable $AFTER$ after TFP and $\widehat{TFP}$. This suggests that intangible capital and its reallocation are important in accounting for the TFP that capital acquirers experience. This result is important since, to the best of my knowledge, this is the first attempt in trying to explain the change in the productivity of capital acquirers through the acquisition of intangible capital like R&D and SMA knowledge.

1.5 Conclusion

In this study, I show results that suggest that one reason why firm conduct M&As is not necessarily to obtain tangible capital, but rather to obtain intangible capital. In the new knowledge-based economy, this seems to be increasingly important and might be the reason for more M&A activity in the technology sector. This knowledge can be coming through patents, through innovative sales and marketing techniques or, even through, efficient ways of undertaking administrative tasks. Given some of this knowledge is internal to the structure of the firm, and hence unacquirable separately, the only way an acquirer might be able to benefit from this knowledge is to acquire the firm outright.

Thus, the empirical results suggests that intangible capital is an important element at the firm-level in accounting for productivity changes after M&As or, in my interpretation, after capital acquisitions. I also show that, at the aggregate level, the cyclicality patterns of tangible and intangible capital reallocation are both distinct. All the data suggests that, when evaluating aggregate implications from capital reallocation, we should consider both forms of capital as unique and model both as such. In the section that follows, I present two models, one with only tangible capital and another with both forms of capital. The models will show that, when intangible capital in included, we can get amplified effects from financial market disturbances in terms of output.

Chapter 2

Financial Shocks and Business Cycles: The Role of Intangible Capital

2.1 Introduction

In macroeconomic models with financial frictions, financial market disturbances lead to output fluctuations through different channels. One channel through which financial market disturbances can lead to output fluctuations is by affecting the extent to which capital is reallocated from less productive to more productive firms. For example, if financial frictions are more severe in recessions than in booms, less capital is reallocated from less productive firms to more productive firms so that output is lower in recessions than in booms. A recent literature[1] attempts to quantify the magnitude of the fluctuations attributable to fluctuations in financial frictions that limit the reallocation of tangible capital to more productive firms. This paper contributes to this literature at a theoretical and an empirical level.

At the theoretical level, this paper contributes to the literature by including intangible

[1] Midrigan and Xu (2010) and Shourideh and Zetlin-Jones (2012)

capital and by positing a collateral constraint in which only tangible capital is collateralizable. The inclusion of intangible capital is motivated by recent work[2] that argues that some firm-level expenses which are not regarded as investment in the national income accounts should be regarded as a form of investment. These papers refer to such investments as adding to intangible capital. In the model, firms have access to a production technology that utilizes tangible and intangible capital as inputs, following McGrattan and Prescott (2010), and financial constraints impede the reallocation of both forms of capital.

I examine the consequences of a tightening of the collateral constraint: I compare the decline in output in the model with both forms of capital with the decline in output in the model with only tangible capital. I find a tightening of the collateral constraint in the model with both forms of capital leads to a decline in output that is 2.8 times the decline in output in the benchmark model. In this sense, allowing for intangible capital magnifies the effects of financial market disturbances on output. The mechanism that delivers this result is as follows: When the collateral constraint is tighter, tangible capital reallocation decreases sharply. This is because tangible capital is more valuable because of its collateralizability. Intangible capital reallocation declines sharply as well since both forms of capital are complementary in production. This results in the misallocation of both forms of capital in the economy resulting in an amplified drop in output from the tightening of the collateral constraint in the model with both types of capital relative to the one-capital benchmark model.

I turn now to a more detailed description of the model. In this paper, I build a benchmark model in which output is produced using tangible capital alone and a model in which output is produced using both tangible and intangible capital. In both models, firms are owned by households. These firms face idiosyncratic productivity shocks. After realizing their productivity shocks, firms reallocate capital between each other and, thereafter, produce. The reallocation is subject to a collateral constraint. In the benchmark model, I show that the capital distribution in the stationary equilibrium exhibits bunching at the top and bottom of the capital holdings. The bunching at the top occurs because capital-rich firms internalize their ability to sell tangible capital in the reallocation market and make higher investments than optimally needed for their own production. The bunching

[2] Corrado, Hulten, and Sichel (2005) and Hulten and Hao (2008)

at the bottom occurs since capital poor firms do not have sufficient resources left over after paying for their purchases in the reallocation market and consuming. In this equilibrium, firms whose capital stock is relatively high or whose productivity is relatively low tend to sell part of their capital. Firms whose capital stock is relatively low or whose productivity is relatively high tend to buy capital. I also show that the measure of constrained firms is endogenously determined in the stationary equilibrium. Mechanically, this result is due to the market clearing condition in the reallocation market which requires a measure of the firms to be constrained for the market to clear. I generate a recession by tightening the collateral constraint and show that a 1% tightening of the collateral constraint causes output to decline by 0.32%.

The model with both types of capital is the same as the benchmark model except that in this model only tangible capital can serve as collateral in the collateral constraint. Hence, this model has an asymmetric treatment of the two forms of capital in terms of their collateralizability. The post-reallocation capital stocks are utilized in production. In this model, I show a 1% tightening of the collateral constraint decreases output by 0.90%. Thus, a tighter collateral constraint delivers an amplified output loss of 1.8 times the output loss in the benchmark model (or, interpreted differently, the model delivers 2.8 times the output change in the benchmark model). The mechanism for this amplification is as follows: The asymmetric treatment of the two forms of capital for collateral causes firms to hold higher levels of tangible capital than intangible capital in the stationary equilibrium. When the collateral constraint unexpectedly tightens, constrained firms are unable to afford the same level of reallocation as they did in the stationary equilibrium. Tangible capital becomes more valuable as collateral and firms are less willing to part with it. This causes tangible capital reallocation to decrease sharply. Since both forms of capital are complements in production, an associated sharp decline in intangible capital reallocation occurs. This results in the amplified drop in output relative to the benchmark model.

2.1.1 Related Literature

My paper relates to multiple sets of papers. There is an active literature that tries to understand the effects of financial constraints in impeding optimal allocation of tangible capital. Buera, Kaboski, and Shin (2011), Buera and Moll (2012) and Moll (2010) find large productivity losses stemming from misallocation (or lack of optimal allocation) through the channel of financial constraints while Midrigan and Xu (2010) finds such losses are small in a calibrated model. Shourideh and Zetlin-Jones (2012) note that financial market disturbances result in modest effects on output. There are a few differences between the paper mentioned above and the current paper. First, these papers model tangible capital as the only capital input in the production function while my model uses both tangible and intangible capital as the two types of capital inputs in the production function. Second, these papers do not explicitly model a market for capital reallocation where prices for capital reallocation are determined in equilibrium. In this paper, the prices in the markets for reallocation of both forms of capital play a key role in delivering the quantitative results.

There is a set of papers that explore the aggregate consequences of M&As. Prominent among them are Jovanovic and Rousseau (2002), Jovanovic and Rousseau (2008) and, more recently, David (2011). Jovanovic and Rousseau (2002) look at M&As through q-theory while Jovanovic and Rousseau (2008) posit a specific technology that is resultant from an M&A. David (2011) proposes a search theoretic framework of M&As (this idea was first proposed by Rhodes-Kropf and Viswanathan (2004) and has seen subsequent work by Martos-Vila (2008) among others) into a macroeconomic model. These papers focus on the technological effects of M&As rather than view M&As as explicit drivers of reallocation of two forms of capital. Another difference from the current literature is that this study focuses on disturbances in the financial markets and their aggregate effects on capital acquisition or M&A activity.

Another recent strand of macroeconomic literature my paper is related to can broadly be classified through Corrado, Hulten, and Sichel (2005), Atkeson and Kehoe (2005), Atkeson and Kehoe (2007) and McGrattan and Prescott (2010). These papers explore the effects of intangible capital on the aggregate economy. McGrattan and Prescott (2010) show that a good percentage of previously ‘unexplained’ economics growth can be accounted for using macroeconomic data on R&D investment. The main difference between my work and McGrattan and Prescott (2010) is that they work with a representative firm model and hence, in their model, there is no need for reallocation since capital is always allocated optimally. My model added dimensions of TFP heterogeneity and financial constraints allow for misallocation and hence the need for reallocation through a reallocation market.

Another contribution of my paper to the literature is the firm-level structural estimation of the input shares of both tangible and intangible capital. Intangible capital measurement at the firm level is also an active area of research as evidenced by Lev (2001), Hulten and Hao (2008) and Hulten (2010). Yet no work have attempted to use these measurements in a theoretical model to measure the effects of financial shocks which this paper does.

A paper closely related to mine is Eisfeldt and Rampini (2006) who posit the idea of reallocation being instantaneous while investment resulting in lagged benefit. I adopt the same difference between investment and reallocation. While Eisfeldt and Rampini (2006) use convex adjustment costs as the friction that hinders reallocation in their model, I use financial constraint which have been shown to have significant effects on the ability of acquirers to engage in M&As. I also add to their empirical results regarding the cyclical properties of reallocation by noting the increased cyclicality of M&As in the last decade and a decrease in the cyclicality of capital sales. I establish that the cyclicality of the two firms of reallocation moves in very different ways in terms of financial recession versus non-recession years: While capital sales exhibit the same cyclicality across financial recession versus non-recession years, M&As exhibit different correlation with GDP.

Another set of papers that started with Lichtenberg and Siegel (1990) examine estimated productivity changes at the plant-level, using data from the Longitudinal Research Database (LRD), after the change of ownership of the plant. Schoar (2002) finds that the effects on productivity of the newly acquired plants are positive, yet small at 1%. Maksimovic and Phillips (2001) also find that the sale of assets and plants result in mean productivity increases of 2%. Harris, Siegel, and Wright (2005) find productivity changes for UK plant sales to be quantitatively much higher than those reported for US LRD data. This paper finds large mean TFP changes at the firm-level at about 9.1-13.6% over a three year period. Why the difference? The larger point of this paper, using the differentiation of tangible capital and intangible capital is to suggest that the studies cited above look at productivity changes accruing from tangible capital sales but not from intangible capital sales. My data includes sale of both forms of capital and I show that the main gains associated with capital reallocation are a product of the intangible capital reallocation that occurs from less productive units to more productive units. A recent paper by Levine (2010) does a similar production function estimation to show productivity changes at the firm-level. A difference between this paper and Levine (2010) is that the latter focuses on the costs in firm accounts while the former uses the costs to construct intangible capital stock. Since Levine (2010) focuses on costs, the production technology only has tangible capital while, in this paper, the technology for production takes inputs of tangible and intangible capital.

My paper also has implications for the M&A literature. Within the set of ex-post M&A performance evaluation literature, there are two major strands[3]. The first is a literature in finance while the other is in industrial organization. Both use different sets of tools to understand the effects of M&As. Given both these literatures are large and the points made in this paper are not mainly associated with this literature, I will refer the interested reader to the cited survey articles.

2.2 Model without Intangible Capital

In this section, I present the model without intangible capital.

2.2.1 Environment

Agents and Technology

Time is discrete and indexed by $t = 0, 1, 2...$ with infinite horizon. The economy has agents that consume and produce. The interpretation of the agents that this paper takes is that the agents are firms that are owned by households. The consumption is by the owners of the firms while the production and investment decision is by the firm. I will refer to these agents as firms and when referring to consumption, I will talk about the owners of the firms.

The owners of the firms consume and the firms produce utilizing an endowment of technology, tangible capital and a unit of labor. This production results in a homogeneous good that can either be consumed or invested for use as tangible capital in the next period. I will assume that the household that owns the firm supplies labor inelastically. Thus,

[3]For an excellent recent survey, look at Andrade, Mitchell, and Stafford (2001). Older surveys include Jensen and Ruback (1983) and Jarrell, Brickley, and Netter (1988). For an older survey contrasting the IO and Finance approaches and results, see Caves (1989).

the production technology is Cobb-Douglas with one input, tangible capital, and is of the following form:

$$y(A, k) = Ak^{\upsilon} \tag{2.1}$$

where a firm's output $y(.)$ has the property of being decreasing returns to scale in tangible capital k and A is the firm-level TFP. The firm-level TFP is subject to uncertainty. In specific, I assume that the firm-level TFP follows a three state Markov chain. The Markov chains are assumed to be independent across firms. Let π_p be the probability a firm has the same productivity in the next period as the current period. The assumption of a Markov chain is done for computational convenience. Hence, I assume $A \in \{A_L, A_M, A_H\}$ and the evolution of TFP evolution is described by a Markov transition matrix of the form:

$$\Pi^A = \begin{bmatrix} \pi_p & \frac{1-\pi_p}{2} & \frac{1-\pi_p}{2} \\ \frac{1-\pi_p}{2} & \pi_p & \frac{1-\pi_p}{2} \\ \frac{1-\pi_p}{2} & \frac{1-\pi_p}{2} & \pi_p \end{bmatrix} \tag{2.2}$$

Firms

There is a continuum of firms with measure 1. Each firm is a measure-zero object, endowed with a production technology that utilizes tangible capital as an input. The owners of the firm consume and the firm invests. Firms are heterogenous in the productivity and in their tangible capital stocks in the model with tangible capital.

The preferences of owners of firm i are defined over consumption $c_t^i \in \mathbb{R}_{++}$:

$$\sum_{t=0}^{\infty} \beta^t \left(\frac{\left(c_t^i\right)^{1-\sigma}}{1-\sigma} \right) \qquad 0 < \beta < 1, \sigma > 1 \tag{2.3}$$

Firm i can use its endowment of tangible capital $k_t^i \in \mathbb{R}_+$ to produce a homogeneous good by utilizing its production technology. It can also trade this capital with other firms at a market price. I will refer to this decision, $k_t^{\rightarrow i} \in \mathbb{R}$, as the reallocation decision undertaken by firm i and denote $p_{k,t}^{\rightarrow} \in \mathbb{R}_{++}$ as the price at which this market clears. Note, that the reallocation variable is allowed to be negative, which will stand in for the firms selling capital. Since a firm cannot sell more capital than it holds, the natural inequality $-k_t^i \leq k_t^{\rightarrow i}$ has to hold. The reallocation decision by firms will be made pre-production but after the realization of their productivity shock. Thus, I will denote $\overline{k_t^i} \in \mathbb{R}_+$ as the post-reallocation capital holding of firm i. As is standard, capital will depreciate after production at rate $\delta \in (0,1)$. Hence, tangible capital is accumulated, either through internal investment $x_{k,t}^i$ or through reallocation $k_t^{\rightarrow i}$. The tangible capital owned by firm is subject to depreciation at rate $\delta \in (0,1)$. Thus, we can state the budget constraint and the capital evolution of firm i as:

$$
\begin{aligned}
c_t^i + x_{k,t+1}^i &\leq A_t^i \overline{k_t^i}^{\upsilon} - p_{k,t}^{\rightarrow} k_t^{\rightarrow i} && (2.4)\\
k_{t+1}^i &= (1-\delta)\,\overline{k_t^i} + x_{k,t+1}^i && (2.5)\\
\overline{k_t^i} &= k_t^i + k_t^{\rightarrow i} && (2.6)
\end{aligned}
$$

A firms's ability to reallocate capital will be constrained financially through a collateral constraint. This will be the main mechanism of having financial shocks affect the production sector of the economy. I posit that the amount of capital bought by a firm in the reallocation market at price $p_{k,t}^{\rightarrow}$ cannot be leveraged more than $\lambda > 1$ of its capital holdings coming into the period. Hence, the collateral constraint is:

$$
p_{k,t}^{\rightarrow} k_t^{\rightarrow i} \leq \lambda k_t^i \qquad (2.7)
$$

Notice, this collateral constraint is only possibly binding on the acquirers of tangible capital and never on the sellers of capital since $k_t^{\rightarrow i} \in \mathbb{R}$. This results in the tightness of this constraint across the capital acquirers determine the amount of tangible capital that is reallocated.

Markets

There are two markets in this model, the market for consumption and the market for tangible capital reallocation. I normalize the price of the first market to one and, as mentioned previously, $p_{k,t}^{\rightarrow}$ will denote the price in the market for tangible capital reallocation. This price will be a relative price as it will be proportional to the price of consumption.

The market for tangible capital reallocation is a market where capital transfers occur from one firm to another. Hence, this market holds in zero net supply. In the aggregate at time t, this will result in:

$$\int_i k_t^{\rightarrow i} di = 0 \tag{2.8}$$

Thus, total aggregate production in the economy is:

$$Y_t = \int_i y_t^i di = \int_i A_t^i \overline{k_t^i}^{\upsilon} di \tag{2.9}$$

Similarly, aggregate consumption and total tangible capital holdings can be rewritten as:

$$C_t = \int_i c_t^i di \tag{2.10}$$

$$K_t = \int_i k_t^i di = \int_i \overline{k_t^i} di \tag{2.11}$$

$$C_t + K_{t+1} = Y_t + (1 - \delta) K_t \tag{2.12}$$

Notice, in 2.11, the total capital stock remains unchanged before and after reallocation.

Timing

The timing in the model is presented in figure 2.1. Firms enter a period with tangible capital stocks. After entering, they realize their productivity shock and after realizing their productivity shock are allowed to trade in the reallocation market for tangible capital. In this market, firm are price takers and reallocate capital amongst each other. After the reallocation market for tangible capital clears, firms undertake production. The production output is either consumed by the owners of the firms or invested. A restriction, in terms of investment, is that firms are only allowed to invest from internal resources. After this, firms move onto the next period.

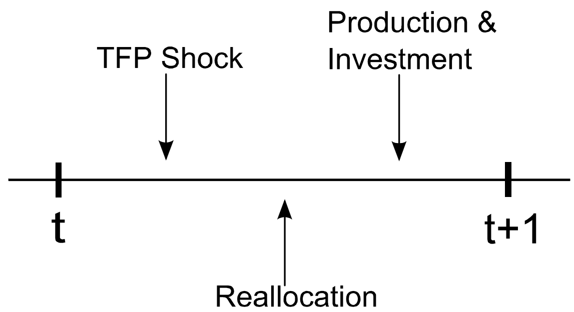

Figure 2.1: Timing of events

Recursive Representation

I will recast this problem into a dynamic programming problem and present the recursive representation of the firm's problem.

A firm is characterized by a double (A, k), i.e. its individual state variables. The aggregate state of the economy is the distribution of firms over these individual states. Define:

- $\mathcal{A} \equiv [A_L, A_M, A_H]$ - possible firm productivities
- $\mathcal{K} \equiv (0, \widehat{k}]$

where $\widehat{k}$ is the upper limit on the capital stocks. Define the Cartesian product as the state space $S \equiv A \times K$ with Borel σ algebra $\mathcal{B}$. The space $(S, \mathcal{S})$ is a measurable space and for any set $\mathcal{S} \in \mathcal{B}$, $\gamma(\mathcal{S})$ is measure of firms in set $\mathcal{S}$ and let Γ be the set of all probability measures over $(\mathcal{S}, \mathcal{B})$. Hence, the aggregate state of this economy is Γ, the distribution of firms in the economy.

Define transition function $\mathcal{Q}((A, k), \mathcal{A} \times \mathcal{K})$ as probability of firm i with current state (A, k) transitioning to the set $\mathcal{A} \times \mathcal{K}$ next period.

Thus, $\mathcal{Q} : S \times \mathcal{B} \to [0, 1]$ and

$$\mathcal{Q}(S, \mathcal{A} \times \mathcal{K}) = \sum_{A' \in \mathcal{A}} I\left\{k'(A, k) \in \mathcal{K}\right\} \pi\left(A', A\right) \tag{2.13}$$

where I is the indicator function and $k'(A,k)$ is the optimal decision of the firm for next period's capital stock and $\pi(A', A)$ is the transition probability, i.e. the probability of having A' tomorrow given A today. Then, $\mathcal{Q}$ is our transition function and the associated T^* operator yields:

$$\gamma_{t+1}(\mathcal{A}\times\mathcal{K}) = T^*(\gamma_t) = \int_{A\times K} \mathcal{Q}((A,k), \mathcal{A}\times\mathcal{K}) d\gamma_t(A,k)$$

I economize on notation and state the problem of firm (A,k) recursively:

$$V(A,k;\gamma) = \max\left\{u(c) + \beta\sum V(A'.k';\gamma')\pi(A'|A)\right\} \tag{2.14}$$

s.t.

$$\begin{aligned}
&c + x_k \leq A\overline{k}^{\upsilon} - p_{\overrightarrow{k}} k^{\rightarrow} && (\mu_1)\\
&p_{\overrightarrow{k}} k^{\rightarrow} \leq \lambda k && (\mu_2)\\
&\overline{k} = k + k^{\rightarrow} \\
&k' = (1-\delta)\overline{k} + x_k \\
&-k \leq k^{\rightarrow} \\
&\overline{k}\in\mathbb{R}_+,\ k^{\rightarrow}\in\mathbb{R}
\end{aligned}$$

2.2.2 Equilibrium

In this section, I formally state the definition of the equilibrium, characterize it and discuss the strategy involved in numerically solving for the equilibrium.

Definition 2.1 *A stationary recursive competitive equilibrium in this economy consists of a value function $V: S\to\mathbb{R}_+$; policy functions for the firm $c: S\to\mathbb{R}_{++}$; $k^{\rightarrow}: S\to\mathbb{R}$; $k': S\to\mathbb{R}_+$; price $p_{\overrightarrow{k}}\in\mathbb{R}_{++}$; stationary measure $\gamma^*\in\Gamma$ such that:*

- *Given prices, policy functions c, $k^{\rightarrow}$, k' solve the firm's problem with V as its associated value function*
- *Markets clear*

- *For all $\mathcal{A} \times \mathcal{K} \in \mathcal{B}$, the invariant probability measure γ^* satisfies:*

$$\gamma^* (\mathcal{A} \times \mathcal{K}) = \int_{A \times K} \mathcal{Q}((A, k), \mathcal{A} \times \mathcal{K}) d\gamma^*(A, k)$$

where $\mathcal{Q}$ is the transition function defined in 2.13.

2.2.3 Results

The Lagrangian associated with the collateral constraint is μ_2. I now state a proposition that characterizes the optimal choices of the firm.

Proposition 2.1 *The optimal choices of a firm in the one capital benchmark model are characterized by the following system of equations:*

$$\begin{aligned} u'(c) &= \beta E\left[\left(u'(c')\left((1-\delta) - \upsilon A' \left(k' + k^{\rightarrow\prime}\right)^{\upsilon-1}\right) + \lambda \mu_2'\right)\right] \\ \mu_2 p_k^{\rightarrow} &= \upsilon A \left(k + k^{\rightarrow}\right)^{\upsilon-1} - p_k^{\rightarrow} + (1-\delta) \end{aligned}$$

The reallocation decision of the firm is a static decision and is affected by the tightness of the collateral constraint. Hence, if the firm is constrained in the reallocation market ($\mu_2 > 0$), it will be unable to undertake the optimal level of reallocation and will have an inefficient level of tangible capital for production.

In the Euler condition, an important feature to note is that the reallocation decision for tomorrow affects the investment decision today for tangible capital. This provides incentives to the firm to take a higher level of tangible capital than needed for optimal production since the firm has the ability to sell the extra capital to other firms in the reallocation market. I state this as a separate corollary.

Corollary 2.1 *Firms have incentives to take a higher stock of tangible capital to the next period than optimally needed for production since they are able to sell this extra capital to other firms that are facing a scarcity of capital.*

Now, I will present the model with intangible capital and then show quantitative results for the two models.

2.3 Model with Intangible Capital

In this section, I formally state the model with intangible capital.

2.3.1 Environment

Agents and Technology

Time is discrete and indexed by $t = 0, 1, 2...$ with infinite horizon. The economy has the same structure as before where households own firms and the owners of the firm consume the output of the firm and the firm produces. In this model, this technology will utilize tangible capital and intangible capital as inputs. The production results in a homogeneous good that can either be consumed or invested for use as tangible capital or intangible capital in the next period. The production technology is Cobb-Douglas with two inputs, tangible capital and intangible capital, and is of the following form:

$$y(A, k, m) = Ak^{\alpha} m^{\eta} \tag{2.15}$$

where a firm's output $y(.)$ has decreasing returns to scale in tangible capital k and intangible capital m and the firm-level TFP. The firm-level TFP is subject to uncertainty. In specific, I assume that the firm-level TFP follows a three state Markov chain. The Markov chains are assumed to be independent across firms. Let π_p be the probability a firm has the same productivity in the next period as the current period. The assumption of the Markov chain is made for computational convenience. Hence, $A \in \{A_L, A_M, A_H\}$ and its evolution is described by a Markov transition matrix of the form:

$$\Pi^A = \begin{bmatrix} \pi_p & \frac{1-\pi_p}{2} & \frac{1-\pi_p}{2} \\ \frac{1-\pi_p}{2} & \pi_p & \frac{1-\pi_p}{2} \\ \frac{1-\pi_p}{2} & \frac{1-\pi_p}{2} & \pi_p \end{bmatrix} \tag{2.16}$$

Firms

There is a continuum of firms with measure 1 that are owned by households. Each firm is a measure-zero object, endowed with a production technology that utilizes tangible capital and intangible capital as inputs. The owners of the firm consume and the firm invests. Firms are heterogeneous in their productivity, tangible capital and intangible capital stocks.

The preferences of owners of firm i are defined over consumption $c_t^i \in \mathbb{R}_{++}$:

$$\sum_{t=0}^{\infty} \beta^t \left(\frac{\left(c_t^i\right)^{1-\sigma}}{1-\sigma} \right) \qquad 0 < \beta < 1, \sigma > 1 \tag{2.17}$$

Firm i can use its endowment of tangible capital $k_t^i \in \mathbb{R}_+$, intangible capital $m_t^i \in \mathbb{R}_+$ to produce a homogeneous good by utilizing its production technology. It can also trade this capital with other firms at a market price. I will refer to this decision $k_t^{\rightarrow i} \in \mathbb{R}$ as the decision to reallocate tangible capital undertaken by firm i and denote $p_{k,t}^{\rightarrow} \in \mathbb{R}_{++}$ as the price at which this market clears. Similarly, $m_t^{\rightarrow i} \in \mathbb{R}$ as the decision to reallocate intangible capital undertaken by firm i and denote $p_{m,t}^{\rightarrow} \in \mathbb{R}_{++}$ as the price at which the intangible capital reallocation market clears. Again, note that the reallocation variable is allowed to be negative, which will stand in for the firm selling tangible capital and intangible capital. Since a firm cannot sell more of both forms of capital than it holds, the natural inequalities $-k_t^i \leq k_t^{\rightarrow i}$ and $-m_t^i \leq m_t^{\rightarrow i}$ have to hold. The reallocation decision by firms will be made pre-production but after the realization of the productivity shock. Thus, I will denote $\overline{k_t^i} \in \mathbb{R}_+$ as the post-reallocation tangible capital holding of firm i and $\overline{m_t^i} \in \mathbb{R}_+$ as the post-reallocation intangible capital holdings of firm i. Both forms of capital will depreciate after production at rate $\delta \in (0,1)$. Hence, both tangible and intangible capital are accumulated, either through internal investment or through reallocation. Thus, we can state the budget constraint of firm i and the evolution of both forms of capital as:

$$c_t^i + x_{k,t+1}^i + x_{m,t+1}^i \leq A_t^i \overline{k_t^i}^{\alpha} \overline{m_t^i}^{\eta} - p_{k,t}^{\rightarrow} k_t^{\rightarrow i} - p_{m,t}^{\rightarrow} m_t^{\rightarrow i} \tag{2.18}$$

$$k_{t+1}^i = (1-\delta)\, \overline{k_t^i} + x_{k,t+1}^i \tag{2.19}$$

$$m_{t+1}^i = (1-\delta)\, \overline{m_t^i} + x_{m,t+1}^i \tag{2.20}$$

$$\overline{k_t^i} = k_t^i + k_t^{\rightarrow i} \tag{2.21}$$

$$\overline{m_t^i} = m_t^i + m_t^{\rightarrow i} \tag{2.22}$$

A firm's ability to reallocate capital will be constrained financially through a collateral constraint. This will be my main mechanism of having financial shocks affect the production sector of the economy. I posit that the value of both forms of capital bought by a firm in the reallocation market at prices $p^{\rightarrow}_{k,t}$ and $p^{\rightarrow}_{m,t}$ respectively cannot be leveraged more than $\lambda > 1$ of its capital holdings coming into the period. Hence, the collateral constraint is:

$$p^{\rightarrow}_{k,t} k_t^{\rightarrow i} + p^{\rightarrow}_{m,t} m_t^{\rightarrow i} \leq \lambda k_t^i \tag{2.23}$$

Notice, this collateral constraint is only possibly binding on the acquirers of capital and never on the sellers of capital since $k_t^{\rightarrow i} \in \mathbb{R}$ and $m_t^{\rightarrow i} \in \mathbb{R}$. This results in the tightness of this constraint across the capital acquirers determine the amount of tangible capital and intangible capital that is reallocated.

Markets

There are three markets in this model, the market for consumption and the markets for tangible capital and intangible capital reallocation. I normalize the price of the first market to one and $p^{\rightarrow}_{k,t}$ will denote the relative price in the market for tangible capital reallocation and $p^{\rightarrow}_{m,t}$ will denote the relative price in the market for intangible capital reallocation.

The market for tangible capital reallocation is a market where tangible capital transfers occur from one firm to another. Hence, this market holds in zero net supply. In the aggregate at time t, this will result in:

$$\int_i k_t^{\rightarrow i} di = 0 \tag{2.24}$$

Similarly, the market for intangible capital reallocation is a market where intangible capital transfers occur from one firm to another. As in the tangible capital reallocation market, this market also holds in zero net supply. In the aggregate at time t, this will result in:

$$\int_i m_t^{\rightarrow i} di = 0 \tag{2.25}$$

Thus, total aggregate production in the economy is:

$$Y_t = \int_i y_t^i di = \int_i A_t^i \overline{k_t^i}^{\alpha} \overline{m_t^i}^{\eta} di \tag{2.26}$$

Similarly, aggregate consumption, tangible capital and intangible capital holdings can be rewritten as:

$$\begin{aligned} C_t &= \int_i c_t^i di && (2.27) \\ K_t &= \int_i k_t^i di = \int_i \overline{k_t^i} di && (2.28) \\ M_t &= \int_i m_t^i di = \int_i \overline{m_t^i} di && (2.29) \\ C_t + K_{t+1} + M_{t+1} &= Y_t + (1-\delta) K_t + (1-\delta) M_t && (2.30) \end{aligned}$$

Notice, in 2.28, the total stock of both forms of capital remains unchanged before and after reallocation.

Timing

The timing in the model is the same as presented for the one capital model in figure 2.1.

Recursive Representation

Then, a firm is characterized by a triple (A, k, m) while the aggregate state is the distribution of firms. Define:

- $\mathcal{A} \equiv [A_L, A_M, A_H]$ - possible firm productivities
- $\mathcal{K} \equiv (0, \widehat{k}]$
- $\mathcal{M} \equiv (0, \widehat{m}]$

where $\widehat{k}$ and $\widehat{m}$ are upper bounds on capital holdings. Define the Cartesian product as the state space $S \equiv A \times K \times M$ with Borel σ algebra $\mathcal{B}$. The space $(S, \mathcal{S})$ is a measurable space and for any set $\mathcal{S} \in \mathcal{B}$, $\gamma(\mathcal{S})$ is measure of agents in set $\mathcal{S}$. Let Γ be the set of all probability measures over $(\mathcal{S}, \mathcal{B})$. Define transition function $\mathcal{Q}((A, k, m), \mathcal{A} \times \mathcal{K} \times \mathcal{M})$ as probability of a firm with current state (A, k, m) transitioning to the set $\mathcal{A} \times \mathcal{K} \times \mathcal{M}$ next period.

Formally, $\mathcal{Q} : S \times \mathcal{B} \to [0,1]$ and

$$\mathcal{Q}((A,k,m), \mathcal{A} \times \mathcal{K} \times \mathcal{M}) = \sum_{A' \in \mathcal{A}} I\left\{k'(A,k,m), m'(A,k,m) \in \mathcal{K} \times \mathcal{M}\right\} \pi\left(A', A\right) \quad (2.31)$$

where I is the indicator function and $k'(A,k,m), m'(A,k,m)$ are optimal decisions for next period's capital stocks and $\pi(A', A)$ is the transition probability, i.e. the probability of having A' tomorrow given A today. Then, $\mathcal{Q}$ is our transition function and the associated T^* operator yields:

$$\gamma_{t+1}(\mathcal{A} \times \mathcal{K} \times \mathcal{M}) = T^*(\gamma_t) = \int_{A \times K \times M} \mathcal{Q}((A,k,m), \mathcal{A} \times \mathcal{K} \times \mathcal{M}) d\gamma_t(A,k,m)$$

I economize on notation and state the problem of firm (A,k,m) recursively:

$$V(A,k,m;\gamma) = \max\left\{u(c) + \beta \sum V(A'.k', m'; \gamma')\pi(A'|A)\right\} \quad (2.32)$$

s.t.

$$\begin{aligned}
&c + x_k + x_m \le A\overline{k}^{\alpha}\overline{m}^{\eta} - p_k^{\rightarrow}k^{\rightarrow} - p_m^{\rightarrow}m^{\rightarrow} && (\mu_1)\\
&p_k^{\rightarrow}k^{\rightarrow} + p_m^{\rightarrow}m^{\rightarrow} \le \lambda k && (\mu_2)\\
&\overline{k} = k + k^{\rightarrow}\\
&\overline{m} = m + m^{\rightarrow}\\
&k' = (1-\delta)\overline{k} + x_k\\
&m' = (1-\delta)\overline{m} + x_m\\
&-k \le k^{\rightarrow}; -m \le m^{\rightarrow}\\
&\overline{k} \in \mathbb{R}_+, \overline{m} \in \mathbb{R}_+,\ k^{\rightarrow} \in \mathbb{R},\ m^{\rightarrow} \in \mathbb{R}
\end{aligned}$$

2.3.2 Equilibrium

Definition 2.2 *A stationary recursive competitive equilibrium in this economy consists of a value function $V : S \to \mathbb{R}_+$; policy functions of the firm $c : S \to \mathbb{R}_{++}$; $k^{\rightarrow}, m^{\rightarrow} : S \to \mathbb{R}$; $k', m' : S \to \mathbb{R}_+$; prices $p_k^{\rightarrow}, p_m^{\rightarrow} \in \mathbb{R}_{++}$; stationary measure $\gamma^* \in \Gamma$ such that:*

- *Given prices, policy functions $c, k^{\rightarrow}, m^{\rightarrow}, k', m'$ solve the firm's problem with V as its associated value function*

- *Markets clear*
- *For all $\mathcal{A} \times \mathcal{K} \times \mathcal{M} \in \mathcal{B}$, the invariant probability measure γ^* satisfies:*

$$\gamma^* \left(\mathcal{A} \times \mathcal{K} \times \mathcal{M}\right) = \int_{A \times K \times M} \mathcal{Q}(\left(A, k, m\right), \mathcal{A} \times \mathcal{K} \times \mathcal{M}) d\gamma^*(A, k, m)$$

where $\mathcal{Q}$ is the transition function defined in 2.31.

2.3.3 Results

The Lagrangian associated with the collateral constraint is μ_2. I now state a proposition that characterizes the optimal choices of the firm.

I now state a proposition that characterizes the optimal choices of the firm.

Proposition 2.2 *The optimal choices of a firm in the two capital model are characterized by the following system of equations:*

$$\begin{aligned}
\mu_2 p_k^{\rightarrow} &= \alpha A \left(k + k^{\rightarrow}\right)^{\alpha-1} \left(m + m^{\rightarrow}\right)^{\eta} - p_k^{\rightarrow} + (1-\delta) \\
\mu_2 p_m^{\rightarrow} &= \eta A \left(k + k^{\rightarrow}\right)^{\alpha} \left(m + m^{\rightarrow}\right)^{\eta-1} - p_m^{\rightarrow} + (1-\delta) \\
u'(c) &= \beta E \left[\left(u'(c') \left((1-\delta) + \alpha A' \left(k' + k^{\rightarrow\prime}\right)^{\alpha-1} \left(m' + m^{\rightarrow\prime}\right)^{\eta} \right) + \lambda \mu_2' \right) \right] \\
u'(c) &= \beta E \left[\left(u'(c') \left((1-\delta) + \eta A' \left(k' + k^{\rightarrow\prime}\right)^{\alpha} \left(m' + m^{\rightarrow\prime}\right)^{\eta-1} \right) \right) \right]
\end{aligned}$$

The reallocation decisions of the firm are static decisions and are affected by the tightness of the collateral constraint. Hence, if the firm is constrained in the reallocation market ($\mu_2 > 0$), it will be unable to undertake the optimal level of reallocation and will have inefficient levels of capital for production given its productivity.

In the Euler conditions, there are two important features to note. First, the reallocation decisions for tomorrow affect the investment decisions today for both forms of capital. This provides incentives to the firm to take higher levels of both form of capital than needed for optimal production since firms have the ability to sell extra capital holdings to other firms in the reallocation market. Second, across the two Euler conditions, the key difference from the asymmetric collateralizability is that there is an extra marginal benefit of holding tangible capital conditional on being possibly constrained tomorrow. I state these features as corollaries below.

Corollary 2.2 *Firms have incentives to take higher stocks of both forms of capital to the next period than optimally needed for production since they are able to sell this extra capital to other firms that are facing a scarcity of capital.*

Corollary 2.3 *The asymmetric collateralizability induces an extra benefit of holding a unit of tangible capital compared to a unit of intangible capital.*

The next section discuss the quantitative results related to the benchmark model with only tangible capital and the two capital model with both tangible and intangible capital.

2.4 Estimation

I estimate my model to discipline the quantitative exercise in the model. The parameters are summarized in table 2.1. The factor input shares for the two capitals are taken from the estimated input shares in the data, presented in table 1.4. This results in a tangible capital factor input share of 0.318 and an intangible capital factor input share of 0.147. The tangible capital share is standard and most studies in the literature have tangible capitals shares in the range of 0.3-0.33[4]. The new element in this paper, namely the intangible capital, has an input share that is in between the range of values that has been used by other studies that use intangible capital as an input to production. For example, McGrattan and Prescott (2010) impute a lower intangible capital input share of 0.07 while Hall and Mairesse (1995) estimate a higher intangible capital input share of 0.19. The interesting thing to note in the estimation presented in table 1.4, as previously discussed, is that the share of intangible capital comes exclusively from the share attributed to labor in studies that ignore intangible capital. This is why the labor share in table 1.4 is 0.55 as opposed to the standard input share in the range of 0.67-0.7 for labor used in models without intangible capital.

[4]See, for example, Buera, Kaboski, and Shin (2011), Midrigan and Xu (2010), Shourideh and Zetlin-Jones (2012)etc

In the benchmark model, I use an input share for tangible capital that is the sum of the two input shares in the two capital model. Thus, I estimate the input share to 0.465. This is done to allow for a reasonable comparison between the two models that are presented in this paper. If an input share of 0.318 is used, the amplification is quantitatively higher.

The depreciation in the model for both capitals is set at 0.1. The discounting rate for firms is 0.96 which is an annual interest rate of 4%. Another standard parameter I use is for risk aversion which is estimated to 4.

2.4.1 Parameter of Collateral Constraint

The parameter of the collateral constraint is an important parameter in studies that explore the effects of financial market disturbances on aggregate output. In this paper, I estimate this parameter to 3.8817 for both models which is the 90th percentile of data analog of this parameter in the paper.

The value for this parameter is obtained from data on M&As and accounting data from CompuStat. In specific, I view the sum of the total value of capital reallocation in equation 2.23 in the data as the value of an M&A. I use accounting data to get the value of the acquirer's physical capital stock, as noted under PPEGT in the balance sheet available through CompuStat, and map this into the k_t^i in the model. This allows me to construct the following statistic:

$$\lambda = \frac{\text{Selling value of M\&A}}{\text{Acquirer's physical capital on balance sheet}}$$

I look at the distribution of this statistic right before a M&A in the data and pick the 90th percentile of this statistic in the data since I view the lambda as providing an upper bound on the leveraging ability of the firm.

This is a very promising statistic, not just because of the direct mapping of the data and model it allows, but also because it tracts GDP cyclicality very well as seen in figure 2.2. This time-series presents the log HP-filtered values for GDP and for the 90th percentile of the λ statistic constructed above. Both time series are normalized by their standard deviations. As we can see, the λ statistic is highly procyclical with a correlation of 0.728 for data from 2001 onwards. This provides suggestive evidence that the mechanism that has been explored in the model is very promising in obtaining output volatility as seen in the data.

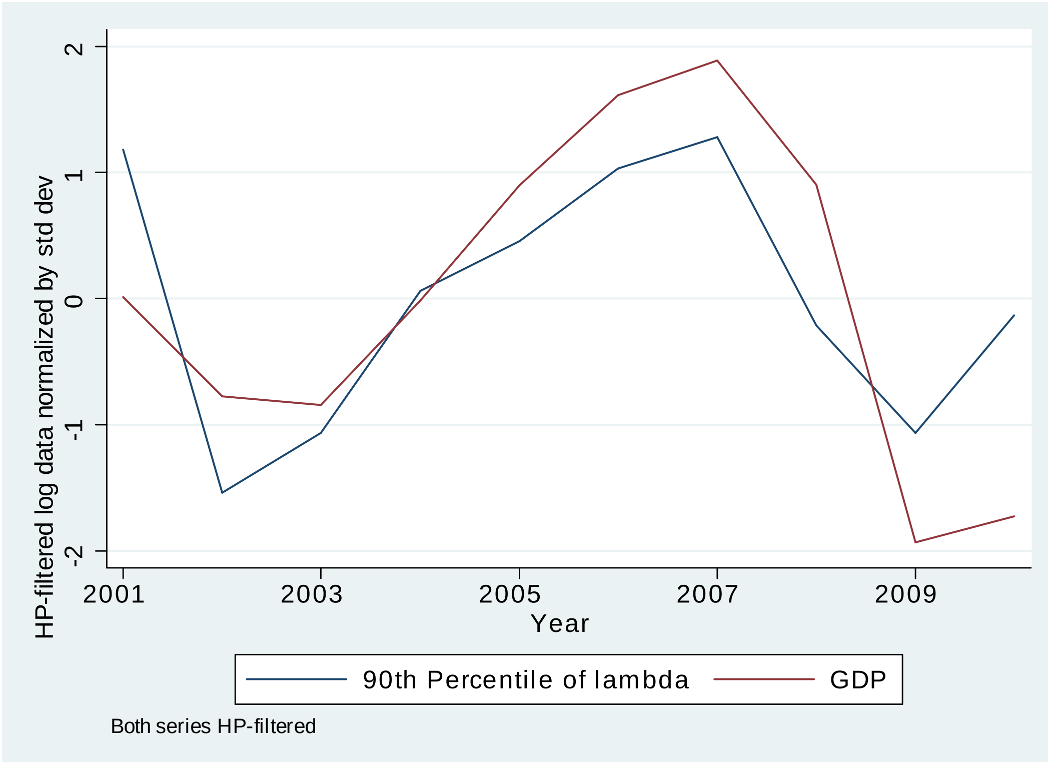

Figure 2.2: Cyclical component of the 90th percentile of lambda statistic in data

One thing to note is that this parameter does not govern the measure of firms that are constrained in the model since the measure of constrained firms is an equilibrium object in this paper. The reason, as we will see in the next section, is because the market clearing condition in the reallocation markets governs the measure of constrained firms and not the value of the parameter itself. Hence, for any given parameter, prices will adjust to obtain the same measure of firms to be constrained in equilibrium.

Description	Parameter	Value
Tangible Capital Share	α	0.318
Intangible Capital Share	γ	0.147
One Capital Share	υ	0.465
Depreciation	δ	0.1
Discounting	$\frac{1}{1+r}$	0.96
Risk Aversion	σ	4
Transition probability	π_p	0.6
Collateral Constraint	λ	3.8817

Table 2.1: Parameter table

2.5 Quantitative Results

In this section, I present the quantitative results for both model. After discussing the details related to estimation, I discuss the results for the model with only tangible capital. I show that the stationary equilibrium has some interesting features. Then, I will document the quantitative effects of a 1% tightening of the collateral constraint. This shock will be an unanticipated shock and is interpreted in this paper as a financial market disturbance. After discussing the results for the model with only tangible capital, I discuss the results pertaining to the model with both forms of capital. In this, I will present the main quantitative result of this paper that a credit tightening in the model with both types of capital results in an output loss that is greater than the output loss in the model with only tangible capital. In this sense, I show that the model with both forms of capital can produce an amplified output loss relative to the model with only tangible capital.

2.5.1 Model without Intangible Capital

I move on to discuss the results of the benchmark model which is the model without intangible capital.

Stationary Equilibrium

The solution strategy involved in calculating the equilibrium is outlined in the algorithm below:

- Guess a firm distribution γ over tangible capital holdings
- Guess price $p_{\vec{k}}$ for the reallocation market
- Solve for the firm's problem using the characterization noted previously to get policy function
- Numerically integrate over firm policy functions using the firm distribution
- If markets do not clear, update the price $p_{\vec{k}}$ to $p_{\vec{k}}'$ and recalculate optimal choices of the firms until markets clear
- When markets clear, update distribution γ to γ' and recompute until norm$(\gamma_i - \gamma_{i-1})$ is less than the desired tolerance

Using the algorithm outlined above, I find some interesting properties of the stationary distribution.

Statistics In table 2.2, I present the aggregate statistics of the economy in the stationary equilibrium. As the table shows, the statistics do a good job in matching observed data in the aggregate. The consumption output ratio is higher than in the data because there is no government in my model. An interesting thing to note is the prediction of the model that about 16% of the capital stock is traded in the stationary equilibrium. While accurate data on such statistic is not available at the aggregate level, the model suggests that firms spend as much money on investment as they do on buying used capital, or reallocating capital, as a whole, something that has been noted by Jovanovic and Rousseau (2002).

Steady State Aggregate Statistics	Value
Consumption/Output	0.74
Tangible Cap Inv/Output	0.26
Tangible Cap Reall/Output	0.16
Tangible Cap Stock/Output	1.12
Tangible Cap Reall/Tangible Cap Stock	0.16
Tangible Cap Inv/Tangible Cap Stock	0.23

Table 2.2: Aggregate statistics in stationarity.

Shape of Distribution In the stationary equilibrium, the tangible capital distribution exhibits bunching of firms at the top and bottom of the tangible capital levels. Firms at the top part of the distribution are firms that invest more capital than efficiently needed for production. This is because they internalize their ability to sell capital in the reallocation market in the next period at a price greater than unity. This results in firms taking the highest possible tangible capital to the next period and selling this capital to firms that are capital deficient. The capital hungry firms, in any period, are the ones that were unable to save the necessary amount of capital needed for production. This occurs because of consumption needs of the owners of the firms. Hence, these firms borrow to buy tangible capital in the reallocation market to produce and payback this loan using the produced output. Since some of these firms have constraints that are very tight, they are unable to achieve the optimal level of tangible capital savings in steady state. Hence, such firms are stuck at the top part of the distribution and are always buyers in the reallocation market for tangible capital.

I also show that the tangible capital distribution in the stationary equilibrium differs across productivities. This is not surprising since I assume in the estimation a persistent Markov chain for productivity. Hence, a firm with high productivity today expects to be more likely to have high productivity tomorrow. Such a firm will make high investments in tangible capital to take advantage of the favorable shock. Similarly, a firm faced with a bad shock today is more likely to have an unfavorable shock tomorrow and invests a lower amount given this. This results in a higher productivity firm to have a higher capital stock when compared to a firm with lower productivity.

Tangible Capital Sales A novel feature of the stationary equilibrium is the existence of tangible capital sales. This is significant because my model has firms that do not just invest for their own production but also invest because they internalize their ability to sell capital to firms that are capital deficient relative to their productivity. In this equilibrium, firms whose capital stock is relatively high or whose productivity is relatively low tend to sell part of their capital. Firms whose capital stock is relatively low or whose productivity is relatively high tend to buy capital. An interpretation of this result is that capital sales, in the aggregate data, occur because firms are willing to invest higher amounts than their own requirements of capital. This is because they can always sell that capital in the reallocation market. This result is predicated on having curvature in the utility in the owner's consumption and decreasing returns to scale in production. For example, if the owner's utility is linear or production is not decreasing returns to scale, firms will either consume more or would utilize the extra capital in their own production to increase their scale of production. For the former to occur, we also need the price in the reallocation market to be less than $1/\beta$.

Endogenous Level of Financially Constrained Firms An interesting feature of the model is that the level of firms that are financially constrained in the model is an endogenous object. This means that the measure of firms that are financially constrained, based on the collateral constraint previously posited, is determined by the market clearing in the tangible capital reallocation market. This clearing requires a fixed proportion of firms be financially constrained in equilibrium. Using my estimation, I find that 72% of the firms are constrained in equilibrium.

Shock to Collateral Constraint

In this section, I document the quantitative results from financial market disturbances in my model. I will show this by an unexpected credit tightening. This credit tightening will be achieved by a 1% decrease of the collateral constraint in the economy, which in the interpretation of this paper is a financial market disturbance. Mechanically, I start with the stationary equilibrium of the model and shock the collateral constraint and allow the economy to reach its new stationary equilibrium. The purpose of this exercise is to document benchmark results on the effects of a shock to the collateral constraint in the model without intangible capital. This will be compared to the results of a shock in the model with intangible capital to show how the model with both forms of capital can produce bigger output losses than the benchmark output loss in the current model.

Change in Aggregate Variable after shock	**Value in %**
Output	-0.32
Consumption	-0.31
Capital	-0.18
Reallocation	-2.61

Table 2.3: Change in aggregate statistics 1% tightening of collateral constraint.

Statistics Table 2.3 shows the effects of the credit tightening on aggregate variables. The shock has a significant effect on all aggregate variables. We see that output decreased by 0.32% while consumption decreased almost as much. Not surprisingly, the collateral constraint resulted in the aggregate tangible capital stock to increase since tangible capital is more valuable as collateral in the new stationary equilibrium. It is interesting to note that the collateral constraint shock caused a very significant decrease in the tangible capital reallocation. Qualitatively, this is expected since firms are unwilling to reallocate tangible capital for its collateralizability. Quantitatively, the model produces a big drop in the tangible capital reallocation showing that reallocation is very sensitive to changes in credit markets. The decrease in investment is because firms' ability to sell tangible capital is reduced.

As the results show, the effects of the collateral constraint shock are significant on output and consumption. I show that tangible capital reallocation is very sensitive to a collateral constraint shock. Next, I discuss the quantitative results of the model with both forms of capital.

2.5.2 Model with Intangible Capital

In this section, I discuss the results of the model with tangible and intangible capital. I show results pertaining to the stationary equilibrium in the economy. I emphasize the differences that arise from the inclusion of intangible capital in the model relative to the benchmark model. I also discuss results from a 1% shock to the collateral constraint in the model and show an amplified loss in output is caused in the model with both forms of capital and discuss the mechanism that is responsible for the amplification.

Stationary Equilibrium

The solution strategy involved in calculating for the equilibrium is outlined in the algorithm below:

- Guess a firm distribution γ over tangible and intangible capital holdings
- Guess price $\{p_{\vec{k}}, p_{\vec{m}}\}$ for the reallocation markets for both forms of capital
- Solve for the firms' problem using the characterization noted previously to get policy functions
- Numerically integrate over firm policy functions using the firm distribution
- If markets do not clear, update the price $p_{\vec{k}}$ to $p_{\vec{k}}'$ and $p_{\vec{m}}$ to $p_{\vec{m}}'$ and recalculate optimal choices of the firms until reallocation markets for both forms of capital clear
- When markets clear, update distribution γ to γ' and recompute until norm$(\gamma_i - \gamma_{i-1})$ is less than the desired tolerance

I now discuss properties of the stationary equilibrium.

Statistics Table 2.4 presents the aggregate statistics of the economy in the stationary equilibrium. As the table shows, the statistics change from the inclusion of the intangible capital. In this model, the consumption output ratio is lower compared to the benchmark model's statistics. The tangible capital investment to output ratio and the tangible capital reallocation to output ratio are both lower because firms invest and reallocate intangible capital as well. Note that the tangible capital to output ratio is more than twice the intangible capital to output ratio. This is because of two ingredients in the model. First, the estimated input share of tangible capital is almost twice the input share of intangible capital. Second, tangible capital serves as collateral while intangible capital cannot serve as collateral by assumption.

Steady State Aggregate Statistics	**Value**
Consumption/Output	0.76
Tangible Cap Inv/Output	0.18
Tangible Cap Reall/Output	0.04
Tangible Cap Stock/Output	1.51
Tangible Cap Reall/Tangible Cap Stock	0.07
Intangible Cap Inv/Output	0.06
Intangible Cap Reall/Output	0.02
Intangible Cap Stock/Output	0.71
Intangible Cap Reall/Intangible Cap Stock	0.06

Table 2.4: Aggregate statistics of stationary equilibrium of model with both forms of capital.

Endogenous Level of Financially Constrained Firms As in the model with only tangible capital, I show that the measure of firms that are constrained is endogenous. This means that for a given parameter of the collateral constraint, there exists a price in the reallocation market that results in the stationary equilibrium having the same measure of firms that are constrained. In the estimated version of the model with both forms of capital, I find that 71% of the firms are financially constrained in equilibrium which is almost the same as the measure of firms that are constrained in the benchmark capital model. This suggests that the amplified output drop in the two capital model is not because of more constrained firms.

Shock to Collateral Constraint

I document the effects of a shock to the collateral constraint as previously done in the benchmark model. I will show that when the same shock is administered in the model with both forms of capital, the loss in output is greater than the loss in output in the benchmark model with one capital. In that sense, I show that the inclusion of intangible capital results in an amplified output loss in the model with both forms of capital relative to the benchmark model.

Change in Aggregate Variable after shock	**Value in %**
Output	-0.90
Consumption	-0.75
Tangible Capital Stock	-0.68
Intangible Capital Stock	-0.96
Tangible Capital Reallocation	-3.59
Intangible Capital Reallocation	-5.91

Table 2.5: Change in aggregate statistics 1% tightening of collateral constraint.

Table 2.5 presents the results from a 1% tightening of the collateral constraint parameter. The results show that the fall in output in the model with both forms of capital is higher than the fall in output in the benchmark model. Output fell by 0.32% in the benchmark model while, in this model, the decrease in output is 0.9% showing a decline that is 2.8 times the decline compared to the benchmark model. In this sense, I show that there is an amplified decline in output from a collateral constraint shock of 1.8 times higher than the decline in output in the benchmark model.

Amplification I will now discuss the economic mechanism that produces the amplified output drop. In the model with both forms of capital, there is asymmetric treatment of the two forms of capital for collateral. I assume that only tangible capital is collateralizable. This, along with higher input shares for tangible capital in production, causes firms to hold higher levels of tangible capital than intangible capital in the stationary equilibrium. As we have established, firms are actively engaged in the reallocation markets for both forms of capital in the stationary equilibrium. When the collateral constraint unexpectedly tightens, financially constrained firms are unable to afford the same level of reallocation as they did in the stationary equilibrium. At the same time, tangible capital becomes more valuable as collateral since each unit of tangible capital allows for lesser borrowing. Because of this, firms are less willing to part with tangible capital. This causes tangible capital reallocation to decrease sharply. Since the technology available to firms has both forms of capital as complements in production, decreased flow of tangible capital to firms results in firm optimally decreasing their intangible capital purchases in the reallocation market as well. This causes an associated sharp decline in intangible capital reallocation. Thus, a higher degree of misallocation of both forms of capital results. This force is not present in the benchmark model since there is only one capital that can be misallocated in that model. This results in an amplified drop in output in the model with both forms of capital relative to the benchmark model with only tangible capital. Hence, the addition of intangible capital in the model with both types of capital allows for a new channel for misallocation in the economy and this causes larger effects on output from financial market disturbances.

2.6 Conclusion

This paper shows that the inclusion of explicit markets for capital reallocation and intangible capital can result in amplified effects of financial market disturbances on aggregate variables relative to the model with only tangible capital. In doing so, this paper presents a novel channel through which financial market disturbances cause fluctuations in aggregate variables by the effects on the reallocation of intangible capital.

Chapter 3

Productivity Gains from Mergers and Acquisitions: Who Gains the Most?

3.1 Introduction

One of the classical questions in corporate finance is regarding the effects of mergers and acquisitions (M&As). Over the years, this issue has become more important as M&As have grown substantially in overall activity. Bao and Edmans (2011) report that M&As account for $2.1 trillion of activity in the US alone, or 15% of GDP.

There has been consensus in the academic community that M&As create wealth for shareholders (the weighted sum of the value created for both the acquirer and target shareholders is positive) yet destroy value for the acquirers' shareholders (see, for example Ross, Westerfield, and Jordan (1995) and Copeland, Weston, and Shastri (1983)). The latter of these results has resulted in the conclusion by the literature that M&As are bad for the acquiring firm. This essay claims that such studies take a partial equilibrium view of M&As since they focus on the effects on shareholders from M&As. I show that if the effects of M&As on executives (or managers) and on workers are included, we find that M&As are actually beneficial to the acquiring firm.

In this paper, I present four novel empirical results. The first two results are shown using the estimated firm-level productivity. First, I show that the productivity of the acquirer increases significantly after an M&A. Second, I show that the ex-post productivity gains are an inverse function of the productivity difference between the acquirer and target at the time of the M&A. The main tool to analyze an M&As is comparing the productivity of the acquirer before and after an M&A. The productivity is the firm-level Solow residual which is structurally estimated using the seminal method of Olley and Pakes (1996) using accounting data from CompuStat.

Using the same panel of M&As, I present the third main result of this study. I show that abnormal announcement returns to an M&A are worse when the ex-post productivity increases are the most (this statement is true both from the perspective of the acquirer and target). The abnormal stock returns are calculated using the standard method of Fama and French (1993). This is discussed in more detail later. This result shows that the shareholders of the acquirers are better when the productivity difference between the acquirer and target is the higher. I view this result, in the larger context, to show that the shareholders are not benefiting from the productivity gains from the M&A. This is consistent with the observations that are readily accepted in the finance literature.

The last result shows that executive compensation increases after M&As but by a small amount. This result is obtained using the ExeComp data and by comparing the compensation of the top executives before and after an M&A.

The combination of the four results above result in the conclusion that the workers are obtaining most of the benefits from the productivity gains. This is somewhat a surprising idea. Most stories involving M&As in popular press present a bleak picture for the workers of entities involved in M&As since massive layoffs are undertaken after M&As through restructuring. This observation is consistent with the evidence here. This papers shows that worker compensation increases after M&As but it is silent about the survival that might be important. Hence, this study shows that, conditional on staying with the firm after an M&A, there are high payoffs to the workers. This might be a method for entities to ensure the most efficient of the workforce is retained and then rewarded for the selection process that they have passed. This higher compensation might be the result of higher wages or higher benefits. That would require more detailed data.

The reason the method of Olley and Pakes (1996) is preferred over ordinary least squares

(OLS) or fixed effects (FE) estimation procedures is because Olley and Pakes (1996) takes into account selectivity and simultaneity bias when backing out TFP. Olley and Pakes (1996) model is written for one capital model in which they use the investments in tangible capital as the proxy for estimating TFP.

The main approach of finance literature is to use reduced-form financial econometrics to evaluate the ex-post performance of the acquirer and target by focusing on the movement of the stock price. Thus, an event study methodology is used, similar in spirit to the one described in detail in MacKinlay (1997), where econometric techniques are utilized to evaluate the 'abnormal' movement of the stock prices of the two parties involved. The definition of the 'abnormal' performance is the residual of the regression where the firm's stock price is the dependent variable and the market or some other more precise benchmarks (like Fama and French (1993)'s three-factor specification). This residual is evaluated around a window of the announcement of the M&A and is interpreted as the market's reaction to the M&A. Under the assumption that the stock market is efficient and that rational investors can correctly interpret the returns of an M&A transaction, these studies use the residual as a indication of what the ex-post performance of the M&A is. The advantage of using these studies is that they are very easily able to go around the identification problem that is inherent to any ex-post evaluation of an action by a firm. The identification problem make it impossible to disentangle what part of the firm's ex-post performance, based on its accounting results, can be attributed to the M&A and what part is the results of exogenous reasons. The disadvantage of such exercises is that in looking at the stock market reaction to M&As, they might be evaluating the expected performance which might be very different from the ex-post realization of the firm's performance.

This paper uses M&A activity which involves public buyers and sellers. The reason for this is because structural estimation of productivity requires accounting data which comparing the productivity results to the abnormal stock market reaction requires stock returns data. The combination of this data is only available for public firms. Although admittedly I miss most M&A transactions that occur in the US, as reported by Bayazitova, Kahl, and Valkanov (2012), we are capturing most M&A activity in terms of dollars.

The rest of this essay is organized as follows: I first review the related literature.In section 1, I present the stylized facts. Then in section 2, I go results related to the productivity estimation exercise. In section 3, I show the results pertaining to the stock returns and in section 4, I present the results related to the executive compensation. Section 5 discusses the implication of the results for worker wages and section 6 concludes.

3.1.1 Related Literature

There are two large sets work that this paper is related to, both of which try to evaluate the effects of M&As[1]. The first, in the field of finance, mostly uses abnormal stock returns to decipher the effects, both over short-run and long-run, and finds M&As are overall good, although all the gains accrue towards the targets. The second set of papers, in the field of Industrial Organization, are unable to build a consensus of the effects of M&As. This fact can be seen from two important, yet contrasting, papers by Ravenscraft and Scherer (1989) and Healy, Palepu, and Ruback (1992). Since this paper is geared towards the corporate finance literature, I will focus on the former's literature review.

The studies of the finance literature are of two time horizons, short-term and long-term. Short term studies evaluate performance usually in a window of a few weeks or months around the announcement date (action date). On the other hand, long-term studies evaluate performance using stock prices over a period of years, usually 3-5 years. As much as there are high output in the latter, I will not consider these papers' results because the criticism, on a methodological level, that has recently come to light of long time horizon event studies. A concise description of the problems can be found in Andrade, Mitchell, and Stafford (2001)[2]. On the other hand, the short horizon studies are methodologically reliable and immune to the identification criticism.

Studies on shorter horizons come to the generally acceptable conclusion that M&As are wealth creating for shareholders, in general, yet destroy value for the acquirers' shareholders (see, for example Ross, Westerfield, and Jordan (1995) and Copeland, Weston, and Shastri (1983)). The wealth creation is a result of the combined change in wealth for the acquirers' and targets' shareholders. These are puzzling and contradictory to the neo-classical view of

[1]For an excellent recent surveys, see Betton, Eckbo, and Thorburn (2011) and Andrade, Mitchell, and Stafford (2001). Older surveys include Jensen and Ruback (1983) and Jarrell, Brickley, and Netter (1988)

[2]For a more detailed description, see Barber and Lyon (1997), Kothari and Warner (1997), Fama (1998), Mitchell and Stafford (2000), Brav (2000).

M&As like the one presented in Weston and Ahern (2007). This view concludes that profit motivated acquirer's shareholders would only undertake M&As if they result in positive benefits. This paper shows that while the benefits are positive for the acquiring firm, they might not be so for the shareholders of the acquirer. The technical result is similar to the corporate finance literature yet the conclusion about the effects for the acquiring firm as a whole is different since I use productivity estimation to assert the effects on the acquiring firm rather than measurements of abnormal stock returns for the shareholders.

Behavioral financial economists have focused on the differential effects of an M&A depending on the form of payment. Prominent among this literature are papers by Shleifer and Vishny (2003) and Dong, Hirshleifer, Richardson, and Teoh (2006). I find evidence of the form of payment having a significant effect on the productivity gains for the acquiring firm. Consistent with the theory of Shleifer and Vishny (2003), M&As in which the payment method is cash result is higher productivity gains for the acquirers than when some other form os payment is used, especially when acquiring firm's stocks are used as a form of payment.

A recent paper by Masulis, Swan, and Tobiansky (2011) shows that using abnormal announcement returns is dangerous since M&A announcements are coupled with negative news which can cause the stock price reaction to not be solely attributable to the announcement of the M&A. They also suggest that an M&A announcement itself is a negative news since it suggests that the acquiring firm feels it will not grow organically. This idea is consistent with the work of Fuller, Netter, and Stegemoller (2002) and Hietala, Kaplan, and Robinson (2003). Lastly, Masulis, Swan, and Tobiansky (2011) claim that M&As by serial acquirers do not see any reaction from the market in terms of abnormal or surprising returns. Malatesta and Thompson (1985) present a model of such an observation. There is certainly anecdotal evidence

One this to note is that Hoberg and Phillips (2010) claim that the magnitude of synergies realized from an M&A relate whether the target's skills or technologies can help the acquirer differentiate its products from rivals and hence improve margins. Although this is dealt with in more details in the next chapter, these results are consistent with the results in this chapter. Most transactions which produce positive productivity gains are associated with interindustry M&As (at the four digit SIC code). Another point to consider is related to Cai, Song, and Walkling (2011) who show that some announcement return surprises are greater surprises than others. This is outside the scope of this paper yet important since differentiating the data along this dimension is an important exercise. The lack of data makes such an exercise unreasonable in this paper.

More recently, there is a new literature that uses structural models to try to evaluate M&As at the plant level. But the emphasis of this literature is on the effects of diversification as a result of M&A rather than the overall effects of M&As. Lichtenberg and Siegel (1990) was the first and examined estimated productivity changes at the plant-level, using data from the Longitudinal Research Database (LRD), after the change of ownership of the plant. Schoar (2002) finds that the effects on productivity of the newly acquired plants are positive, yet small at 1%. Maksimovic and Phillips (2001) also find that the sale of assets and plants result in mean productivity increases of 2%. Harris, Siegel, and Wright (2005) find productivity changes for UK plant sales to be quantitatively much higher than those reported for US LRD data. As will be seen, this paper shows large mean TFP changes at the firm-level at about 19.4-28.9% over a three year period. Why the difference? One reason for the difference is that studies on plant sales usually restrict focus towards the manufacturing sector while my study, which uses firms rather than plants as entity on which productivity is estimated, includes non manufacturing sectors as well. Given the well known empirical differences, especially caused by the recent decline in manufacturing, such differences are expected. The large difference in the quantitative sense will be dealt with in more detail in the next chapter of this study.

3.2 Stylized Facts

In this section, I establish novel stylized facts for the M&A literature and go into details about the data sets used to establish these facts. I also go into details of the exercises that I conduct and conclude this section by discussing and stressing the economic importance and significance of my results and check the robustness of the results.

The stylized facts are the following:

1. M&As result in productivity increases for the acquiring firms;

2. Acquirer's productivity is an increasing function of the difference in productivity of

the acquirer and target at the time of acquisition;

3. Abnormal announcement returns to an M&A are worse when the ex-post productivity increases are the most (this statement is true both from the perspective of the acquirer and target);

4. Executive compensation increases after M&As but by a small amount

I move onwards to discuss some details related to the data sets that I use.

3.3 Productivity

In this section, I describe in detail the exercise performed to calculate productivity of the firms. The purpose of the exercise is to obtain productivity, measured as the Solow residual, for the acquirers and targets. After obtaining these productivity estimates, I compute a statistic which is the difference of the productivity of the acquirer and the target.

3.3.1 Data and Exercise

Data

In this section, I discuss the data construction that is used to establish the stylized facts (1) and (2). For these results, I use Thompson Reuters' transaction-level data set on mergers and acquisitions. This data is for the period 1978-2010. I also utilize firm financial data from CompuStat for the period 1970-2010. I merge the transaction-level data to the CompuStat firm financial data. This allows to track the financial information of the acquirer before and after the M&A and, in the case of targets, the financial information approaching the M&A[3]. Since CompuStat contains data on only public firms, my panel consists contains M&A transactions that involve public entities on both sides of the transaction. I drop transaction where either the acquirer or target are financial or utility firms (SIC code 4999 or 6000-6999). I also exclude transactions where the M&A involves acquisitions of less than 50% of the target. This is done to allow focus on transactions where the acquirer

[3]Eventhough almost all targets cease to exist (and hence have no financial data after the M&A), there are cases where target continue to exist as seperate entities, in the form of subsidiaries or the like. I focus on targets that cease to exist after an M&A only.

has majority control of the firm and hence is unable to run the firm as it sees fit. The summary statistics of the resultant data set are presented in tables 3.1 and 3.2 for the acquirers and targets respectively.

VARIABLES	Count	Mean	Std. Dev.	1st Qu.	Median	3rd Qu.
Sales	1991	7340.02	20221.97	211.51	991.03	5126.60
Tangible Capital	1991	3915.32	12538.26	72.89	415.62	2450.42
Assets - Total	1991	8396.10	25209.97	261.41	1152.84	5219.28
Shareholder Equity	1990	3442.92	8937.78	116.70	524.41	2189.00
Employees	1991	29.32	73.97	1.15	5.32	29.00
Capital Expenditure	1975	451.96	1392.90	11.46	61.55	296.00
Operating Income Bef Dep	1986	1352.30	3812.27	26.29	146.28	834.25
Research & Development Exp	1411	538.92	1290.36	5.67	42.85	255.00
Net Assets / Sales	1991	233.39	1755.88	76.88	107.89	165.93
Capital / Sales	1975	14.02	57.52	2.98	5.16	9.41
Cost Goods Sold / Sales	1991	71.14	294.67	41.86	60.71	74.53
Employees / Sales	1991	0.85	2.00	0.34	0.55	0.89
Operating Income / Sales	1986	-4.84	324.79	8.53	14.78	23.13
Operating Income / Net Assets	1986	12.99	15.89	9.16	14.85	20.49
Shareholder Equity / Sales	1990	143.57	1585.15	30.67	49.98	88.87
Shareholder Equity / Net Assets	1990	49.52	23.22	36.08	49.31	64.80
Sales / Net Assets	1991	107.54	81.68	60.27	92.69	130.08
Sales / Shareholder Equity	1990	288.28	1378.87	107.75	192.74	315.32
R&D Expenditure / Sales	1411	22.92	158.85	1.25	5.68	13.88
R&D Expenditure / Net Assets	1411	7.59	10.51	1.32	4.85	10.15

Statistics right before M&A

Table 3.1: Summary statistics for acquirers

From the summary statistics, the average acquirer is about 10-13 times bigger (depending on how size is measured) and makes about 17-20 times more income per year when compared to the target, as measured by the mean or median statistics. At the same time, acquirers have twice the capital, 1.4 times the employees, three times the equity and R&D expenditure per dollar of sales. This suggests that acquirers are more labor and research intensive and utilize higher capital in production. These measures are quantitatively altered if the same figures are viewed from per dollar unit of net assets but still present the same picture as the proceeding statement.

The interesting thing that these statistics suggest is that the popular notion that acquirers are buying highly efficient firms or firms with a large knowledge base does not seem to be as true in these statistics. Admittedly, given the data is for only public firms, we can not extend this statement to most M&As in which small, young and private firms are acquired. However, these statistics are somewhat striking and allow us to have a better understanding of the nature of the firms involved in M&As.

VARIABLES	Count	Mean	Std. Dev.	1st Qu.	Median	3rd Qu.
Sales	1989	582.62	2079.21	32.19	107.31	351.61
Tangible Capital	1991	389.21	1782.32	10.52	35.05	143.86
Assets - Total	1991	623.04	2436.87	38.00	108.97	351.71
Shareholder Equity	1991	260.09	1134.94	15.51	52.30	161.40
Employees	1991	3.13	8.75	0.19	0.60	2.30
Capital Expenditure	1971	47.49	329.38	1.42	5.29	19.84
Operating Income Bef Dep	1983	78.70	358.41	-0.61	8.69	42.03
Research & Development Exp	1368	27.28	140.03	0.93	5.74	18.32
Net Assets / Sales	1976	563.84	10467.48	66.76	97.45	164.87
Capital / Sales	1958	28.64	325.77	2.28	4.63	9.91
Cost Goods Sold / Sales	1976	153.43	1513.91	42.88	61.40	76.45
Employees / Sales	1976	1.29	7.11	0.39	0.64	1.06
Operating Income / Sales	1971	-100.39	1517.13	-1.35	8.54	16.09
Operating Income / Net Assets	1983	1.70	32.89	-1.88	10.23	16.45
Shareholder Equity / Sales	1976	411.81	8178.22	25.42	48.52	95.35
Shareholder Equity / Net Assets	1991	48.16	44.95	34.46	53.03	72.53
Sales / Net Assets	1989	115.84	85.92	59.74	101.76	149.26
Sales / Shareholder Equity	1989	376.12	5070.07	85.53	181.31	338.82
R&D Expenditure / Sales	1358	74.94	579.13	1.21	7.57	20.30
R&D Expenditure / Net Assets	1368	12.33	20.79	1.35	6.90	15.89

Statistics right before M&A

Table 3.2: Summary statistics for targets

Exercise

The productivity estimation is done using the standard method of Olley and Pakes (1996). Their method of productivity estimation allows for investment (measured as the change in physical capital) to be used as an instrumental variable when estimating productivity. This allows for problems associated with simultaneity and selection bias to be avoided, the latter of which is an important issue to consider when working with CompuStat data.

The model is a firm level Neoclassical model. Assume each firm i has a Cobb-Douglas production function of the specification:

$$y_{it} = A_{it} k_{it}^{\alpha} l_{it}^{\beta}$$

In this model, y_{it} is firm value added, A_{it} is firm's TFP, k_{it} is capital and l_{it} is labor for firm i. When estimating productivity, I use industry, age and fiscal year dummies. I use data on physical capital as presented in variable PPEGT in CompuStat, number of employees reported in CompuStat. CompuStat does not have data of material input costs nor wage bills as firms rarely declare these in their 10-K reports. Hence, tasked with such a problem, I use the strategy of Imrohoroglu and Tuzel (2011b) to construct wage bills at the firm level and add these to the 'new' operating income to obtain data on value added. The wage bill construction involves using number of employees and multiplying this with the average wage in the economy for the year[4]. The average wage data is obtained from the Bureau of Labor Statistics (BLS). Imrohoroglu and Tuzel (2011b) report that this estimate ends up being very accurate when compared to non-zero wage bills in 10-K reports. Therefore, the value added used in the firm level TFP estimation is:

$$\text{Value Added}_{it} = \text{Op Income}_{it} + (\text{Constructed Wages}_{it})$$

Hence, a firms value-added is the sum of operating income before deprecation and total labor payments. An important element to note here is that the constructed wages are admittedly not the ideal statistic one would want to use when estimating productivity. But this will work well to this study's advantage. Given the wages are constructed from BLS average wage statistics, it allows for trend changes in wages to be accounted for in the data. It also allows any residual changes that might come in wages to be accounted in the productivity measure A_{it}. Said different, if wages increase after an M&A, this would show up in this estimation as higher productivity. We will see this will allow us to provide evidence that, by construction, increased productivity changes will either have to account

[4]I have redone this exercise using average wages by industry at the 2-digit SIC code as reported by BLS and find that my results are not affected by this. Because the industry level data is only available from 1990 onwards, I revert of economy average wages to be able to look at productivity in the 1980s as well.

towards higher wage payments, higher shareholder value (as measured by future stream of payments to shareholders) or higher executive compensation.

VARIABLES	Acquirer Value-Added	Target Value-Added
Capital	0.410***	0.390***
	(0.00286)	(0.00117)
Labor	0.761***	0.733***
	(0.00257)	(0.0173)
Observations	794,415	111,255
Year FE	Yes	Yes
Industry FE	Yes	Yes
Age FE	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.3: Production function estimation results

The detailed results of the estimation are presented in the table 3.3. The results are consistent with most papers that conduct such exercises and are statistically significant at the 1% level. Using these estimates, and using investment as a proxy, we estimate the productivity A_{it} of a firm.

3.3.2 Results

In this section, I present two results. First, I show that the productivity of the acquirer increases significantly after an M&A. Second, I show that the ex-post productivity gains are an inverse function of the productivity difference between the acquirer and target at the time of the M&A.

The residual from the estimation is the productivity. This productivity increases after an M&A. To show this result, I use the following general OLS equation:

$$\begin{aligned} \ln TFP_{it} &= a_i + b(\text{Lagged } \ln(TFP)) + c(\text{AFTER}) \\ &\quad + d(\text{SIZE}_{it}) + e(\text{PAYMENT METHOD}) + \epsilon_{it} \end{aligned} \tag{3.1}$$

An important technical note is that the panel from the estimation above is dynamic. I verify this using the Fisher-type Augmented Dickey Fuller test. Given I have a dynamic panel, the relevant regressions that I consider are the Arellano and Bond (1991) one-step and two-step regressions. To obtain consistent standard errors for these, I use robust standard errors for the two-step regressions while the standard errors for the one-step regressions are GMM computed.

First, given the knowledge that the structurally estimated panel of TFP is dynamic, I have the previous period's TFP as a term on the right hand side (RHS). This is referred to as 'Lagged ln(TFP)'. I construct a dummy variable 'AFTER' that is 0 for years before the M&A and 1 for years after the M&A. I also control for firm size effects and the payment method of the M&A using 'SIZE' and 'PAYMENT METHOD' variables in the regression respectively. Here size is measured as the equity value of the firms twenty days before the M&A and the variable 'SIZE' splits the sample into 5 quintiles. The reason these are important is because we know from previous studies that firm-level TFPs are highly correlated with firm size, and hence, controlling for effects related to size is important. Lastly, payment method is considered since it has been shown in the M&A literature to result in significant effects on the economic effects of the M&A. Thus, I use dummy variable 'PAYMENT METHOD' that controls for different payment methods. Table 3.4 presents the evidence for the first result.

	OLS 1	OLS 2	OLS 3	FE 1	FE 2	AB 1	AB2
VARIABLES				ln(TFP)			
Lagged ln(TFP)	0.953***	0.901***	0.901***	0.619***	0.513***	0.311***	0.439***
	(0.00143)	(0.00273)	(0.00284)	(0.00658)	(0.00892)	(0.00705)	(0.0235)
AFTER	0.00778	0.0442***	0.0444***	0.201***	0.227***	0.289***	0.194***
	(0.00728)	(0.00854)	(0.00855)	(0.00741)	(0.00893)	(0.00666)	(0.0112)
SIZE							
SIZE 2		0.155***	0.156***		0.216***		
		(0.0139)	(0.0139)		(0.0195)		
SIZE 3		0.217***	0.218***		0.364***		
		(0.0150)	(0.0151)		(0.0253)		
SIZE 4		0.303***	0.303***		0.533***		
		(0.0169)	(0.0170)		(0.0309)		
SIZE 5		0.441***	0.441***		0.725***		
		(0.0199)	(0.0201)		(0.0393)		
PAYMENT							
COMBINATION			-0.0137				
			(0.0118)				
OTHER			0.00147				
			(0.0171)				
STOCK			-0.00150				
			(0.0113)				
UNKNOWN			0.00968				
			(0.0170)				
Constant	0.422***	0.455***	0.457***	1.973***	2.180***	3.446***	2.784***
	(0.00848)	(0.0121)	(0.0146)	(0.0307)	(0.0450)	(0.0331)	(0.104)
Observations	11,142	7,421	7,421	11,142	7,421	9,151	9,151
R-squared	0.976	0.976	0.976	0.662	0.596		
Firm FE	No	No	No	Yes	Yes		
No. of Acquirers				1,991	1,920	1,990	1,990

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.4: Acquirer productivity increase after M&A

Columns (1), (2) and (3) present the results for different versions of the OLS regressions, columns (4) and (5) present the results using the fixed-effects model while columns (6) and (7) presents the results using the Arellano and Bond (1991) 1-step and 2-step regressions respectively. The standard errors for the one-step regression are obtained using GMM while the two-step regression has robust standard errors.

I will focus on the results from the Arellano and Bond (1991) regressions in columns (6) and (7) since for dynamic panels these are the ones that present the consistent standard errors. As we can see, the AFTER dummy shows that firms that engage in M&As see 19.4-28.9% higher TFP over a three year period. That is a significant advantage for the firms that engage in an M&A. The result are statistically significant at the 1% level. This allows for the following result to be stated formally:

Proposition 3.1 *Acquirer productivity increases after an M&A*

The second result shows that the changes in productivity after an M&A are intricately related to the productivity differences between the acquirer and target at the time of the M&A. To show this, I construct a statistic 'PROD DIFF' which measures the productivity difference between the acquirer and target. Formally:

$$\text{PROD DIFF} = \text{Acquirer Productivity}_{t=0} - \text{Target Productivity}_{t=0} \tag{3.2}$$

Hence, a positive value of PROD DIFF denotes that the acquirer is more productive than the target. To show the second result, I regress the normalized firm-by-firm productivity estimates on PROD DIFF and AFTER while controlling for size and payment method using SIZE and PAYMENT METHOD respectively.

$$\begin{aligned} \ln TFP_{it} &= a_i + b(\text{PROD DIFF}) + c(\text{AFTER}) \\ &\quad + d(\text{SIZE}_{it}) + e(\text{PAYMENT METHOD}) + \epsilon_{it} \end{aligned} \tag{3.3}$$

VARIABLES	OLS 1	OLS 2 ln(TFP)	OLS 3
AFTER	0.603***	0.472***	0.474***
	(0.0357)	(0.0316)	(0.0305)
PROD DIFF	0.686***	0.270***	0.255***
	(0.00774)	(0.00854)	(0.00846)
SIZE			
SIZE 2		1.196***	1.182***
		(0.0502)	(0.0486)
SIZE 3		2.116***	2.064***
		(0.0510)	(0.0495)
SIZE 4		3.124***	3.067***
		(0.0532)	(0.0517)
SIZE 5		4.252***	4.167***
		(0.0602)	(0.0584)
PAYMENT			
COMBINATION			-0.185***
			(0.0430)
OTHER			-0.502***
			(0.0614)
STOCK			-0.872***
			(0.0391)
UNKNOWN			-0.428***
			(0.0612)
Constant	2.979***	2.144***	2.566***
	(0.0323)	(0.0401)	(0.0458)
Observations	11,416	7,453	7,453
R-squared	0.415	0.664	0.686

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3.5: Acquirer productivity increase as a function of productivity difference at time of M&A

The results of the exercise are presented in table 3.5. As shown below, as PROD DIFF increases, the ex-post productivity decreases. Columns (3) and (4) show that the results are robust to controlling for size and payment methods. This allows for the second result to be stated formally:

Proposition 3.2 *Acquirer's productivity is an increasing function of the difference in productivity of the acquirer and target at the time of acquisition*

This result is interesting since it suggests that the ex-post productivity gains that the acquirers experience are not from the productivity of the target. In fact, in the data, when the productivity of the target is higher than that of the acquirer at the time of the M&A, the ex-post productivity of the acquirer either stays constant or declines in the years following the M&A. Although these result do not shed light on the exact source of the productivity gains, they do provide evidence that the gains are not accruing because of the productivity of the target. The evidence here might be consistent with ideas of synergies, diversification or even market power. Unfortunately, lack of detailed data does not allow to parse the exact source of the productivity increase and would be a very interesting topic to explore with more detailed data.

3.4 Stock Returns

In this section, I present the third main result of this study. We show that abnormal announcement returns to an M&A are worse when the ex-post productivity increases are the most (this statement is true both from the perspective of the acquirer and target). The methodology used here is generally discussed in MacKinlay (1997) and is standard in the finance literature. A point of departure from MacKinlay (1997) is that I use the Fama and French (1993) three-factor model.

3.4.1 Data and Exercise

Data

In this section, I discuss the data sets that is used to establish the stylized facts mentioned above. I start from the panel that was constructed for the productivity estimation exercise and use CRSP stock return data from 1977-2010. This data tracks the returns of each stock as well as share price and amount of outstanding shares. I merge the productivity estimation panel with the CRSP stock return data to obtain stock returns around the announcement for the acquirer and the target.

I use the popular Fama and French (1993) three-factor model to obtain measurements of abnormal stock returns around the announcement. An M&A transaction is dropped if the stock return data is missing for either the acquirer or the target or both. For the first exercise, I merge the transaction level data to the CompuStat firm financial data to obtain financial data of the acquirer and the target.

Exercise

The returns r_t are calculated using the three-factor model which uses the risk-free rate R_f, the net return on the whole market $(K_m - R_f)$, SMB (small firms minus big firm returns) and HML (high book to market ratio firms minus low book-to-market ratio firms) returns also included in the regression. Thus, the relevant regression is:

$$r_{it} = R_{tf} + \beta_{3it}(K_m - R_f) + b_{ist}.SMB + b_{ivt}.HML + \alpha_{it} \tag{3.4}$$

This firm-transaction level regression is over an estimation window of $[-120, -30]$ days before the announcement of the M&A. Note for serial acquirers, each M&A transaction is a separate observation. The coefficients estimated from the regression are used to predict returns for the pre-post M&A event window of $[-5, 5]$. Then the actual returns are subtracted from the predicted returns to get abnormal return:

$$\text{Abnormal Returns}_{it} = \text{Actual returns}_{it} - \text{Predicted returns}_{it} \tag{3.5}$$

where $t = [-5, 5]$.

3.4.2 Results

In the section, I establish the result that M&As that have the highest ex-post productivity increase involve participants that have worse stock price reaction, both from the side of the acquirer and the side of the target.

First, as a check on the panel, I ensure that the stock price reactions for the acquirer and the target are consistent with those noted in a large corporate finance literature. In this literature, there is general agreement that the acquirer's shareholders see around a 5% decline in the abnormal stock returns while the targets see a 30-40% increase in the abnormal stock returns. I replicate these findings in my data which suggests that my data set does not have any overall bias based on the merged construction with the panel that was used for the productivity estimation.

As is true with abnormal return studies, we rely on the assumption that the market reaction is rational and market participants are reacting in an optimal fashion given the information set available to them. This assumption allows for the

	OLS 1	OLS 2	OLS 3	OLS 4
VARIABLES	Acquirer Abnormal Stock Returns			
AFTER		-0.00259***	-0.00263***	-0.00263***
		(0.000508)	(0.000514)	(0.000513)
PROD DIFF	0.000142	0.000142	0.000507***	0.000367***
	(0.000109)	(0.000109)	(0.000137)	(0.000140)
SIZE				
SIZE 2			-0.00317***	-0.00316***
			(0.000982)	(0.000983)
SIZE 3			-0.00278***	-0.00271***
			(0.000985)	(0.000988)
SIZE 4			-0.00329***	-0.00325***
			(0.000995)	(0.001000)
SIZE 5			-0.00486***	-0.00489***
			(0.00108)	(0.00108)
PAYMENT				
COMBINATION				-0.00260***
				(0.000730)
OTHER				-0.00127
				(0.00103)
STOCK				-0.00323***
				(0.000652)
UNKNOWN				-0.000669
				(0.00102)
Constant	-0.00129***	0.000125	0.00227***	0.00418***
	(0.000379)	(0.000470)	(0.000845)	(0.000942)
Observations	21,395	21,395	20,702	20,702
R-squared	0.000	0.001	0.002	0.004
Firm FE	No	No	No	No

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.6: Abnormal announcement returns of acquirers

The first part result is that the higher the difference between the productivities of the acquirer and target, the higher the abnormal announcement returns for the acquirer. Said differently, the acquirers that benefitted the most from an acquisition saw the highest loss to their shares. The results are presented in table 3.6. The columns are all OLS regressions and the results are over a 10 day window around the announcement of the M&A. The variable definitions are exactly the ones in table 3.5 and the general OLS specification is:

$$\begin{aligned}\text{Abnormal Returns}_{it} &= a_i + b(\text{PROD DIFF}) + c(\text{AFTER}) \\ &\quad + d(\text{SIZE}_{it}) + e(\text{PAYMENT METHOD}) + \epsilon_{it}\end{aligned} \tag{3.6}$$

The results in table 3.6 show that the relationship of abnormal returns and AFTER is negative and significant. This shows that the returns for acquirers from M&A are negative. However, the relationship of the abnormal returns and PROD DIFF is positive showing that as abnormal returns got better, the higher was the productivity difference between the acquirer and target. These results are not sensitive to controlling for firm size and payment method of the M&A.

We see the interesting observation that the returns for the shareholders of the acquirers are better when the productivity difference between the acquirer and target is the higher. Again, this speaks against the idea that acquirers are benefitting from merging or acquiring highly productive targets.

From the side of the target, the second part of the result is establish. This shows that the higher the difference between the productivities of the acquirer and target, the higher the abnormal announcement returns of the target. This result is presented in table 3.7. The variable definitions are exactly the ones in table 3.5 and the general OLS specification is the same as 3.6.

The results in table 3.7 show that the relationship of abnormal returns and AFTER is positive and significant. This shows that the returns for targets from M&A are positive. Similarly, the relationship of the abnormal returns and PROD DIFF is positive showing that as abnormal returns got better, the higher was the productivity difference between the acquirer and target. These results are not sensitive to controlling for firm size and payment method of the M&A.

Taking the two results, presented in tables 3.6 and 3.7, along with the result established in the last section, we can now establish the third novel result of this study.

Proposition 3.3 *Abnormal announcement returns to an M&A are worse when the ex-post productivity increases are the most (this statement is true both from the perspective of the acquirer and target).*

	OLS 1	OLS 2	OLS 3	OLS 4
VARIABLES	Target Abnormal Stock Returns			
AFTER		0.0259***	0.0265***	0.0265***
		(0.00174)	(0.00180)	(0.00180)
PROD DIFF	0.00230***	0.00230***	0.00245***	0.00212***
	(0.000381)	(0.000379)	(0.000393)	(0.000410)
SIZE				
SIZE 2			-0.0110***	-0.0121***
			(0.00284)	(0.00285)
SIZE 3			-0.0135***	-0.0144***
			(0.00283)	(0.00284)
SIZE 4			-0.0131***	-0.0140***
			(0.00284)	(0.00285)
SIZE 5			-0.0160***	-0.0169***
			(0.00289)	(0.00291)
PAYMENT				
COMBINATION				-0.00760***
				(0.00253)
OTHER				-0.0126***
				(0.00391)
STOCK				-0.00783***
				(0.00227)
UNKNOWN				-0.0135***
				(0.00377)
Constant	0.0176***	0.00342**	0.0135***	0.0206***
	(0.00129)	(0.00160)	(0.00244)	(0.00288)
Observations	18,414	18,414	17,237	17,237
R-squared	0.002	0.014	0.017	0.018
Firm FE	No	No	No	No

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.7: Abnormal announcement returns of targets

3.5 Executive Compensation

In this section, I show the last novel empirical result of this study. I show that the gains associated with the higher productivity result in higher compensation for the executives but this increase in compensation is small compared to the value creation from the productivity gains.

3.5.1 Data and Exercise

In this section, I discuss the data used to establish the last empirical result. I use ExecuComp data from 1992-2010. The shorter time span is because of data limitations since ExecuComp is a data set that has been constructed only recently. In the data, the compensation of the top five executive of a firm are presented broken into salary, benefits, stock options, balloon payments, bonuses and all other kinds of compensation. In this paper, I use the total compensation of the executives.

I merge the ExecuComp data with the panel from the productivity estimation. This obviously means that I am only able to account for a subset of the panel data from the estimation. It also means that given that only the top five executive's compensation is reported, I can only consider the executives who are with the company before and after the M&A. If an executive leaves after an M&A (which is common because of voluntary movement and restructuring), that executive will not be part of the statistics that will be presented in this section. The exercise to only looks at the overall changes in executive compensation.

3.5.2 Results

In the section, I establish the last novel result of this study. This result shows that executive compensation increases after an M&A yet the increase is small. I find suggestive evidence that given the small nature of the change in compensation of the executives, the majority of the value creation from the productivity gains are not accruing towards the executives.

	OLS 1	OLS 2	OLS 3	OLS 4
VARIABLES		Log Compensation		
PROD DIFF	0.0631**	0.0631**	0.0671	0.111**
	(0.0254)	(0.0255)	(0.0415)	(0.0437)
AFTER		-0.0125	-0.0526	-0.0501
		(0.117)	(0.152)	(0.147)
SIZE				
SIZE 2			-0.267	-0.348
			(0.240)	(0.236)
SIZE 3			0.0124	-0.196
			(0.239)	(0.245)
SIZE 4			-0.270	-0.361
			(0.243)	(0.242)
SIZE 5			-0.211	-0.247
			(0.302)	(0.298)
PAYMENT METHOD				
COMBINATION				0.413**
				(0.188)
OTHER				0.783
				(0.514)
STOCK				0.228
				(0.202)
UNKNOWN				-1.382***
				(0.514)
Constant	9.105***	9.111***	9.286***	9.061***
	(0.0929)	(0.111)	(0.183)	(0.201)
Observations	236	236	136	136
R-squared	0.026	0.026	0.041	0.145
Firm FE	No	No	No	No

Standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 3.8: Executive compensation

The results of the exercise are presented in table 3.8. I regress the log compensation of the executives on PROD DIFF and AFTER while controlling for size and payment method using SIZE and PAYMENT METHOD respectively.

$$\begin{aligned} \ln(\text{Compensation})_{it} &= a_i + b(\text{PROD DIFF}) + c(\text{AFTER}) \\ &\quad + d(\text{SIZE}_{it}) + e(\text{PAYMENT METHOD}) + \epsilon_{it} \end{aligned} \tag{3.7}$$

The results in table 3.8 show that the relationship of abnormal returns and AFTER is negative, even though these results are not statistically significant. This shows that the returns for executives from M&A are almost zero. However, the relationship of the abnormal returns and PROD DIFF is positive showing that as executive compensation improve, the higher the productivity difference between the acquirer and target. These results are not sensitive to controlling for firm size and payment method of the M&A.

We see that the effects for the managers are almost zero showing that the increase in productivity gains are passed to the executives in higher compensation.

3.6 Implications for Workers

This study has found that there are positive productivity gains from M&As and the gains are not accruing towards the shareholders nor executives. Hence, under the reasonable assumption that only workers, executives or shareholders can receive these gains, we find suggestive evidence that the workers are obtaining most of the benefits from the productivity gains.

This is somewhat a surprising idea. Most stories involving M&As in popular press present a bleak picture for the workers of entities involved in M&As since massive layoffs are undertaken after M&As through restructuring. This observation is consistent with the evidence here. This papers shows that worker compensation increases after M&As but it is silent about the survival that might be important. Hence, this study shows that, conditional on staying with the firm after an M&A, there are high payoffs to the workers. This might be a method for entities to ensure the most efficient of the workforce is retained and then rewarded for the selection process that they have passed. This higher compensation might be the result of higher wages or higher benefits. That would require more detailed data.

Independent verification of this claim is not possible because of data limitations. Almost all CompuStat firms, as discussed previously, do not disclose their compensation to workers.

This was the reason why I had to construct an unbiased estimator of wages. This wages estimate allowed me to ensure that higher wages ex-post will have to be accounted in higher productivity. Hence, we find that the higher productivity would not result if more precise data on wages was available. Future work that have better data on worker wages and compensation would allow for independent verification of these results.

3.7 Conclusion

This study presents novel empirical observations about mergers and acquisitions and uses the evidence to suggest that labor obtains the most benefit associated with an M&A in the form of increased wages and benefits. The study has not dealt with the fact why shareholders allows such transactions to materialize when they do not provide any value to them. Future work that focuses on theoretical models, similar to the work of Martos-Vila (2008), would greatly help the understanding of these results.

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